Wastewater Treatment and Collection: In-Person Operator Certification Training

Presented by :

Geosyntec Consultants, Inc

Innovative Consulting and Training, LLC

21 June 2023

ADEQ Arizona Department of Environmental Quality

Check-In (Pre-Registrations)

08:00 – 08:30 AM

Did everyone register before joining the training event?

Welcome/Introductions

08:30 – 09:00 AM

Operator Training Event Presenters

Arizona Department of Environmental Quality

Tina Pico, E.I.T.
Operator Certification Program Coordinator
azopcert@azdeq.gov

Geosyntec Consultants

Jason Flowers, Ph.D., P.E.

Innovative Consulting and Training, LLC (ICT)

Mario Castaneda

Warren Dancer

Agenda

- Check-In (Pre-registrations)
- Welcome/Introductions
- Regulation Review
- Wastewater Treatment Operations and Maintenance
- Water Quality Sampling and Safety
- Laboratory Sampling and Analysis/Field Testing Method
- Permitting Basics
- Regulatory Reporting (Live Demo In-Person Only)
- Funding Sources

ADEQ Arizona Department of Environmental Quality

REGULATION REVIEW (APP AND AZPDES)

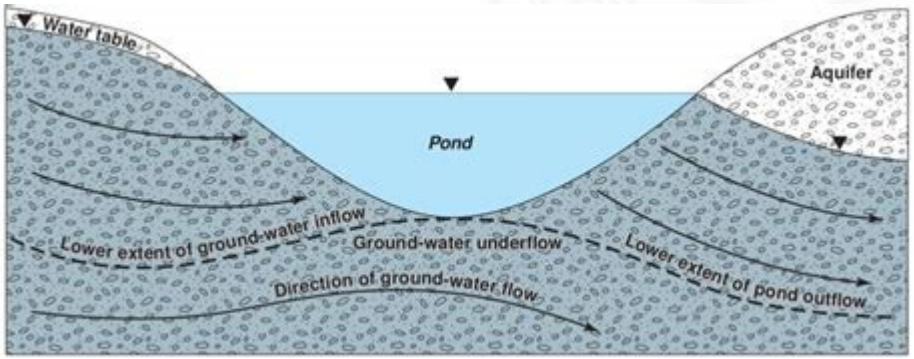
9:00 – 9:45 AM

What is the difference between APP and AZPDES Permits?

APP vs AZPDES

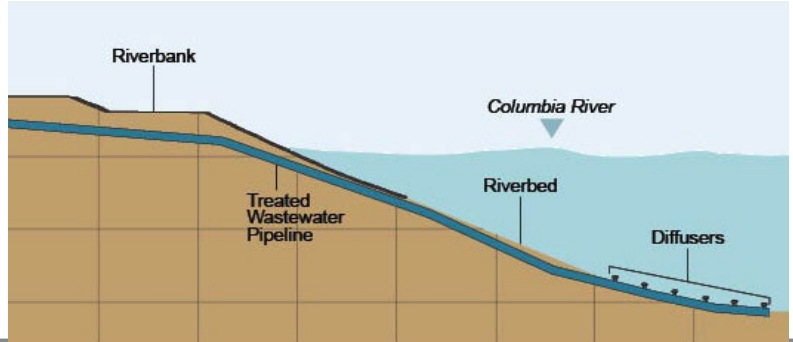
Aquifer Protection Permit (APP)

- Discharge to the subsurface/groundwater (water does not leave the site)



Arizona Pollution Discharge Elimination System Permit (AZPDES)

- Discharge to a surface water body that leaves the site



APP PERMIT SUMMARY

Regulation Review-Aquifer Protection Permits

The APP is designed to protect groundwater from exceeding the Arizona Aquifer Water Quality Standards (AWQS)

Arizona Aquifer Water Quality Standards (AWQS)

- Discharge shall not cause a pollutant to be present in an aquifer classified for drinking water-protected use in a concentration that endangers human health
- A discharge shall not cause or contribute to a violation of an AWQS
- A discharge shall not cause a pollutant to be present in an aquifer that impairs existing or reasonably foreseeable uses of water in an aquifer

Regulation Review - AWQS

Ariz. Admin. Code § 18-11-406

A. Aquifer water quality standards apply to aquifers that classified for drinking water protected use

B. AWQS for inorganic chemicals:
- Antimony 0.0006 mg/L
- Arsenic 0.05 mg/L
- etc...

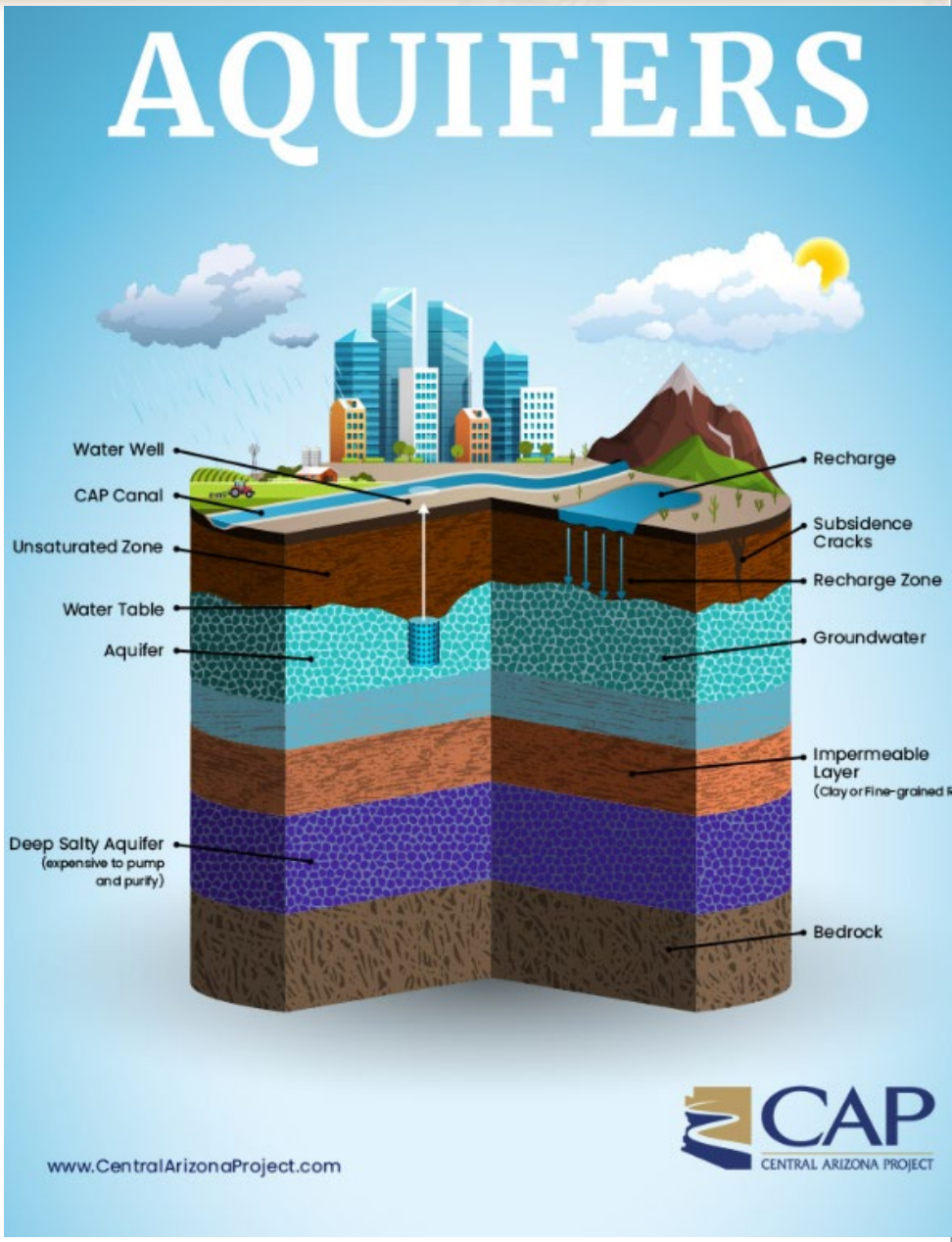
C. AWQS for organic chemicals:
- Benzene 0.005 mg/L
- Benzo (a) pyrene 0.0002 mg/L
- etc…

D. AWQS for pesticides and polychlorinated biphenyls (PCBs):
- Alachlor 0.002 mg/L
- Atrazine 0.003 mg/L
- etc…

E. AWQS for radionuclides:
- Max gross alpha particle activity, including Radium-226 but excluding radon and uranium, 15 pCi/L
- Max combined Radium-226 and Radium-228, 5 pCi/l
- etc…

F. AWQS for microbiological
- Presence/absence of total coliforms in a 100-ml sample

G. AWQS for turbidity
- 1 NTU monthly average
- 5 NTU if it does not interfere with disinfection



Regulation Review - Aquifer Protection Permit

- Aquifer Protection Permit (APP)
  - Required for any facility that discharges pollutants directly into an aquifer or vadose zone
  - The permit is valid for the life of the facility

  Key Requirements are:

  - Meet Aquifer Water Quality Standards (AWQS) at compliance point
  - Demonstrate Best Available Demonstrated Control Technology (BADCT)

Regulation Review - Aquifer Protection Permit

- Compliance Point
  - Vertical plane downgradient of the facility that extends through aquifer(s)
  - It will not extend further than the property boundary

EXPLANATION

Estimated Discharge Impact Areas:
Based conservatively on 40 degrees of lateral spreading from ground surface to water table

Point of Compliance Wells

Production Wells

Typical APP Discharge Concentration Limits

- Organic Content
  - An average (avg.) 5-day Biochemical Oxygen Demand (BOD_5) over 30 days of < 30 mg/L and 7-day avg. < 45 mg/L; or
  - A 30-day avg. Carbonaceous Biochemical Oxygen Demand ($CBOD_5$) < 25 mg/L, or 7-day average; 40 mg/L
- Total Suspended Solids (TSS) < 30 mg/L (30-day avg) and 45 mg/L (7-day avg)
- pH between 6 and 9 S.U.
- A removal efficiency of 85% for BOD_5, $CBOD_5$, and TSS

Alert Levels, Discharge Limitations, and Aquifer Quantity Limits

- Aquifer Quantity Limit (AQLs)
  - If pollutant concentration in the aquifer does not exceed, then AQL = AWQS
  - If pollutant concentration in the aquifer does exceed, then AQL > AWQS
- Alert levels
  - Serves as an early warning, indicating a potential permit violation
  - Measured at POCs and are set at some percentage of the Aquifer Quantity Limit (AQL)
  - Proposed by the permittee and set by ADEQ
- Discharge limits
  - Apply to treatment facility effluent
  - Determined by ADEQ

APP Reporting Requirements

- Notify ADEQ of any permit violation within 5 days of becoming aware
- Follow-up written report within 30 days of becoming aware
- Submit APP Contingency Reports with myDEQ, ADEQ's online Portal
- Receive bi-weekly alerts on unresolved reports so you can stay in compliance

BADCT

- Designed, constructed, and operated to ensure greatest degree of discharge reduction achievable
- Processes, operating methods or other alternatives, including, where practicable, a technology permitting no discharge of pollutants
- In determining BADCT, ADEQ considers any treatment process contributing to:
  - Discharge
  - Site-specific hydrologic and geologic characteristics
  - Other environmental factors
  - The opportunity for water conservation or augmentation
  - Economic impacts of the use of alternative technologies
  - Processes or operating methods on an industry-wide basis

BADCT factors for existing facilities

- Toxicity, concentrations, and quantities of discharge likely to reach an aquifer from various types of control technologies
- Age of equipment and facilities involved
- Industrial and control process(es) employed
- Engineering aspects of the application of various types of control techniques
- Process changes
- Non-water quality environmental impacts
- Extent to which water is available for beneficial uses

Wastewater Treatment Plant BADCT Review

ADEQ Arizona Department of Environmental Quality

Wastewater Treatment Plant
Aquifer Protection Permit
Engineering Substantive Checklist

Attachment A: Wastewater Treatment Plant BADCT Review	
Yes/No/NA	Y: yes, meets the requirement; N: no, does not meet the requirement (see comment below); NA: does not apply
The requirements cited in the following rules (A.A.C. R18-9-B201 through B206) are applicable to all sewage treatment facilities that treat wastewater containing sewage, unless the discharge is authorized by a general permit under Article 3 (A.A.C. R18-9-A301 et. seq.).	
	B201(C) - Operator is certified for the grade of the WWTP (see R18-5-114)
comment	
	B201(D) - O&M plan/outline submitted (Example: Bulletin 11, Chapter XI)
comment	
	B201(E) - Connections between the WWTP and a potable water supply will not cause contamination of a potable or public water supply. For example: backflow prevention.
comment	
	B201(F) - Untreated sewage from the WWTP CANNOT bypass the treatment system. Check for bypass pipes on plans/flow diagram.
comment	
	B201(G) - Reclaimed water is regulated under a valid Reuse permit (18 AAC 11, Article 3). (Indicate where reclaimed water is dispensed. Indicate any direct reuse sites. Indicate whether there is an NOI on file)
comment	
	B201(H) - Biosolids regulation – Prep, transport, land application of biosolids is regulated under 18 AAC 9, Art 10 (Indicate the ultimate disposition of biosolids) These regulations apply to land application, transport or disposal in a "sewage sludge unit" defined as "land on which only sewage sludge is placed for final disposal. This does not include land on which sewage sludge is either stored or treated".

Regulation Review - Aquifer Protection Permit

APP Application

For individual APP, temporary APP, and amendments

- ADEQ recommends scheduling a pre-application meeting with ADEQ Project Team to go over the permit requirements
- The ADEQ permit team will bill at a rate of $122/hr to a maximum of $200,000 for a new permit

APP Application Form

Regulation Review - Aquifer Protection Permit

ADEQ Arizona Department of Environmental Quality

APP Application

GENERAL INFORMATION

1. **Application to obtain [A.R.S. 49-241]:**

New APP _____
Amendment to a current APP Inventory No._____LTF No._____
Amendment Type: ☐ Significant ☐ Other ☐ Minor

Description of all amendment requests and justification for the amendment type included in Report Section/Appendix _____

A copy of the current permit, annotated with any inconsistencies between the permit requirements and the existing facilities or operation, included in Report Section/Appendix _____
NOTE: ADEQ can provide the permit in WORD file format upon request.

2. **Applicant/Permittee Name [A.A.C. R18-1-503(1)] (see Definitions):**

Company/Government/Entity Name: (RESPONSIBLE FOR ALL PERMIT CONDITIONS)

_____

3. **Applicant/Permittee - Certification Statement [A.A.C. R18-9-A201(B)(7)]:**

I certify under penalty of law that this Aquifer Protection Permit application and all attachments were prepared under my direction or authorization and all information is, to the best of my knowledge, true, accurate and complete. I also certify that the APP discharging facilities described in this form is or will be designed, constructed, operated, and/or closed in accordance with the terms and conditions the Aquifer Protection Permit and applicable requirements of Arizona Revised Statutes Title 49, Chapter 2, and ArizonaAdministrative Code Title 18, Chapter 9 regarding aquifer protection permits. I am aware that there are significant penalties for submitting false information, including permit revocation as wells as the possibilityof fine and imprisonment for knowing violations.

Authorized person signature:

Name:_____

Title:_____

Signature_____

Date: _____

4. **Applicant/Permittee Address**

Mailing Address: _____

Billing Address: _____

Email Address: _____

Phone Number: _____

5. **Authorized Agent [A.A.C. R18-1-503(A)(3)] (Optional, see Definitions):**

Name:_____

Firm Name: _____

Mailing Address: _____

Email Address: _____

Phone Number: _____

6. **6. Facility Information [A.A.C. R18-1-503(2), A.A.C. R18-9-201(B)(1)]**

Name:_____

Address:_____

County: _____

Latitude: ____° ____' ____" Longitude: ____° ____' ____"

Coordinate System used for Latitude and Longitude: ☐ NAD27 ☐ NAD83

Township_____Range_____Section: _____

Driving directions from a major intersection: _____

_____

7. **Facility Notices of Violation, Consent Orders or Compliance Orders in the last 2 years [A.A.C. R18-9-A202(A)(11), included in Report Section/Appendix** _____

8. **Facility Owner**

Company/Government/Entity Name: _____

Contact Person Name: _____

Mailing Address: _____

Email Address: _____

Phone Number: _____

9. **Contact Person for Facility Emergencies [A.A.C. R18-9-A202(A)(11)]**

Name:_____Title:_____

Mailing Address: _____

Email Address: _____

Phone Numbers landline:_____mobile phone: _____

Regulation Review

- APP Example

STATE OF ARIZONA
AQUIFER PROTECTION PERMIT NO. P-103890
PLACE ID 6976, LTF 93437
SIGNIFICANT AMENDMENT

1.0 AUTHORIZATION

In compliance with the provisions of Arizona Revised Statutes (A.R.S.) Title 49, Chapter 2, Articles 1, 2, and 3, Arizona Administrative Code (A.A.C.) Title 18, Chapter 9, Articles 1 and 2, A.A.C. Title 18, Chapter 11, Article 4 and amendments thereto, and the conditions set forth in this permit, the Arizona Department of Environmental Quality (ADEQ) hereby authorizes Picacho Sewer Company to operate the Picacho Water Reclamation Plant located at 6197 West Cornman Road, Eloy, Arizona, Pinal County, over the groundwater of the Pinal Active Management Area.

This permit becomes effective on the date of the Water Quality Division Director's signature and shall be valid for the life of the facility (operational, closure, and post-closure periods) unless suspended or revoked pursuant to A.A.C. R18-9-A213. The permittee shall construct, operate and maintain the permitted facilities:

Regulation Review - Aquifer Protection Permit

- ## APP Example

This permit becomes effective on the date of the Water Quality Division Director's signature and shall be valid for the life of the facility (operational, closure, and post-closure periods) unless suspended or revoked pursuant to A.A.C. R18-9-A213. The permittee shall construct, operate and maintain the permitted facilities:

1. Following all the conditions of this permit including the design and operational information documented or referenced below, and
2. Such that Aquifer Water Quality Standards (AWQS) are not violated at the applicable point(s) of compliance (POC) set forth below or if an AWQS for a pollutant has been exceeded in an aquifer at the time of permit issuance, that no additional degradation of the aquifer relative to that pollutant and as determined at the applicable POC occurs as a result of the discharge from the facility.

1.1. PERMITTEE INFORMATION

Facility Name:	Picacho Water Reclamation Plant
Facility Address:	6197 West Cornman Road Eloy, Arizona, 85231
County:	Pinal County
Permitted Flow Rate:	499,000 gallons per day
Permittee:	Picacho Sewer Company
Permittee Address:	9532 East Riggs Road Sun Lakes, Arizona 85248
Facility Contact:	David Voorhees, Utilities Superintendent
Emergency Phone No.:	(480) 895-5009
Latitude/Longitude:	32° 50' 06" North/ 111° 37' 53" West
Legal Description:	Township 7 South, Range 7 East, Section 4, NW ¼, SW ¼, SW ¼ and Section 9, NW ¼, NW ¼, NE ¼

Regulation Review - Aquifer Protection Permit

- APP Example

PERMIT NO. P-103890
LTF No. 93437 Place ID No. 6976

2.0 SPECIFIC CONDITIONS

[A.R.S. §§ 49-203(4), 49-241(A)]

2.1. FACILITY / SITE DESCRIPTION

[A.R.S. § 49-243(K)(8), and A.A.C. R18-5-114]

The permittee is authorized to operate the Picacho Water Reclamation Facility (PWRF) at 499,000 gpd, Grade 3 wastewater treatment plant, which includes an influent pump station, elevated screenings process, elevated steel SBR tanks, filtration process, open channel UV system, and an effluent pump station. The influent pump station will pump the raw wastewater up into a screenings process then to the SBR packaged wastewater treatment plant. After processing, the treated wastewater flows by gravity through a filter, UV disinfection channel, and finally into the effluent pump station. The WRF is designed to produce Reclaimed Water Reuse Class A+ effluent. The effluent pump station pumps the effluent to the golf course for irrigation. The plant effluent can also gravity flow into the adjacent recharge basins if the effluent pumps are not pumping all of the treated effluent. All industrial hookups and other non-residential hookups to the treatment system shall be authorized according to the applicable federal, state or local regulations.

Regulation Review - Aquifer Protection Permit

Permitted Discharge Facilities

PERMIT NO. P-103890
LTF No. 93437 Place ID No. 6976

The site includes the following permitted discharging facilities:

Table 1: DISCHARGING FACILITIES		
Facility	**Latitude**	**Longitude**
Water Reclamation Plant	32° 50' 06" N	111° 37' 53" W
Recharge Basin No. 1	32° 50' 03" N	111° 38' 10" W
Recharge Basin No. 2	32° 50' 03" N	111° 38' 08" W
Recharge Basin No. 3 (Proposed)	32° 50' 03" N	111° 38' 06" W
Recharge Basin No. 4 (Proposed)	32° 49' 52" N	111° 38' 10" W
Recharge Basin No. 5 (Proposed)	32° 49' 52" N	111° 38' 08" W
Recharge Basin No. 6 (Proposed)	32° 49' 52" N	111° 38' 06" W

Regulation Review - Aquifer Protection Permit

- Pre-Operational Requirements

PERMIT NO. P-103890
LTF No. 93437 Place ID No. 6976

2.2.3. Pre-Operational Requirements

Prior to initiating use of the new headworks and influent pump station, sequencing batch reactor system, additional UV disinfection, and biosolids handling facilities and any newly constructed improvements to the facility, the permittee shall submit a signed, dated, and sealed Engineer's Certificate of Completion in a format approved by the Department per the compliance schedule in Section 3.0. The certificate shall be submitted to the Groundwater Protection Value Stream.

Regulation Review - Aquifer Protection Permit

- Point of Compliance

PERMIT NO. P-103890
LTF No. 93437 Place ID No. 6976

2.4. POINT OF COMPLIANCE (POC)

[A.R.S. § 49-244]

The Points of Compliance (POCs) have been established at the following locations:

Table 2: POINT(S) OF COMPLIANCE

POC #	POC Location	Latitude (North)	Longitude (West)
1	Conceptual hazardous and non-hazardous POC located on the southwest corner of the WRF site	32° 50' 05"	111° 38' 06"
2	Conceptual hazardous and non-hazardous POC located on the southwest corner of the Recharge Basins	32° 50' 03"	111° 38' 13"

Groundwater monitoring is not required at the point of compliance wells, except as a contingency action. The director may require an amendment of this permit to install a monitoring well if there is cause or concern that groundwater quality may be impacted at the POC. The Director may amend this permit to designate additional points of compliance if information on groundwater gradients or groundwater usage indicates the need.

2.5.2. Routine Discharge Monitoring

The permittee shall monitor the effluent according to Section 4.2, Table 8: ROUTINE DISCHARGE MONITORING. Representative samples of the effluent shall be collected at the point of discharge from the ultraviolet disinfection channel.

Regulation Review - Aquifer Protection Permit

- Alert Levels

PERMIT NO. P-103890
LTF No. 93437 Place ID No. 6976

2.6.2.3.2. Alert Levels for Pollutants with Numeric Aquifer Water Quality Standards

1. In the case of an exceedance of an AL for a pollutant set in Section 4.1, Table 10: GROUNDWATER MONITORING, the permittee may conduct verification sampling for those pollutant(s) that exceeded their respective AL(s) within five (5) days of becoming aware of the exceedance. The permittee may use results of another sample taken between the date of the last sampling event and the date of receiving the result as verification.

2. If verification sampling confirms the AL exceedance or if the permittee opts not to perform verification sampling, then the permittee shall increase the frequency of monitoring for each pollutant exceeding its' respective AL(s) as follows:

- "AL" means a value or criterion established in an individual permit that serves as an early warning, indicating a potential permit condition violation related to BADCT or discharge of a pollutant.
- "AQL" is a permit limitation set for aquifer water quality measured at the compliance point that either represents an AWQS or ambient water quality for that pollutant.

Regulation Review - Aquifer Protection Permit

- Reporting Location

PERMIT NO. P-103890
LTF No. 93437 Place ID No. 6976

2.7.5. Reporting Location

All Self-Monitoring Report Forms (SMRFs) shall be submitted through the myDEQ portal accessible on the ADEQ website at: http://www.azdeq.gov/welcome-mydeq

All other documents required by this permit shall be mailed to:

The Arizona Department of Environmental Quality
Groundwater Protection Value Stream
Mail Code 5415B-3
1110 West Washington Street
Phoenix, Arizona 85007
Phone (602) 771-4571

Regulation Review - Aquifer Protection Permit

ADEQ Arizona Department of Environmental Quality

- ## Compliance Monitoring

PERMIT NO. P-103890
LTF No. 93437 Place ID No. 6976

4.2. COMPLIANCE OR OPERATIONAL MONITORING

Table 8: ROUTINE DISCHARGE MONITORING					
Sampling Point Number	**Sampling Point Identification**			**Latitude (North)**	**Longitude (West)**
1	Effluent Pump Station			32° 50' 06"	111° 37' 53"
Parameter	**Alert Level**	**Discharge Limit**	**Units**	**Sampling Frequency**	**Reporting Frequency**
Total Flow[1]: Daily[2]	Not Applicable[3]	Not Applicable	mgd[4]	Daily	Quarterly
Total Flow: Monthly Average[5]	0.39	0.49	mgd	Monthly Calculation	Quarterly
Reuse Flow: Daily	Not Applicable	Not Applicable	mgd	Daily	Quarterly
Recharge Flow: Daily	Not Applicable	Not Applicable	mgd	Daily	Quarterly
Recharge Flow: Monthly Average	0.39	0.49	mgd	Monthly Calculation	Quarterly
Fecal Coliform: Single sample maximum	Not Applicable	23.0	CFU	Daily[6]	Quarterly
Fecal Coliform: four (4) of seven (7) samples in a week[7]	Not Applicable	Non-detect[8]	CFU	Weekly Evaluation	Quarterly
Total Nitrogen[9] :Five-sample rolling geometric mean[10]	8.0	10.0	mg/l[11]	Monthly Calculation	Quarterly
Cyanide (as free cyanide)	0.16	0.2	mg/l	Quarterly	Quarterly
Fluoride	3.2	4.0	mg/l	Quarterly	Quarterly
Metals (Total)					
Antimony	0.0048	0.006	mg/l	Quarterly	Quarterly
Arsenic	0.04	0.05	mg/l	Quarterly	Quarterly
Barium	1.60	2.00	mg/l	Quarterly	Quarterly
Beryllium	0.0032	0.004	mg/l	Quarterly	Quarterly
Cadmium	0.004	0.005	mg/l	Quarterly	Quarterly
Chromium	0.08	0.1	mg/l	Quarterly	Quarterly
Lead	0.04	0.05	mg/l	Quarterly	Quarterly
Mercury	0.0016	0.002	mg/l	Quarterly	Quarterly
Nickel	0.08	0.1	mg/l	Quarterly	Quarterly
Selenium	0.04	0.05	mg/l	Quarterly	Quarterly
Thallium	0.0016	0.002	mg/l	Quarterly	Quarterly

Regulation Review - Aquifer Protection Permit

- Operational Monitoring

PERMIT NO. P-103890
LTF No. 93437 Place ID No. 6976

Table 11: FACILITY INSPECTION AND OPERATIONAL MONITORING			
The permittee shall record the inspection performance levels in a log book as per Section 2.7.2, and report any violations or exceedances as per Section 2.7.3. In the case of an exceedance, identify which structure exceeds the performance level in the log book.			
Pollution Control Structure/Parameter	**Performance Level**	**Inspection Frequency**	**Reporting Frequency**
Pump Integrity	Good working condition	Weekly	Quarterly
Treatment Plant Components	Good working condition	Weekly	Quarterly
Recharge Basins	No day-lighting or runoff (outside basins)	Weekly	Quarterly
Freeboard in Recharge Basins	Minimum 1 foot	Weekly	Quarterly
Freeboard in Storage Basins	Minimum 2 foot	Weekly	Quarterly

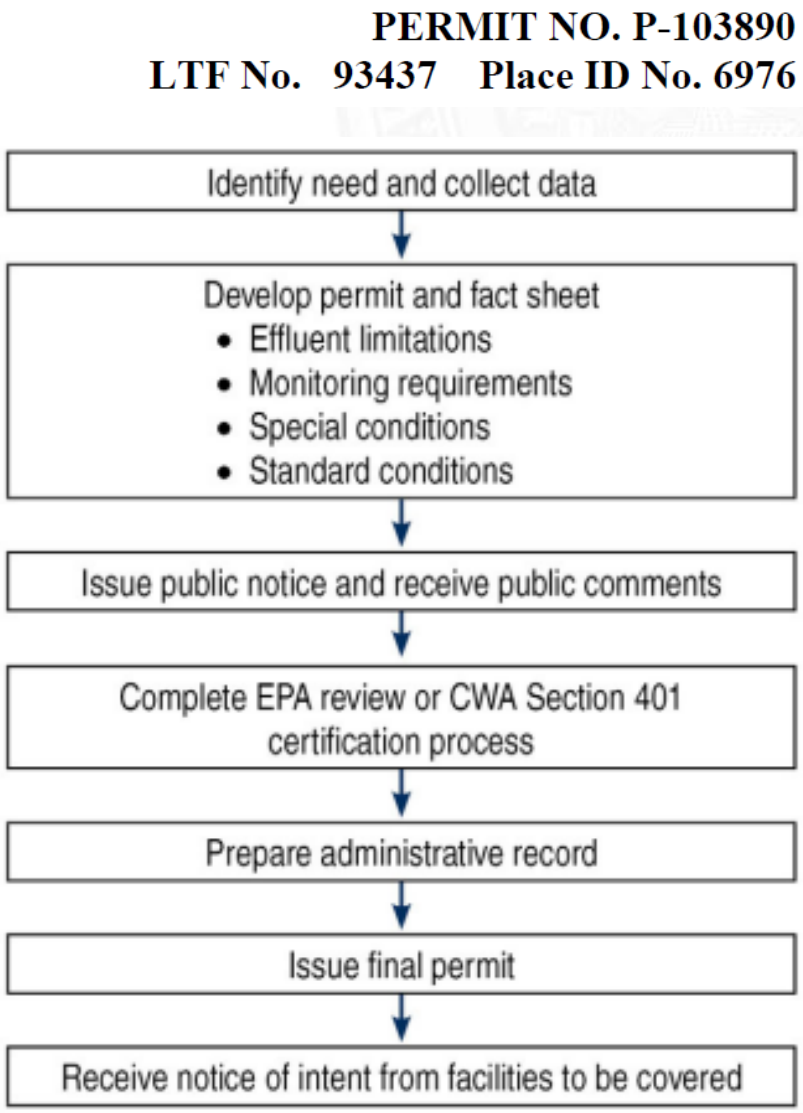
AZPDES PERMIT SUMMARY

Regulation Review - AZPDES

Arizona Pollutant Discharge Elimination System (AZPDES)

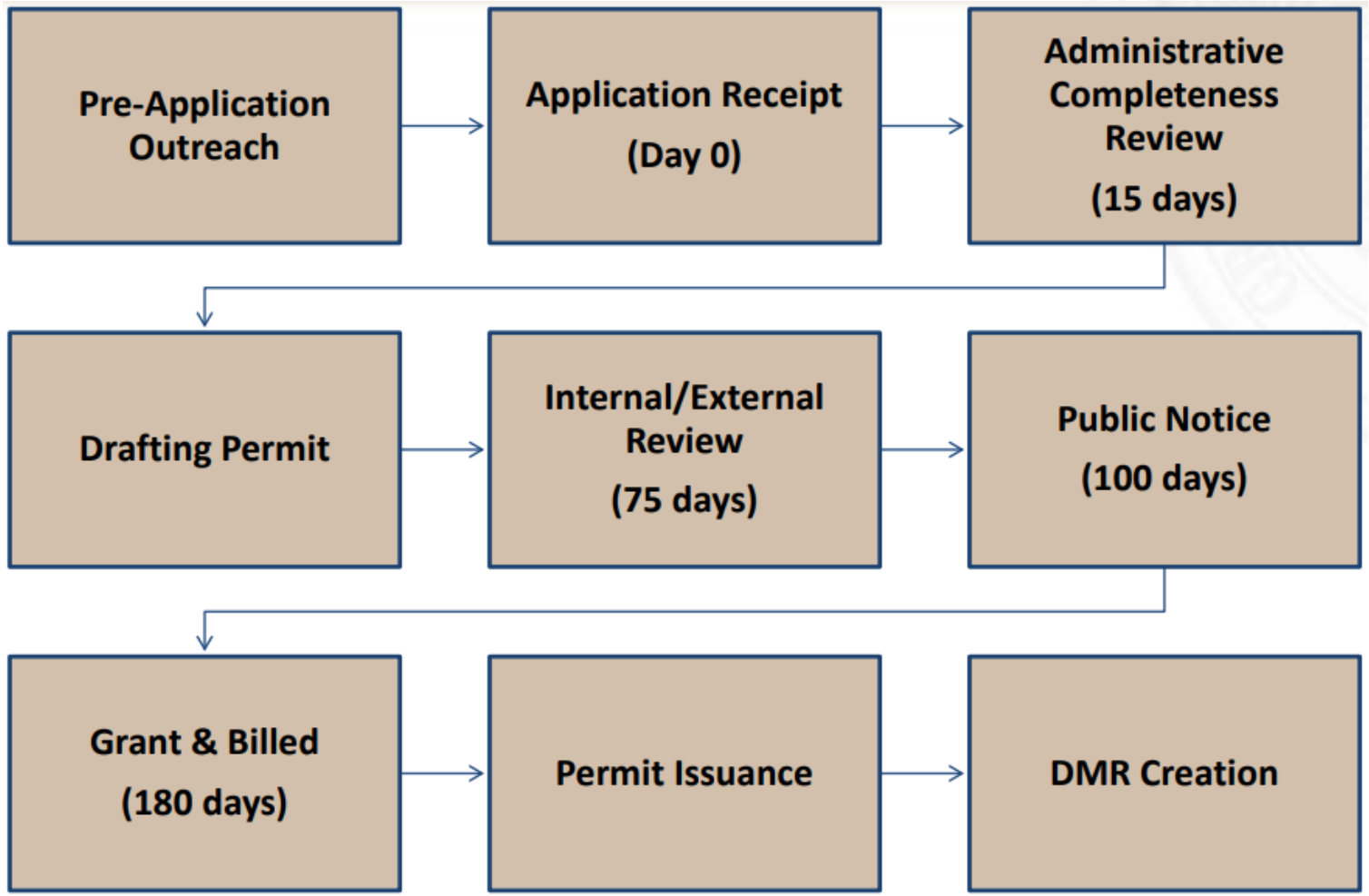
Municipal, domestic, and non-domestic (industrial) discharges of pollutants to "waters of the U.S. (WOTUS)," as described in the Clean Water Act.

- Valid for 5 years
- Can be renewed past 5 years if application received 180 days prior to expiration
- Compliance reporting is on myDEQ



Regulation Review - AZPDES

- Individual Permits Review Process



Regulation Review - AZPDES

- Permitting Fees

  Individual permit for wastewater treatment plant maximum fees:

  - 3,000 - 99,999 gallons of discharge per day: $15,000
  - 100,000 - 999,999 gallons of discharge per day: $20,000
  - 1,000,000 - 9,999,999 gallons of discharge per day: $30,000
  - 10,000,000 or more: $50,000
  - Amendment: $12,500

  These are the current fees; however, it is subject to change because of inflation.

Regulation Review - AZPDES

- Form 2A/2S

ADEQ Arizona Department of Environmental Quality

ARIZONA POLLUTANT DISCHARGE ELIMINATION SYSTEM APPLICATION - FORM 2A/2S

For discharges from Publicly Owned Treatment Works and Domestic Wastewater Treatment Works

In completing and submitting this form, the Applicant is applying for an individual AZPDES permit to authorize the discharge of treated domestic wastewater to a Waters of the United States.

Instructions:

1) Type in or clearly hand print the requested information on the form.
2) This application consists of the main part and Supplements A (Table Data) and B (Sewage Sludge).

Wastewater Treatment Facility Design Capacity	Maximum Fee
3,000 to 99,999 gallons per day	15,000
100,000 to 999,999 gallons per day	20,000
1,000,000 to 9,999,999 gallons per day	30,000
10,000,000 or more gallons per day	50,000

a. (See: http://www.azdeq.gov/environ/water/permits/fees.html for more information on AZPDES fees including permit processing and annual fees.)

Regulation Review - AZPDES

- ## Form 2A/2S

A.11. Current design flow.

Indicate the design flow rate of the treatment plant *(i.e., the wastewater flow rate that the plant was built to treat on a daily basis – not including peak flows).*

a. Design flow rate _____ mgd

Provide the average daily flow rate and the maximum daily flow rate for each of the last three years. Each year's data must be based on a 12 month time period with the 12th month of this year occurring no more than three months prior to this application submittal.

	Two Years Ago	Last Year	This Year
b. Annual average daily influent flow rate:	_____ mgd	_____ mgd	_____ mgd
c. Maximum daily influent flow rate:	_____ mgd	_____ mgd	_____ mgd
d. Describe how you measure (or estimate) flow:	_____ mgd	_____ mgd	_____ mgd

A.12. Anticipated design flow.

Are there any plans within the next five years for implementing improvements at the treatment works or at the outfall(s) that will affect the wastewater treatment, effluent quality or design capacity of the treatment works? ☐ Yes ☐ No

If no, then skip to Part A.13. If yes, then complete the following:

Note: If the treatment works has several different implementation schedules or is planning several improvements, submit separate responses for each.

a. List the outfall number (assigned in A.14) for each outfall that is covered by this implementation schedule.

b. Indicate whether the planned improvements or their implementation schedule are required by local, state or federal agencies. ☐ Yes ☐ No

c. Briefly describe the improvements to be made for the outfall(s) listed in A.14.a and include new maximum daily flow rate, if applicable.

Note: Maximum permitted capacity within a 5-year permit term will be the basis for developing limits and setting annual fees.

d. Provide dates imposed by any compliance schedule or planned independently of local, state or federal agencies. Also provide any actual dates of completion for the implementation steps listed below, as applicable. Indicate dates as accurately as possible. Place an (*) in front of the improvements required by a governmental agency.

Regulation Review - AZPDES

- Industrial Pretreatment Program is required when:
  - Pollutants are indirectly discharged and introduced into publicly owned treatment works (POTWs)
  - POTWs receive wastewater from sources subject to national pretreatment standards
  - Any new or existing source subject to national pretreatment standards

Regulation Review – AZPDES

- Industrial Pretreatment Program (IPP) Drivers
  - If industrial dischargers make up 5% of the flow or concentration loading, then an IPP program is required.
  - If discharger exceed 25,000 gpd, then an IPP is required.
  - If discharger is covered under a categorical standards, an IPP program is required (Metal finisher)

Regulation Review - AZPDES

- Small facility example

AZPDES Individual Permits (arcgis.com)

ADEQ Arizona Department of Environmental Quality

www.azdeq.gov

ADEQ Inventory No.	100798	Permit No.	AZ0025411
LTF No.	93076	Place ID No.	1102

AUTHORIZATION TO DISCHARGE UNDER THE ARIZONA POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of Arizona Revised Statutes (A.R.S.) Title 49, Chapter 2, Article 3.1; the Federal Water Pollution Control Act, (33 U.S.C. §1251 *et seq.*, as amended), and Arizona Administrative Code (A.A.C.) Title 18, Chapter 9, Articles 9 and 10, and amendments thereto the,

City of Yuma
Main Street Water Treatment Plant
155 W. 14th St.
Yuma, Arizona 85364

is authorized to discharge treated filter backwash decant water from the water treatment plant located at 175 N. Main St. serving the City of Yuma in Yuma County, Arizona to the Colorado River, a protected surface waters in Arizona that is a Waters of the U.S. (WOTUS), in the Colorado – Lower Gila River Basin at:

Outfall No.	Latitude	Longitude	Legal
002	32° 43' 36.45" N	114° 37' 0.93" W	Township 7 S, Range 6 E, Section 22

Regulation Review - AZPDES

- Small facility AZPDES Permit Validity

Annual Registration Fee [A.R.S. 49-255.01 and A.A.C. R18-14-104]

The annual registration fee for this permit is payable to ADEQ each year. For the purposes of the annual fees, this permit is a Minor permit. If the facility is not yet constructed or is incapable of discharge at this time, the permittee may be eligible for reduced fees under rule. Send all correspondence requesting reduced fees to the Water Quality Division of ADEQ. Please reference the permit number, LTF number and why reduced fees are requested under rule.

This permit shall become effective on June 1, 2022.

This permit and the authorization to discharge shall expire on May 31, 2027.

Signed May 27, 2022.

Valid for 5 years

- Small facility monitoring requirements

ADEQ Arizona Department of Environmental Quality

PART I. DISCHARGE LIMITATIONS AND MONITORING REQUIREMENTS

A. Discharge Limitations and Monitoring Requirements

1. The Permittee shall limit and monitor discharges from Outfall 002 as specified in Table 1 which follows. These requirements are based on a design capacity of 0.68 million gallons per day (MGD).

Table 1. Discharge Limitations and Monitoring Requirements

Parameter	Maximum Allowable Discharge Limitations						Monitoring Requirement (2)(3)	
	Mass Limits (1)			Concentration Limits				
	Monthly Average	Weekly Average	Daily Maximum	Monthly Average	Weekly Average	Daily Maximum	Monitoring Frequency	Sample Type
Discharge Flow (MGD)	REPORT (4)	---	REPORT	---	---	---	Continuous	Metered
Total Suspended Solids (TSS)	51 kg/day	103 kg/day	---	20 mg/L	40 mg/L	---	1x/Every 2 weeks	Discrete
Chlorine, Total Residual (TRC) (5) (8)	51 g/day	---	85 g/day	20 µg/L	---	33 µg/L	1x/Every 2 weeks	Discrete
Nitrogen, Total Kjeldahl (TKN)	(4)	---	(4)	(4)	---	(4)	1x/quarter	Discrete
Phosphorus	(4)	---	(4)	(4)	---	(4)	1x/quarter	Discrete
Arsenic	26 g/day	---	38 g/day	10 µg/L	---	15 µg/L	1x/ quarter	Discrete
Mercury	0.03 g/day	---	0.05 g/day	0.01 µg/L	---	0.02 µg/L	1x/ quarter	Discrete
Selenium (7)	4.6 g/day	---	9.3 g/day	1.8 µg/L	---	3.6 µg/L	1x/ quarter	Discrete
Alpha particles (gross) Radioactivity	---	---	---	---	---	15 pCi/L	1x/year	Discrete
Hardness (CaCO3) (6)	--	---	---	REPORT [mg/L]	---	REPORT [mg/L]	1x/quarter	Discrete
pH (8)	Not less than 6.5 standard units (S.U.) nor greater than 9.0 S.U.						1x/week	Discrete

Regulation Review - AZPDES

- Large facility permit number and address

ADEQ Arizona Department of Environmental Quality

www.azdeq.gov

ADEQ Inventory No.	100760	Permit No.	AZ0020427
LTF No.	79298	Place ID No.	1092

AUTHORIZATION TO DISCHARGE UNDER THE ARIZONA POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of Arizona Revised Statutes (A.R.S.) Title 49, Chapter 2, Article 3.1; the Federal Water Pollution Control Act, (33 U.S.C. §1251 et. seq., as amended), and Arizona Administrative Code (A.A.C.) Title 18, Chapter 9, Articles 9 and 10, and amendments thereto,

City of Flagstaff - Water Services
Wildcat Hill Water Reclamation Plant
2323 N. Walgreens St., Suite 1
Flagstaff, Arizona 86004

Regulation Review – AZPDES

- Large facility discharge locations

is authorized to discharge treated domestic wastewater from the Water Reclamation Plant located at 2800 N. El Paso-Flagstaff Rd serving Flagstaff in Coconino County, Arizona to an unnamed wash, tributary to Rio de Flag River in the Little Colorado River Basin at:

Outfall No.	Latitude	Longitude	Legal
001 – Discharge to Rio de Flag River	35° 13' 34" N	111° 33' 13" W	Township 21 N, Range 8 E, Section 4
005 – Discharge to Frances Short Pond in the Rio de Flag River	35° 12' 21" N	111° 39' 17" W	Township 21 N, Range 7 E, Section 16

in accordance with effluent limitations, monitoring requirements and other conditions set forth herein, and in the attached "Standard AZPDES Permit Conditions."

Regulation Review - AZPDES

- ## Large facility AZPDES permit validity

Annual Registration Fee [A.R.S. 49-255.01 and A.A.C. R18-14-104]

The annual registration fee for this permit is payable to ADEQ each year. The permitted flow for fee calculation is 6,000,000 gallons per day (gpd). If the facility is not yet constructed or is incapable of discharge at this time, the permittee may be eligible for reduced fees under rule. Send all correspondence requesting reduced fees to the Water Quality Division of ADEQ. Please reference the permit number, LTF number and why reduced fees are requested under rule.

This permit shall become effective on June 1st, 2020.

This permit and the authorization to discharge shall expire at midnight, May 31st, 2025.

Signed this 1st day of June, 2020.

Regulation Review - AZPDES

- Large facility monitoring requirements

Table 1.a. - Effluent Limitations and Monitoring Requirements for Outfall 001

Parameter	Maximum Allowable Discharge Limitations						Monitoring Requirement (2)(3)	
	Mass Limits (1)			Concentration Limits				
	Monthly Average	Weekly Average	Daily Maximum	Monthly Average	Weekly Average	Daily Maximum	Monitoring Frequency	Sample Type
Discharge Flow (MGD)	Report (4)	---	Report	---	---	---	Continuous	Metered
Biochemical Oxygen Demand (BOD) (5-day)	680 kg/day	1,000 kg/day	---	30 mg/L	45 mg/L	---	1x /week	24-hour Composite (5)
BOD (6)	---	---	---	85% REMOVAL MINIMUM	---	---	1x /week	24-hour Composite
Total Suspended Solids (TSS)	680 kg/day	1,000 kg/day	---	30 mg/L	45 mg/L	---	1x /week	24-hour Composite
TSS (6)	---	---	---	85% REMOVAL MINIMUM	---	---	1x /week	24-hour Composite
E. coli (7)	---	---	---	126 cfu/100 mL	---	575 cfu/100 mL	4x /month	Discrete
Chlorine, Total Residual (TRC) (8)(9)	200 g/day	---	410 g/day	9.0 µg/L	---	18 µg/L	5x /week	Discrete
Copper (10)	550 g/day	---	820 g/day	24 µg/L	---	36 µg/L	1x /month	24-hour Composite
Cyanide	180 g/day	---	360 g/day	7.9 µg/L	---	16 µg/L	1x /month	Discrete
Selenium	40 g/day	---	64 g/day	2 µg/L	---	3 µg/L	1x /month	24-hour Composite
Ammonia (11)	---	---	---	Report [mg/L]	---	Report [mg/L]	2x /month	Discrete
Ammonia Impact Ratio	---	---	---	1 (12)	---	2 (12)	2x /month	Discrete
Temperature (9)(11)	---	---	---	Report [°C](11)	---	Report [°C](11)	2x /month	Discrete
pH (9)	Not less than 6.5 standard units (S.U.) nor greater than 9.0 S.U.						5x/week	Discrete

- Large facility monitoring requirements

Table 2.b. - Effluent Limitations and Monitoring Requirements for Outfall 005

Parameter	Maximum Allowable Discharge Limitations						Monitoring Requirement (2)(3)	
	Mass Limits (1)			Concentration Limits				
	Monthly Average	Weekly Average	Daily Maximum	Monthly Average	Weekly Average	Daily Maximum	Monitoring Frequency	Sample Type
Discharge Flow (MGD)	Report (2)	---	Report	---	---	---	Continuous	Metered
Chlorine, Total Residual (TRC) (3) (4)	---	---	---	9.0 µg/L	---	18 µg/L	1x /week (5)	Discrete

B. Trace Substance Monitoring

The permittee shall monitor discharges from Outfalls 001 and 005 as specified in Table 2. Discharges from Outfall 001 are considered representative of discharges from Outfall 005, and monitoring and reporting for discharges from Outfall 005 is not required except as specified in Table 1.b. Monitoring results above the Assessment Levels (ALs) listed below do not constitute a permit violation, but may trigger evaluation of Reasonable Potential (RP) by ADEQ. The permittee shall use an approved analytical method with a Limit of Quantitation (LOQ) lower than the AL values as described in Part II.A.5.

Table 3 – Assessment Level Monitoring

Parameter	Assessment Levels (1)		Monitoring Requirements (2) (3)	
	Monthly Average	Daily Maximum	Monitoring Frequency	Sample Type
Oil & Grease	10 mg/L	15 mg/L	1x/quarter	Discrete
Total dissolved solids (TDS) (source water) (4)	Report [mg/L]	Report [mg/L]	2x /year	Discrete
Total dissolved solids (TDS) (effluent) (4)	Report [mg/L]	Report [mg/L]	2x /year	Discrete

Regulation Review - AZPDES

- Large facility action levels

Table 3 – WET Testing

Effluent Characteristic (1)	Action Levels		Monitoring Requirements	
	Daily Maximum (2) (3)	Monthly Median (3)	Monitoring Frequency (4)	Sample Type
Chronic Toxicity *Pseudokirchneriella subcapitata* (Green algae) (5)	1.6 TUc	1.0 TUc	1x/6 months	24-hr Composite
Chronic Toxicity *Pimephales promelas* (Fathead minnow)	1.6 TUc	1.0 TUc	1x/6 months	24-hr Composite
Chronic Toxicity *Ceriodaphnia dubia* (Water flea)	1.6 TUc	1.0 TUc	1x/6 months	24-hr Composite

Regulation Review - AZPDES

- Large facility effluent testing

Table 4a – Effluent Characterization Testing – General Chemistry and Microbiology for Outfall 001

Parameter	Reporting Units	Monitoring Requirements	
		Monitoring Frequency (1)	Sample Type
Ammonia (as N) (2)	mg/L	1x /quarter	Discrete
Biochemical Oxygen Demand (BOD-5)	mg/L	1x /quarter	24-hour Composite
Chlorine, Total Residual (TRC) (4)(5)	µg/L	1x /quarter	Discrete
Dissolved Oxygen (5)	mg/L	1x /year	Discrete
E. coli	cfu/100 mL (3)	1x /quarter	Discrete
Nitrate/Nitrite (as N)	mg/L	1x /quarter	24-hour Composite
Nitrogen, Total Kjeldahl (TKN)	mg/L	1x /quarter	24-hour Composite
Oil and Grease	mg/L	1x /quarter	Discrete
pH (5)	S.U.	1x /quarter	Discrete
Phosphorus	mg/L	1x /quarter	24-hour Composite
Temperature (5)	°Celsius	1x /quarter	Discrete
Total Dissolved Solids (TDS)	mg/L	1x /quarter	24-hour Composite
Total Suspended Solids (TSS)	mg/L	1x /quarter	24-hour Composite

Regulation Review - AZPDES

- Large facility effluent testing

Table 4c – Effluent Characterization Testing – Selected Volatile Organic Compounds for Outfall 001

Parameter	Reporting Units	Monitoring Requirements	
		Monitoring Frequency	Sample Type
Acrolein	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
Acrylonitrile	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
Benzene	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
Bromoform	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
Carbon tetrachloride	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
Chlorobenzene	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
Chlorodibromomethane	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
Chloroethane	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
2-chloroethylvinyl ether	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
Chloroform	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
Dichlorobromomethane	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
1,1-dichloroethane	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
1,2-dichloroethane	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
Trans-1,2-dichloroethylene	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
1,1-dichloroethylene	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
1,2-dichloropropane	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
1,3-dichloropropylene	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
Ethylbenzene	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
Methyl bromide	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
Methyl chloride	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
Methylene chloride	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
1,1,2,2-tetrachloroethane	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
Tetrachloroethylene	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
Toluene	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
1,1,1-trichloroethane	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
1,1,2-trichloroethane	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
Trichloroethylene	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete
Vinyl chloride	µg/L	1x /year in years 2021,2022,2023 of permit term	Discrete

- Large facility reporting requirements

Table 5 – DMR Reporting Requirements for Daily Maximum Limits and Assessment Levels

For Daily Maximum Limits/Assessment Levels	The Permittee shall Report on the DMR
When the maximum value of any analytical result is greater than or equal to the LOQ	The maximum value of all analytical results
When the maximum value detected is greater than or equal to the laboratory's LOD but less than the LOQ	NODI (Q)
When the maximum value is less than the laboratory's LOD	NODI (B)

C. Twenty-four Hour Reporting of Noncompliance

1. The permittee shall orally report any noncompliance which may endanger the environment or human health within 24 hours from the time the permittee becomes aware of the event to:

ADEQ 24 hour hotline at (602) 771-2330

by phone call or voice mail by 9 a.m. on the first business day following the noncompliance. The permittee shall also submit an electronic report to the Surface Water Inspection and Compliance Unit within 5 days of the noncompliance event using the myDEQ electronic portal provided by ADEQ. The permittee shall include in the written notification: a description of the noncompliance and its cause; the period of noncompliance, including dates and times, and, if the noncompliance has not been corrected, the time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

LOQ – Limit of Quantification, LOD – Limit of Detection

- Large facility biosolids requirements

I. General Biosolids Monitoring Requirements (dry weight testing)

1. Biosolids Self-monitoring Frequency

Table 7 – Biosolids Self-Monitoring Frequency

Amount of Biosolids Prepared per Calendar Year (dry metric tons)	Minimum Monitoring Frequency
>0 to <290	One sampling even per year
≥290 to <1500	One sampling event per quarter
≥1500 to <15,000	One sampling event per 60 days
≥ to 15,000	One sampling event per month

Regulation Review - AZPDES

- Large facility biosolids requirements

Table 9 – Metal Concentrations for Land Applications

Pollutant	Ceiling Concentrations (milligrams/ kilogram) (1)	Monthly Average Pollutant Concentrations (milligrams/ kilogram) (1)	Minimum Monitoring Frequency per Volume Prepared Annually
Arsenic	75.0	41.0	0 to < 290 dry metric tons – 1 sampling event /year ≥ 290 to < 1500 dry metric tons – 1 sampling event /quarter ≥ 1500 to < 15,000 dry metric tons – 1 sampling event /60 days ≥ 15,000 dry metric tons – 1 sampling event /month
Cadmium	85.0	39.0	
Chromium	3000.0	Not Applicable	
Copper	4300.0	1500.00	
Lead	840.0	300.00	
Mercury	57.0	17.0	
Molybdenum	75.0	Not Applicable	
Nickel	420.0	420.00	
Selenium	100.0	100.0	
Zinc	7500.0	2800.00	

WASTEWATER TREATMENT OPERATIONS AND MAINTENANCE

10:00 – 11:00 AM

Wastewater Treatment Anatomy

- Anatomy- the study of the structure of body parts and their relationship to one another.
- Something you can see and touch

Wastewater Treatment Physiology

- Physiology- concerns the function of the body's structural machinery.
- How the parts work and carry out their life-sustaining activities

Human Systems

What are some human systems?

- Skeletal
- Respiratory
- Circulatory
- Digestive
- Nervous/Electrical

Air

- The mixture of invisible odorless tasteless gases (such as nitrogen and oxygen) that surrounds the earth.
- Approximately 78 percent nitrogen and 21 percent oxygen.
- Air also has small amounts of other gases too, such as carbon dioxide, neon, and hydrogen.

Matter

What are the 3 common states of matter?

- Liquid - Urine
- Solids - Poop
- Gases - Break wind (fart)

How?

How?

How?

How does understanding human anatomy help us to understand wastewater treatment?

Wastewater Treatment

- *A minute ago, we were talking about the 3 common states of matter. We looked at it from a human standpoint.*
- *What would happen if we did not treat those human wastes?*

Environmental Impact

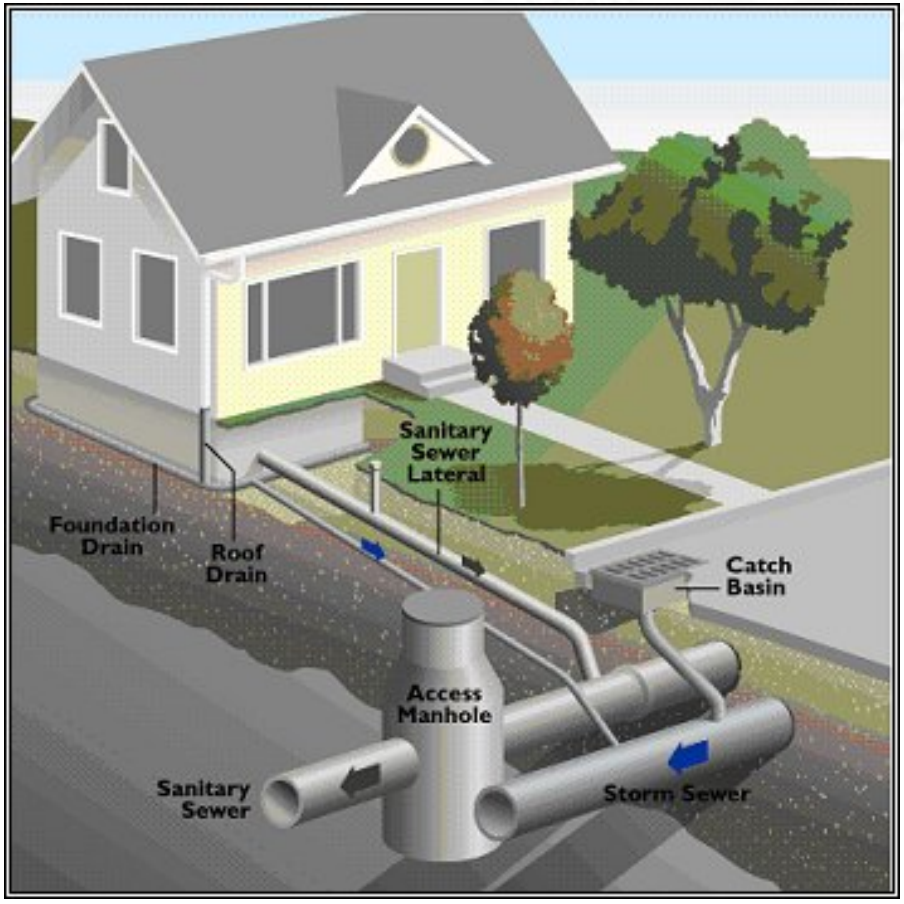
1. Liquids (Ammonia)
   - Fish kills
   - Eutrophication
2. Solids (Poop)
   - Oxygen depletion
   - Disease transmission
3. Gases (Hydrogen sulfide)
   - Rotten egg odor
   - Stinks

Leadership

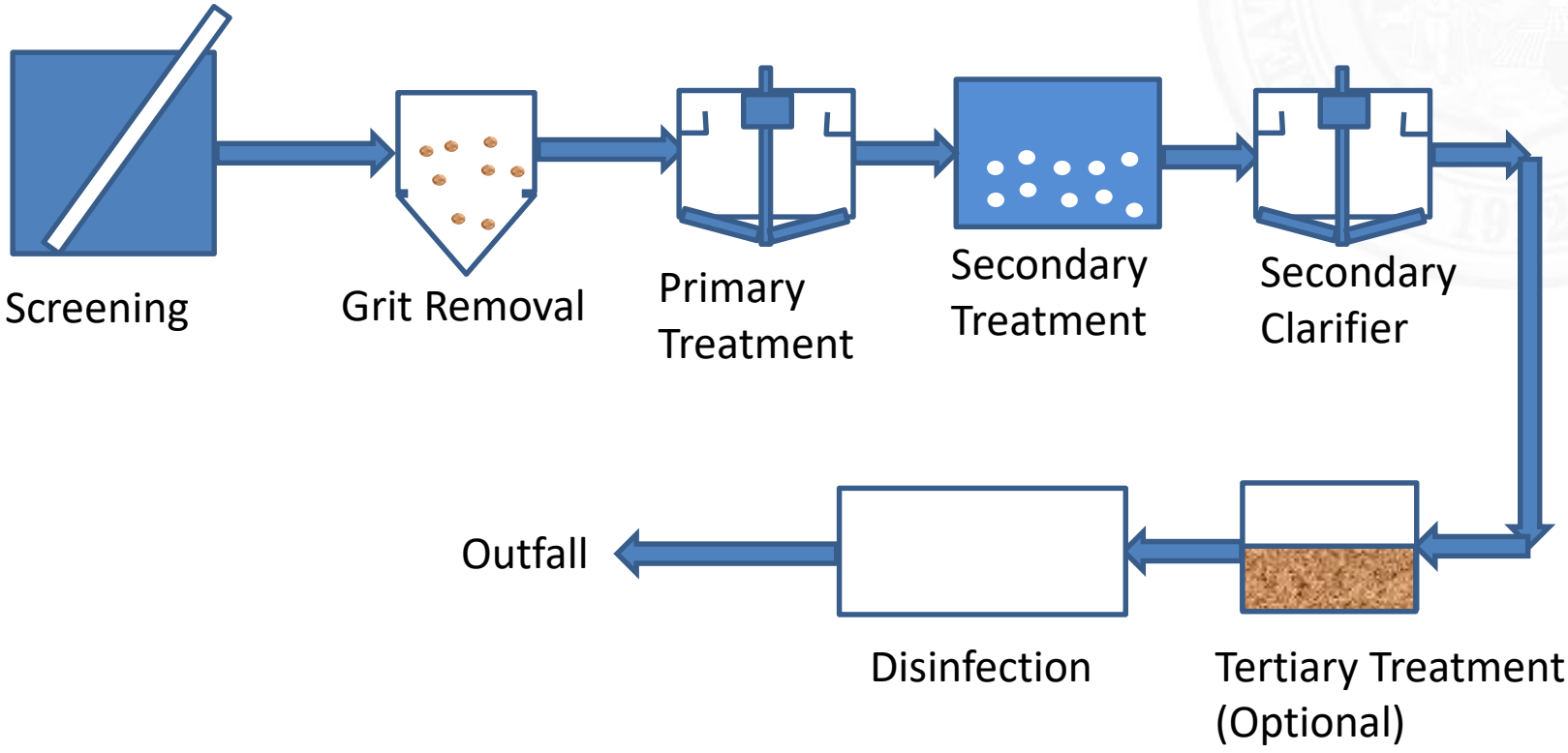
- When you know better, you should do better.
- Don't sit on the sidelines
- Be active in problem solving

Wastewater Collection System

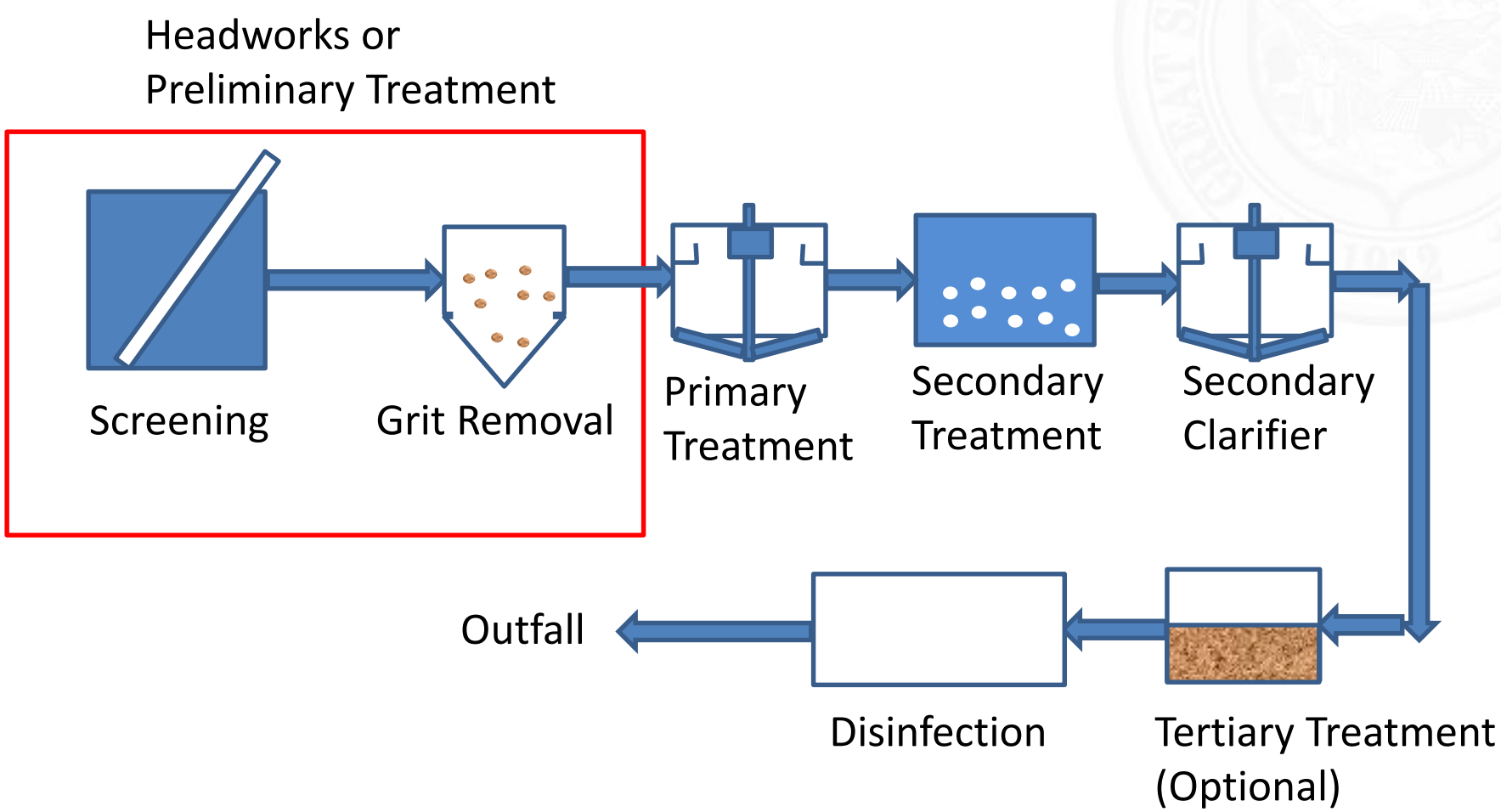
- Network of gravity and pressure pipes, pumping stations, and other facilities used to transport wastewater to a treatment facility.
  - Residential
  - Commercial office areas
  - Hospitals
  - Industrial plants



Standard WWTP Process Diagram



Preliminary/Primary Treatment



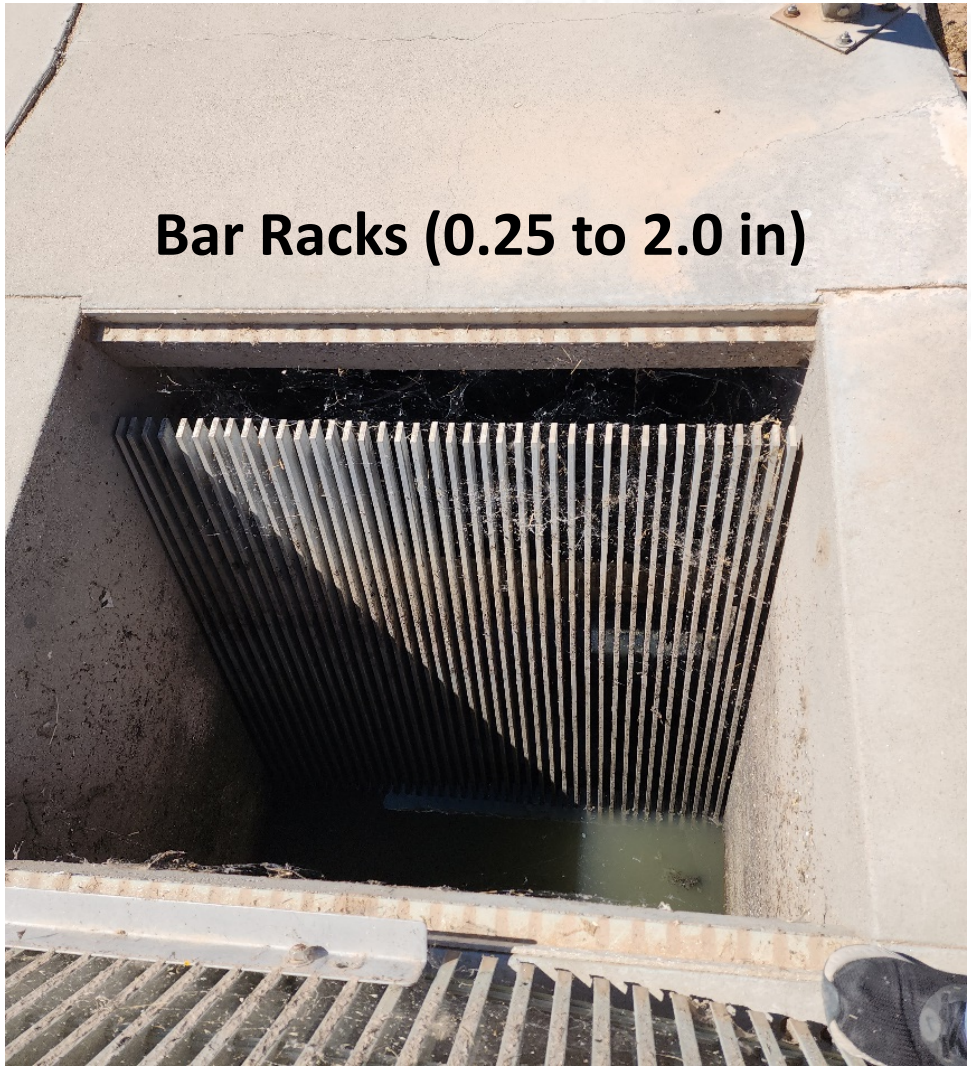
Preliminary/Primary Treatment

- Getting ready to cook
- Grocery Shopping- Food
  - Cans, plastic wrap and unpackaged
  - Do you eat everything you bring home?
- At a typical plant, we have to remove material the microorganisms do not consume and that could potentially collect in and/or damage downstream processes
  - Asphalt, egg shells, metal, rocks, sand, other inorganics

Preliminary/Primary Treatment

Bar Racks

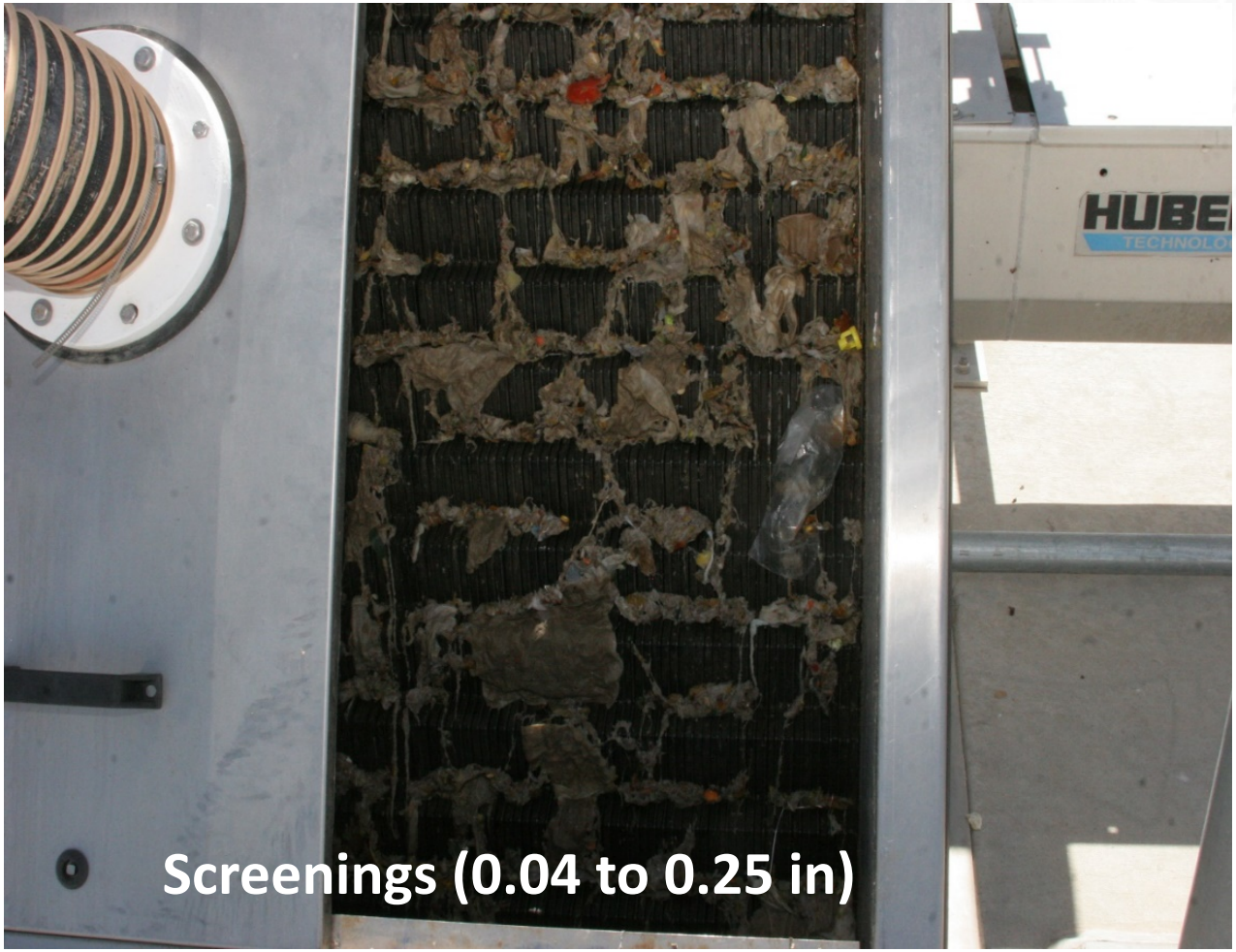
- Tree Branches
- Cans
- Footballs
- Building Materials
- Rocks



Preliminary/Primary Treatment

Fine Screens

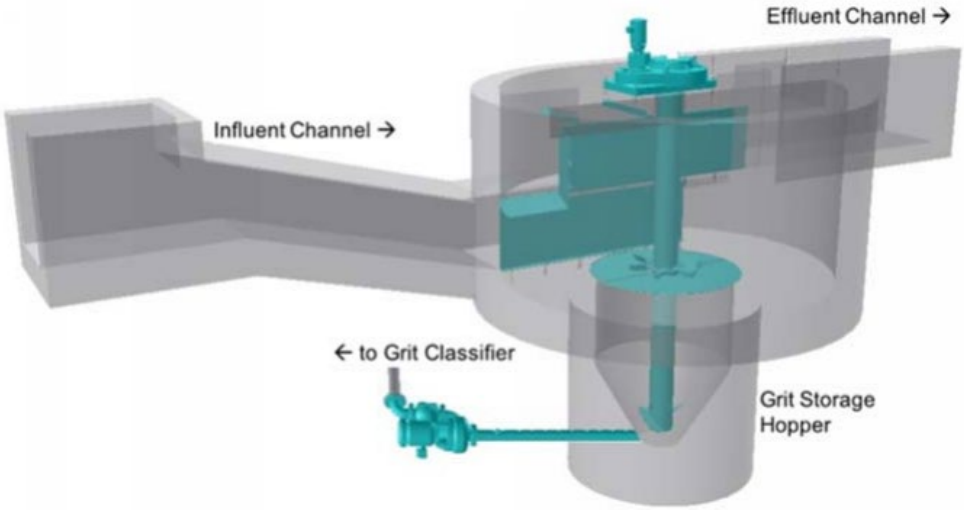
- Wipes
- Rags
- Food Waste
- Sanitary Napkins
- Plastics



Screenings (0.04 to 0.25 in)

Preliminary/Primary Treatment

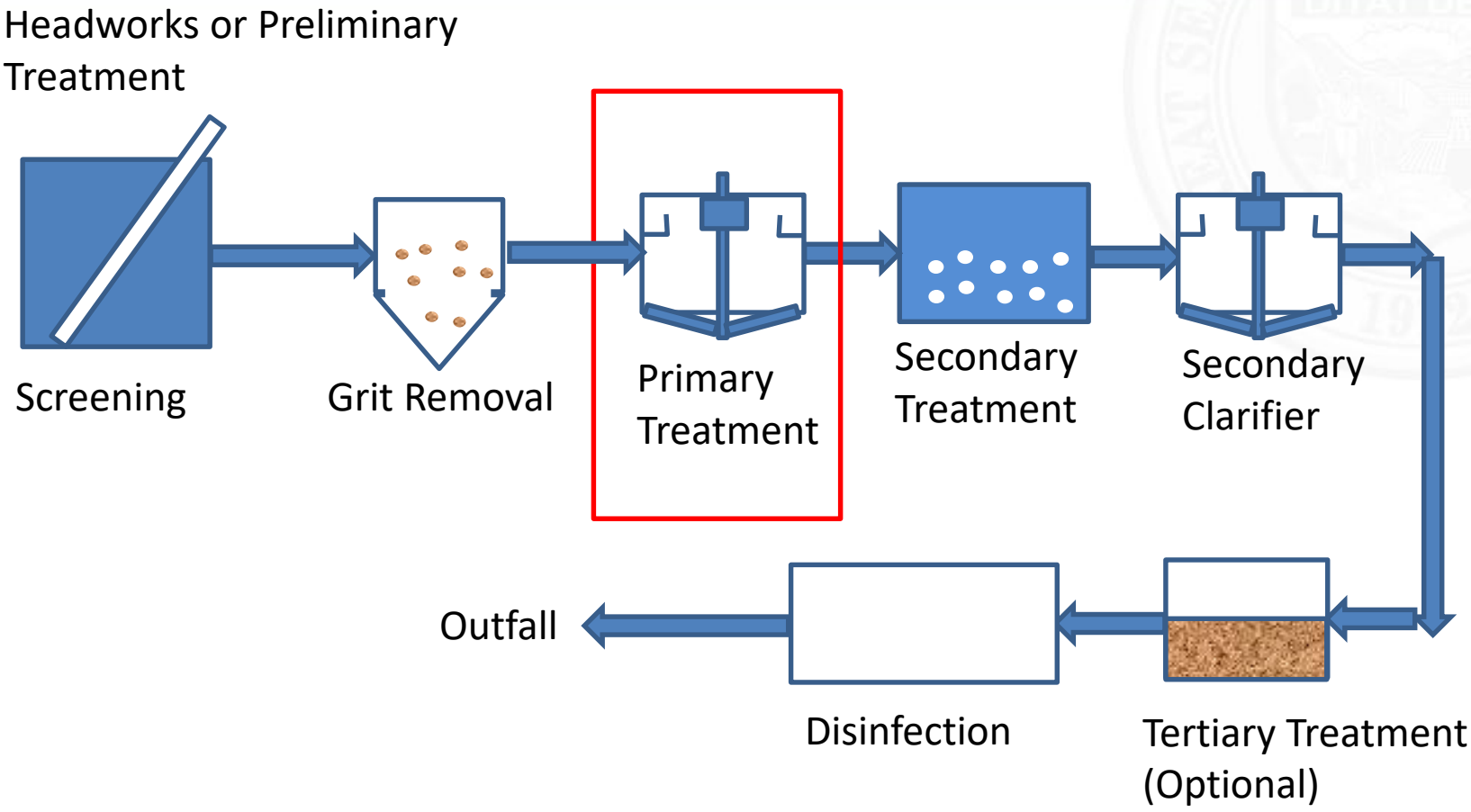
Grit Removal System



Removes 60-90% of inert solids

[WSEC-2017-FS-021 MRRDC LSF Grit Removal_v2.pub (wef.org)]

Preliminary/Primary Treatment

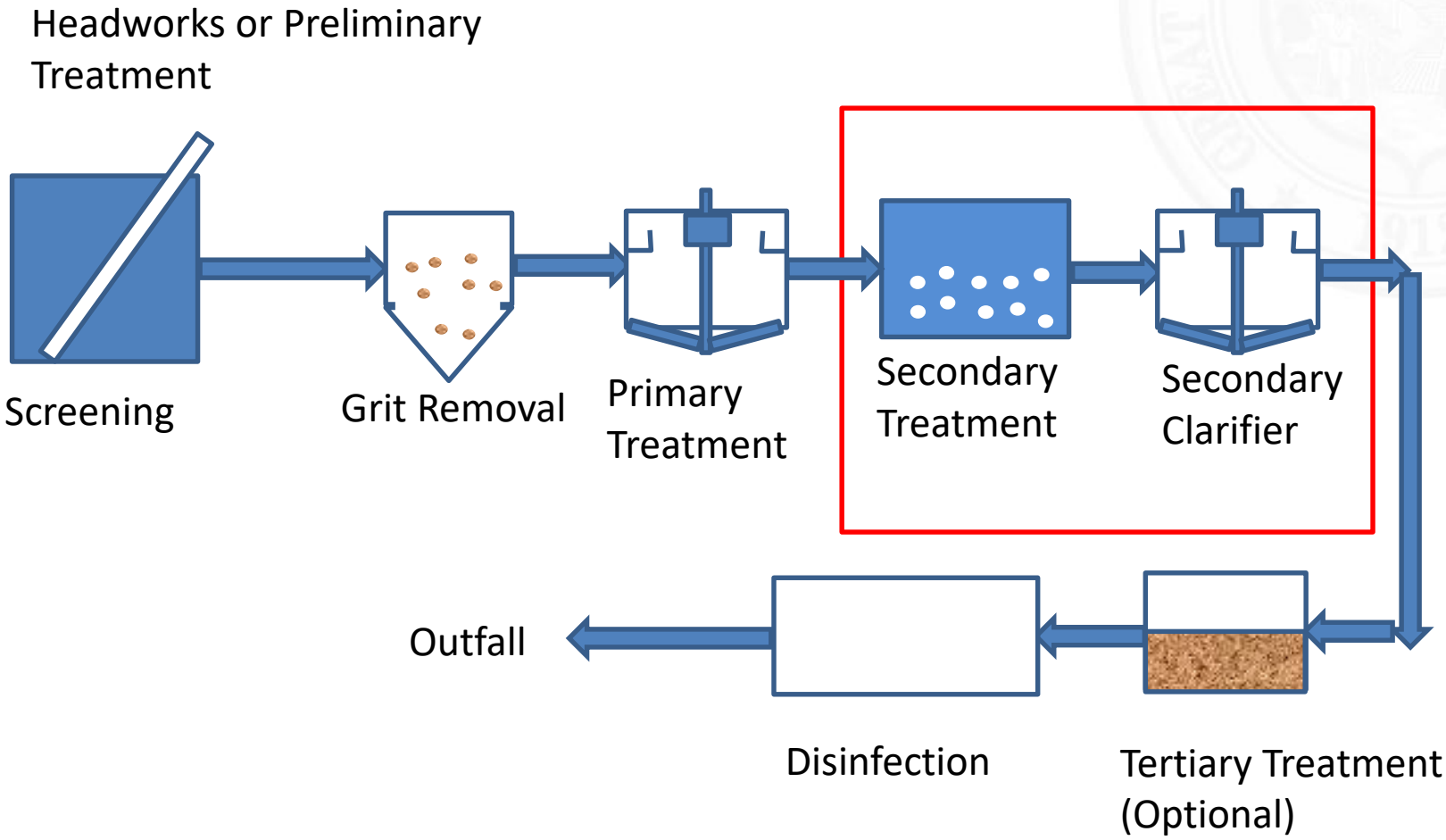


ADEQ Arizona Department of Environmental Quality

Primary Clarifier

- Reduce BOD Demand (25 to 35%)
- Removes Settleable Solids (50 to 65%)
- Remove Floatable Solids

Secondary Treatment



Secondary Treatment (Biological)

- Removes BOD, TSS, ammonia, and phosphorus depending on the design
- Type of Biological Treatment
  - Ponds/Lagoons
  - Trickling Filters
  - Activated Sludge
    - Oxidation Ditches
    - Aeration Basins
    - Sequence Batch Reactors

Secondary Treatment - Ponds/Lagoons

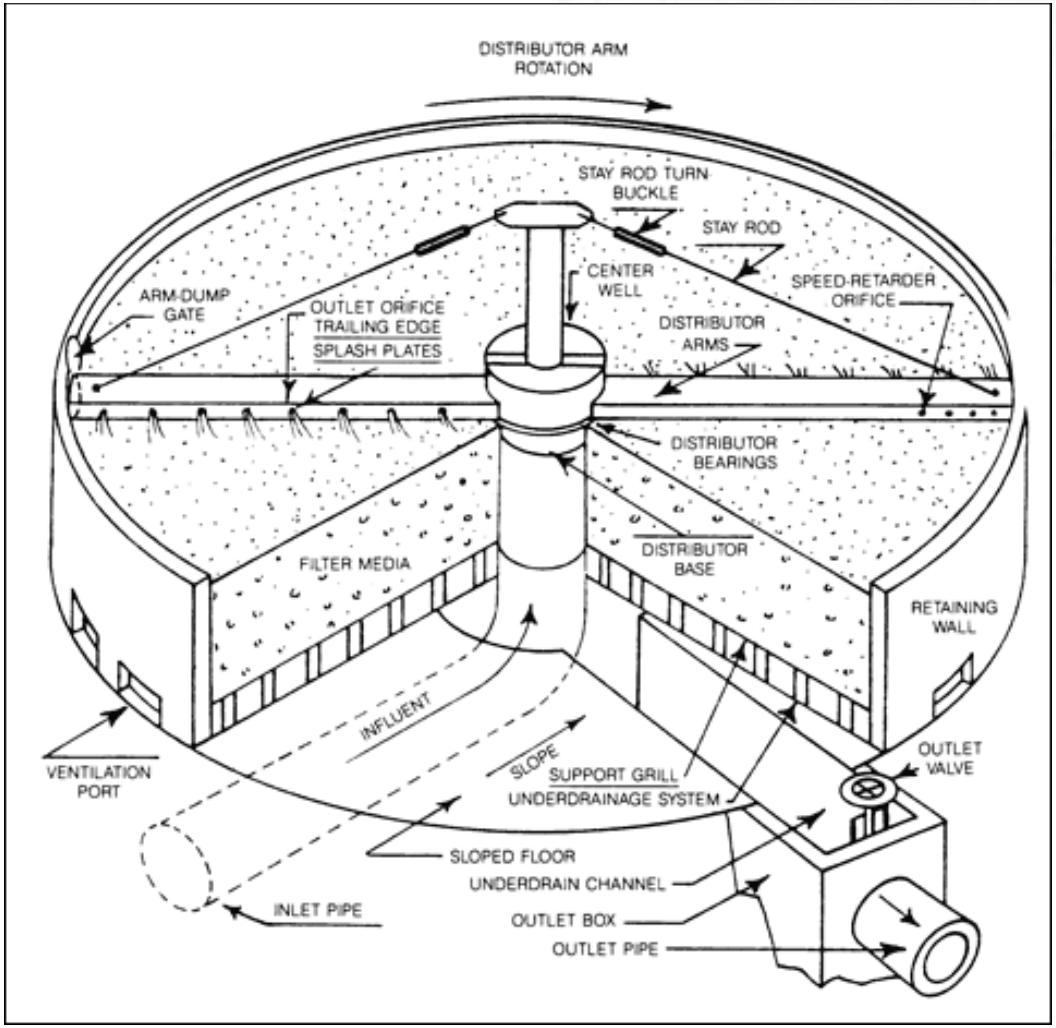
- Large lined earthen structures that include mixers and aerators
- Aerobic, facultative, or anaerobic
- Designed to remove BOD and TSS
- Treat domestic, industrial, and agricultural waste

Secondary Treatment - Ponds/Lagoons

- Physical, biological, or chemical processes
- Water can exit ponds/lagoons by evaporation, percolation or discharge
- Detention time can range from 3 days to 6 months
- Large volume so handles variable flow.

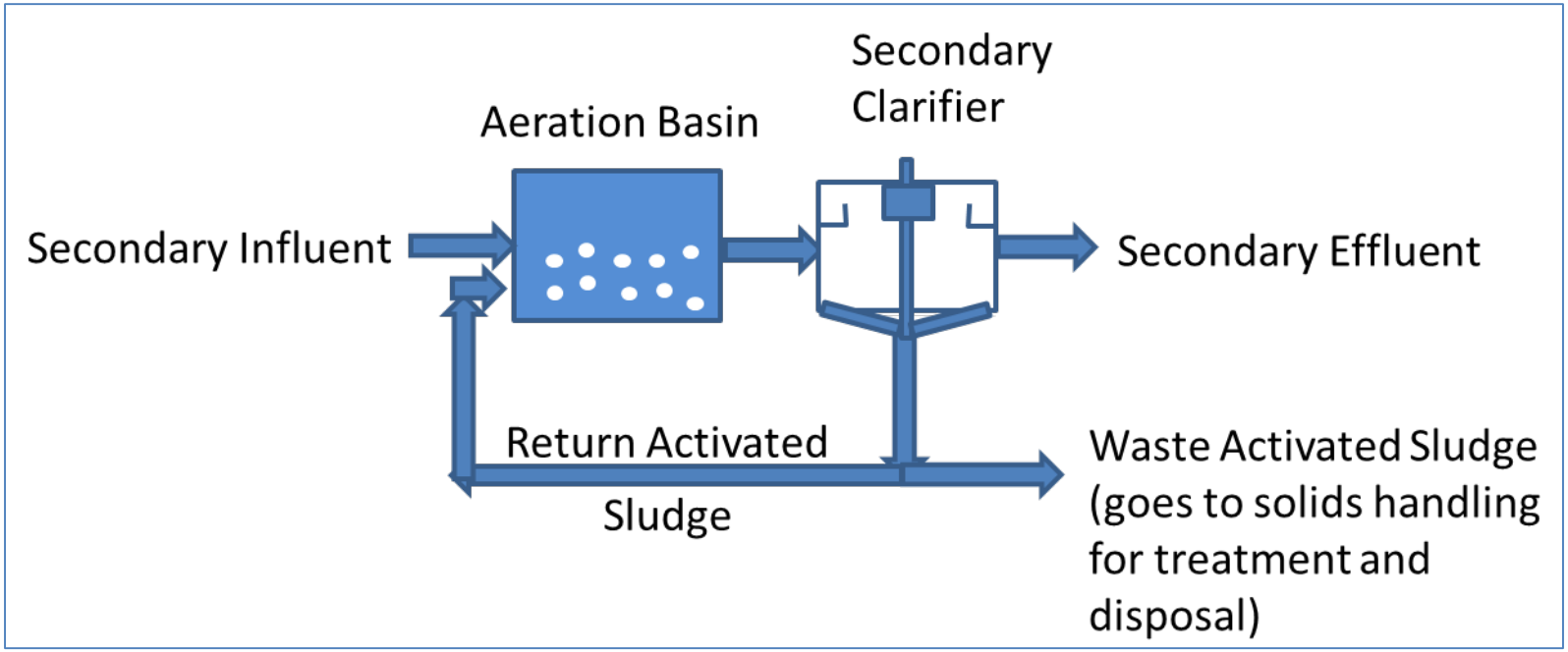
Trickling Filters/Biotowers

- Cylindrical, rectangular, or square
- Media of stone or plastic
- Wastewater is sprayed over the media and forms a slime
- Aerobic and facultative bacteria grows in the slime and oxidizes the waste
- Designed to remove TSS and BOD
- Limited ammonia removal.



Activated Sludge Treatment

- Mixed-Liquor Suspended Solids (MLSS)
  - Solids in the Aeration Basin
- Returned-Activated Sludge (RAS)
  - Sludge Returned from the Clarifier to the Aeration System
- Waste-Activated Sludge (WAS)
  - Sent to a Digestor or Drying beds



Activated Sludge Key Terms

- Sludge Age
  - Average amount of time sludge stays in the wastewater treatment plant.

$$SRT = \frac{MLSS\ in\ Aeration\ Basin, lb}{TSS\ effluent\ \left(\frac{lbs}{day}\right) + WAS\left(\frac{lbs}{day}\right)}$$

  - Sludge age determines type of bacteria that are present in the activated sludge system
  - Typical sludge age:
    - 3-5 days for BOD/TSS Removal (Poop)
    - 5-15 days for ammonia removal (Pee)

Mixed Liquor Suspended Solids

Returned Activated Sludge

ADEQ Arizona Department of Environmental Quality

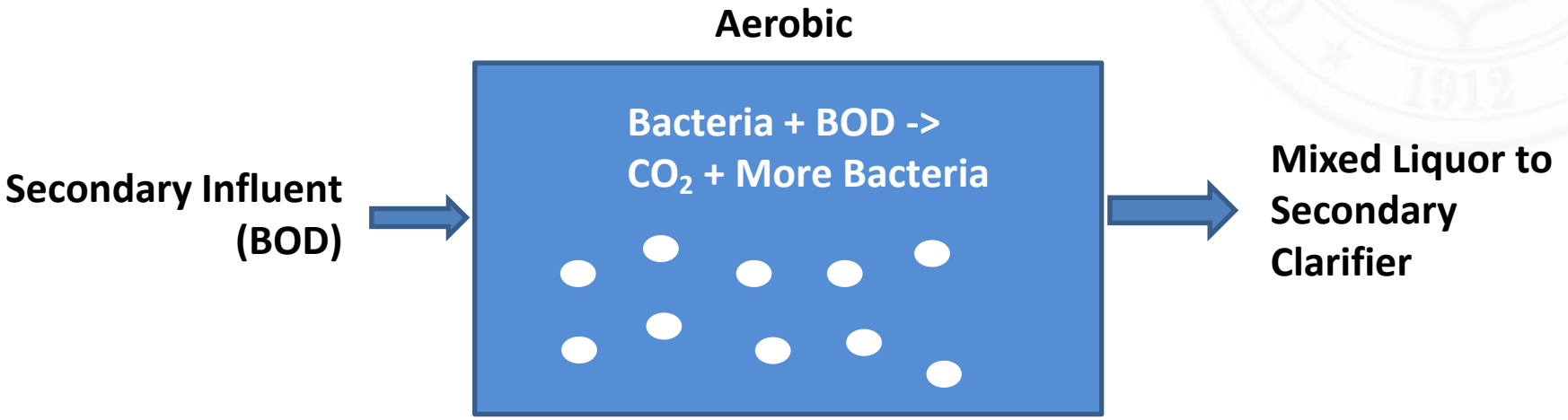
#2 Solids Stream (Poop)

- Organics - Food source for the microorganisms
- Microbes consume organic solids and produce bacterial biomass in “flocs”
- The floc is settled out and removed by secondary clarifiers

How it works

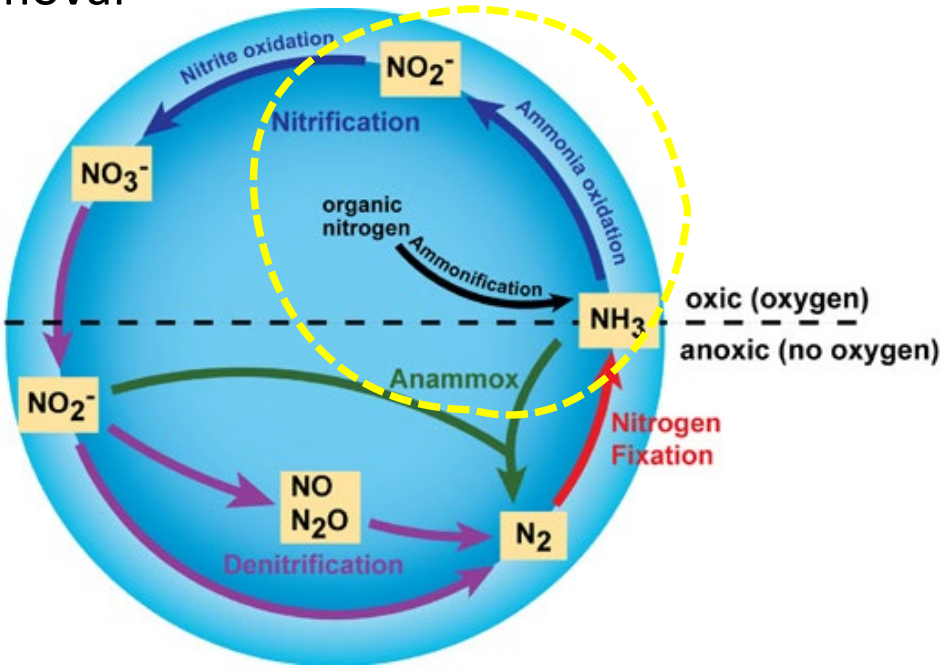
- Microorganisms
  - Aerobic (with oxygen)
  - Facultative anaerobe (lives with or without oxygen)
  - Anoxic (without oxygen but nitrate or nitrite are present)
  - Anaerobic (no oxygen or nitrate/nitrite present)

Standard Activated Sludge Configuration



- #1 Liquid stream (Ammonia)

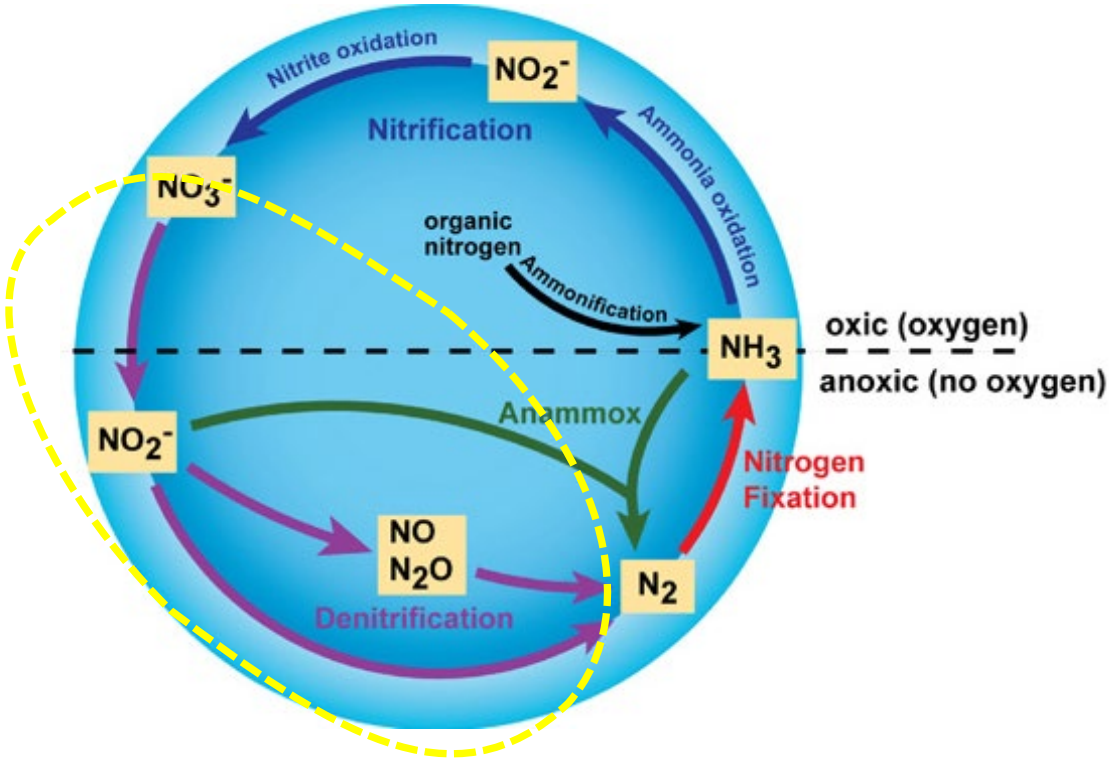
- Nitrification
- Aerobic microorganisms convert ammonia to nitrites-nitrates.
  - $NH_4^+ + O_2 \rightarrow NO_2^-/NO_3 + H^+$
  - Process consumes 7.1 g alkalinity per 1 g of ammonia oxidized, which can impact pH
  - Nitrifying bacteria prefer pH near neutral for performance
  - pH < 6.5 can inhibit ammonia removal

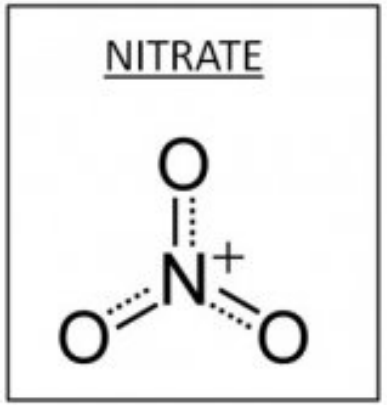


Activated Sludge

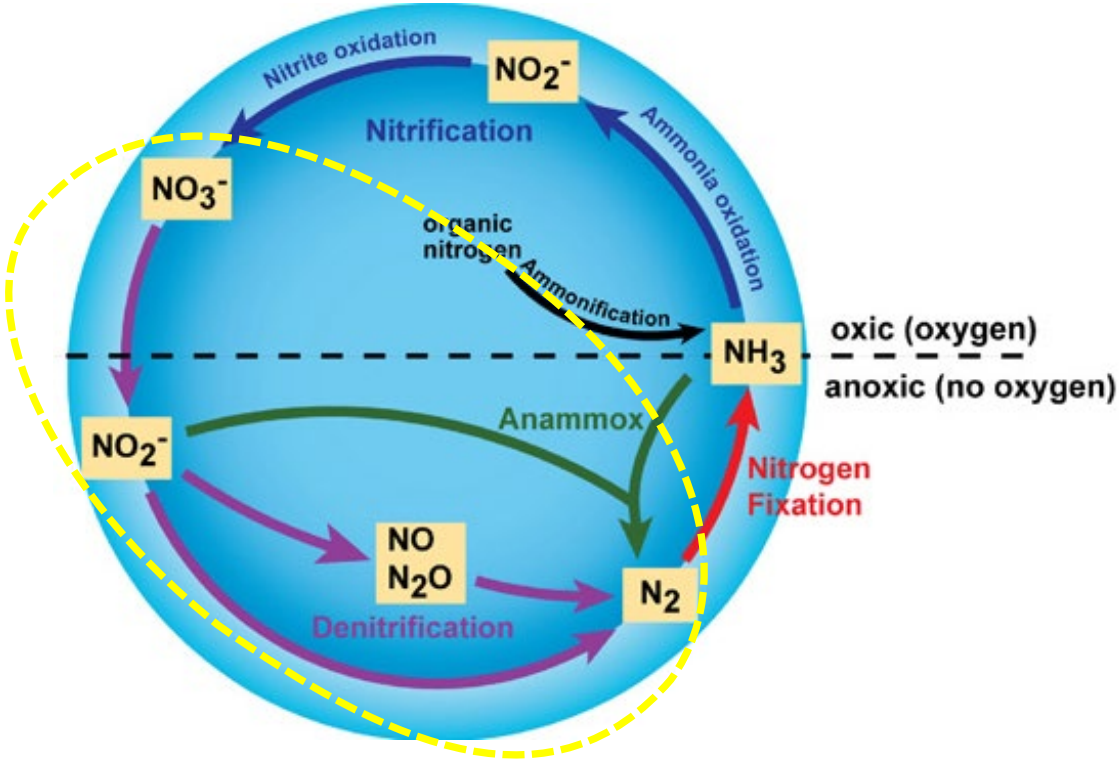
- #1 Liquid stream (Ammonia)

- Discharging nitrates back into the environment can be a problem
- We have to break the nitrate molecule down

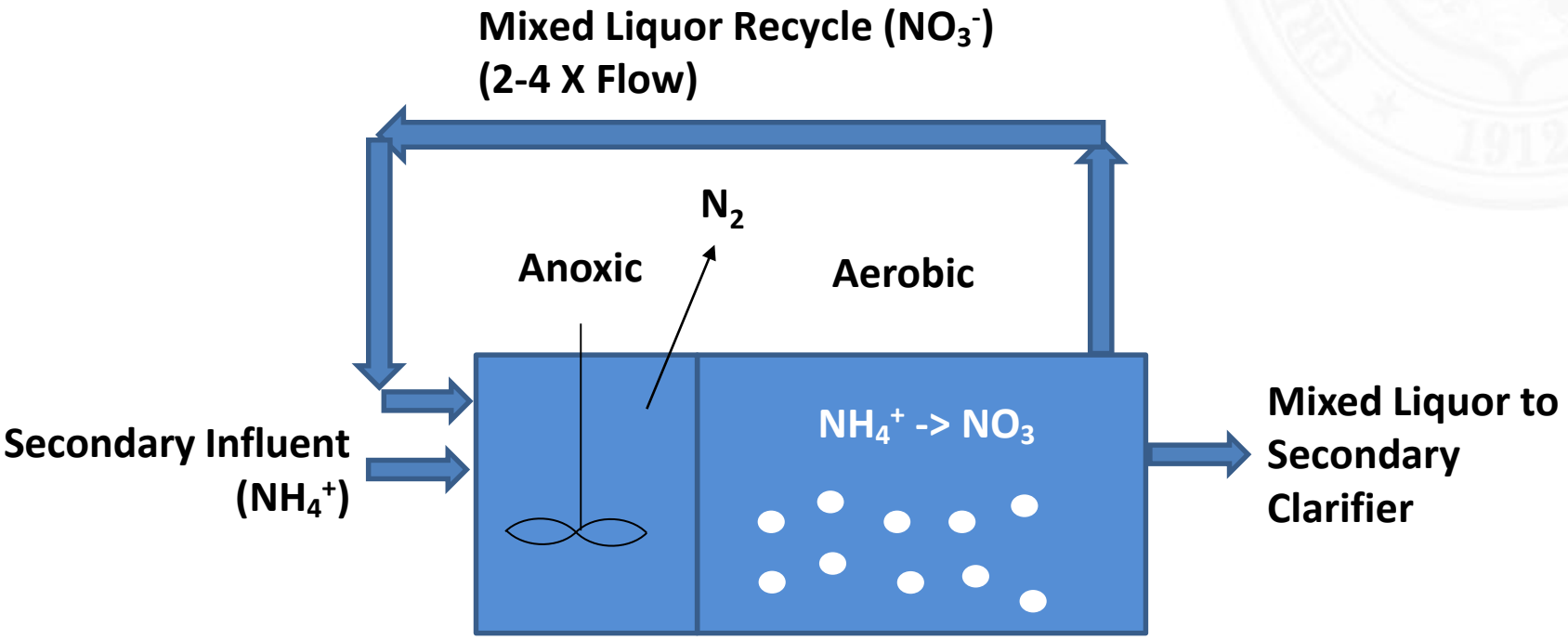




- Denitrification
  - Anoxic microorganisms break down the nitrates into nitrogen gas
  - NO_3 + Organic matter → N_2 + H_2O + Bicarbonate
  - Produces 3.55 g of Alkalinity per 1 g of nitrite reduced



Biological Nitrogen Removal



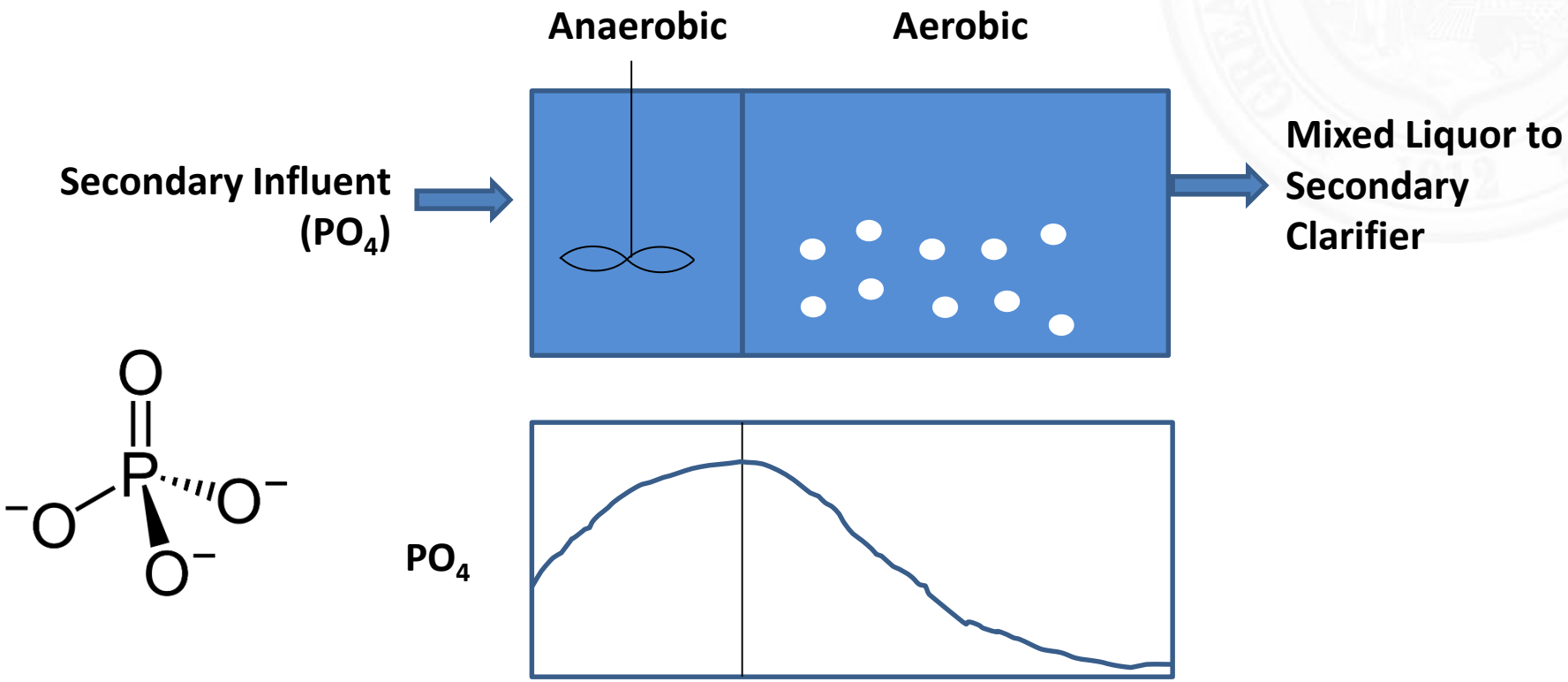
Activated Sludge

Anoxic (De-Nitrification)

Aerobic (Nitrification)

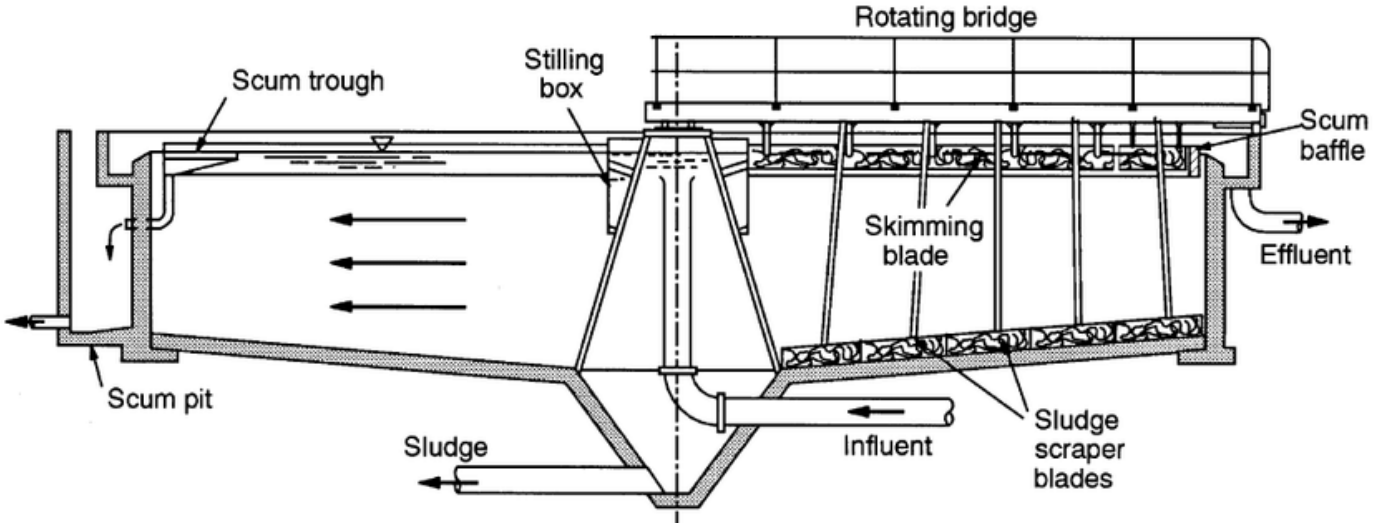
Pictures of Activated Sludge System

Biological Phosphorus Removal Configuration



Phosphorus stored inside Polyphosphate Accumulating Bacteria that are removed during wasting

Secondary Clarifier



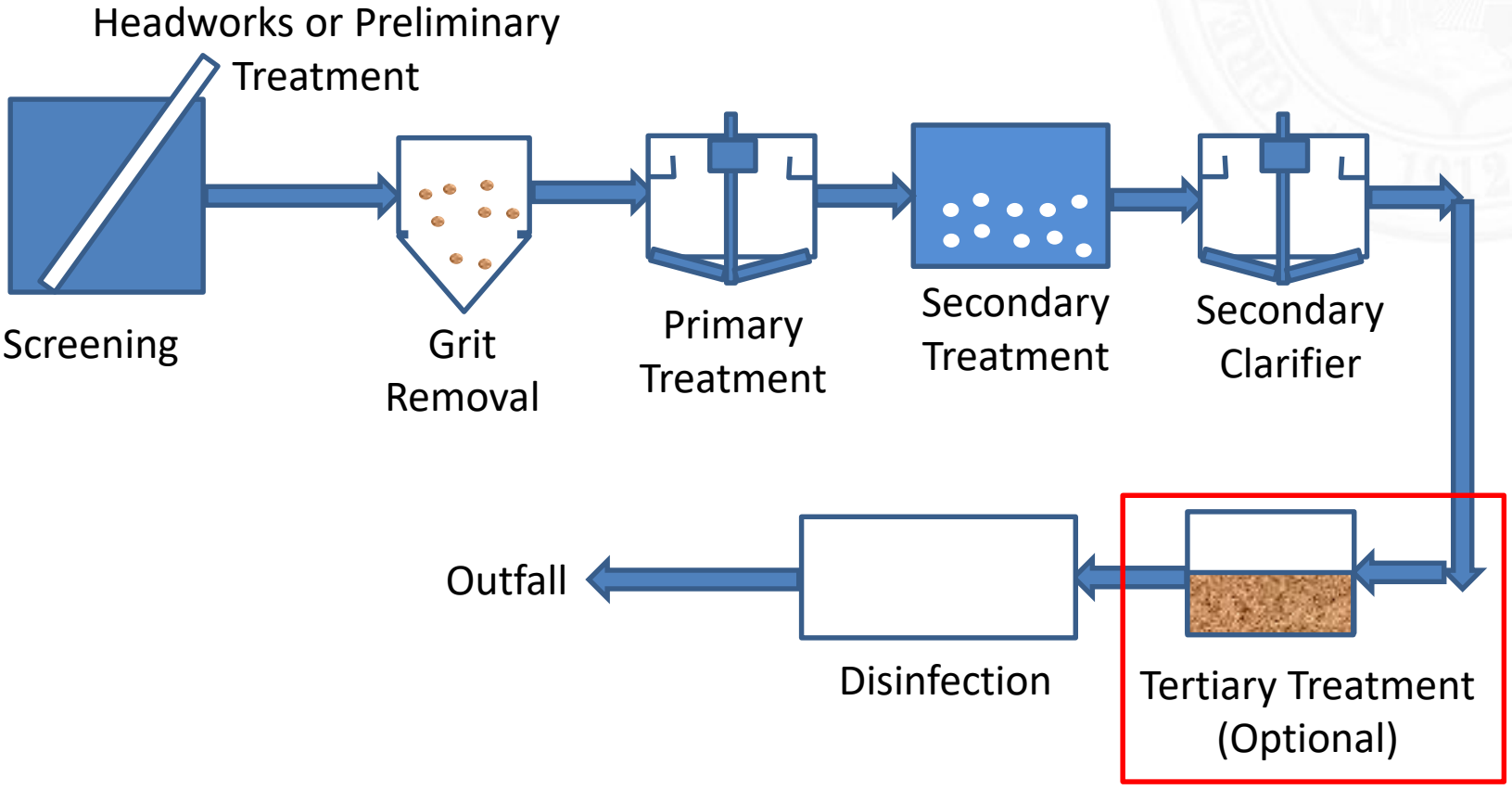
Secondary Clarifier Design Parameters

- Solids Loading Rate (SLR)
  - SLR = MLSS Biomass (lbs/day) / Surface Area (sf)
- Surface Overflow Rate (SOR)
  - SOR = Flow Rate (gpd/day) / Surface Area (sf)
  - Typical Range
    - Average Design = 800-1,200 gpd/sf
    - Peak Design = 2,000 – 3,000 gpd/sf
- Weir Loading Rate
  - Range: 10,000 - 40,000 gpd/lf.

Sequence Batch Reactor (SBR)

- Fill and Draw (All in One)
  - Idle
  - Fill
  - React
  - Settle
  - Draw
- Requires Equalization Basin

Tertiary Treatment (Optional)



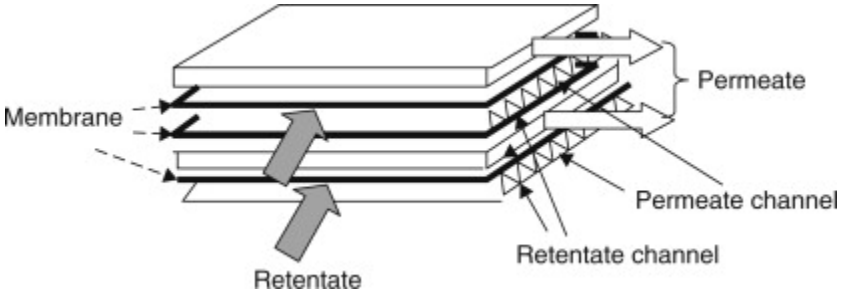
Sand Filtration

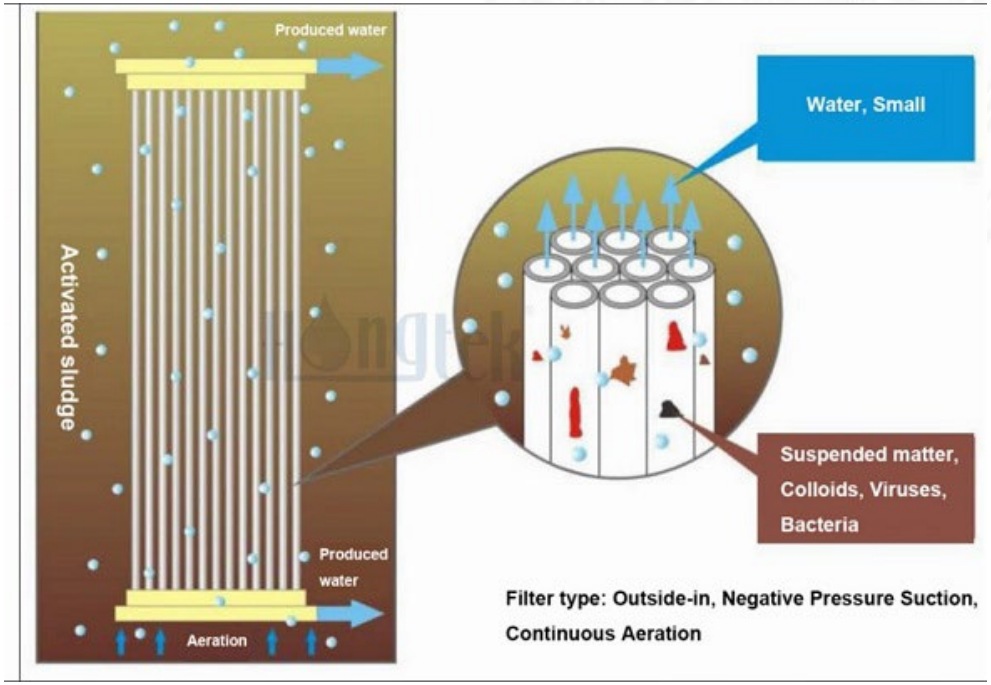
Cloth Filtration

Membrane Bioreactor

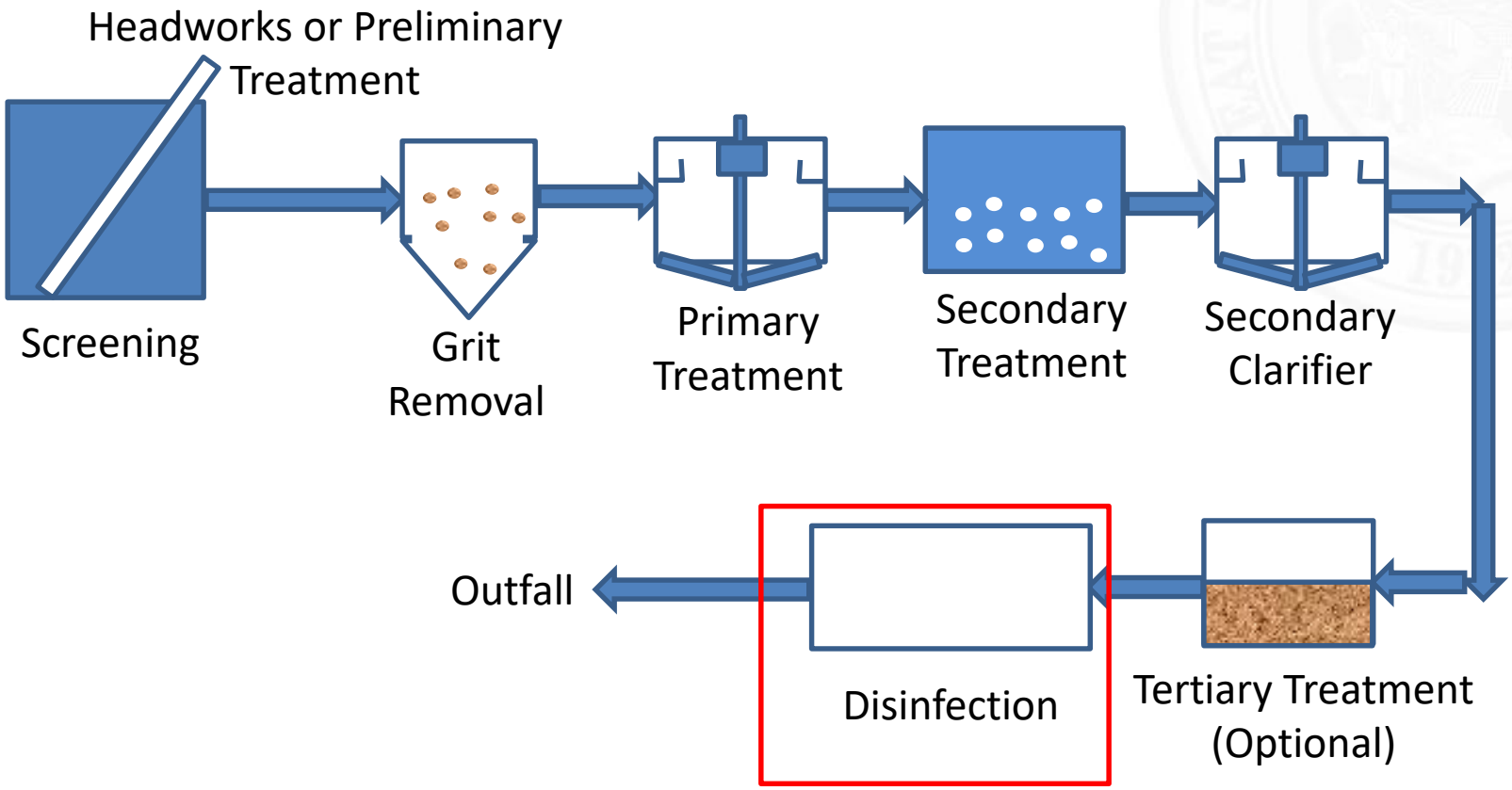
Advanced Treatment

- Membranes
  - Hollow Fiber
  - Flat Sheet
- Water Reclamation





Disinfection



Disinfection Basics

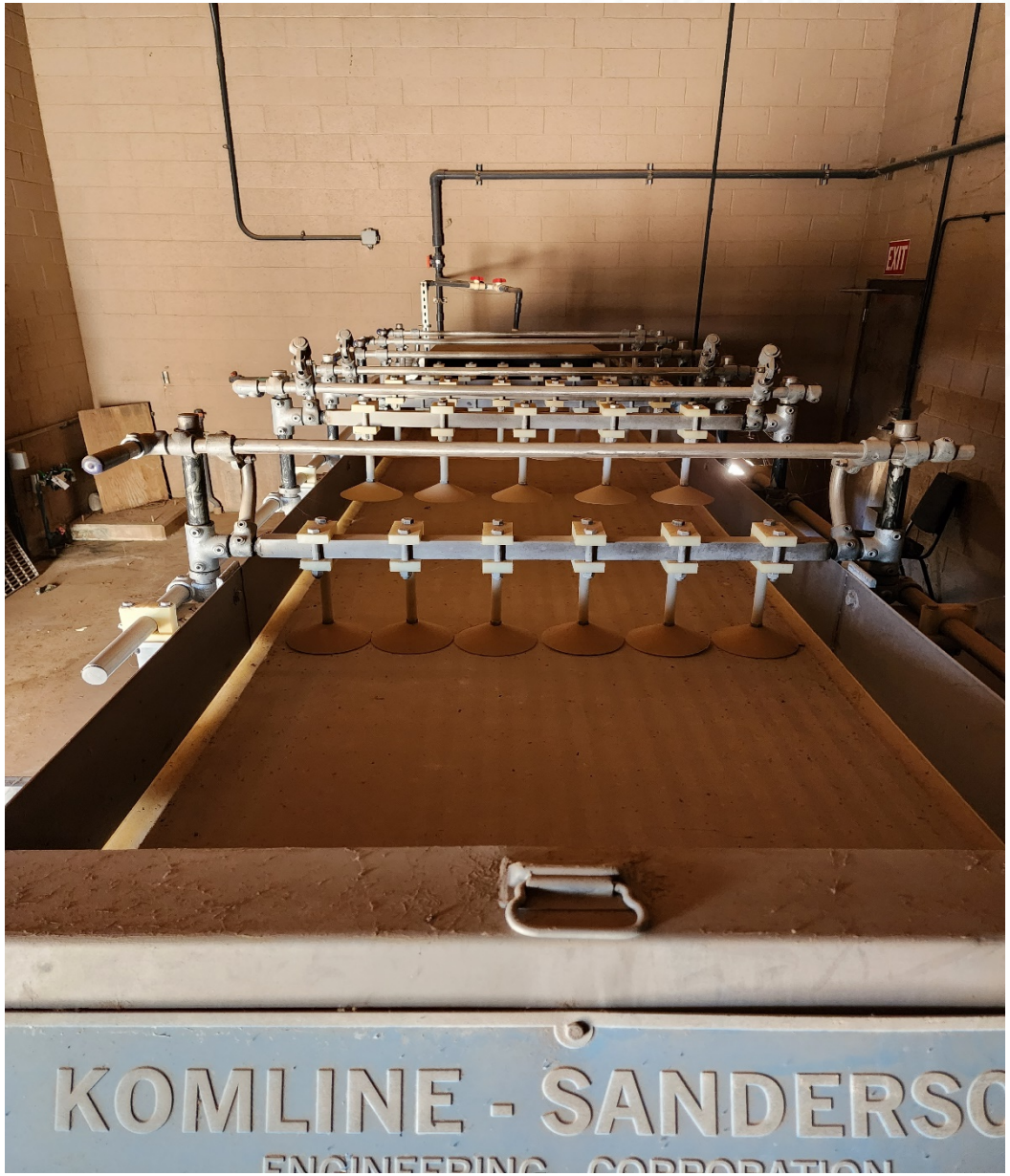
- Process to remove pathogens from wastewater
- Typical Target Organisms include:
  - Fecal Coliform
  - Total Coliform
  - E. Coli

Disinfection Basics

- Treatment Options
  - Chlorine Contact Tank
  - Ozone Disinfection
  - UV Disinfection
- Design Parameters
  - Performance measured by two variables
    - Concentration/Dose
    - Time

Solids Handling

- Sludge Thickening
  - Gravity Thickeners
  - Rotary Drums
- Sludge Digestion
  - Aerobic
  - Anaerobic
- Sludge Dewatering
  - Sludge Drying Beds
  - Screw Press
  - Belt Filter Press



Biosolids

- Semisolid, nutrient-rich product known as biosolids
- Must meet federal and state requirements
- Class A and Class B biosolids
- Biosolids are used for multiple land application
  - Agriculture
  - Forestry
  - Lawns and gardens
  - Reclamation sites

ADEQ Arizona Department of Environmental Quality

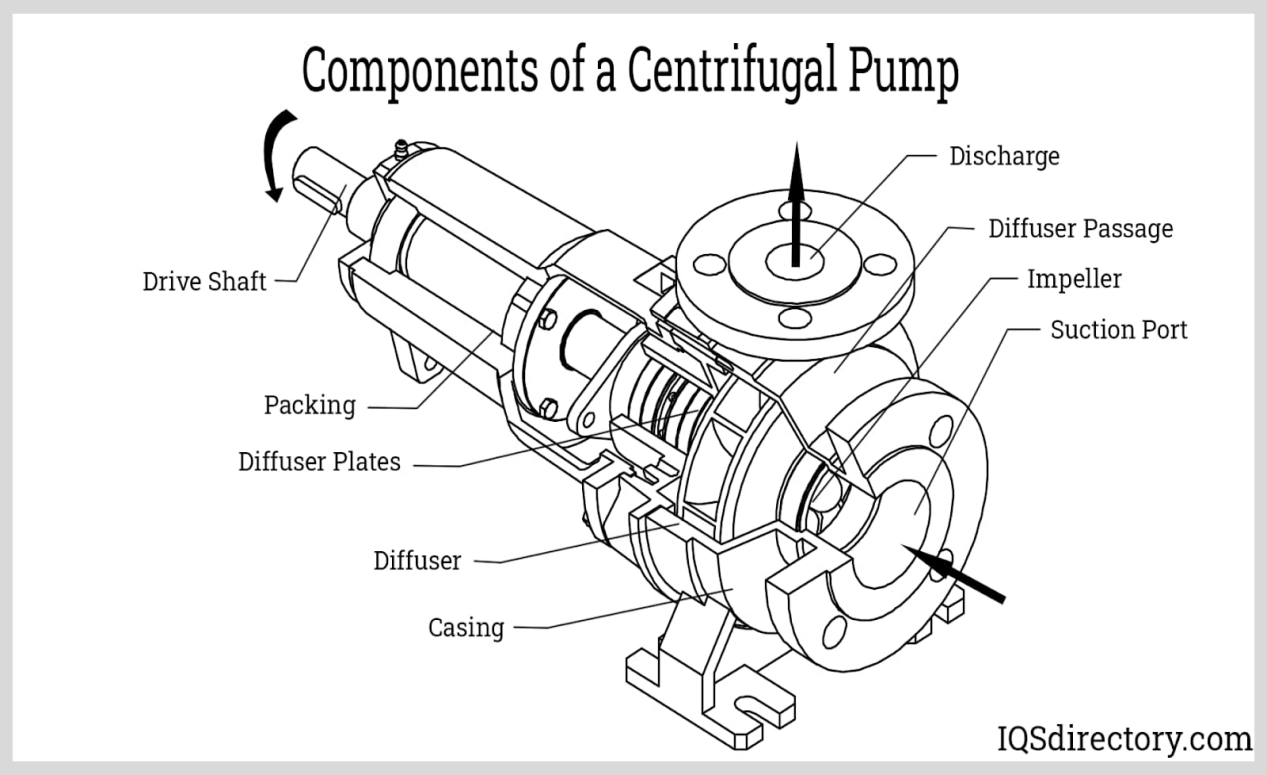
MAINTENANCE

Maintenance

- Types
  - Preventative - activities performed on equipment or systems in working condition
  - Predictive - uses data as equipment or systems are operating to identify preemptive maintenance activities
  - Corrective- (Repair) performed to restore equipment or systems that are not operating as intended.

Centrifugal Pump

- Hydraulic machine that changes mechanical energy into hydraulic energy by the use of centrifugal force acting on the fluid



https://www.iqsdirectory.com/articles/centrifugal-pump.html

Positive Displacement Pump

- Progressive Cavity Pump

  Mechanical device that displaces a known quantity of liquid for every revolution

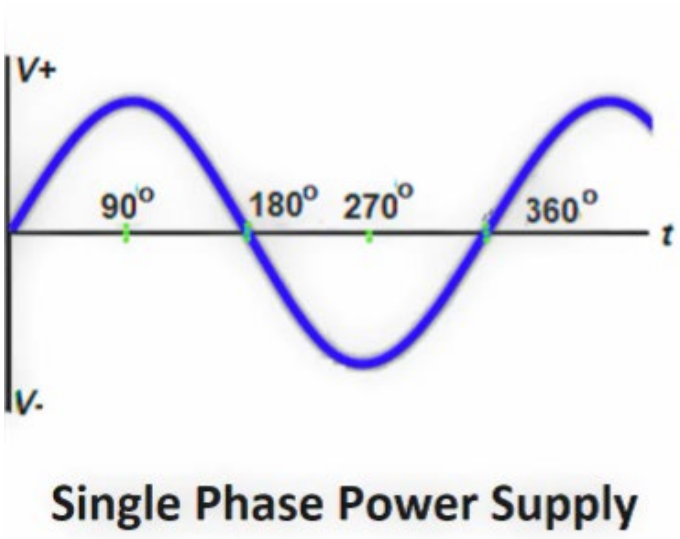
https://www.google.com/search?q=moyno+displacement+pump

Electric Motors

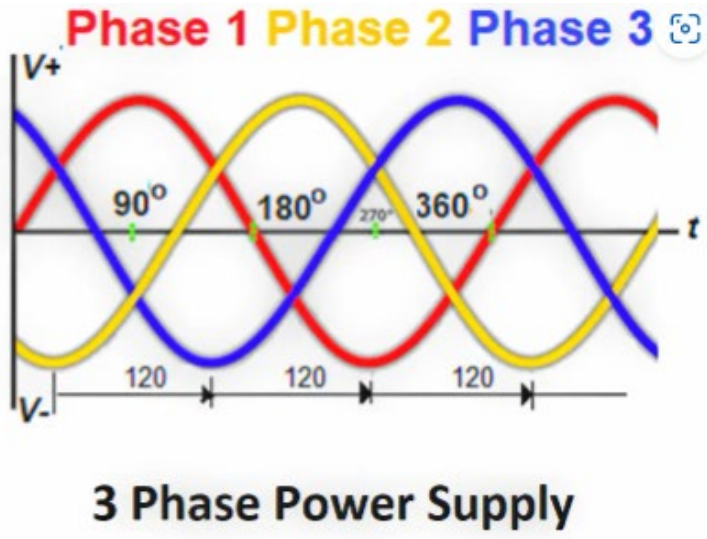
- Machines used to convert electrical energy into mechanical energy
- Drive equipment such as pumps, valves, compressors, and other equipment
- Must be properly aligned to prevent excessive vibration and wear and tear
- Require minimal maintenance such as lubrication and keeping them free of accumulated dirt to prevent overheating

Electric Motors

- 1-Phase
  - Low starting torque
  - Requires external startup devices
- 3-Phase
  - High starting torque
  - Does not require external startup devices



Single Phase Power Supply



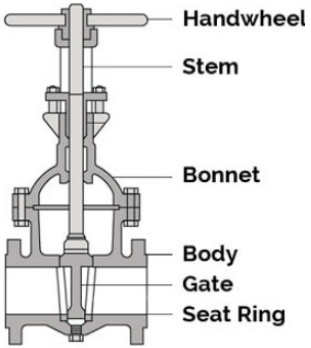
3 Phase Power Supply

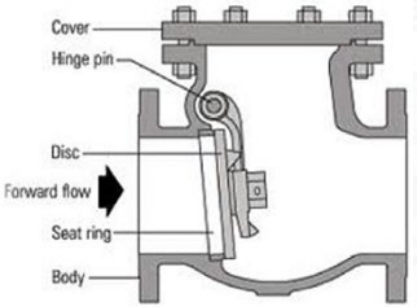
Difference between Single-phase and Three-phase Power (instrumentationtools.com)

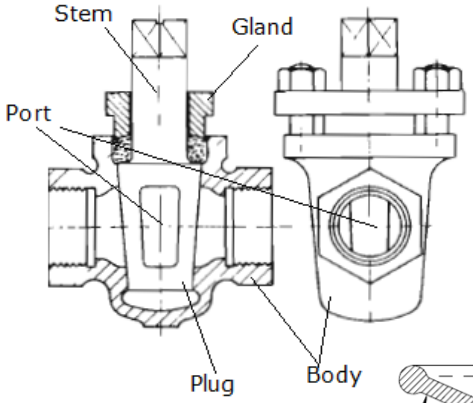
Valves

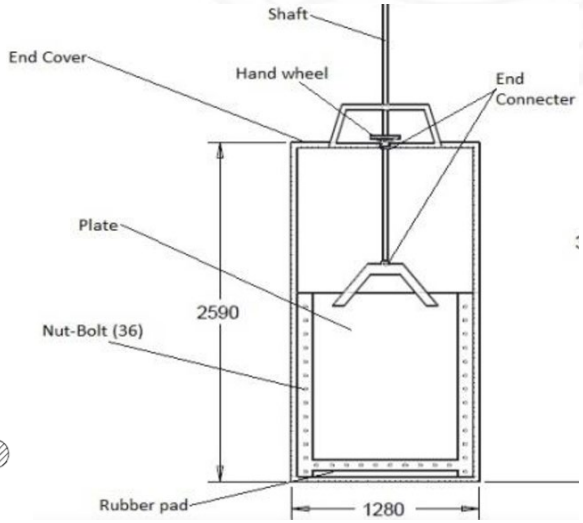
Types

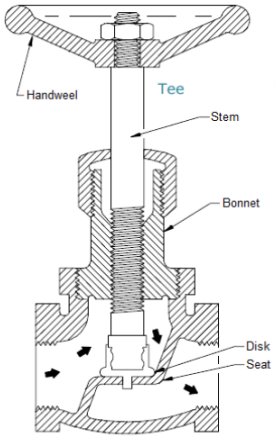
- Gate Valves
  - Rising Stem
  - Non-Rising Stem
- Check Valves
- Plug Valves
- Sluice Gates
- Globe Valves
- Pressure Relief Valves

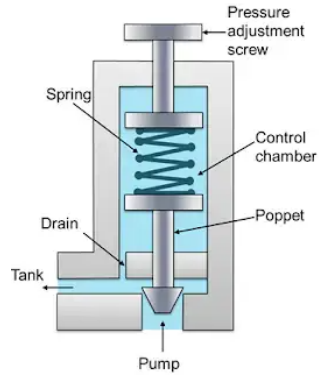












Valves

- Valves are used to control flows (Start, Stop, and Direct)
- Gate Valve - Fully open or closed. Used to start or stop flow
- Globe Valve - Used to throttle flow. They can be partially opened or closed
- Check Valve - Permits flow in only one direction

Valve Maintenance

- Exercising
- Replace packing
- Replacing worn or damage parts
- Cleaning/Removing deposits
- Lubrication
- Resurfacing

https://www.ussaws.com/the-importance-of-valve-exercise/

Flow Meters

Flow measurements are necessary to determine volume of wastewater flowing in, through, and out of plant, as well as volume of treatment chemicals and waste streams

- Open channel - parshall flume
- Rotometer - measuring gases
- Magnetic meters - used to measure pipeline flows

Parshall Flume

Rotometer

Sensors

- Level
- Pressure
- Temperature
- Position
- Turbidity
- Chemical

Sensors

- Level – Water Level (How tall you are)
- Pressure – Water or Pump Pressure (Blood Pressure)
- Temperature– Water and Equipment (Body Temperature)
- Position – Valve open or closed, Pump on or off (Posture)
- Turbidity – Water clear or cloudy (Check your eyes)
- Chemical – Contaminants/Constituents (BAC/THC)

Sensors

Pressure

Temperature

WATER QUALITY SAMPLING AND SAFETY

11:00 – 12:00 PM

Water Quality Sampling

- Why collect samples at a wastewater treatment plant?

  To be compliant with:

  - NPDES permit
  - APP
  - AWQS
  - Secondary treatment standards
    - Effluent limitations for TSS, BOD_5, or $CBOD_5$
  - Combined sewer overflows
  - Sanitary sewer overflows
  - National pretreatment program
  - Biosolids

NPDES Permit

- NPDES permit may also specify:
  - Monthly average and maximum levels of TSS
  - BOD
  - pH values
  - Oil and Grease
  - Most probable number (MPN) of coliform bacteria
  - Effluent temperature and loadings
  - Bioassays (measure of effluent toxicity)
  - Sampling frequency and reporting results methods

Water Quality Sampling

- Process control and troubleshooting
  - Tracking water quality and quantity:
    - Provides information if processes are performing correctly
    - Allows operators to make proper process adjustments
    - Provides information needed to troubleshoot problems
  - List of parameters monitored:
    - Varies from plant to plant (depending on treatment process used)
    - Parameters to be considered useful

Typical Water Quality Parameters

- For plant influent
  - BOD, COD, TOC
  - Solids – TSS and settleable
  - Temperature
  - Oil and Grease
  - pH
  - Alkalinity
  - Nitrogen – ammonia, nitrate, total
  - Phosphorus
  - Heavy metals
  - Hydrogen sulfide dissolved in water

Monitoring Water Quality

- Operators monitor water quality
  - For plant operations
  - To demonstrate compliance with regulations
- Importance of representative sampling:
  - For accurate and meaningful monitoring
  - Poorly chosen samples can lead to incorrect decisions on how to operate the plant
  - Difficulty in meeting permit requirements

Elements of a Sampling Program

- Defining a monitoring purpose
- Ensuring representativeness
- Sampling properly
- Handling the sample properly after collection

Industrial Water Sampling and Analysis - Scientific Control Laboratories (sclweb.com)

Common Monitoring Goals

- Demonstrate regulatory compliance
  - Need daily average concentrations
  - Use of composite samples
- Maximum or minimum concentrations
  - To adjust plant operation
  - Series of samples at different times
- Monitor the effluent
  - Need a daily flow-weighted composite sample in a plastic bottle
  - Sample cannot be used for oil and grease
  - Sample cannot be used for bacteria counts
- Average temperature in a pond/lagoon in the summer
  - Need to collect samples at different pond/lagoon levels and mix them

Representative Samples

- Wastewater flows are complex
  - Vary in time of the day
  - Day of the week
  - Location within the plant
- Sample collected at any one time cannot be representative of the daily average
- All days are not the same
- Sample highly dependent on the sampling location
- If 1 gallon of sample is collected to represent a million-gallon flow
  - Careful selection of sample location and time

Representative Samples

- Mixing
  - Collect samples where waste stream is uniform in composition
  - Significant for higher solids concentrations
    - Solids tend to separate rapidly
    - Heavier solids settle toward the bottom of channels or tanks
    - Lighter solids reside in mid-depths
    - Floatable rise toward the surface
    - Less important for dissolved solids because they do not settle

Collecting Samples

- Grab samples (discrete samples)
  - Dissolved gases, bacteria, residual chlorine, temperature, pH
  - Must be analyzed immediately after collection
  - Single volume of wastewater taken at a single time and location
- Composite samples
  - Prepared by collecting grab samples throughout the day or from multiple locations and mixing them in the same container
  - Results represent average characteristics
  - Should be flow-weighted
  - Proportional to the flow
    - High flows - large aliquots
    - Low flow - small aliquots
  - Use of continuous automated sampler

https://www.us.endress.com/en/field-instruments-overview/liquid-analysis-product-overview/automatic-water-samplers

Manual Grab Samplers

- Sampling equipment needs to be rinsed/cleaned out before each sample collection
- Dippers
  - Wide-mouth corrosion resistant mounted on long handles
- Weighted bottle
  - Collects water from a specific depth
  - At the specific depth, operator pulls a cord to open the bottle stopper and the container
- Adapted small pumps
  - Hand-operated, powered-suction, peristaltic pumps
  - Collection end of tubing placed at the desired depth

Small Pump

Automated Samplers

- Consist of a small computer, a pump, and a sample container
- Computer connected to a flow measuring device (flume or meter)
- Computer programmed so volume of each aliquot is proportional to the flow
- As an alternative:
  - All aliquots are the same but at different timing
    - High flows – more frequent aliquots
    - Low flows – less frequent aliquotes
- Sample containers need to be kept cold
  - Use of ice
  - Use of refrigeration equipment

Automated Sampler

Flow Sensor

Sampler Containers

- Sample bottle materials
  - Materials compatible with constituent being analyzed
  - Plastic being the most common, followed by glass
  - Glass containers - oil and grease and many organic substances
  - Microbial samples must be made of material that can be sterilized
- Proper sample containers and preservatives can be obtained from local laboratories

Preservative and Holding Times

Parameter	Preservative	Hold time
Alkalinity	4°C	14 Days
Ammonia Nitrogen	H_2SO_4 to pH<2, 4°C	28 Days
BOD_5/$CBOD_5$	4°C	48 Hours
COD	H_2SO_4 to pH<2, 4°C	28 Days
Conductivity	4°C	28 Days
Fecal coliforms	4°C	24 Hours
Hardness	HNO_3 to pH<2, 4°C	28 Days
Nitrate	4°C	48 Hours
Nitrite	4°C	48 Hours
Total Suspended Solids	4°C	7 Days
Total Dissolved Solids	4°C	7 Days
Total Solids	4°C	7 Days
Trace Metals	HNO_3 to pH<2, 4°C	180 Days

40 CFR – Part 136 (CODE OF FEDERAL REGULATIONS)

Water Quality Field Parameters - pH

- Indicator of hydrogen ion activity/concentration in the sample
  pH = - log [H+]
- Expressed in logarithms (log)
  - *"log" means pH of 3 is 10 times more acidic that pH of 4*
  - *pH of 3 is 1,000 times more acidic that pH of 6*
- High ion concentration – acidic
- Low ion concentration – basic or alkaline
- Ranges from 0 to 14
- pH <7 is acidic
- pH = 7 is neutral
- pH >7 is basic

https://www.sciencelearn.org.nz/resources/3019-acids-and-bases-introduction

pH Measurement

- pH paper
  - For quick pH determinations (not aceptable for regulatory compliance)
- pH meter
  - Usually required for permit compliance
  - pH meters need to be calibrated before use
  - pH sensors need to be maintained

pH paper - for qualitative measurements

pH meter - preferred method for permit compliance

Cleaning of pH sensors

- If electrode becomes contaminated, meter readings may become inaccurate, erratic, or unstable
  - Clean electrode by soaking in cleaning solution for 10 to 30 min.
  - Rinse with water (deionized, reverse osmosis, or distilled water)
    - Tap water can be used, but may cause static charge to build on electrode which will increase measurement errors
  - Never soak electrode in water for long periods of time
    - This will damage the electrode
  - Never wipe or rub electrode
  - After soaking in cleaning solution, it is necessary to rehydrate electrode

pH Sensor Hydration

- Hydration of pH sensors
  - The electrode must be properly hydrated
  - If electrode has been in storage for long periods of time, it should be rehydrated.
  - Soak the electrode in electrode storage solution for at least one hour to rehydrate it. In some cases, it may be necessary to soak the electrode overnight.
  - If storage solution is unavailable, pH 4 buffer solution can be used, although it is not as effective.

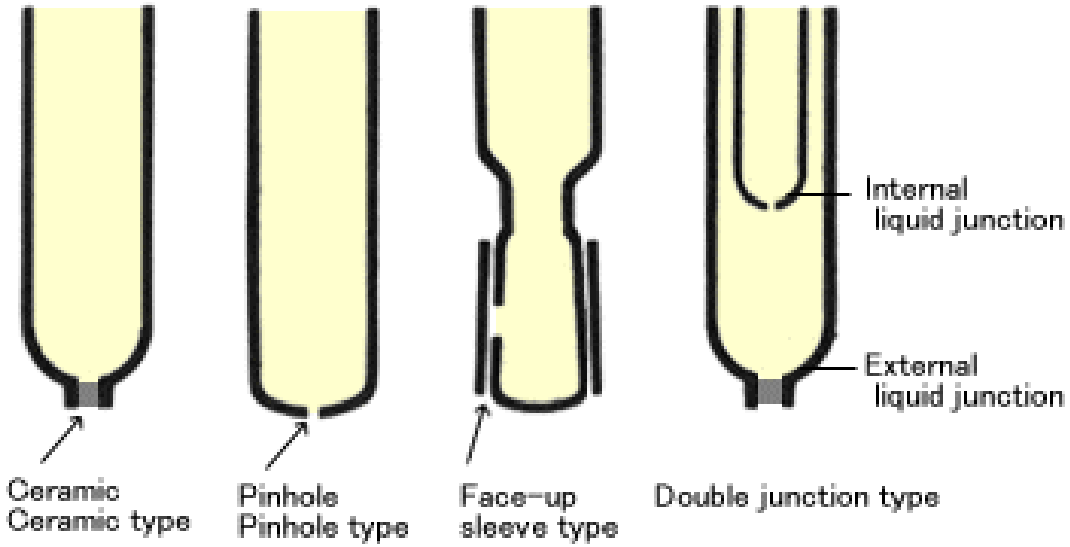
Hydration of a pH sensor

Calibration of pH Sensors

- Daily calibration before use in order to obtain an accurate measurement.
- The meter should always be calibrated when the electrode is replaced.
- If pH readings are unstable or erratic, clean and hydrate the electrode before calibration.
- Calibration of the meter is applied by use of standardized pH buffer solutions at the calibration points of 4, 7, and 10 pH.
- Always calibrate at pH 7 first, and then at 4 or 10, if desired.
- If your pH meter has automatic temperature compensation (ATC), the indicated pH value on the meter will be automatically adjusted according to the temperature of the solution. Allow enough time for temperature to stabilize before taking a reading.
- Consult your pH meter's manual for specific calibration procedures.
- Rinse the electrode before moving to the next buffer solution.

Additional Information

- Follow SOPs in permit requirements
- Additional guidance in [AZPDES/APP Field Testing Info]



Types of pH sensors

Samples in contact with sensor's internal solution

pH Importance

- pH between 6 and 8 desired for optimum microorganism activity
- Too high or too low pH can be corrosive and deadly to microbes
- Chlorine effectiveness depends on pH
- Ammonia is in “ammonium” form of NH_4^+ at medium and low pH values, which is non-toxic
  - Ammonia in the form NH_3 is toxic
  - NH_3 is a disolved gas that can create odors and is a health hazard
- Check your permit for required pH accuracy
  - Usually pH within +/- 0.1 units

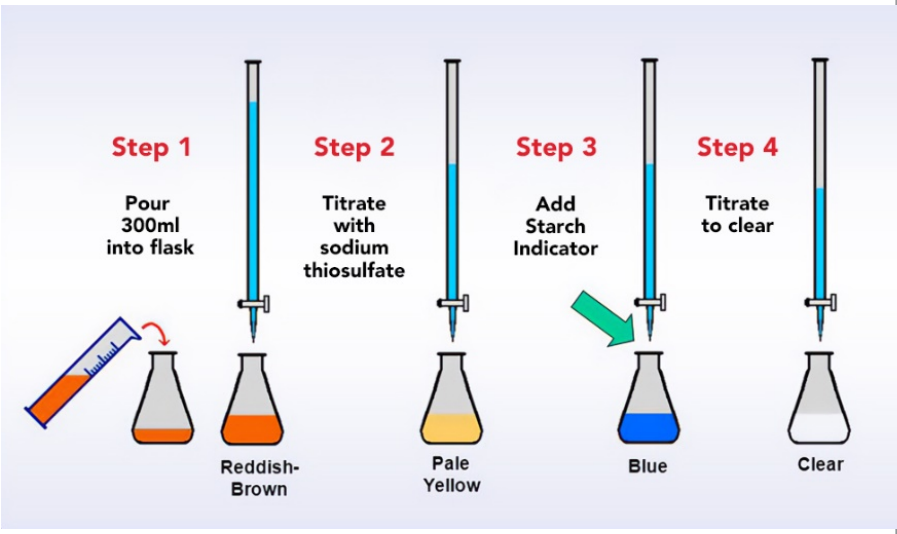
pH Adjustment Methodology

- Bases raise the pH:
  - Sodium Hydroxide (NaOH)
  - Potassium Hydroxide (KOH)
  - Calcium Hydroxide (Lime)
- Acids Lower the pH:
  - Sulfuric Acid (H_2SO_4)
  - Carbonic Acid ($H_2CO_3 – CO_2$)
  - Hydrochloric Acid (HCl)

Dissolved Oxygen (DO)

- Factors affecting dissolved oxygen:
  - As temperature rises, DO decreases
  - As pressure decreases, DO decreases
  - As salinity increases, DO decreases
- Recommended DO level in secondary wastewater treatment: 1- 2 mg/L
- Optimal DO for aquatic life: 8-9 mg/L
- Online monitoring
- DO levels are needed for BOD determinations
  - DO sensors
  - Winkler Method

DO Meter

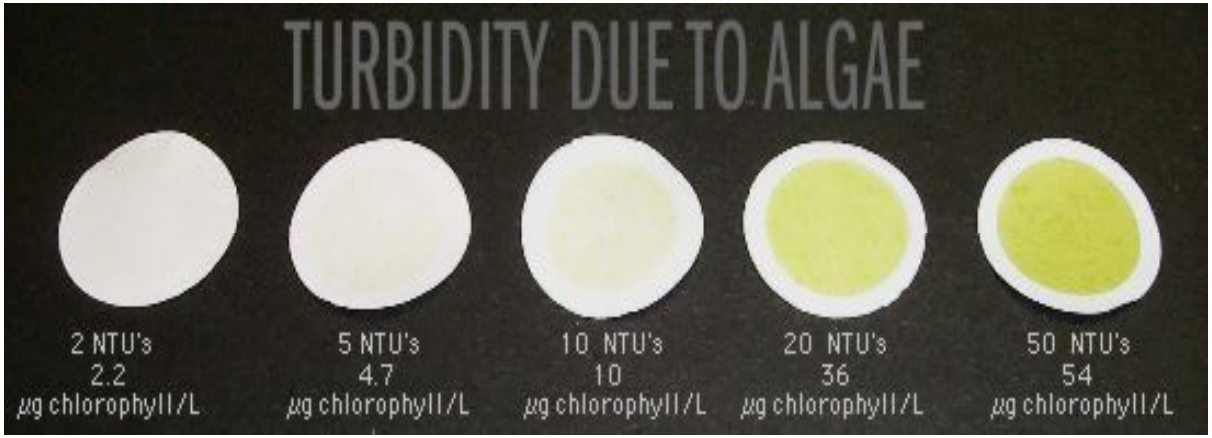


Typical Titration Procedure

Turbidity

- How much light is scattered by the sample
  - Causes of turbidity
    - Particles suspended in water
      - Clarity of the water
    - Particles scatter or reflect light rays
      - i.e., water appears cloudy
    - Can be organic and inorganic matter
  - How about total suspended solids (TSS)?
    - Suspended solids – weight of suspended material in the sample

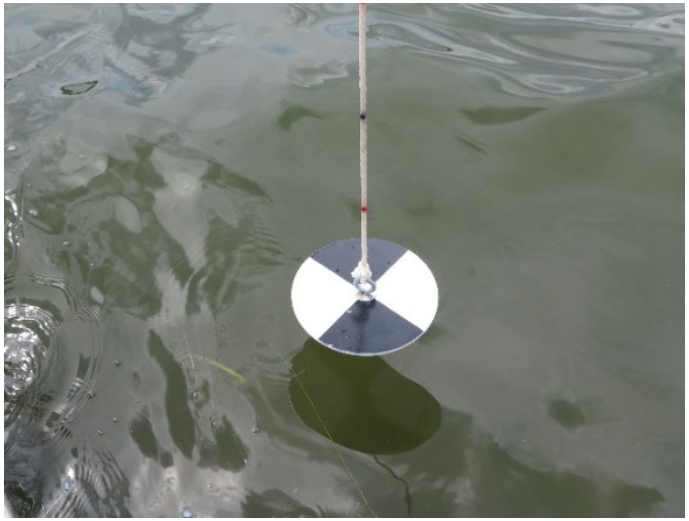
DON'T BE CONFUSED!!!!



Clarity – Secchi Disk

- Simple way to measure turbidity
- Secchi disk lowered into water until no longer visible, and that depth is measured
- Secchi depth values that are high indicate clearer water, and low Secchi depths indicate high turbidity
- Not a quantitative measure for process control
- Used to monitor:
  - Effluent channels or chlorine contact tanks
  - Upper layer of settling tanks
  - Treatment ponds
- Factors that affect the measurement
  - Ambient light
  - Operator perceptions

Typical Secchi Disk



Electrical Conductivity (EC)

- Numerical expression wastewater's ability to conduct an electrical current
- Mass concentration of ionized substances and their charges
- Higher EC value indicates higher minerals concentration
- It is not a common parameter for the NPDES permits
- Typical values in influent and effluent:
  - 200 to 1000 mg/L
- Correlates with TDS
  - TDS = (k)*(EC)
    - K varies from 0.5 TO 0.9 depending on TDS and water temperature
    - Typical value: 0.64
- EC meter needs to be calibrated

Electrical Conductivity Meter

Additional Resources:

- EPA Standard Operating Procedures for Calibrating Field Instruments, Region 1 Calibration of Field Instruments Revision Number: 2 Date: June 3, 1998, Revised January 19, 2010
- Arizona Department of Health Services, Laboratory Licensure and Certification
- ADEQ Water and Wastewater Training Resources

Wastewater Plant Safety

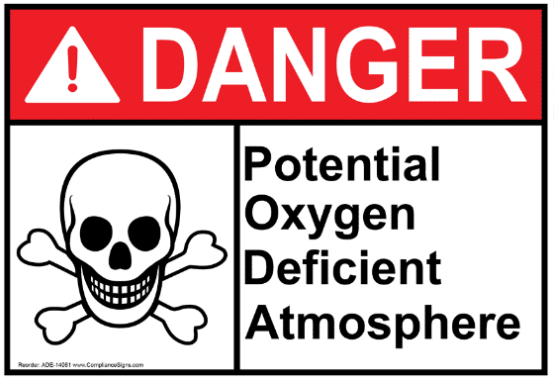
- Safety:
  - Being free from exposure to danger
  - Exempt from hurt, injury, loss, or other accidents
  - Having knowledge and skills to avoid incidents that cause injury and illness
- Management Responsibilities
  - Provides training and funding for an effective safety program
- Operators
  - Follow rules and instructions, and avoid unnecessary risks
  - Share in the responsibility for an effective safety program

Wastewater Treatment Plant Hazards

- Type of hazards
  - Accidents
  - Exposures
  - Work environment or conditions
- Acute Hazard
  - Experienced as soon as the person is exposed to the hazard
    - Resolved as soon as the person is no longer in contact with the hazard
    - Resolved when medical attention is provided
- Chronic Hazard
  - Long-term exposure effects
  - May not appear immediately but hours or days after exposure
  - Non-reversible effects with/without treatment
  - Permanent effects
- All incidents need to be reported (even minor ones)
  - To establish a record in case of injury developing into a more serious one

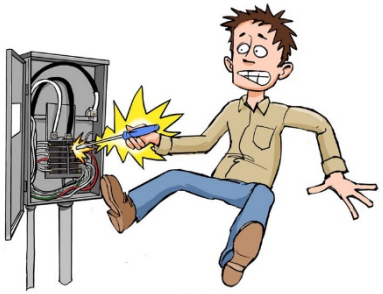
Types of Hazards

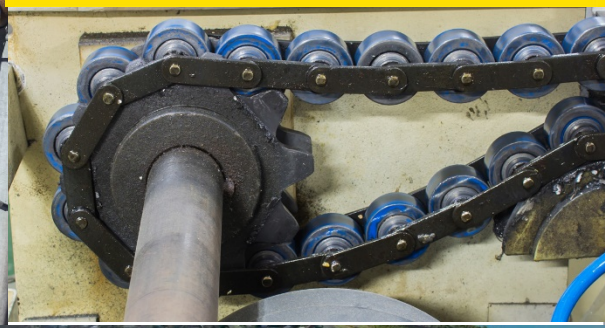
- Hazards in and around a wastewater treatment plant
  - Chemical dust, fumes, gases (chlorine, ammonia, sulfur dioxide)
  - Oxygen-deficient atmosphere
  - Toxic or explosive gases
  - Biological, chemical, physical



Types of Hazards

- Hazards in and around a wastewater treatment plant
  - Weather
  - Slips, trips, falls
  - Chemical burns
  - Electric shock
  - Mechanical
  - Vehicle collision
  - Water-filled structures
  - Confined spaces





Preventing Hazards

Three ways to protect operators

- Engineering controls
  - Initial design specifications
  - Substitution of less harmful material
  - Enclosing or isolating a process
- Work practice controls
  - Modify work to remove exposure to potential hazard
  - Improving sanitation and hygiene practices
- Personal protective equipment (PPE)
  - Does not eliminate the hazard, but protects the operator
  - It is the last line of defense

Safety Responsibilities

- Employers:
  - Responsible for implementing engineering controls, work practices controls, providing PPE, and training

- Employees:
  - Responsible for proper and constant use of safe work practices and PPE
  - Keeping PPE clean and ready to use condition
  - Training, training, and more safety training!

https://elearningindustry.com/safety-training-topics-to-cover-in-compliance-library

Operator Protection

- PPE
  - Eye protection
  - Foot protection
  - Hand protection
  - Head protection
  - Noise exposure protection
- Respiratory protection to:
  - Chemical dusts, fumes, gases such chlorine, ammonia, sulfur dioxide
  - Oxygen-deficient atmosphere
- Drowning protection
- Safety Data Sheets (SDS)
- **Training, training, and more safety training!!!**

Laboratory Hazards

- Glassware
- Hazardous materials (corrosives, poisons, and flammables)
- Infectious materials (containing disease-causing microbes)
- Cuts and bruises
- Fire
- Burns (by heat and chemicals)
- Electric shock
- Toxic fumes

Laboratory Hazards

- Toxic Chemicals
  - Solids
    - Cyanide, chromium, cadmium, mercury, other heavy metals
  - Liquids
    - Carbon tetrachloride, chloroform, ammonium hydroxide
  - Gases
    - Hydrogen sulfide, chlorine, ammonia, sulfur dioxide
- Corrosive chemicals
  - Acids (low pH) - HCl, H_2SO_4, HNO_3
  - Bases (high pH)- NaOH, KOH
  - Miscellaneous corrosives
    - Chlorine, ferric salts, and strong oxidants (hydrogen peroxide)
  - Bicarbonate effectively neutralize acids
  - Vinegar can neutralize bases

Laboratory Hazards

- Explosive and flammable materials
  - Methane – use in Bunsen burners in the lab
  - Oxygen – will accelerate and magnify fires
  - Liquids – Carbon disulfide, benzene, ethyl ether, petroleum ether, acetone, and gasoline
  - Gases – Acetylene, hydrogen
- Infectious materials
  - Pathogenic organisms that can cause:
    - Tetanus, typhoid, tuberculosis, dysentery, infectious hepatatis, COVID
  - Disease rate for operators similar to general population
- Exposure has many mechanisms
  - Ingestion
  - Absorbed into the skin
  - Vapors

Minimizing Laboratory Hazards

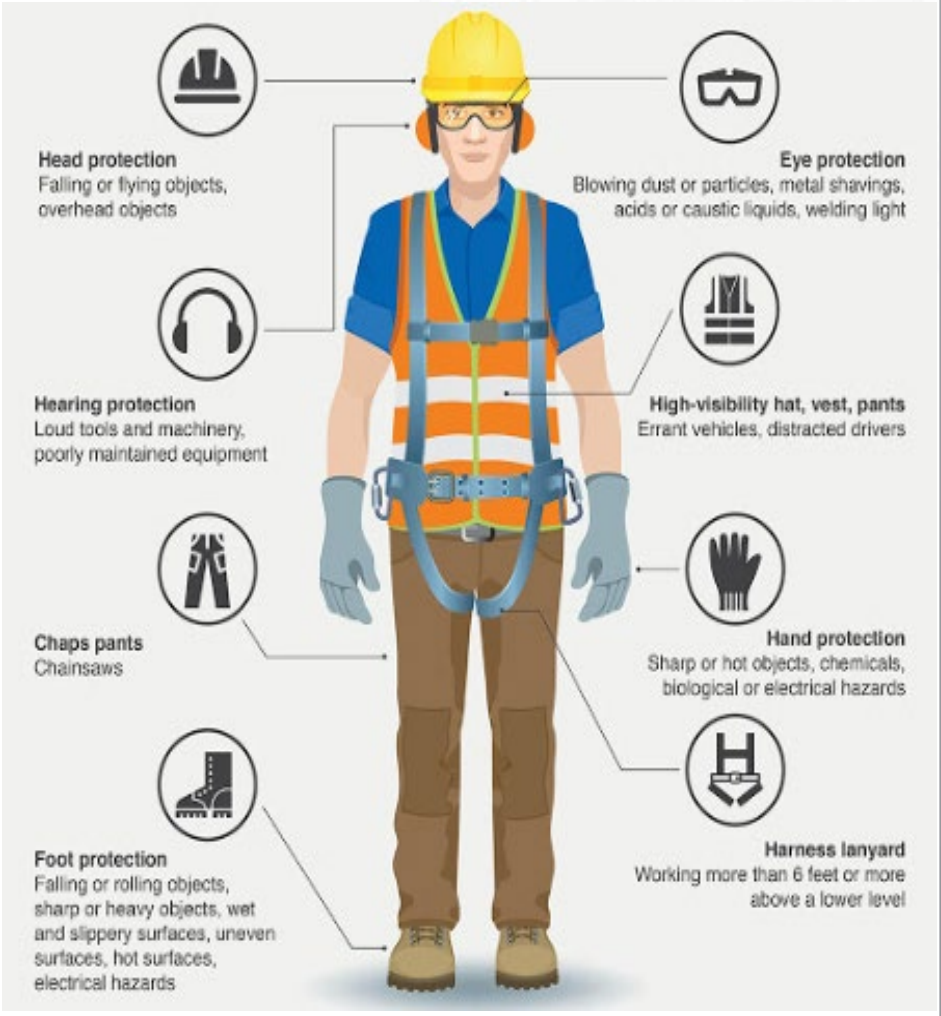
- Hazards can be minimized by:
  - Using proper laboratory techniques and equipment
  - A hazard communication program must be in place
    - Ensure that effectively trained people understand and manage risks
    - Must have written guidelines on labels, updated SDSs, and training materials related to lab procedures
  - Wearing proper PPE every time in the lab
- Federal OSHA demands that proper safety procedures be followed in the lab at all times

Minimizing Lab Hazards

- Glassware
  - Never use chipped, cracked, or broken glassware
  - Dispose of it in a container marked “for broken glass only”
  - Never put broken glass in wastebaskets
  - Clean up any broken glass or spilled chemicals
  - Never leave broken glass pieces in the sink or sink drains
  - Washing glassware is always a potential hazard

Preventing Laboratory Accidents

- General rules:
  - Stay in contact with others
  - Protect your eyes
  - Protect your face
  - Protect your skin and clothes
  - Protect your feet
  - Protect your lungs
  - Protect your digestive system
  - Know location and operation of safety showers and eyewash stations
  - Exercise good housekeeping habits



Preventing Laboratory Accidents

- Personal hygiene
  - Set of practices that need to be followed to minimize exposure and avoid infection or illness
  - No smoking, eating, or drinking in the laboratory
  - Keep wounds protected
    - Waterproof bandages, rubber gloves, protective clothes
    - Work clothes should remain at work
  - Thoroughly wash your face and body with soap and water
  - Never pipette samples by mouth
    - Use mechanical pipette fillers

Preventing Laboratory Accidents

- Toxic fumes
  - Use a ventilated fume hood for routine reagent preparation
  - Select a hood that has adequate air displacement
  - Make sure hood is properly vented
  - Check with your local regulatory agency for specific requirements
  - Annual check of laboratory building and fume hood
- Electric shock
  - Do not use worn or frayed wires
  - Ground all apparatus using three-pronged plugs or pigtail adapters
  - Use of Ground-fault circuit interrupters (GFCIs)
    - Water and electricity do not mix
  - Explosion-proof electrical units
  - All permanent wiring installed by an electrician with proper conduit armored cable

Preventing Laboratory Accidents

- Chemical handling
  - Store chemicals in proper locations
  - Gas cylinders should be secured and be prevented from falling
  - Use of safety glasses or face shields when handling acids and bases
  - Always pour acid into water (never water into acid)
  - Never pour mercury, gasoline, oil, or organic compounds into laboratory drains
  - Never pour hazardous waste into your lab drain

Preventing Laboratory Accidents

- Storage
  - Storeroom properly ventilated and lighted
  - Incompatible chemicals should be separated
  - Store acids and bases on separate storage cabinets designed for acid and base storage
  - Keep volatile liquids away from heat sources, sunlight, or electrical switches
  - Flammable gases must be stored separately
  - Use of explosion-proof wiring and lighting fixtures
  - Heavy items should be stored on or as near to the floor as possible
  - Proper labeling/dating of all chemicals or bottles and reagents
  - SDS for all the chemicals should be readily available
  - Practice good housekeeping…messiness increases safety risks

Fire Safety

Type of Fire	Type of Material	Type of Fire Extinguisher
Class A	Ordinary combustibles such as wood, paper, cloth, rubber, plastics	Foam, water, soda-acid, carbon dioxide gas, almost any type
Class B	Flammable and combustible liquids such as gasoline, oil, grease, tar, oil-based paint, lacquer and solvents	Foam, carbon dioxide, dry chemicals
Class C	Energized electrical equipment such as starters, breakers, motors	Use carbon dioxide or dry chemicals
Class D	Combustible metals such as magnesium, sodium, zinc, and potassium	Use class D fire extinguisher or fine dry soda ash, sand, or graphite to smother the fire

People should receive proper training on the operation and use of fire extinguishers

Fire Safety

1. *Operations of Wastewater Treatment plants*, Vol 1, Eight Edition, 2019, Sacramento State University Water Programs
2. *Wastewater Operator Certification Training*, Module 12: Laboratory Overview, Pennsylvania Department of Environmental Protection

LABORATORY SAMPLING AND ANALYSIS/FIELD TESTING METHOD

1:00 – 2:00 PM

Typical Water quality parameters monitored

RECAP FROM PREVIOUS SECTION

- For liquid treatment train
  - BOD, COD, TOC
  - Temperature
  - TSS of settled liquid
  - Mixed-liquor volatile suspended solids (MLVSS)
  - pH
  - Alkalinity
  - Nitrogen – ammonia, nitrate, total
  - Phosphorus
  - Settleability of MLSS
  - Sludge Volume Index (SVI)

Typical Water quality parameters monitored

RECAP FROM PREVIOUS SECTION

- Digester control and sludge management
  - Volatile acids
  - Total alkalinity
  - Temperature
  - Carbon dioxide (CO_2) in digester gas
  - Sludge (digested) dewatering characteristics
  - Digester supernatant solids
  - Total Solids

Preservative and Holding Times

RECAP FROM PREVIOUS SECTION

Parameter	Preservative	Hold time
Alkalinity	4°C	14 Days
Ammonia Nitrogen	H_2SO_4 to pH<2, 4°C	28 Days
BOD_5/$CBOD_5$	4°C	48 Hours
COD	H_2SO_4 to pH<2, 4°C	28 Days
Conductivity	4°C	28 Days
Fecal coliforms	4°C	24 Hours
Hardness	HNO_3 to pH<2, 4°C	28 Days
Nitrate	4°C	48 Hours
Nitrite	4°C	48 Hours
Total Suspended Solids	4°C	7 Days
Total Dissolved Solids	4°C	7 Days
Total Solids	4°C	7 Days
Trace Metals	HNO_3 to pH<2, 4°C	180 Days

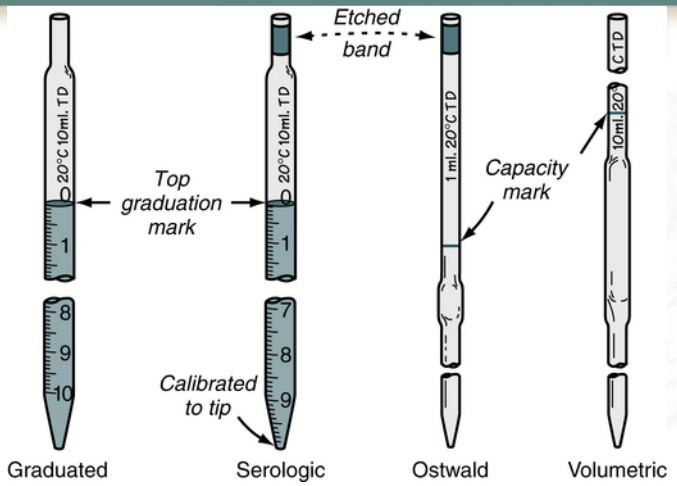
40 CFR – Part 136 (CODE OF FEDERAL REGULATIONS)

Laboratory Units of Measurement

- Metric system to express units of:
  - Length - meter (m)
  - Volume – Liter (L)
  - Weight (mass) – gram (g), milligram (mg)
  - Concentration – mg/L, parts per million (ppm)
  - Temperature – Celsius (°C)
- All metric units use factors of 10 for larger or smaller quantities
  - i.e., kilo, milli, centi
- Use of proper unit conversions is critical

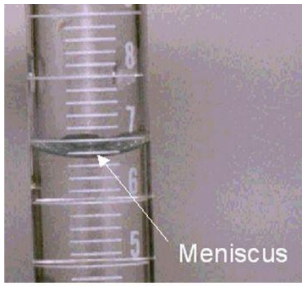
Glassware and Equipment

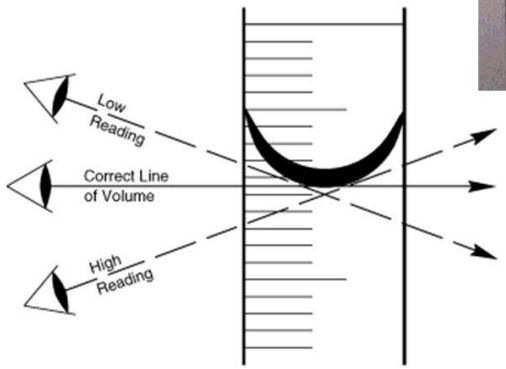
- Proper knowledge and use of glassware and equipment
  - Vessels for containing liquids (approximately)
  - Glassware for measuring volumes
  - Special-purpose glassware
  - General laboratory equipment
- Measurement techniques
  - Reading volumes
    - Cylinders
    - Pipettes
    - Burets
    - Beakers



Different Type of Pipettes

Volume of Liquids
Reading a Meniscus



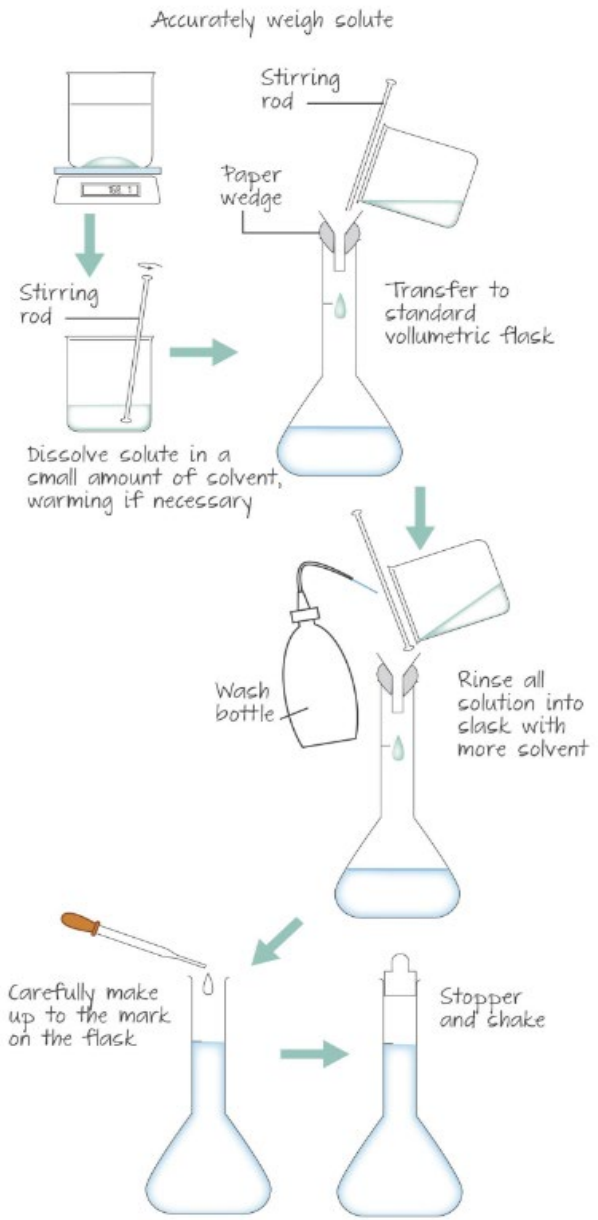


Chemical Names and Solutions

- Basic knowledge of chemical names and formulas encountered in wastewater
  - Names, symbols, atomic weight
  - Chemical elements vs. compounds
- Chemical solutions
  - Mass concentration (mg/L)
  - Molar concentration (Molarity - moles/L)
  - Normal concentration (Normality – equivalents/L)

Standard Solutions

- Solutions when an exact concentration of a chemical or compound is known
- Can be ordered pre-made
- Can be prepared using a dry chemical that can be accurately weighted
- Can be used to standardize other solutions
  - Standardize: the process of using one solution of known concentration to determine the concentration of another solution



Mixing Solutions

- Mixing solutions
  - Common activity in the laboratory
  - “the mass of substance in the mixture is the sum of the masses contributed by each solution”
  - General mixing equation:

$$C_{mix} \times V_{mix} = C_1 \times V_1 + C_2 \times V_2$$

$$C_{mix} = \frac{C_1 \times V_1 + C_2 \times V_2}{V_1 + V_2}$$

Mixing Problem Example

- Example: there are two solutions containing nitrates: one solution is 150 mL with a concentration of 3 mg/L and the other solution is 525 mL with 12 mg/L of nitrate. What is the nitrate concentration if you mix the two solutions?

Work in pairs

- Other scenarios are possible
  - Solving for an unknown method

Mixing Problem Example Solution

$$C_{mix} = \frac{C_1 \times V_1 + C_2 \times V_2}{V_1 + V_2}$$

$$C_{mix} = \frac{150\ (mL) \times 3\ (mg/L) + 525\ (mL) \times 12\ mg/L)}{150\ mL + 525\ mL}$$

$$C_{mix} = 10\ mg/L$$

Laboratory Quality Control (QC)

- How would you know if the lab result is correct?
  - Humans are not perfect; we introduce errors
  - Also, numbers on a digital readout of an instrument do not mean that the displayed value is always correct
- Typical errors:
  - Sloppy or incorrect lab technique
  - Deteriorated reagents or standards
  - Poorly operated or miscalibrated equipment
  - Calculation errors
  - Mistyped data

Laboratory Plan Quality Assurance (QA)/QC

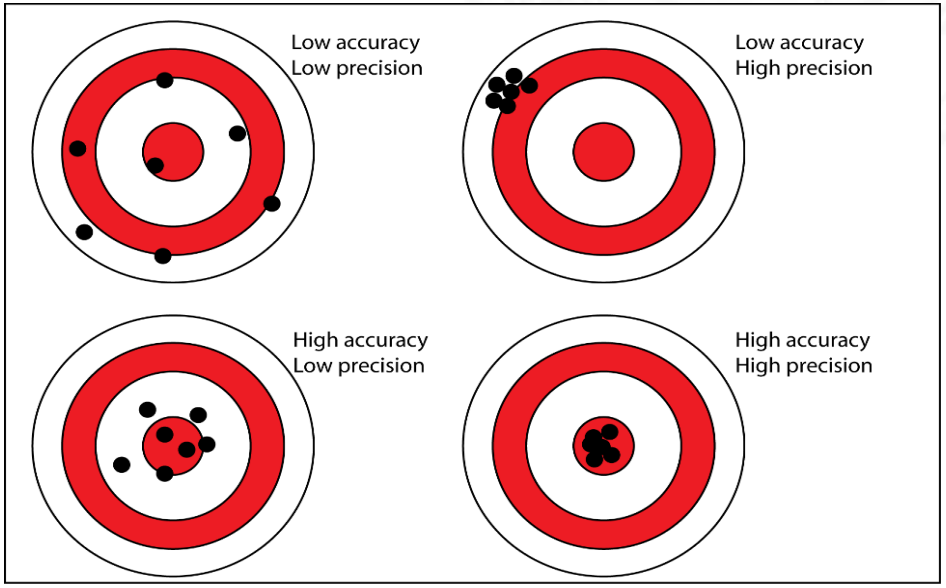
- Data Quality Objectives (DQO's)
- Calibration procedures
- Data reduction, validation, reporting, and verification
- QC
- Schedule of internal audits
- Preventive maintenance procedures and schedules
- Corrective action contingencies
- Record-keeping procedures

Data Quality Indicators

- The PARCCS parameters – precision, accuracy, representativeness, comparability, completeness, and sensitivity
- The PARCCs parameters are used to describe the quality of analytical data in quantitative and qualitative terms using the information provided by the laboratory QC information

Precision and Accuracy

- You should be able to answer the question:
  - How precise and accurate your lab result is?
  - What is precision?
  - What is accuracy?
  - We need additional samples (QC samples)
    - Duplicates/References



Precision and Accuracy

Typical QC Samples

- Blanks, external reference, laboratory control samples (LCS), matrix spike (MS), lab control duplicate (LCDS), matrix spike duplicate (MSD), split (field duplicate)
  - These samples are blind to the laboratory
- And you thought you only had one sample to be analyzed!!!!
- Budget considerations

Sample Handling

- Samples need to reflect the concentration of what is being sampled
- Concentration can change in the sample from sample collection to lab analysis
  - Biological, chemical, coagulation, settling
- These changes can lead to erroneous results and bad decision-making
- The shorter the time between collection and analysis, the more reliable the test result is

Sample Preservation, Storage, and Transport

- Sample Preservation, Storage and Transport
  - EPA has acceptable methods to preserve samples
  - CFR Title 40 – Section 136 also provides information on these topics
- Some constituents cannot be stored and must be analyzed immediately at the plant
  - Temperature, pH, dissolved oxygen

Typical Chain of Custody

ADEQ Arizona Department of Environmental Quality

Pat-Chem Laboratories
1824 1st Street
San Fernando, CA 91340

CHAIN OF CUSTODY RECORD

Phone (818) 639-5300
Fax (818) 639-5306

Environmental Sample

Sample I.D.#: _____

Customer:		Project :	
Address:	Sampled by:	P.O. #:	
	Report Attention:	Phone #:	

Sample Description	Date Sampled	Time Sampled	# of bottles	Required Tests	Sample Type	Matrix	Bottle Type	Preserve	Field Data (pH / Temperature) pH: Field Lab

Signature	Print Name (Company)	Date	Time
Relinquished by			
Received by			
Relinquished by			
Received by			
Relinquished by			
Received in lab by			

Sample Received Checklist

Temperature upon receipt: _____

# of bottles agrees with COC?	Yes	No
Samples intact?	Yes	No
Samples properly preserved?	Yes	No
Samples in holding time?	Yes	No

Compliance Monitor

Initial Flow _____

Final Flow _____

Sample Type
Grab
Comp

Matrix
AQ - Water
SO -Soil / Sludge
OT - Other

Bottle Type
P - Plastic
G - Amber Glass
VOA - 40 ml Vial
Coli - bacteria

Preservations
HC - HCl
HS - H_2SO_4
HN - HNO_3
HP - H_3PO_4
OH - NaOH
ST - Sodium Thiosulfate
AA - Ascorbic Acid
Al - $AlCl_3$
Cu -$CuSO_4$

Note: Samples are discarded 30 days after results are reported, unless other arrangements are made.

Rev 2 Effective 6/1/17

Typical Chain of Custody

Standardized Test Procedures

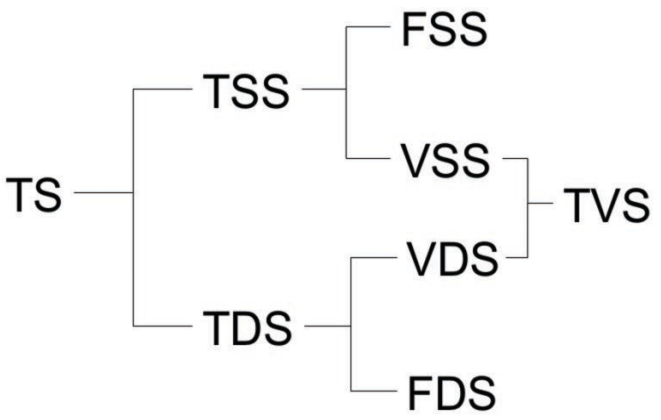
- Ensures that everyone is testing for the same thing
- Saves each laboratory the trouble of having to prove that its results are accurate and true
- Standard Methods for the Examination of Water and Wastewater
  - List of approved biological methods for wastewater and sewage sludge such as fecal coliform number
  - List of approved inorganic tests such as alkalinity
  - List of approved tests for pesticide and non-pesticide organic compounds etc.

Common Laboratory Procedures

- Solids and physical parameters
  - Total, settleable, suspended, dissolved, and volatile solids
  - Electrical Conductivity
  - Turbidity
- Chemical parameters
  - Acidity and alkalinity
  - Chloride, chlorine residual, pH, various forms of nitrogen (ammonia, organic-N, nitrite, nitrate), oil and grease, dissolved oxygen, oxygen demand (BOD/COD), phosphorus and ortho-phosphate, sulfates
  - Gases
    - Carbon dioxide and hydrogen sulfide

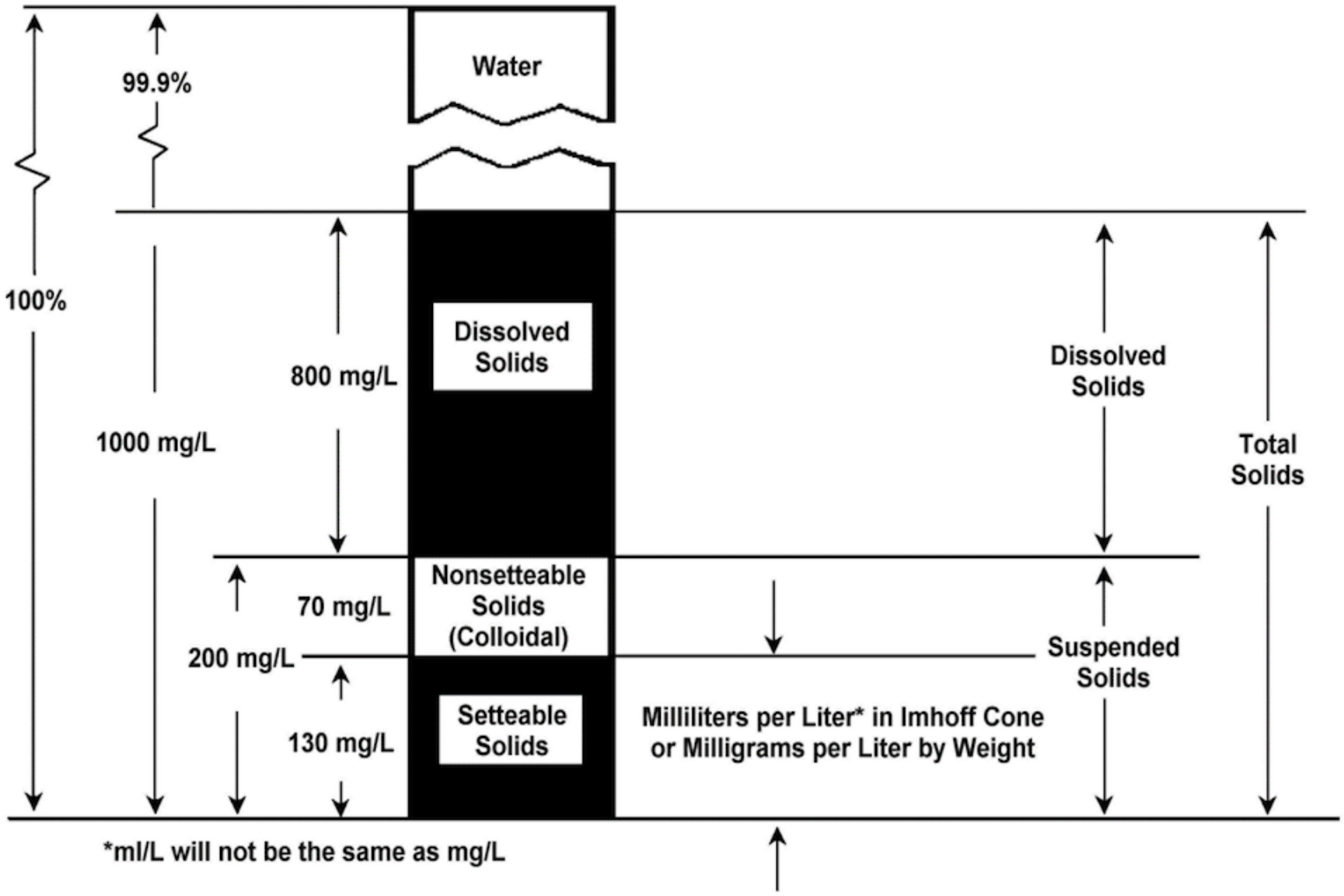
Common Laboratory Procedures

- Gravimetric Analysis – Methods based on mass
  - Total solids (TS)
  - Total suspended solids (TSS)
  - Total dissolved solids (TDS)
  - Volatile/fixed suspended solids (VSS/FSS)
  - Volatile/fixed dissolved solids (VDS/FDS)
- Based on mass per volume of original sample
- Requires filtration, evaporation, and sometimes burning
- Measuring mass requires the use of an analytical balance (to measure small masses)



Volatile and Fixed Solids Relationship

Solids


Water
99.9%
100%
1000 mg/L
800 mg/L
Dissolved Solids
70 mg/L
Nonsetteable Solids (Colloidal)
200 mg/L
130 mg/L
Setteable Solids
Dissolved Solids
Suspended Solids
Total Solids
Milliliters per Liter* in Imhoff Cone or Milligrams per Liter by Weight
*ml/L will not be the same as mg/L

Solids

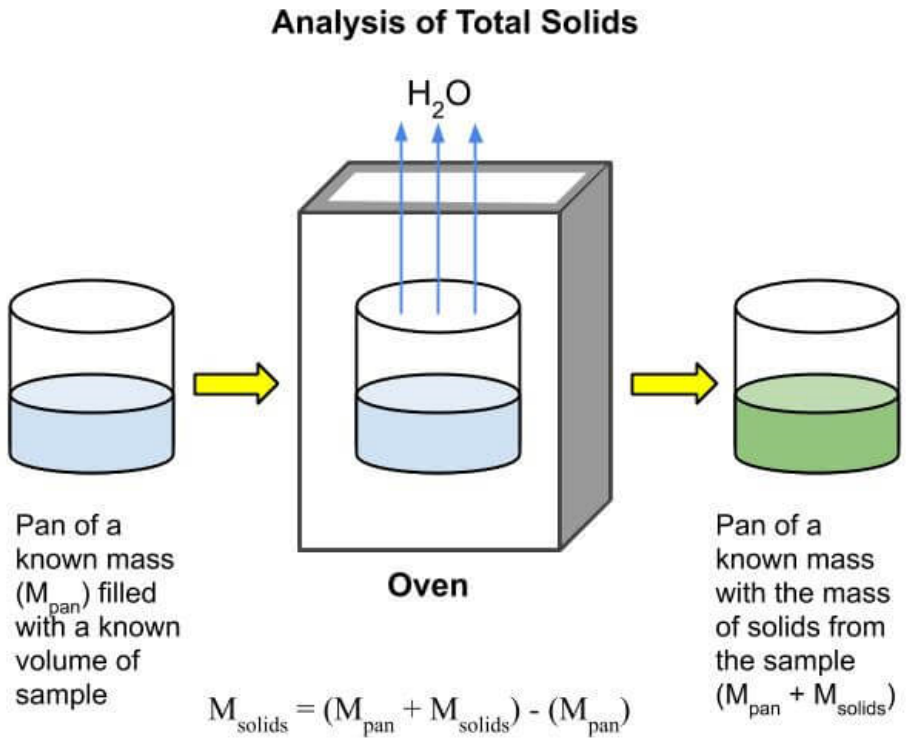
- Solid particles suspended or dissolved in water
  - Particles come in all sizes
  - Size is an important characteristic: whether they can be settled or filtered
- Organic solids
  - Treated by biological processes
- Inorganic solids
  - Sand, gravel, minerals, salts
  - Physical-chemical separation

Solids

- Suspended solids and dissolved solids
  - Difference is whether or not they pass through a glass fiber filter of nominal pore size (smaller than 1 micron)
  - Passing through the filter
    - True molecules and colloids
      - Molecules are truly dissolved
      - Colloids – so small that they act as dissolved
- Volatile solids
  - Organic particles converted to CO_2(gas) at high temperature
- Suspended and disolved solids can either be volatile or non-volatile

Total Solids (TS)

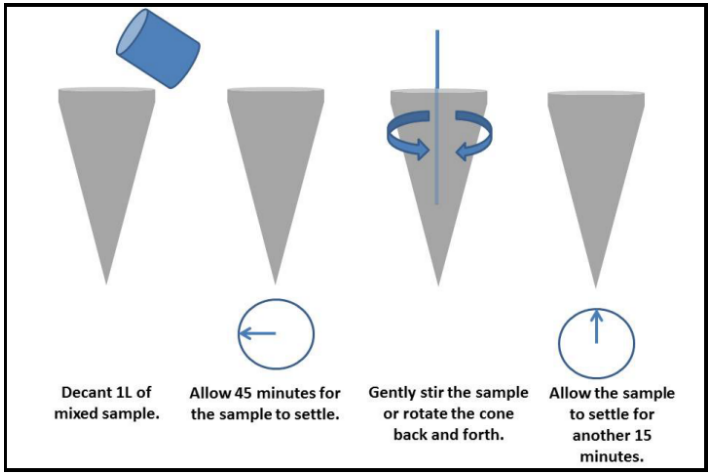
- Combined amounts of suspended and dissolved material
- Does not differentiate by particle size or composition
- Total mass of material left in a container after all water is evaporated at 103°C to 105°C
  - Drying-cooling-weighting steps are repeated until successive weights agree within 4% or 0.5 mg (whichever is less)
- Untreated wastewater:
  - TS range 400-1200 mg/L



Total Solids Procedure

Suspended Solids - Settleable

- Measures the volume of settleable solids in 1 L of sample that settles to the bottom of an Imhoff cone within one hour
- An indication of the volume of solids removed by sedimentation tanks, clarifiers, or ponds
- Typical values:
  - Influent: 6-20 mL/L
  - Primary effluent: 0.1 – 3 mL/L
  - Secondary effluent: trace to 0.5 mL/L
- Difference between a clarifier (solids compacted differently/may not capture all solids that should settle) and the Imhoff cone (perfect settling device)



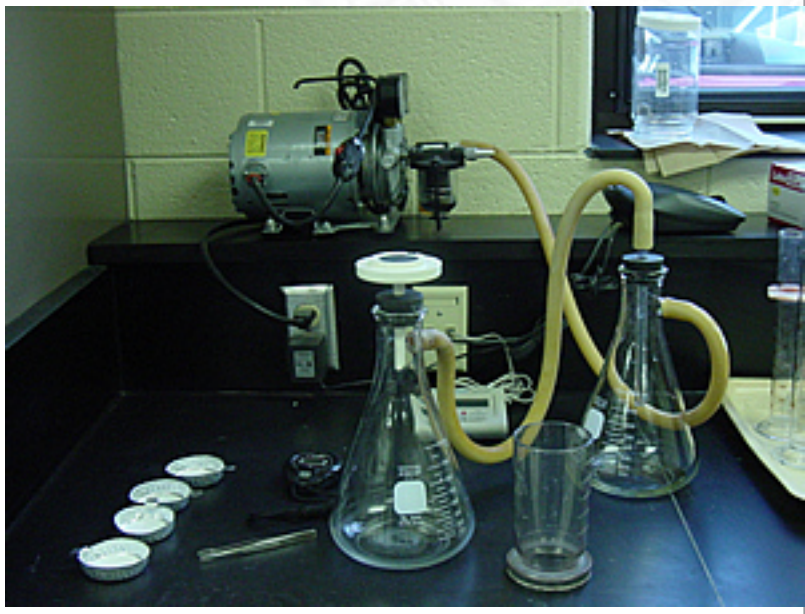
Settleable Solids

Suspended Solids - Nonsettleable

- Centrifuge method (non-standard method)
  - Sample placed in a graduated centrifuge tube and spun for 15 min.
  - Develop a correlation with the TSS standard method results
  - Sample has settling characteristics to those samples used for the correlation graph
    - i.e., develop the correlation curve for a primary effluent and not the one constructed from an activated sludge

Total Suspended Solids (TSS)

- Mass concentration of material in the sample that may settle in a reasonable time
- A measured sample volume poured through a previously weighted glass-fiber filter mounted on a vacuum flask
- Filter is dried at 103 – 105°C for at least 1 hour
- Filter cooled in a desiccator and re-weighted
- Drying-cooling-weighing process repeated until successive weights agree within 4% or 0.5 mg, whichever is less



Total Suspended Solids Equipment

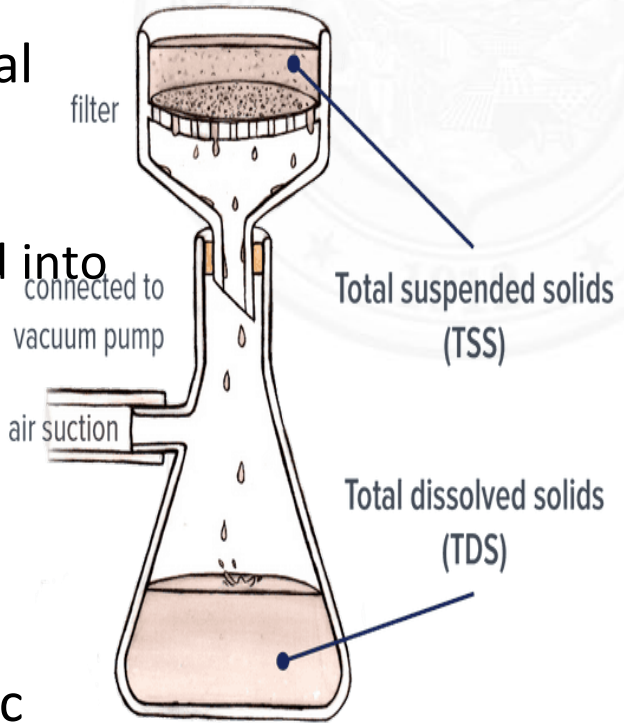
Total Suspended Solids (TSS) Contd.

- Typical values:
  - Influent: 150mg/L (weak) to > 400 mg/L (strong)
  - Primary effluent: 60 (weak) to 150 (strong) mg/L
  - Secondary effluent: 10 (good performance) to > 60 (poor) mg/L
  - Activated sludge: mixed liquor: 1,000 to < 5,000 mg/L
  - Return or waste sludge: 2,000 to < 12,000 mg/L
  - Digester test: Supernatant: 3,000 to < 10,000 mg/L
- TSS should never exceed total solids
- No relationship with TDS

Total Suspended Solids Equipment

Total Dissolved Solids (TDS)

- Determine the mass concentration of material in the sample that will not settle
- Truly dissolved molecular substances and colloidal particles less than 1 micron
- Test sequence:
  - Liquid that passes through the filter is transferred into a previously weighted evaporating dish
  - Dish dried at 180 °C for 1 hour
  - Dish cooled in the desiccator and weighted
  - Drying-cooling-weighting process repeated until successive weights agree within 4% or 0.5 mg, whichever is less
- High TDS can mean high level of minerals, organic substances or both
  - BOD or EC needed to distinguish them
- Typical values:
  - Influent and effluent: 150 to 600 mg/L
  - Depends on industrial activity and local water supply
- TDS usually correlates with EC



Total Dissolved Solids Setup

Volatile and Fixed Solids

- Represent the organic and inorganic portion of the solids
  - Organics are converted (volatilized) to gas by high temperatures (550 °C)
  - Inorganics do not volatilize
- Heating a sample to 550 °C in a muffle furnace
  - Glass-fiber filter that has been dried
  - Heat-resistant container with a dried residue
- Ignite the sample for 15-20 mins
- Cool sample at a desiccator
- Weight sample and repeat process until successive weights agree within 4% or 0.5 mg, whichever is less
- Test results expressed in % by weight (rather than mg/L)
- Typical values:
  - Raw sludge: 6-9%
  - Raw sludge plus waste activated sludge: 2-5%
  - Recirculated sludge: 1.5-3%
  - Supernatant: < 1%
  - Digested sludge to air dry: 3% to <8%
- 1% by weight = 10,000 mg/L

Acidity and Alkalinity

- Acidity
  - Quality or state of being an acid.
  - Sources:
    - CO_2 from atmosphere
    - Biological oxidation of organic matter
    - Industrial waste discharges
- Alkalinity
  - Measure of its capacity to neutralize acids
  - Major form is bicarbonate ions (HCO_3^-) coming from calcium, magnesium, and sodium compounds from natural sources and waste discharges
  - Acidity and alkalinity are complementary: high alkalinity means low acidity and vice versa
  - Acids neutralize bases and bases neutralize acids
  - Sample showing little pH change, even though an acid or base is added to the water, shows water sample's buffering capacity

Importance of Alkalinity

- Example:
  - Aerobic microorganisms produce CO_2 gas (which produces carbonic acid)
  - In nitrification, the formation of nitrates (NO_3) is functionally the same as adding nitric acid
  - In both cases, if the alkalinity is too low the pH will drop to undesirable levels
- Another example: algae in treatment ponds consume carbon dioxide
  - If the acidity is too low, the pH will rise to undesirable values
- In anaerobic digestion: formation of organic acids will lower the pH if alkalinity is insufficient
- If pH drops too low, the organisms will become inactive or die
  - Digestor becomes upset and no longer capable of decomposing organic matter

Importance of Metals

- Concern of metals in wastewater
  - Adverse effect in treatment
  - Violation of discharge requirements
- Can be determined by
  - Colorimetric methods
  - Atomic absorption spectroscopy
- Metals of potential interest:
  - Aluminum, Antimony, Arsenic, Barium, Beryllium, Cadmium, Calcium, Cobalt, Copper, Iron, Lead, Magnesium, Manganese, Mercury, Molybdenum, Nickel, Potassium, Selenium, Silver, Thallium, Tin, Titanium, Vanadium, Zinc

Importance of Nitrogen

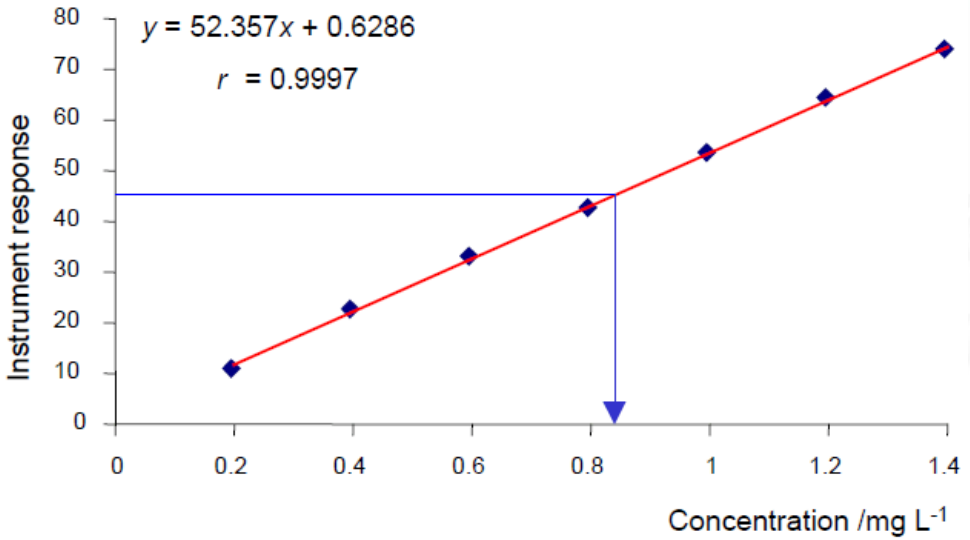
- Nitrogen compounds are of great interest to operators
  - They impact the biological wastewater treatment
  - Affect quality of effluent receiving waters
- Municipal waste contain nitrogen in:
  - Organic molecules from proteins and urine that are converted to ammonia
- Ammonia exists either:
  - Ionized ammonia (NH_4^+) or free ammonia (NH_3, a gas)
- NH_4^+ dominant at lower pH
- NH_3 more prevalent as pH increases
- Nitrification
  - Bacteria convert ammonia to nitrite (NO_2^-) and then to nitrate (NO_3^-) in presence of oxygen
- De-nitrification
  - Bacteria convert nitrate to nitrogen gas (N_2) in absence of oxygen

Importance of Nitrogen (Contd)

- Ammonia, org-N, nitrite, and nitrate are the most important nitrogen forms in wastewater treatment
- Total Kjeldahl Nitrogen (TKN) is the sum of org-N and ammonia nitrogen (NH_3-N)
- Treatment plants are required to nitrify ammonia as part of the wastewater treatment process
- Ammonia also contributes to chlorine demand (will impact chlorine dosage when chlorination is used)
- Ammonia in receiving water represents an oxygen demand detrimental to fish
- Total nitrogen in the effluent may be a concern because nitrogen is a fertilizer to contribute to algal bloom

Nitrogen Compounds Measurements

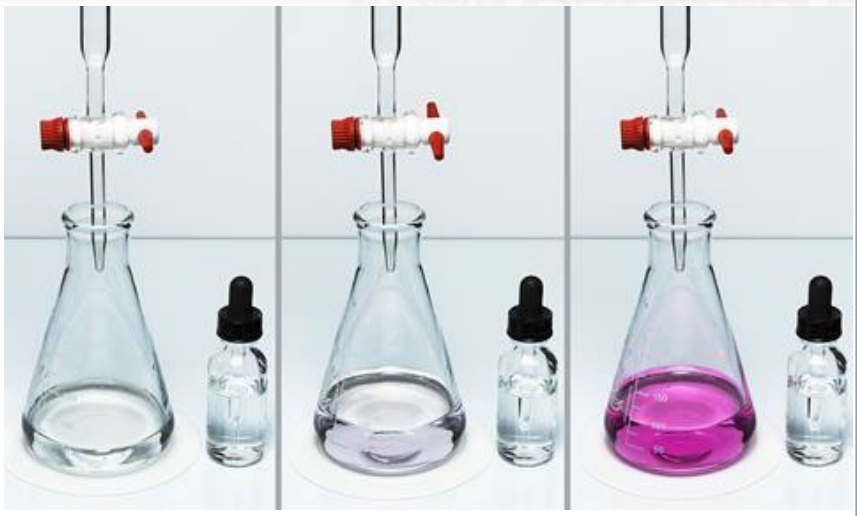
- Ammonia
  - Titration method
  - Ion-Specific electrode
  - Colorimetric Phenate Method
- Total Kjeldahl Nitrogen (TKN)
  - Hach Colorimetric Method
    - Measures Total N (TN)
    - TKN = TN – (NO_3^--N + NO_2- N)
    - Uses a second aliquot to determine Nitrites and Nitrates
- Nitrates
  - Colorimetric method
    - Nitrates + Nitrates
  - Ion-Selective Electrode
  - Hach Colorimetric Method
    - Uses a spectrophotometer
    - Specific wavelength



Absorbance vs Concentration Curve

Titration and Indicators

- Adding a standardized solution (known composition) to a sample whose composition is unknown
- Titrant added to sample until reaction is complete (end point) using an indicator
- End point will shift color of solution caused by indicator
- Indicators change color in presence of specific chemical ions or under specific pH values
- Test procedure will specify indicator that will give most recognizable and reproducible results
- Used for acidity/alkalinity, chlorine residual, BOD/COD



Colorimetry Method

- A color reagent is added to a sample containing a constituent of unknown concentration
- Color reagent reacts with compound being tested and produce a colored byproduct
- Color intensity indicates concentration of test constituent
- Colorimetric analysis performed either by eye (sight) or by using an instrument
  - Human-based color comparator have the short-coming of different people having different perceptions of color
  - Photoelectric analysis color can be read very accurately and precisely
  - Measures many metals
  - Measures nitrogen (TKN, Nitrites/Nitrates)
- Meters need to be calibrated

Probe-based Electronic Instruments

- Produce a change of voltage (or current) that is proportional to a constituent concentration
- Meter to read the voltage (or current) and displays result as a concentration
- Measures pH, DO, EC, and specific ions meters
- Specific ions electrodes: ammonia, nitrate, fluoride, chloride
- Probes need to be calibrated

Probe-based Electronic Equipment

BOD

- Decomposed organic matter is food source for bacteria. The bacteria breaks down this matter and combines it with oxygen, in a process called oxidation.
- BOD is measure of quantity of oxygen used by bacteria during oxidation of the organic matter.
- 5-day test that measures amount of O_2 consumed in a wastewater sample by a mixed population of heterotrophic bacteria in the dark at 20°C
- BOD of wastewater is typically 110-440 mg/L and must be reduced to 20 mg/L for discharge
- BOD can be sampled by using composite samples

BOD Sampling Considerations

- Samples for BOD should be collected before chlorination
  - Chlorine interferes with microbes
  - Although not recommended, samples can be dechlorinated by using a dechlorinating agent (sodium sulfite)
  - Sodium sulfite also consumes oxygen
- Nitrification can be a problem in:
  - Secondary treatment effluent in plants doing nitrification
  - Wastewater treatment ponds
  - Some rivers and lakes
  - Nitrification can be inhibited in the sample by using 2-chloro-6-(trichloromethyl) pyridine (TCMP) or ATU (inhibitor agents)

BOD Sampling Considerations

- Typical BOD values:
  - Municipal influent – 150 to 400 mg/L
  - Primary effluent – 60 to 160 mg/L
  - Secondary effluent – 5 to 30 mg/L
  - Digester supernatant – 1,000 to > 4,000 mg/L

BOD Calculation

$$BOD = \frac{D_i - D_f}{P}$$

where:

D_i = initial dissolved O_2 concentration

D_f = final or 5-day dissolved O_2 concentration

P = volumetric fraction of wastewater

Example: 5 ml wastewater is added to a 300 ml BOD flask

$P = \frac{5}{300} = 0.0167$ $D_i = 8$ mg/L $D_f = 2$ mg/L

$$BOD = \frac{8 - 2}{0.0167} = 359 \text{ mg/L}$$

Oxidation is usually 60-70% complete after 5 days

Chemical Oxygen Demand (COD)

- COD uses a chemical reaction to estimate oxygen demand
- Major advantage over BOD test is providing answer in few hours (not 5 days)
- Organics are completely consumed
- Does not distinguish between biodegradable/non-biodegradable organic substances
- COD results always higher than BOD for the same sample

COD

- Correlation between COD and BOD
  - Depends on the characteristics of wastewater
  - Correlation will vary from plant to plant
- COD does not mimic the effect of dissolved oxygen in receiving waters as well as BOD
  - Regulatory agencies usually requires BOD to satisfy permit conditions
- Wastes from COD tests are considered hazardous (contents of silver, mercury, chromium, and high pH)
  - Waste disposed according to appropriate regulations

Microscopy

- Used to monitor health of biological treatment and observe kinds of microorganisms present
- Microscopes will have magnifications up to 100 times (100x)
  - Wastewater microbes are mostly transparent and difficult to identify with simple light
  - Phase-contrast microscopes manipulate light to enhance contrast between specimen and background
- Bacteria, protozoa, rotifers

OAR_2452.jpg (3696×2448) (inkfreenews.com)

Chlorine Residual

- Chlorination:
  - As an oxidizing material
    - To control odors, improve scum, and grease removal
  - As a toxin
    - Disinfect treated effluent before recharge or reuse
    - Control microbes that contribute to activated-sludge bulking and foaming
- Discharge permits severely limit the concentration in plant effluent
  - Chlorine is toxic to aquatic organisms

Chlorine Residual

- Typical values:
  - Effluent (after 30 minutes of contact time) – 9.2 to 5 mg/L of chlorine residual
  - Effluent used for potential human contact (i.e., park irrigation)
    - Up to several mg/L to prevent bacteria regrowth in recycled water delivery system
  - Effluent discharged into natural water bodies
    - Could be a low as 0.5 mg/L (considering dilution factors)
    - Check your permit for specific requirements

Chlorine Residual Tests

- Chlorine tests rely on oxidation-reduction chemistry
  - Compounds that act like chlorine will interfere with the method and provide erroneous results
    - Iodine, bromine, oxidized forms of manganese, nitrites, organic chloramines
- Wastewater color and turbidity interfere with color reading or finding titration endpoints.
- Different tests better suited to different facilities
  - Wastewater composition and required detection limits
- Different tests have different detection limits and require different operator skill levels

Chlorine Residual Tests

- DPD Methods:
  - DPD acts as a colorimetric indicator
  - Sample with low turbidity and color
  - Color intensity proportional to amount of chlorine in the sample
  - Spectrophotometer to read color intensity, and concentration calculated using a calibration curve
- Iodometric methods
- Electrode methods
- Amperometric titration
  - Based on measurement of electrical current
  - It can measure chlorine residual below 0.2 mg/L
  - Subject to fewer interferences
  - Differentiate between free and combined chlorine
  - Requires a specialized instrument and greater operator skills

Bacteria (Total and Fecal Coliforms)

- Methods for counting bacteria
  - Not done to monitor biological treatment
  - Done to monitor disinfection of treated secondary effluent before being discharged into receiving waters or reused for irrigation or other purposes
  - Sampling and counting bacteria at the natural waters receiving the effluent

Precautions in Sampling for Bacteria

- Proper precautions in sampling and handling samples
  - Results are questionable if sterile techniques are not followed
- Containers
  - Glass or other water-tight material
  - Capable of being sterilized
  - Must be thoroughly cleaned (suitable detergent and hot water)
  - Rinsed with hot water (180°F)
  - Rinsed with distilled or de-ionized water

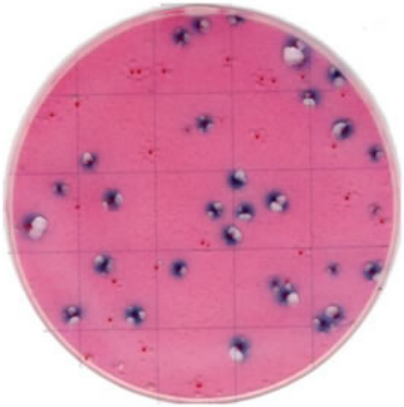
Precautions in Sampling for Bacteria

- Sampling
  - If sampling chlorinated water, add sodium thiosulfate before sterilization to neutralize residual chlorine
  - Do not flush out sodium thiosulfate (if present) when filling bottles with sample, or contaminate the bottle or the sample
  - Fill bottles approximately ¾ full and analyze the sample within 1 hour
  - If not possible, hold the sample below 10°C but not longer than 6 hours
- Culture media
  - Used to cultivate the microorganisms
  - Well-mixed and sterile media
  - Purchase of pre-hydrated media
  - Follow supplier's instructions on the time, temperature, and other conditions needed for storage

Precautions in Sampling for Bacteria

- Water
  - Use sterilized distilled or Deionized water
  - Dilution water needs to be pH buffered
  - Used in preparing media or sample dilution
- Bacteria Cultures
  - Tests based on growing bacterial cultures in lab
  - Bacteria must produce gas, consume a special media, or grow a colony to produce a result that can be observed and counted
  - Seeds for the cultures are the wastewater microorganisms
  - Bacterial growth takes time (24 to 48 hours)
  - Bacteria culture needs to be maintained at a specific temperature
  - Incubator or constant temperature water bath must maintain a constant temperature of +/- 0.2°C

Bacteria Incubator



Bacteria Culture

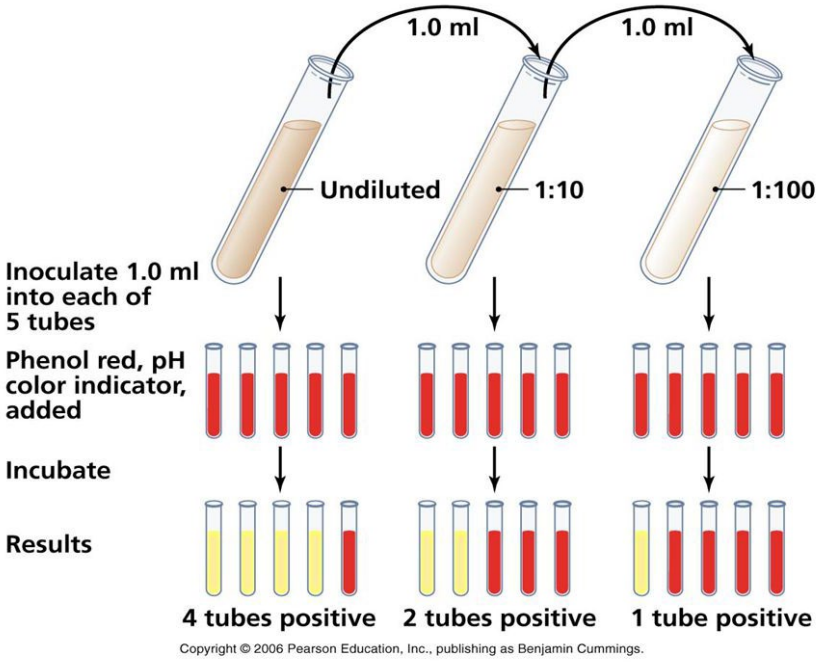
Coliforms Bacteria

- Broad range of bacteria
  - Include all aerobic and facultative anaerobic
  - Gram negative
  - Non-spore forming
  - Rod-shaped
- These bacteria ferment lactose within 48 hours at 35 °C
- Fecal and non-fecal group
- Fecal can grow at a higher temperature than non-coliform
  - Coliform are found in digestive tracts of human and other warm-blooded animals
  - Finding coliforms is an indication of fecal contamination
  - Not all coliforms are associated with fecal contamination; some found in soil
    - Positive coliform results in stormwater runoff and recreational waters may not be produced by fecal contamination

Coliforms Bacteria

- Two NPDES-approved methods for counting bacteria:
  - Most Probable Number (MPN)
    - Statistical estimate of number of bacteria needed to produce a specific laboratory response (production of gas or a biochemical reaction with an indicator compound in the media)
  - Membrane Filter (MF)
    - Bacteria are captured on a filter and colonies counted
- MPN is most often used in wastewater applications
  - TSS caught on the filter can interfere with the MF test
- Need to check NPDES permit to verify which method is allowed for your permit

Coliform Bacteria Test



Procedure for Coliform Bacteria

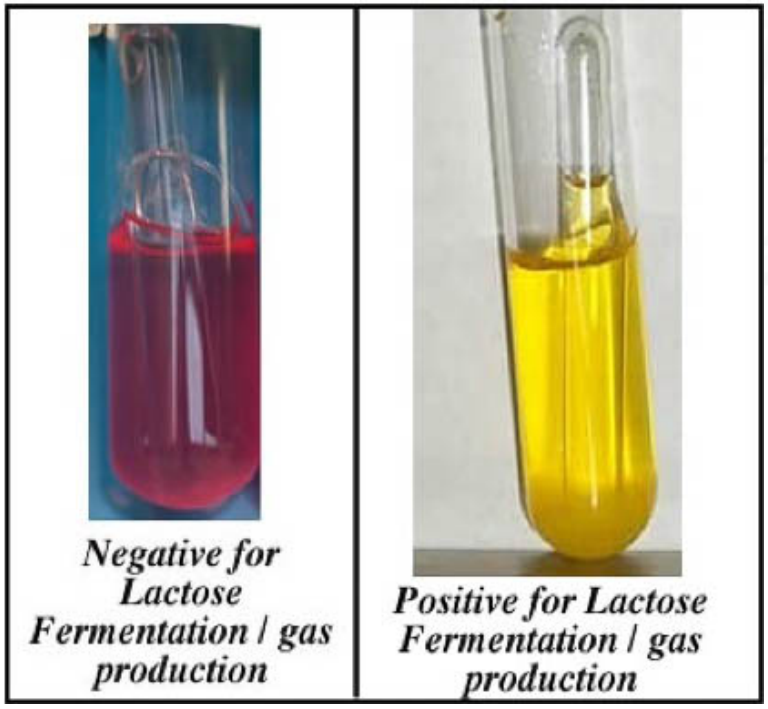
No. of Positive Test													
EC-Medium			H_2S				P–A		Standard MPN			Total no. of H_2S Sample	Source
MPN (Index/100 ml)	N0. +	Total	+++	++	+	-	P	Total	MPN (Index/100 ml)	N0. +	Total		
2.2	2	10	0	2	3	0	2	2	12	7	10	5	1
2.2	2	10	5	0	0	0	2	2	> 23	10	10	5	2
6.9	5	10	1	4	0	0	2	2	12	7	10	5	3
3.6	3	10	0	0	5	0	0	2	6.9	5	10	5	4
< 1.1	0	10	0	0	5	0	0	2	6.9	5	10	5	5
< 1.1	0	10	0	0	0	5	0	2	< 1.1	0	10	5	6
2.2	2	10	2	3	0	0	1	1	9.2	6	10	5	7
1.1	1	10	0	0	0	5	0	1	3.6	3	10	5	8
< 1.1	0	10	5	0	0	0	1	1	> 23	10	10	5	9
< 1.1	0	10	5	0	0	0	1	1	> 23	10	10	5	10
< 1.1	0	10	0	0	0	5	0	1	< 1.1	0	10	5	11
1.1	1	10	1	2	0	0	1	1	> 23	10	10	3	12
2.2	2	10	0	3	0	0	1	1	23	9	10	3	13
2.2	2	10	0	0	3	0	1	1	12	7	10	3	14
1.1	1	10	0	0	3	0	0	1	5.1	4	10	3	15
< 1.1	0	10	0	0	0	5	0	1	< 1.1	0	10	5	16
< 1.1	0	10	0	0	2	3	1	1	< 1.1	0	10	5	17
< 1.1	0	10	0	1	1	3	0	1	< 1.1	0	10	5	18
< 1.1	0	10	0	0	0	5	0	1	< 1.1	0	10	5	19
6.9	5	10	5	0	0	0	1	1	6.9	5	10	5	20
< 1.1	0	10	2	0	4	0	1	1	< 1.1	0	10	6	21
> 23	10	10	2	3	1	0	1	1	> 23	10	10	6	22
> 23	10	10	4	0	2	0	1	1	> 23	10	10	6	23
> 23	10	10	4	2	0	0	1	1	> 23	10	10	6	24
3.6	3	10	2	2	0	1	2	2	6.9	5	10	5	25
3.6	3	10	3	1	1	0	2	2	6.9	5	10	5	26
6.9	5	10	5	0	0	0	2	2	12	7	10	5	27
3.6	3	10	3	1	1	0	2	2	6.9	5	10	5	28
<1.1	0	10	0	0	0	5	0	2	< 1.1	0	10	5	29
2.2	2	10	0	3	2	0	2	2	5.1	4	10	5	30
< 1.1	0	10	0	0	0	5	0	2	< 1.1	0	10	5	31
< 1.1	0	10	0	0	1	4	0	2	1.1	1	10	5	32
< 1.1	0	10	0	4	1	0	1	2	2.2	2	10	5	33
> 23	10	10	5	0	0	0	2	2	>23	10	10	5	34
16.1	8	10	5	0	0	0	2	2	16.1	8	10	5	35
16.1	90	350	59	31	35	46	33	52		175	350	171	Total

others showed 5 CFU/100 ml or more (Grant and Ziel, streptococci and *Clostridium perfringens* (Mosely an

Most Probable Number (MPN) Chart

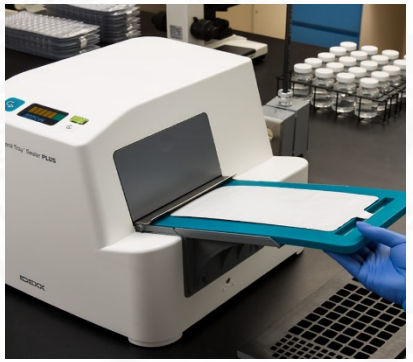
Multiple Tube Fermentation (MTF)

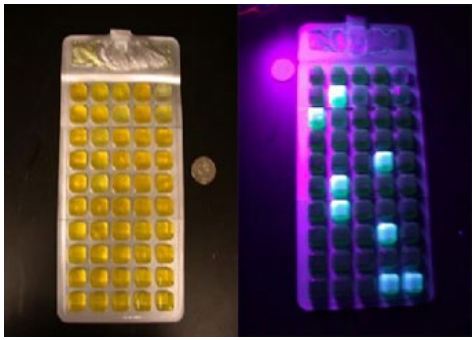
- Three test phases: presumptive, confirmed, and completed
  - Each test using different media
- Presumptive (lauryl tryptose)
  - Positive results presumes presence of coliforms
  - Gas formation in serial sample dilutions
- Confirmed (brilliant green bile)
  - Selection against non-coliform bacteria
  - Positive results is enough evidence of coliforms
- Completed (LES endo agar)
  - Usually not required, but recommended once per quarter as a QC check
  - Only coliforms can grow on all three media
  - Examination under a microscope



Enzyme Substrate Tests

- Based on a proprietary organic nutrient (ONPG)
  - Coliform bacteria
  - Broken piece is yellow
  - Solution will go from clear to yellow over a 24-hour period at 35 °C
  - IDEXX Colilert Method
    - USEPA approved
    - Incubated sample will fluoresce using UV for E-coli determination





References

1. *Operations of Wastewater Treatment plants*, Vol 1, Eight Edition, 2019, Sacramento State University Water Programs
2. *Wastewater Operator Certification Training*, Module 12: Laboratory Overview, Pennsylvania Department of Environmental Protection

LIVE DEMO
IN PERSON ONLY

REGULATORY REPORTING: MYDEQ MODULES

2:00 – 3:00 PM

PERMITTING BASICS (APP & AZPDES)

3:15 – 4:00 PM

Permitting Basics Agenda

- APP
  - Public Process
  - Individual Permits
  - General Permits (does not apply)
- AZPDES
  - General and Permit Coverage Requirements and Deadlines
  - AZPDES Program Standards
  - Public Process

- R18-9-109 Public Participation
  - Individual Permits
    - Notice of Preliminary Decision
    - Public Hearing
    - ADEQ responds in writing to all comments
    - ADEQ notifies the permittee or applicant regarding the Public and ADEQ comments
  - General Permits
    - Public participation requirements do not apply

APP – Individual Permits

- R18-9-A201 Individual Permit Application
  - Wastewater, industrial etc.
  - Provide ADEQ with following documents
    - Application form
    - Certificate of Disclosure
    - Evidence that facility complies with applicable municipal or county zoning
    - Documentation that sewage treatment facility or expansion conforms with the Certified Areawide Water Quality Management Plan and Facility Plan
  - Pre-application conference – on request
  - Draft Permit
  - Permit Duration
    - Except for temporary permit, valid for operational life of facility and any period during which facility is subject to a post-closure plan
  - Permit issuance or denial

APP – Individual Permits

- R18-9-A202 Technical Requirements
  - Topographic map, facility site plan, design documents
  - BADCT evaluation
  - Facility proposes compliance points
    - Should meet AWQS for pollutants
  - Contingency Plan
  - Hydrogeologic Study
  - Pertinent licensed operators with work experience

APP – Individual Permits

- R18-9-A203 Financial Requirements
  - Financial demonstration
  - Financial assurance
    - Financial test for self-assurance
    - Certificate of deposit
    - Trust fund
    - Insurance Policy
  - Permit Amendment potentially required if financial conditions change

APP – Individual Permits

- R18-9-A204 Contingency Plan
  - Specify contingency plan – defines actions on violations of AQL, discharge limitation, exceedance of alert levels etc.
    - Verification sampling, notification to downstream/downgradient users, inspection, testing, evaluation of pretreatment processes etc.
  - Corrective action needs to be approved by ADEQ
  - Should consists of emergency plans
  - Maintain at least one copy of the contingency at the facility
  - All employees responsible for the operation of the facility know the location of the contingency plan

- ## R18-9-A204 Contingency Plan Example

The Points of Compliance (POCs) have been established at the following locations:

Table 2: POINT(S) OF COMPLIANCE			
POC #	**POC Location**	**Latitude (North)**	**Longitude (West)**
1	Conceptual hazardous and non-hazardous POC located on the southwest corner of the WRF site	32° 50' 05"	111° 38' 06"
2	Conceptual hazardous and non-hazardous POC located on the southwest corner of the Recharge Basins	32° 50' 03"	111° 38' 13"

Groundwater monitoring is not required at the point of compliance wells, except as a contingency action. The

2.6. CONTINGENCY PLAN REQUIREMENTS

[A.R.S. § 49-243(K)(3), (K)(7) and A.A.C. R18-9-A204 and R18-9-A205]

2.6.1. General Contingency Plan Requirements

At least one copy of this permit and the approved contingency and emergency response plan shall be maintained at the location where day-to-day decisions regarding the operation of the facility are made. The permittee shall be aware of and follow the contingency and emergency plans.

Any AL exceedance, or violation of an AQL, DL, or other permit condition shall be reported to ADEQ following the reporting requirements in Section 2.7.3, unless more specific reporting requirements are set forth in Section 2.6.2 through 2.6.5.

Some contingency actions involve verification sampling. Verification sampling shall consist of the first follow-up sample collected from a location that previously indicated a violation or the exceedance of an AL.

- ## R18-9-A204 Contingency Plan Example

2.6.4. Aquifer Quality Limit Violation

1. If an AQL set in Section 4.1, Table 10: GROUNDWATER MONITORING has been exceeded, the permittee may conduct verification sampling for those pollutant(s) that were above their respective AQL(s) within five (5) days of becoming aware of the exceedance. The permittee may use results of another sample taken between the date of the last sampling event and the date of receiving the result as verification.
2. If verification sampling does not confirm an AQL exceedance, no further action is needed under this Section.
3. If verification sampling confirms that an AQL was exceeded for any parameter or if the permittee opts not to perform verification sampling, then, the permittee shall increase the frequency of monitoring for those parameters as follows:

Table 4: ACCELERATED MONITORING - AQUIFER QUALITY LIMIT VIOLATION	
Specified Monitoring Frequency	**Monitoring Frequency for AQL Violation**
Daily	Daily
Weekly	Daily
Monthly	Weekly
Quarterly	Monthly
Semi-annually	Quarterly
Annually	Quarterly

In addition, the permittee shall immediately initiate an evaluation for the cause of the violation, including inspection of all discharging units and all related pollution control devices, and review of any operational and maintenance practices that might have resulted in unexpected discharge.

APP – Individual Permits

- <u>R18-9-A205 Alert Levels, Discharge Limitations, and AQLs</u>

  ADEQ sets these levels and limitations

  - Base the alert levels on site-specific conditions, pollutants, and sampling location appropriate for discharge activity.
  - Will base the AQLs if pollutant concentration in the aquifer does/does not exceed the AWQS
    - Does not exceed then, AQL = AWQS
    - Does exceed then, AQL > AWQS

APP – Individual Permits

- R18-9-A206 Monitoring Requirements
  - ADEQ will determine if it is required or not. If required, then ADEQ will specify
    - Type & method, frequency, maintenance and intervals of monitoring
  - Recordkeeping
    - Maintain a monitoring record for each sample taken
      - Date, time, place of sample, procedures, analysis date, chain of custody, field notes etc.
    - Maintain monitoring records for at least 10 years after the sample date

APP – Individual Permits

- R18-9-A208 Compliance Schedule
  - Permittee shall follow the compliance schedule established in the individual permit.
  - ADEQ will consider all following factors when setting up a schedule
    - Character & impact of discharge
    - Nature of construction or activity
    - Number of persons affected/potentially affected by discharge
    - Current treatment technology
    - Age of facility

APP – Individual Permits

- R18-9-A208 Compliance Schedule Example

3.0 COMPLIANCE SCHEDULE

[A.R.S. § 49-243(K)(5) and A.A.C. R18-9-A208]

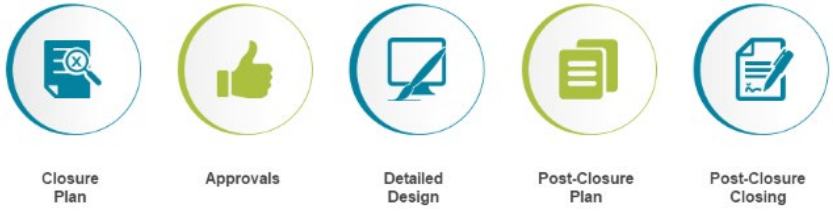
Unless otherwise indicated, for each compliance schedule item listed below, the permittee shall submit the required information to the Groundwater Protection Value Stream.

Table 7: COMPLIANCE SCHEDULE ITEMS

No.	Description	Due By:	Permit Amendment Required?
1	The permittee shall submit a signed, dated, and sealed Engineer's Certificate of Completion (ECOC) in a format approved by the Department for the new and modified units of the WRF prior to discharge and within 90 days of completion of construction per Section 3.0 of the permit.	Prior to discharging under this permit and within 90 days of completion of construction.	No
2	The permittee shall submit a demonstration that the financial assurance mechanism listed in Section 2.1, Financial Capability, is being maintained as per A.R.S. 49-243.N.4 and A.A.C. R18-9-A203(H) for all estimated closure and post-closure costs including updated costs submitted under Section 3.0, No. 2 below. The demonstration shall include a statement that the closure and post-closure strategy has not changed, the discharging facilities listed in the permit have not been altered in a manner that would affect the closure and post-closure costs, and discharging facilities have not been added. The demonstration shall also include information in support of a performance surety bond as required in A.A.C. R18-9-A203(C)(2).	Every 6 years from the date of permit signature, for the duration of the permit.	No
3	The permittee shall submit updated cost estimates for facility closure and post-closure, as per A.A.C. R18-9-A201(B)(5) and A.R.S. 49-243.N.2.a.	Every 6 years from the date of permit signature, for the duration of the permit.	Yes

APP – Individual Permits

- <u>R18-9-A209 Temporary Cessation, Closure, Post-Closure</u>
  - Temporary Cessation – Permittee should notify ADEQ before cessation at least 60 days duration.
  - Closure –
    - Notify ADEQ to cease operations
    - Submit a closure plan within 90 days following notification of intent to cease operations
    - ADEQ review a site investigation plan – lateral and vertical contamination extent in soil and groundwater
  - Post-Closure –
    - Describe post-closure monitoring and maintenance activities
    - Duration, operating and maintenance procedures; schedule and inspection descriptions; estimated cost; and limitations



APP – Individual Permits

- R18-9-A210 Temporary Individual Permit
  - A pilot project to develop data for APP or facility with a discharge no more than 6 months
  - Preliminary application
  - Public participation
  - Expires after one year unless it is renewed. ADEQ may renew a temporary individual permit no more than one time

APP – Individual Permits

- R18-9-A211 Permit Amendments Triggers
  - Increase in design flow of a sewage treatment facility

Permitted Design Flow	Increase in Design Flow
500,000 gallons per day or less	10%
Greater than 500,000 gallons per day but less than or equal to five million gallons per day	6%
Greater than five million gallons per day but less than or equal to 50 million gallons per day	4%
Greater than 50 million gallons per day	2%

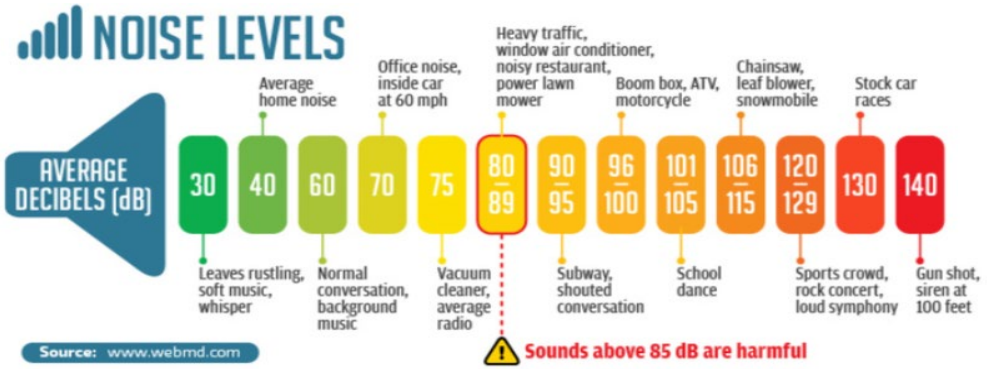
  - Update of BADCT for a facility
  - Discharge limits could be modified based on past results and quantity of increased flow
  - Other permit amendments

BADCT for Sewage Treatment Facilities

- R18-9-B201 General Considerations & Prohibitions Setbacks

Sewage Treatment Facility Design Flow (gallons per day)	No Noise, Odor, or Aesthetic Controls (feet)	Full Noise, Odor, and Aesthetic Controls (feet)
3000 to less than 24,000	250	25
24,000 to less than 100,000	350	50
100,000 to less than 500,000	500	100
500,000 to less than 1,000,000	750	250
1,000,000 or greater	1000	350

  - Some exceptions if setbacks cannot be met
    - Noise < 50 dB or < level established in a local noise ordinance
    - All odor producing components of STF are fully enclosed



BADCT for Sewage Treatment Facilities

- <u>R18-9-B201 General Considerations & Prohibitions Contd.</u>

  Setbacks

  - Some exceptions if setbacks cannot be met
    - Odor scrubbers are installed on all vents
    - Fencing aesthetically matched to surrounding area

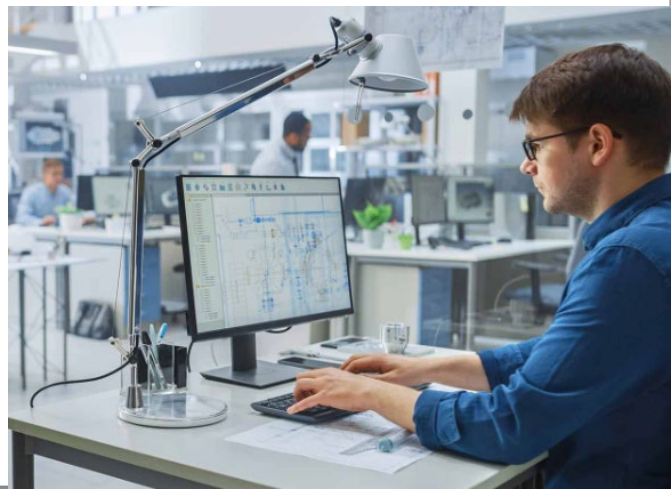
Operator shall not operate STF so that it emits an offensive odor on a persistent basis beyond setback distances

BADCT for Sewage Treatment Facilities

- R18-9-B202 Design Report
  - Applying for Individual Permit shall submit a design report signed by AZ-registered PE
    - Wastewater characterization, disposal method-solids management
    - Unit processes descriptions, diagrams and calculations to demonstrate that the design meets BADCT requirements
    - Planned normal operation description
    - Key maintenance description, and startup plan
    - Construction management controls description, compliance with setback requirements
    - Description of design flow, minimum-maximum daily/monthly flow, peak flows, pipe and power specifications
  - ADEQ may inspect the facility without prior notice to ensure construction conforms to the design report

BADCT for Sewage Treatment Facilities

- <u>R18-9-B203 Engineering Plans and Specifications</u>
  - Apply for individual permit for a STF with a design flow of <1 MGD
  - Design flow =/> 1 MGD submit these plans and specifications if design report fails to provide
    - Sufficient details
    - Use innovative technologies
    - Protection from physical damage due to 100-year flood
    - Provision for a standby power source
    - Many other reasons



BADCT for Sewage Treatment Facilities

- <u>R18-9-B204 Treatment Performance Requirements for a New Facility</u>

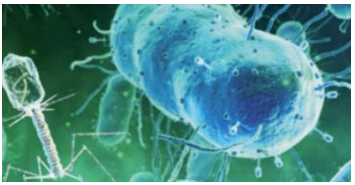
RECAP from Regulation Review

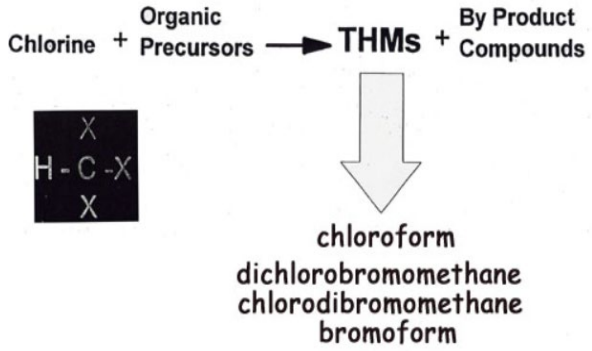
  - Operator of a new STF ensures that the facility meets following performance requirements upon release of the treated wastewater at the outfall:
  - Secondary treatment levels.

    - BOD_5 < 30 mg/L (30-day avg) and 45 mg/L (7-day avg) or $CBOD_5$ < 25 mg/L (30-day avg) or 40 mg/L (7-day avg)
    - TSS < 30 mg/L (30-day avg) and 45 mg/L (7-day avg)
    - pH between 6 and 9 S.U.
    - A removal efficiency of 85% for BOD_5, $CBOD_5$, and TSS
  - Secondary treatment by waste stabilization ponds is not considered BADCT

BADCT for Sewage Treatment Facilities

- R18-9-B204 Treatment Performance Requirements for a New Facility (Contd.)
  - Total nitrogen in the treated wastewater < 10 mg/L (5-month rolling geometric mean)
  - Pathogen removal requirements vary from design flow and other conditions
  - Performance requirement for each constituent is regulated under AWQS
  - Performance requirement for a regulated constituent is the removal to the greatest practical extent regardless of cost.





  - Minimize trihalomethane compounds-disinfection byproducts
  - Regulate industrial influent sources

BADCT for Sewage Treatment Facilities

- R18-9-B205 Treatment Performance Requirements for an Existing Facility
  - Identify design improvements that bring the facility closer to or within the treatment performance requirements
  - The designer may eliminate from consideration alternatives that are more expensive than the number of gallons of design flow times $1.00 per gallon
  - Select a design that incorporates one or more of the considered alternatives that will provide the greatest improvement

ARTICLE 9: ARIZONA POLLUTANT DISCHARGE ELIMINATION SYSTEM (AZPDES)

- R18-9-A907 Public Notice

A. Individual Permits

- ADEQ shall publish a notice that a draft individual permit has been prepared/tentatively denied in one or more newspapers of general circulation
- ADEQ shall provide the applicant with a copy of the draft individual permit
- ADEQ shall provide copy of the notice to the applicant, any identified user, any affected federal/state/tribal/local agency, county department of health, environmental services etc.

- R18-9-A908 Public Participation, EPA Review, EPA Hearing

A. Public comment period

- Begins on the publication notice date and extends for 30 calendar days
- ADEQ accepts written comments from any interested person
- If any data raise substantial new questions concerning a permit, ADEQ may reopen or extend the comment period
- If the District Engineer from Corps of Engineers advises ADEQ on permit denying to avoid any substantial impairment of anchorage or navigation, then the director shall deny the permit

- <u>R18-9-A908 Public Participation, EPA Review, EPA Hearing (Contd.)</u>

  B. Public hearing

  - ADEQ will provide notice and conduct a public hearing
  - ADEQ will accept written public comments until the close of the hearing or until a later date

- R18-9-A908 Public Participation, EPA Review, EPA Hearing (Contd.)

C. EPA Review

- ADEQ will send a copy of the draft permit to EPA
- If EPA objects to draft permit (before or after public comments) within 30 days from the date of receipt, the EPA comment period is extended to 90 days
- If EPA withdraws its objection to the draft/proposed permit or has no response within 90 days, ADEQ shall submit the permit

D. EPA Hearing

E. Final Permit Determination

AZPDES – Individual Permits

- R18-9-B901 Individual Permit Application

A. Time to apply

- Any person who owns or operates a facility, shall apply for an AZPDES individual permit at least 180 days before the date of the discharge or a later date if granted by ADEQ
- Any person who proposes a construction activity and wishes coverage under an individual permit shall apply for the individual permit at least 90 days before the date on which construction is to commence

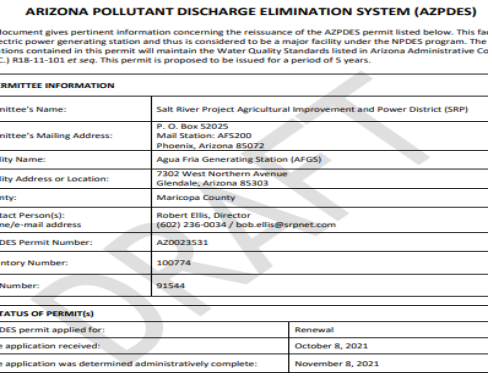
AZPDES – Individual Permits

- R18-9-B903 Individual Permit Issuance or Denial

  A. Once the application is complete, ADEQ shall either prepare a draft permit or deny the application

  B. Permit Issuance – ADEQ determines that an applicant complies with the regulations, ADEQ shall issue a permit

  C. Permit Denial – ADEQ provide a written notice of intent of denying the permit application; can also provide opportunity for public comments



ARIZONA POLLUTANT DISCHARGE ELIMINATION SYSTEM (AZPDES)

ocument gives pertinent information concerning the reissuance of the AZPDES permit listed below. This fa
ctric power generating station and thus is considered to be a major facility under the NPDES program. The
tions contained in this permit will maintain the Water Quality Standards listed in Arizona Administrative Co
.) R18-11-101 *et seq*. This permit is proposed to be issued for a period of 5 years.

RMITTEE INFORMATION

nittee's Name:	Salt River Project Agricultural Improvement and Power District (SRP)
nittee's Mailing Address:	P. O. Box 52025 Mail Station: AF5200 Phoenix, Arizona 85072
lity Name:	Agua Fria Generating Station (AFGS)
lity Address or Location:	7302 West Northern Avenue Glendale, Arizona 85303
nty:	Maricopa County
tact Person(s): ne/e-mail address	Robert Ellis, Director (602) 236-0034 / bob.ellis@srpnet.com
DES Permit Number:	AZ0023531
ntory Number:	100774
Number:	91544

TATUS OF PERMIT(s)

DES permit applied for:	Renewal
e application received:	October 8, 2021
e application was determined administratively complete:	November 8, 2021

DRAFT

AZPDES – Individual Permits

- R18-9-B904 Individual Permit Duration, Reissuance, and Continuation

A. Permit Duration

- Effective for a fixed term of not more than 5 years, but can be < 5 years
- If ADEQ does not reissue a permit within the period specified in the permit, the permit expires, unless it is continued under subsection C. Continuation

B. Permit Reissuance

- A permittee shall reapply at least 180 days before the permit expiration date

C. Continuation

General Pretreatment Regulations

- R18-9-A906 General Pretreatment Regulations for Existing and New Sources of Pollution
  - Pretreatment applies to:
    - Pollutants from non-domestic sources that are indirectly discharged, transported by truck or rail, or introduced into POTWs
    - POTWs that receive wastewater from sources subject to national pretreatment standards
    - Any new or existing source subject to national pretreatment standards
  - Reduction/alteration of a pollutant obtained by physical, chemical, or biological processes. Pretreatment technology includes control equipment such as equalization tank or treatment systems.

General Pretreatment Regulations

- R18-9-A906 General Pretreatment Regulations for Existing and New Sources of Pollution (Contd.)
  - National pretreatment standards do not apply to sources that discharge into a sewer that is not connected to a POTW.
  - "National Pretreatment Standard" and "Pretreatment Standard" mean any regulation containing pollutant discharge limits promulgated by EPA under section 307(b) and (c) of the Clean Water Act (33 U.S.C.1317), which applies to Industrial Users.

FUNDING SOURCES

4:00 – 4:45 PM

Funding Sources

- Agenda
  - Water Infrastructure Finance and Innovation Act (WIFIA)
  - Arizona Water Infrastructure Finance Authority
    - Clean Water SRF – State Revolving Fund
  - Municipal Bonds
  - Rate Studies/Rate Increases

Funding Sources

- Water Infrastructure Finance and Innovation Act (WIFIA)

  A federal credit program administered by EPA for eligible water and wastewater infrastructure projects.

  Eligible borrowers are:

  - Local, state, tribal, and federal government entities
  - Partnerships and joint ventures
  - Corporations and trusts
  - Clean Water and Drinking Water State Revolving Fund (SRF) programs

Source: What is WIFIA? | US EPA

WIFIA

- Fund Eligible Projects
  - Wastewater conveyance and treatment projects
  - Enhanced energy recovery efficiency projects at wastewater facilities
  - Desalination, aquifer recharge, and water recycling projects
  - WIFIA has closed 107 loans totaling $18 billion in credit assistance to help finance $39 billion for water infrastructure projects and create 130,000 jobs.
  - **No Funds have been provided to AZ projects to date.**

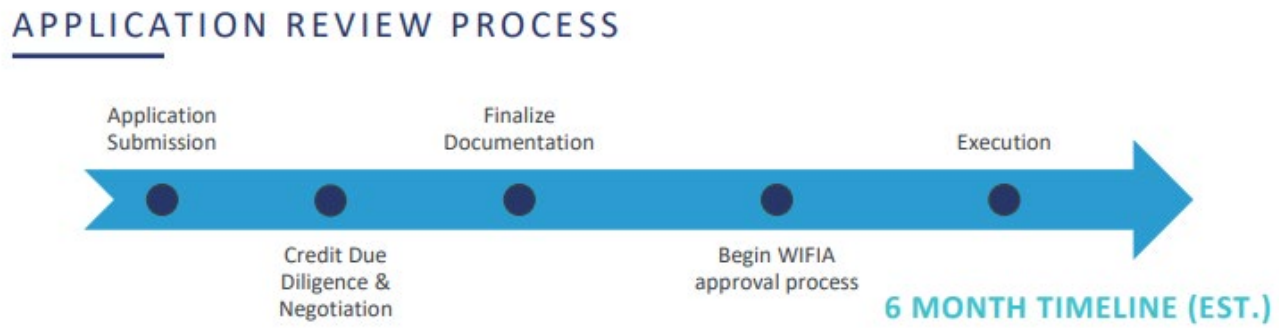
WIFIA

- Key Program Features
  - Maximum final maturity date from substantial completion – 35 years
  - Minimum project size for small communities (<25,000) - $5M
  - Minimum project size for large communities - $20M
  - Maximum portion of eligible project costs that WIFIA can fund – 49%
  - Interest rate will be ≥ U.S. Treasury rate of a similar maturity
  - Payments may be deferred up to 5 years after the project substantial completion

WIFIA

- Other WIFIA Loan Information
  - WIFIA only authorized to provide long-term, low-cost loans
  - Projects receiving WIFIA credit assistance must comply with all relevant federal laws and regulations, including the National Environmental Policy Act (NEPA)

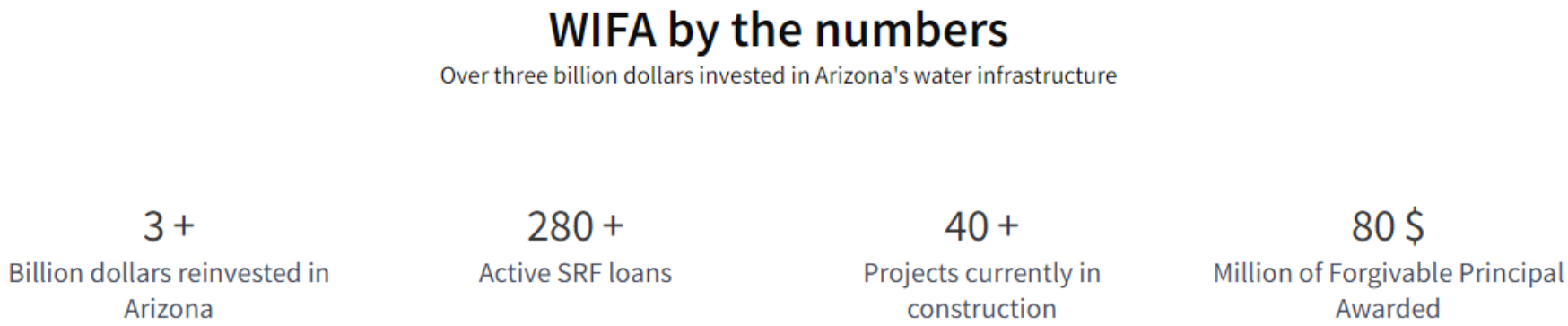
- Application
  - Phase I – Project Selection
    - EPA solicits applications
    - EPA selects prospective borrowers from applicants
  - Phase II – Project Review, Negotiation, and Closing
    - Each invitee must apply for WIFIA loan
    - Conduct financial and engineering review
    - WIFIA program must receive approval from administrator
    - At closing, the prospective borrower executes the legal credit agreement



WIFIA Application Process Factsheet (epa.gov)

Funding Sources – Clean Water State Revolving Fund

- ## Arizona's State Revolving Fund
  - Water Infrastructure Finance Authority of Arizona (WIFA) – finance construction, rehabilitation, acquisition, and improvement of water infrastructure.



Water Infrastructure Finance Authority of Arizona (azwifa.gov)

Examples

Arizona's Clean Water Revolving Fund
Project Priority List 2021 Funding Cycle
February 2021

PPL Rank	Applicant	Population	County	Project Name	Description	Project Number	Amount Requested / Probable Green Amount	Subsidy
1	[4] Town of Florence	15,900	Pinal	Wastewater System Improvements	The Town of Florence has identified the need for Capital Improvement Projects at its South Wastewater Treatment Plant and collection system which includes; primary and biological system component upgrades, expanding the existing effluent recharge basin capacity, and the replacement of an aged sewer transmission line.	011 2021	$5,059,900.00	80%
2	[1,4] City of Globe	6,068	Gila	Wastewater Improvements	This sewer system improvement project includes: septic to sewer conversion, sewer system study, installation of de-chlorination system, line and manhole replacement, the covering of a wet well and installation of an odor control system.	013 2021	$2,000,000.00	75%
3	[1,4] Clifton, Town of	1,667	Greenlee	Wastewater Treatment Plant Upgrades and Rehabilitation	This project will construct a new Wastewater treatment system and rehabilitate aging components of the existing Plant. A Moving Bed Biological Reactor will be installed to replace the existing trickling filter wastewater treatment system.	003 2021	$3,612,500.00	80%
4	[1, 2] Town of Huachuca City	1,797	Cochise	Wastewater Lagoon System Closure	The Town is seeking funding to Clean Close their wastewater lagoon system per a Significant Amendment to its APP and as required in a consent order from ADEQ.	015 2021	$1,770,000.00	80%

Clean Water State Revolving Fund (CWSRF)

- Federal-state partnership provides low-cost financing to communities such as municipal wastewater facilities, water reuse etc.

  Project Eligibilities

  - Construction of publicly owned treatment works
  - Construction/repair/replacement of decentralized wastewater treatment system
  - Water reuse

Application

LOAN APPLICATION FOR A CLEAN WATER (WASTEWATER OR STORMWATER) PROJECT

Financial Assistance Project Priority List Application
Project Number: CW-xxx-2020

1. APPLICANT AND CONTACT INFORMATION

1.1 Utility Information

Name:

Address: City: State: Zip: County:

1.2 Utility Representative to be Contacted Regarding Application

First Name: Last Name:

Title:

Address: City, State & Zip:

Phone: Fax:

E-Mail:

1.3 Median Household Income: $

*Median household income was obtained from American Fact Finder (**http://factfinder2.census.gov**) based on US Census Bureau information.*

2. SYSTEM INFORMATION

2.1	Aquifer Protection Permit #:		
2.2	Arizona Pollution Discharge Elimination System Permit #:		
2.3	Number of connections to system		☐ Not Applicable
2.4	Population served by the system		☐ Not Applicable
2.5	Monthly residential fee (base + use) for 5,000 gallons, or flat rate, if applicable	$	☐ Not Applicable
2.6	Existing debt (principal only) payable by system users	$	

2.7 System Compliance

○ Notice of violations and/or consent orders from regulatory agency *(*must mail or upload supporting documents)*
◉ In compliance

2.8 Is the system registered with the **E-Verify** Program? ○ Yes ◉ No

Applicants are required to provide proof of participation prior to the execution of a loan or grant agreement.

- Types of CWSRF Assistance
  - Loans
    - Loan term may not exceed 30 years or the useful life of the project
    - Interest rates must be at or below market rate, including interest-free
  - Purchase of Debt or Refinance
    - Community's debt may be purchased by a CWSRF program
  - Guarantees and Insurance
    - Can be used where such assistance will result in improved credit market access
  - Additional Subsidization
    - Annual CWSRF approximation must be > $1 Billion
    - Recipient must be a municipality or inter-municipal, interstate, or state agency

- US EPA Financing Alternatives Comparison Tool (FACT)

  Financial analysis tool that helps municipalities identify the most cost-effective method to fund a wastewater project.

  - Produces a comprehensive analysis that compares financing options for these projects by incorporating financing, regulatory, and other important costs
  - Creates several reports showing the analysis results
  - Can download FACT v.3.1 to get familiarized with the tool

- Application and Scoring
  - Add your project to the Project Priority List (PPL)
    - First step in the application process
    - Assess initial eligibility screening
    - Estimated financial benefits (forgivable principal, technical assistance & rate subsidy)
    - Assigned a PM and a fiscal service representative
  - Loan terms vary and may include an interest rate discount
  - Repayment periods of up to 30 years
  - Additional requirements are **American Iron and Steel, Davis-Bacon Related Acts, Cost and Effectiveness Analysis Certification, and Fiscal Sustainability Plan**

- Additional Requirements

  American Iron and Steel (AIS)

  - Required to use iron and steel produced in U.S
  - Applies to construction, alteration, maintenance, or repair of POTWs
  - Some WIFA projects are deemed exempt from AIS requirements

- Additional Requirements

  Davis-Bacon Related Acts

  - All construction workers on SRF projects must receive Davis-Bacon wages, and those wages must be verified
  - Cost of hiring a contractor to assist with Davis-Bacon is reimbursable with SRF loan funds
  - Borrowers will be responsible for compliance
  - Department of Labor (DOL) is responsible for Davis-Bacon rules and regulations

- Additional Requirements

  Cost and Effectiveness Analysis Certification

  - It is a process that maximizes water and energy conservation
  - It demonstrates that the recipient has studied and evaluated the cost and effectiveness of the processes, materials, techniques, and technologies
  - Maximizes the potential for efficient water use, reuse, recapture, and conservation
  - The list of receipts of this funding must be submitted with this form before receiving final design funding

- Additional Requirements

  Fiscal Sustainability Plan

  - Describes how the owner will find the creation, acquisition, operation, maintenance, rehabilitation, and replacement of assets to meet their established level of service with minimal cost
  - Must be developed and included in the loan application

Rural Water Infrastructure Committee (RWIC)

- Seek to create a sustainable organization of funders and technical assistance providers who partner to meet the needs of wastewater systems throughout AZ

RWIC Partners

- Arizona Corporation Commission (AZCC)
- AZ Department of Environmental Quality (ADEQ)
- Arizona Department of Housing (ADOH)
- Arizona Department of Water Resources (ADWR)
- Border Environment Cooperation Commission (BECC)
- North American Development Bank (NADBank)
- Rural Water Association of Arizona (RWAA)
- U.S. Department of Housing and Urban Development (HUD)
- Water Infrastructure Finance Authority (WIFA)
- USDA Rural Development (USDA-RD)
- Rural Community Assistance Corporation (RCAC)
- Bureau of Reclamation (BOR)

- USDA Rural Development (USDA-RD)

  Long-term and low interest loans for sanitary sewage disposal, sanitary solid waste disposal etc.

  Eligible borrowers:

  - Most state and local government entities
  - Private nonprofits
  - Federally recognized Tribes

  Eligible area:

  - Rural areas with population <10,000
  - Tribal lands in rural areas

- USDA Rural Development (USDA-RD)

  Funds can be used for:

  - Sewer collection, transmission, treatment, and disposal
  - Solid waste collection, disposal, and closure
  - Legal and engineering fees
  - Start-up operations and maintenance
  - Purchase of facilities to improve service or prevent loss of service
  - Interest incurred during construction

Rural Water Infrastructure Committee (RWIC)

- USDA Rural Development (USDA-RD)
  - Loan term is up to 40-year payback period
  - Interest rate is based on the project need and the median household income
  - Projects must be financially sustainable
  - Applications are accepted year-round and may be filed electronically RD Apply

Municipal Bonds

- Municipal bond market has been the primary source of capital for U.S. infrastructure
  - Tax-exempt bonds
  - Direct payment bonds
  - Private activity bonds

Municipal Bonds

- Tax-exempt bonds
  - Issued by state and local governments to raise capital for public purposes
  - Investors don't pay federal taxes on the earned interests
  - Lower interest rates
  - These bonds can be used for all types of publicly owned infrastructure but not for privately owned
  - This bond market is very deep with millions of investors

Municipal Bonds

- Direct Payment bonds

  Another form of state and local government debt

  - Interest is taxable
  - Investors require higher interest rates, in which the federal government pays a portion of the interest on the bond
  - Federal payments go directly to state and local governments rather than to investors through tax exemption
  - Only available for publicly owned projects

Municipal Bonds

- Private Activity Bonds
  - Support privately owned projects
  - Offer tax-exempt interest if the bond is issued to finance a qualifying project such as
    - Airports, docks, water, and sewer facilities
  - Less attractive to investors who do not have federal tax liability
  - Currently have a statutory “volume cap” that limits the amount that may be issued in each state

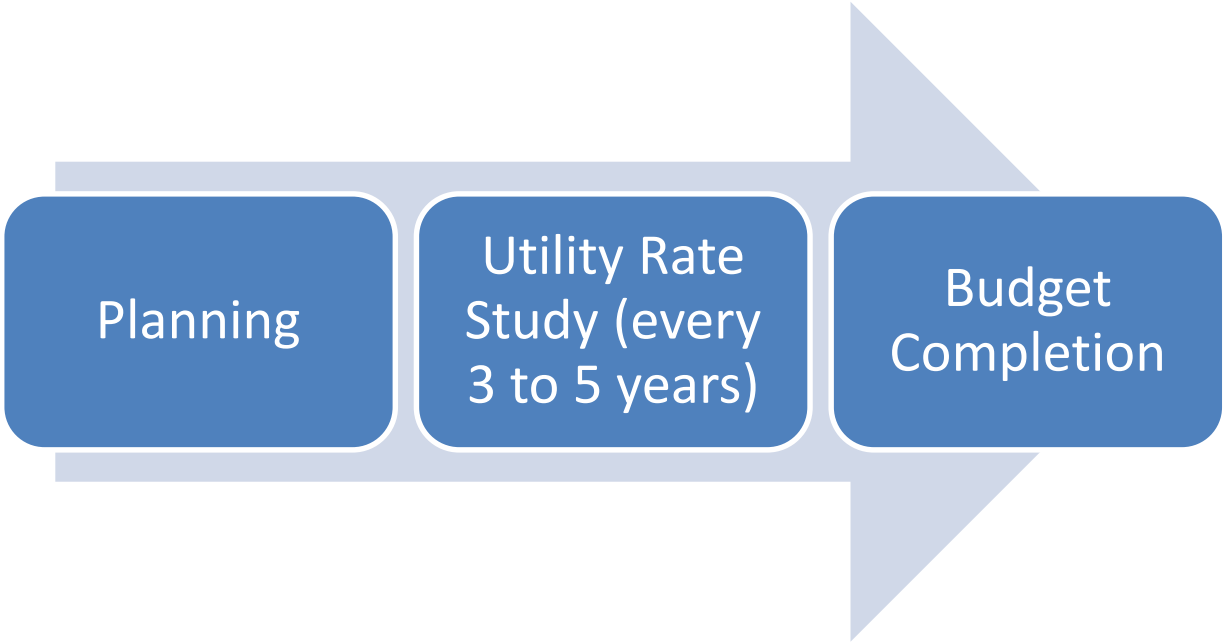
FINANCIAL PLANNING – RATE STUDIES

Rate Studies

- Rate studies provide clarity into what your utility can expect in the upcoming years (3 to 5 years) in terms of ensuring financial resources to:
  - Meet budget
  - Maintain infrastructure
  - Expand distribution system
  - Implement capital improvement plan
  - Investigate new technologies

Rate Studies

- First utility rate study is performed after planning which rely on:
  - Prior and present data
  - Public works budget

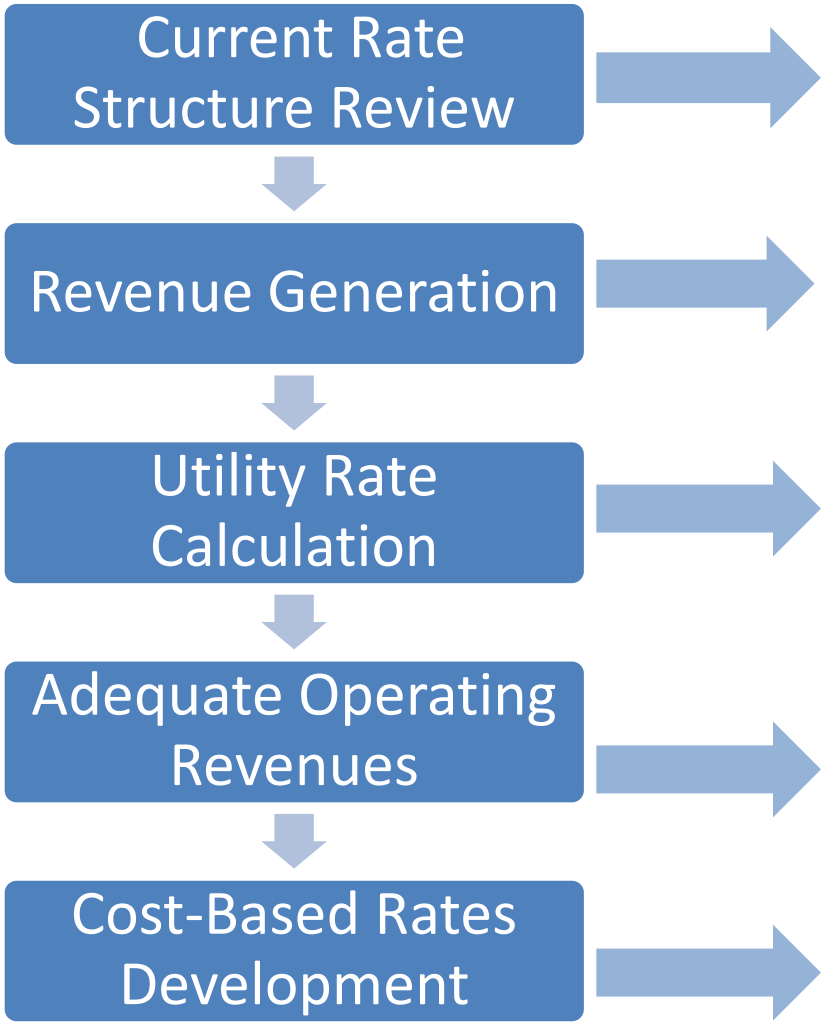


Rate Studies

- Benefits
  - Get informed on total revenue requirements
  - Predicts revenue stability
  - Make sure equality in the total service costs distribution among different ratepayers
  - Plays a keen role in utility rate design

Rate Studies

- Steps



Review municipal water utility's current rate structure, past financials, planned capital improvements and debt obligations.

Analyze current rate structure's ability to produce adequate revenue to fund improvements during 5-year period.

Rates are calculated based on the utility's revenue, which is required to meet its financial obligations.

Determine whether your operating revenues are sufficient to meet your present and upcoming expenses.

Important to comprehend how rates are developed and increased

Rate Studies

- Utility Rate Calculation

  Important to consider how a particular rate structure will impact the billing procedures and varying demographics of utility consumers

  - Uniform Rates - Constant unit price for all metered volumetric units of water consumed per year.
  - Decreasing Block Rates - Unit price of each subsequent block of usage is charged at a lower unit rate than the previous block(s).
  - Increasing Block Rates - The rate per unit of water increases as the volume of consumption increases.

Rate Studies

- Example

City of Scottsdale, Arizona
Annual Report of the Collection and Use of Development Fees
For Fiscal Year Ended June 30, 2022

Fee Type	Fund
Water Development Fees	626
Water Supply Development Fees	627
Sewer Development Fees	628

SUMMARY OF THE COLLECTION AND USE OF DEVELOPMENT FEES

	Water Fund 626	Water Supply Fund 627	Sewer Fund 628
REVENUES			
Development Fees Assessed/Collected[1,3]	$ 3,165,129	$ 606,821	$ 2,159,005
EXPENDITURES			
Capital Improvement Project Expenditures	6,599,474	-	2,686,769
Professional Services/Fee Study Costs	13,385	-	10,401
Debt Service Interest Payments	1,867,140	606,982	2,152,980
Total Expenditures	8,479,999	606,982	4,850,150
Net Cash Increase (Decrease)	(5,314,870)	(161)	(2,691,145)
Beginning Fund Cash Balance[2]	(61,158,462)	(8,539,728)	(82,875,963)
Ending Fund Cash Balance[4]	$ (66,473,332)	$ (8,539,889)	$ (85,567,108)

[1]Development fees have three components: Buy-In of Existing Facilities, Growth Related Projects, and Interest.

[2]Beginning Fund Cash Balances include inception to date expenditures on growth related construction, acquisition, principal, and interest.

[3]There were no interest or other earnings; each fund had a negative fund balance during the fiscal year.

[4]Infrastructure related expenses do not generally occur when the Development Fee Assessment revenue is collected. As such, funds are advanced from the Water Operating Fund to both the Water and Water Supply Development Funds and advanced from the Sewer Operating Fund to the Sewer Development Fund. This internal, temporary borrowing is to be repaid when revenues within the Development Fee Funds exceed eligible expenses.

Example

City of Scottsdale, Arizona
Annual Report of the Collection and Use of Development Fees
For Fiscal Year Ended June 30, 2022

SCHEDULE OF CAPITAL IMPROVEMENT PROJECT EXPENDITURES

WATER DEVELOPMENT FEES - FUND 626

Project	Project Name and Location	Expenditures
WF02A	Site 42 Reservoir Storage	$5,382,463
WF05A	Well Site – Crossroads East North of AZ State Route 101	1,198,218
WF06A	Crossroads East Water	18,582
WH23B	Zone 14/16 Water System Improvement Phase 2	211
		$6,599,474

WATER SUPPLY DEVELOPMENT FEES - FUND 627

Project	Project Name and Location	Expenditures
None		$ -

SEWER DEVELOPMENT FEES - FUND 628

Project	Project Name and Location	Expenditures
VF02A	Jomax Rd Sewer Interceptor & Lift Station	$ 9,275
VF03A	Crossroads East Sewer	2,612,725
VF06B	Wastewater Collection System Improvements	64,769
		$2,686,769

Development Fees

- Municipality may assess development fees to offset costs to the municipality associated with providing necessary public services to development
  - Costs of infrastructure
  - Improvements
  - Real property
  - Engineering and architectural services
  - Financial and professional services

Development Fees

- Requirements
  - Fees shall result in a beneficial use to the development
  - Calculate the fees based on infrastructure improvement plan
  - Fees shall not exceed a proportionate share of the cost of necessary public services
  - Projected interest charges and other finance costs may be included in determining the development fees amount
  - Schedule for fee payment shall be provided by municipality
  - There are other requirements too

Rate Fees

- Fees are different for residential and industrial

Wastewater/Sewer Rates Schedule

Effective July 1, 2022

Source: City of Scottsdale Revised City Code, Section 49-141

	Charge Per 1,000 Gallons[1]		
User Category	**O & M**	**Capital**	**Total**
Single-family Residential	$1.22	$1.49	$2.71
Multi-family Residential	$1.22	$1.49	$2.71
Commercial without dining	$1.22	$1.49	$2.71
Commercial with dining	$1.94	$2.38	$4.32
Hotels, motels without dining	$1.22	$1.49	$2.71
Hotels, motels with dining	$1.94	$2.38	$4.32
Carwashes	$1.22	$1.49	$2.71
Commercial Laundry	$1.60	$1.96	$3.56
Laundromats	$1.22	$1.49	$2.71
Metal Platers	$1.39	$1.70	$3.09
Restaurants; bakeries	$2.62	$3.21	$5.83
Service station auto repair	$1.23	$1.50	$2.73
Medical Institutes	$1.22	$1.49	$2.71
Schools	$1.22	$1.49	$2.71
Non-compliant	See below	See below	See below

Notes: The monthly wastewater service charge is calculated by multiplying 90% of the customer's average winter consumption for the prior December, January and February by the rates shown above. In addition to the O & M and Capital charges, all wastewater users shall pay a base fee for all customer classes as follows:

Meter size	Base Fee
5/8, 3/4 and 1 Inch	$5.80
1.5 Inch	$34.80
2 Inch	$81.20
3 Inch	$104.40
4 Inch	$153.00
6 Inch	$290.00
8 Inch	$406.00

- Non-Compliant: Once a customer is designated as non-compliant, the then current O & M and Capital charges will be adjusted by one hundred and fifty percent (150%) for a minimum of six months.
- Out of City customers are charged a surcharge up to fifteen percent (15%) applied to the O & M, Capital and Base Fees described above.
- Applicable privilege tax will be added.

Summary

- Discussed the APP & AZPDES regulations
- BADCT requirements
- Wastewater treatment unit processes
- Wastewater field sampling
- Compliant with the permit
- Laboratory methods to analyze wastewater samples
- Safety measures during sampling and analysis
- myDEQ requirements and submission process
- Various funding sources options and their limitations