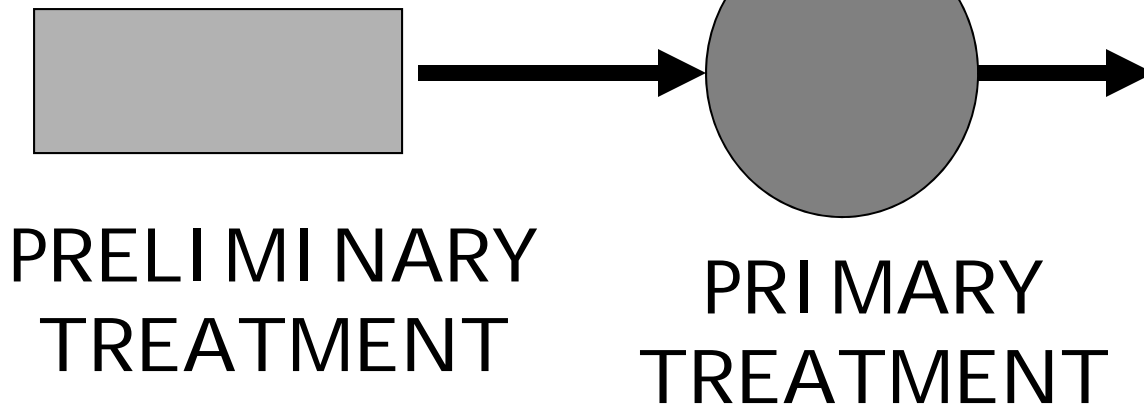
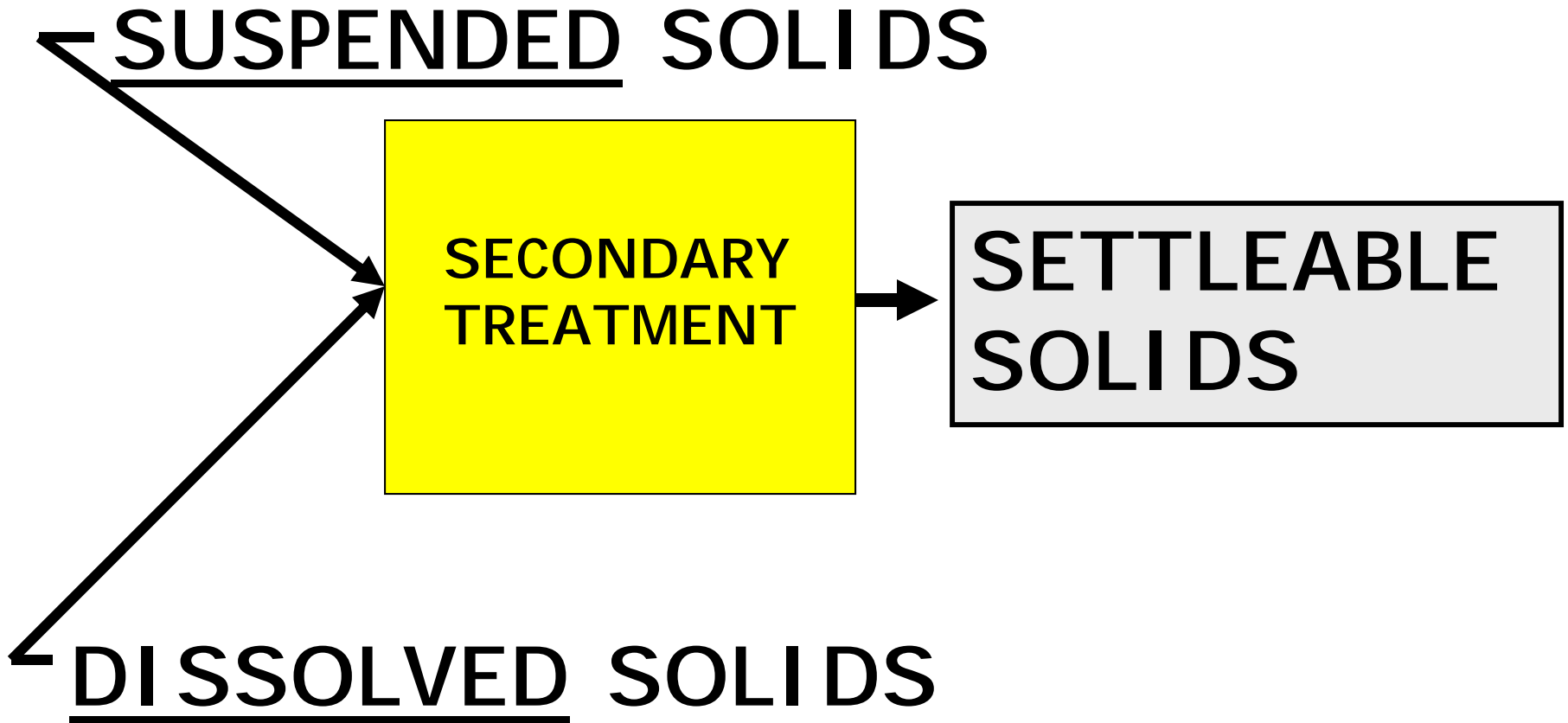


QUICK REVIEW



SECONDARY
TREATMENT

REVIEW, con't



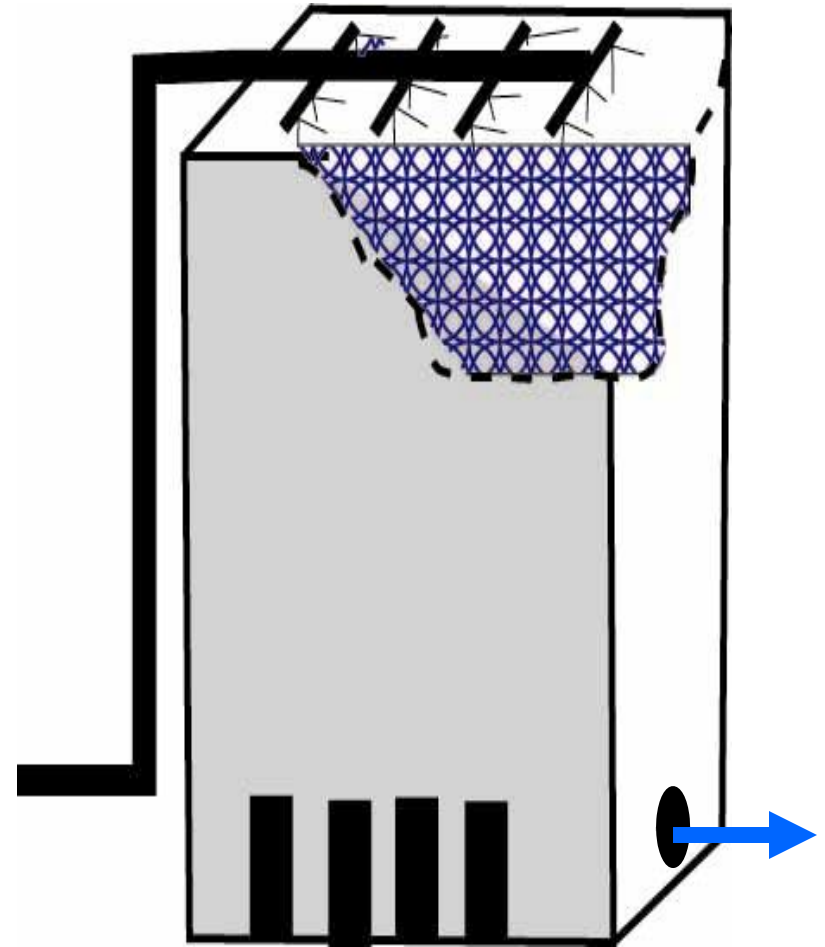
SECONDARY TREATMENT

- WASTE TREATMENT PONDS
 - TRICKLING FILTERS
 - ROTATING BIOLOGICAL CONTACTORS
 - ACTIVATED SLUDGE

TRICKLING FILTERS



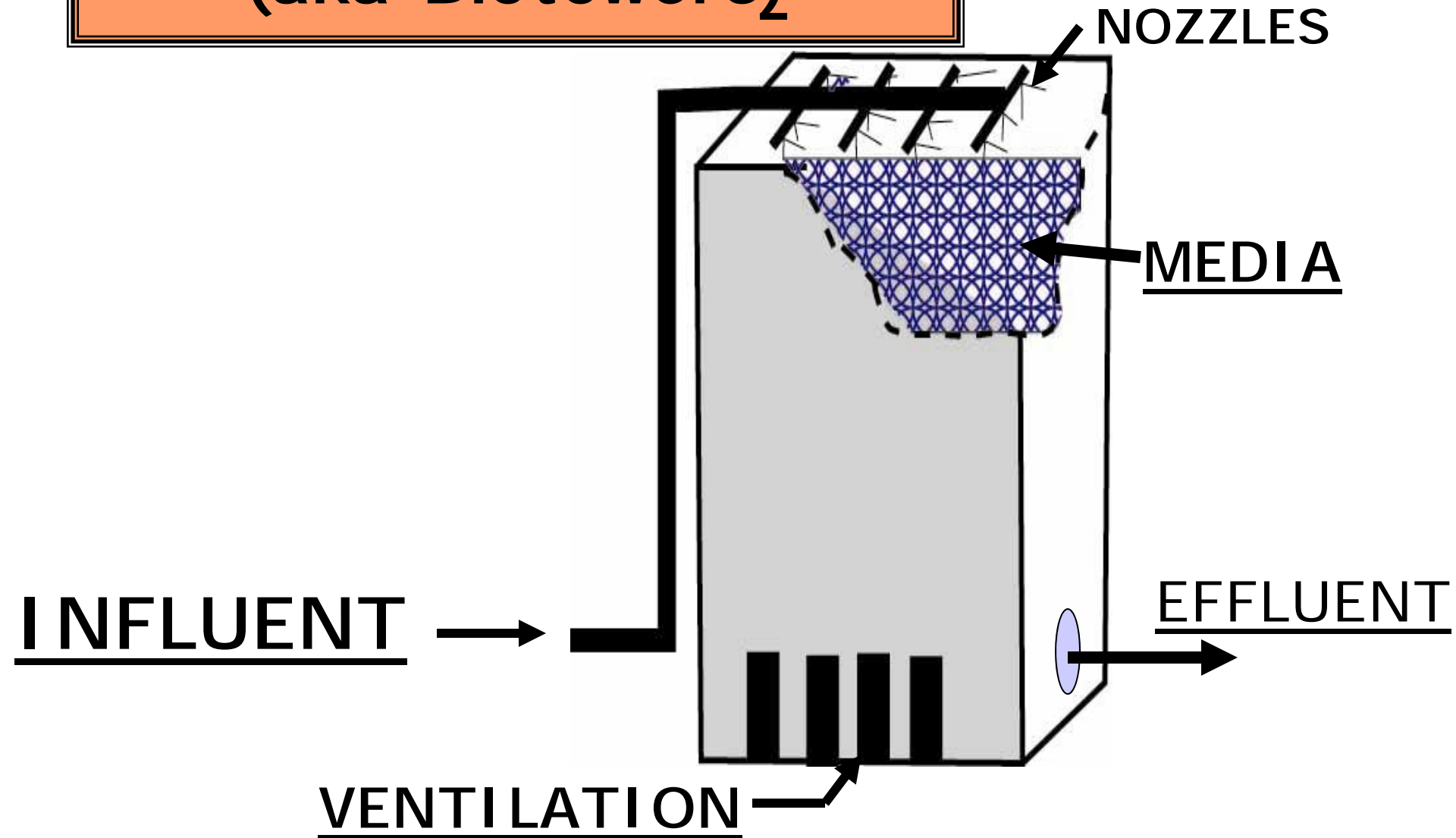
ROTATING
DISTRIBUTOR



FILTER TOWER

FILTER TOWERS

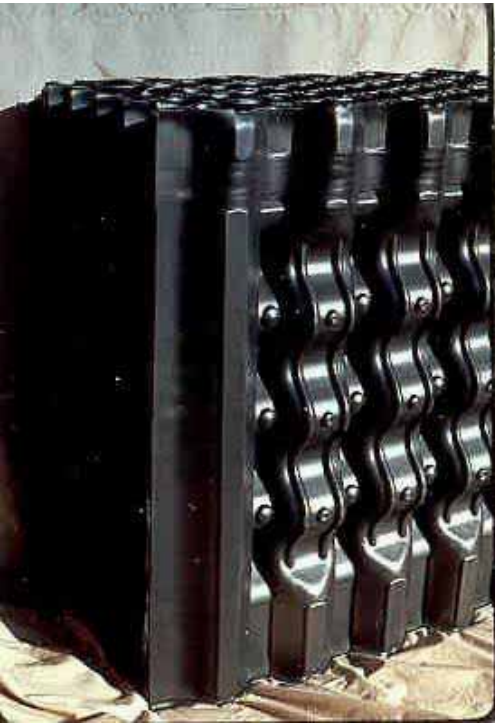
(aka Biotowers)





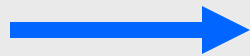


FILTER TOWER MEDIA



PLASTIC
MEDIA

**ALL TRICKLING
FILTERS CONSIST OF 3
PARTS**



- **MEDIA**
- **UNDERDRAIN**
- **DISTRIBUTION
SYSTEM**

**TRICKLING FILTERS
COULD BE CALLED...**

**“ATTACHED
GROWTH
BIOLOGICAL
REACTORS”**

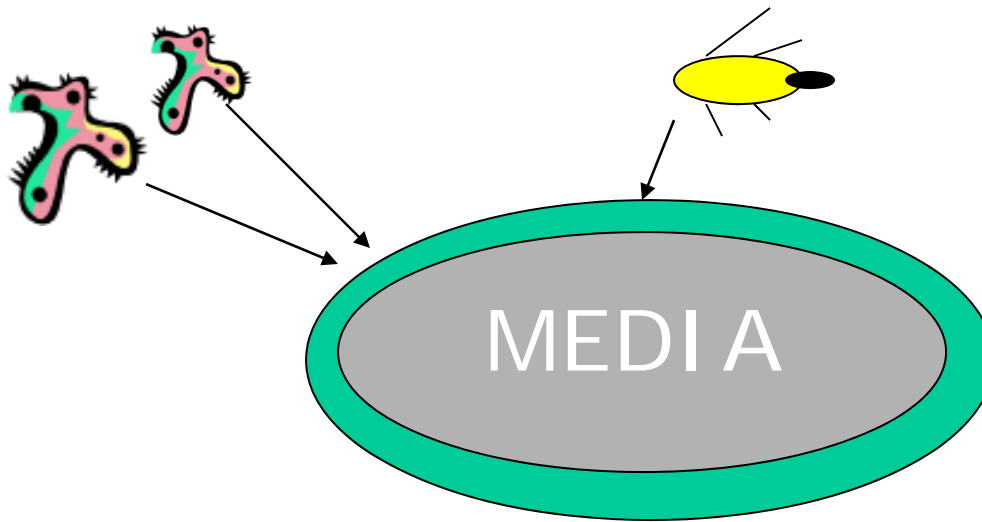
MEDIA

FUNCTION

- PROVIDES A PLACE FOR BIOLOGICAL SLIME TO DEVELOP

SLIME: aka ZOOGLEAL FILM
(ZOE-gee - al)

ZOOGLICAL FILM

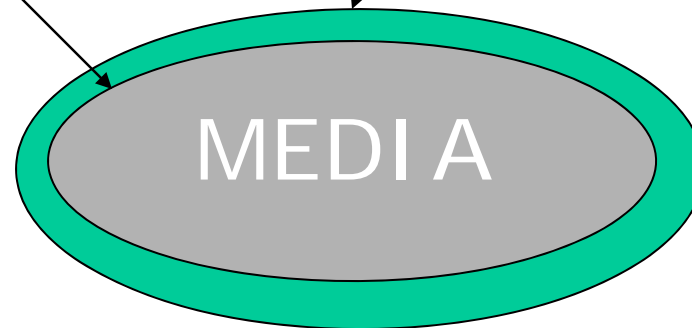


CONSISTS OF BACTERIA, ALGAE
PROTOZOA, FUNGI, WORMS...+?

ZOOGLEAL FILM

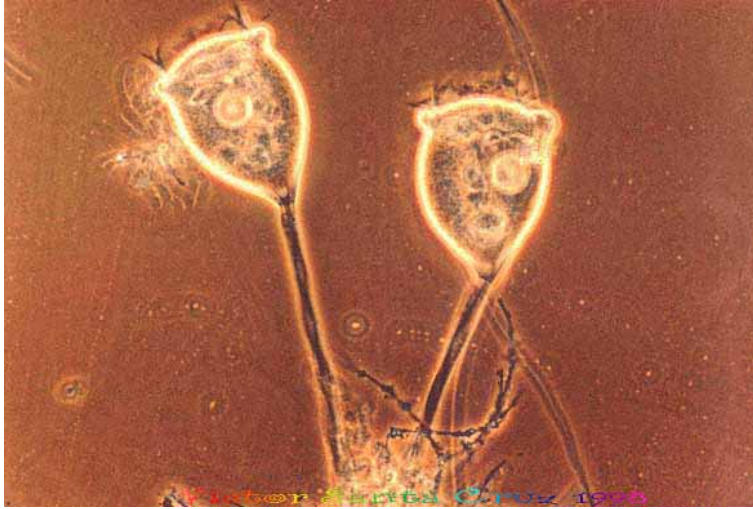
ANAEROBIC

AEROBIC



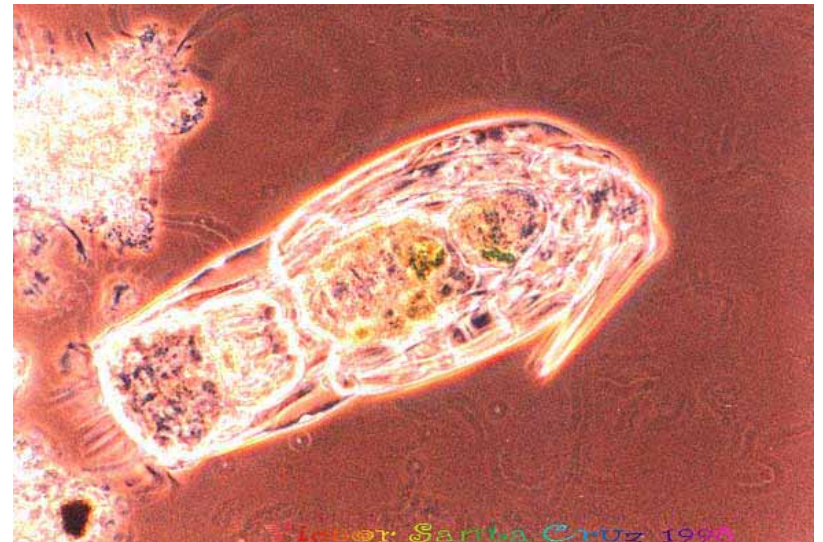
THE PROCESS IS AEROBIC—
EVEN WITH AN ANAEROBIC
LAYER NEXT TO THE MEDIA

SOME ZOOGLEAL CRITTERS AT 1000 X

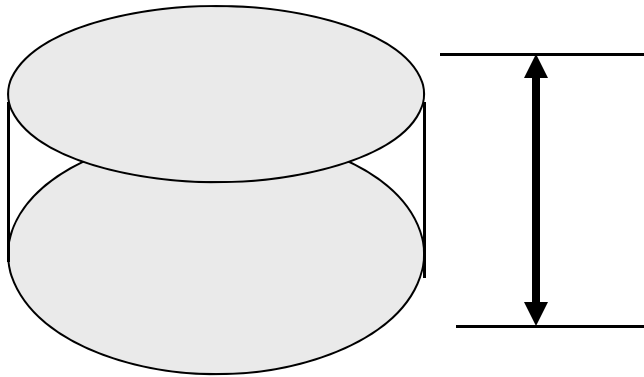


"STALKED"
CILIATES

ROTI FER

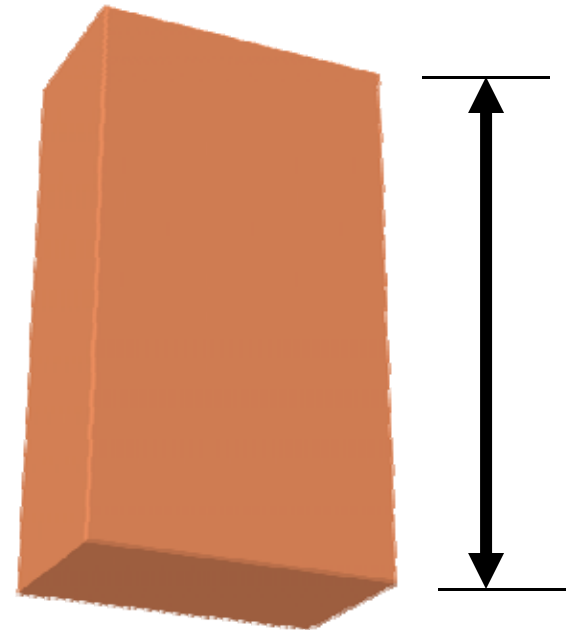


DEPTH OF MEDIA



3-8 FT FOR
ROCKS

(DEPTH LIMITED
BECAUSE OF
WEIGHT OF ROCKS)



15-30 FT FOR
SYNTHETIC
MEDIA

**ALL TRICKLING
FILTERS CONSIST OF 3
PARTS...**

• MEDIA

→ • UNDERDRAIN

• DISTRIBUTION
SYSTEM

UNDERDRAIN



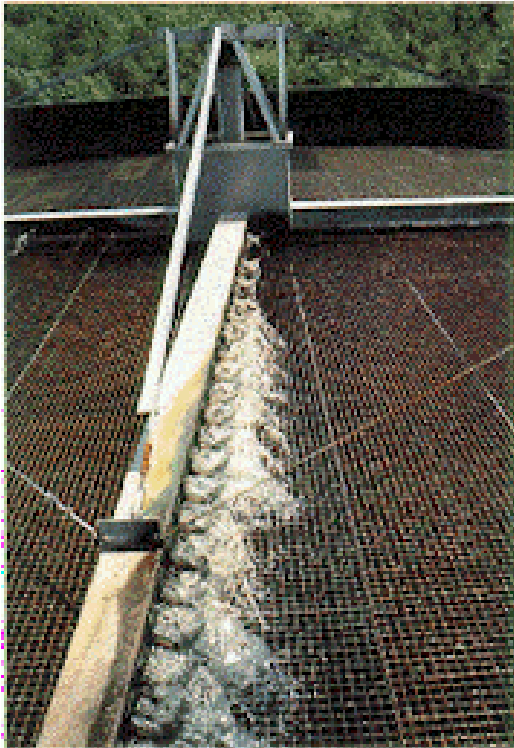
UNDERDRAIN

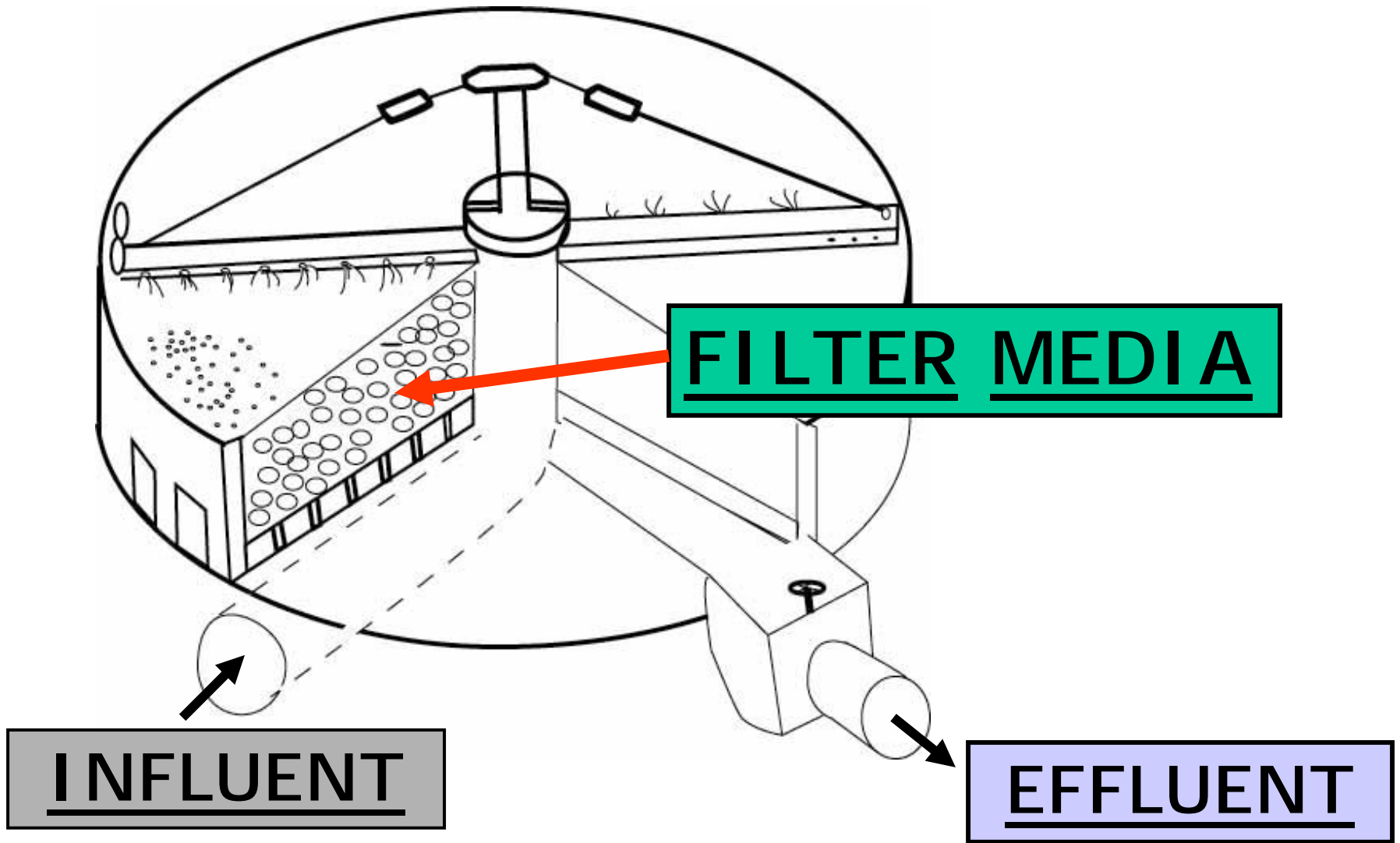


- THESE ARE DESIGNED TO FLOW ½ FULL AT MAXIMUM FLOW RATES

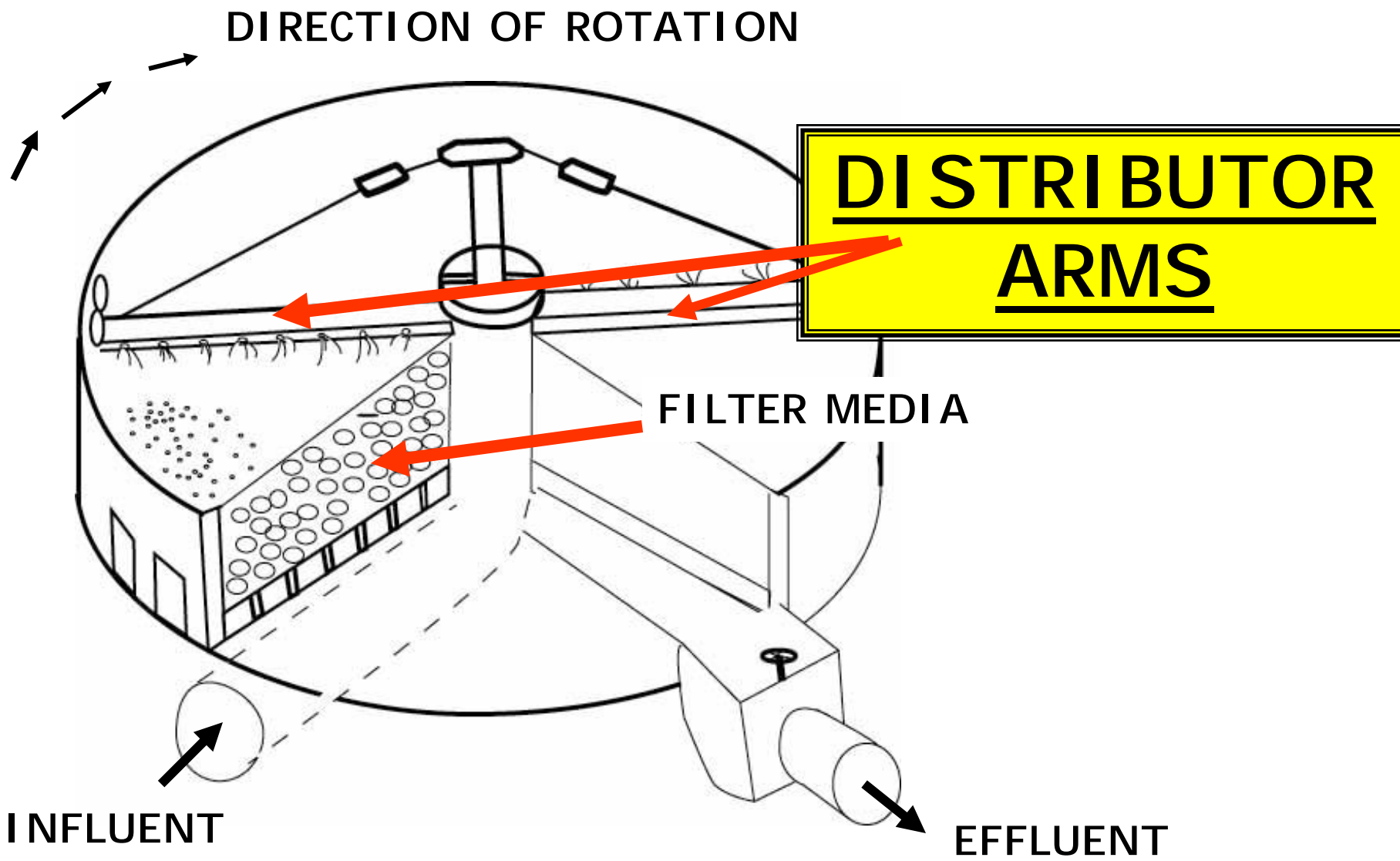
- SLOPED TO DRAIN AT MINIMUM OF 2 fps

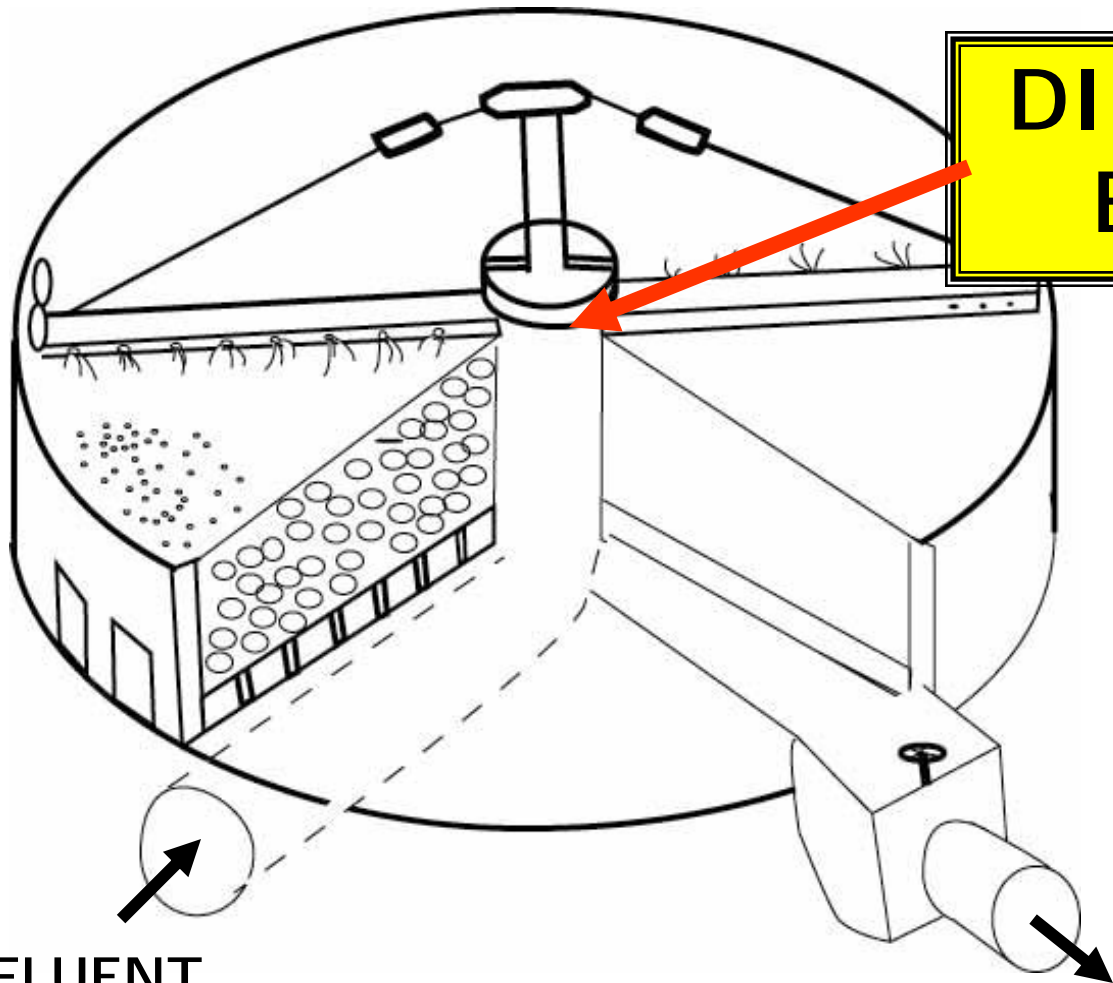
DISTRIBUTION SYSTEM





TRICKLING FILTER





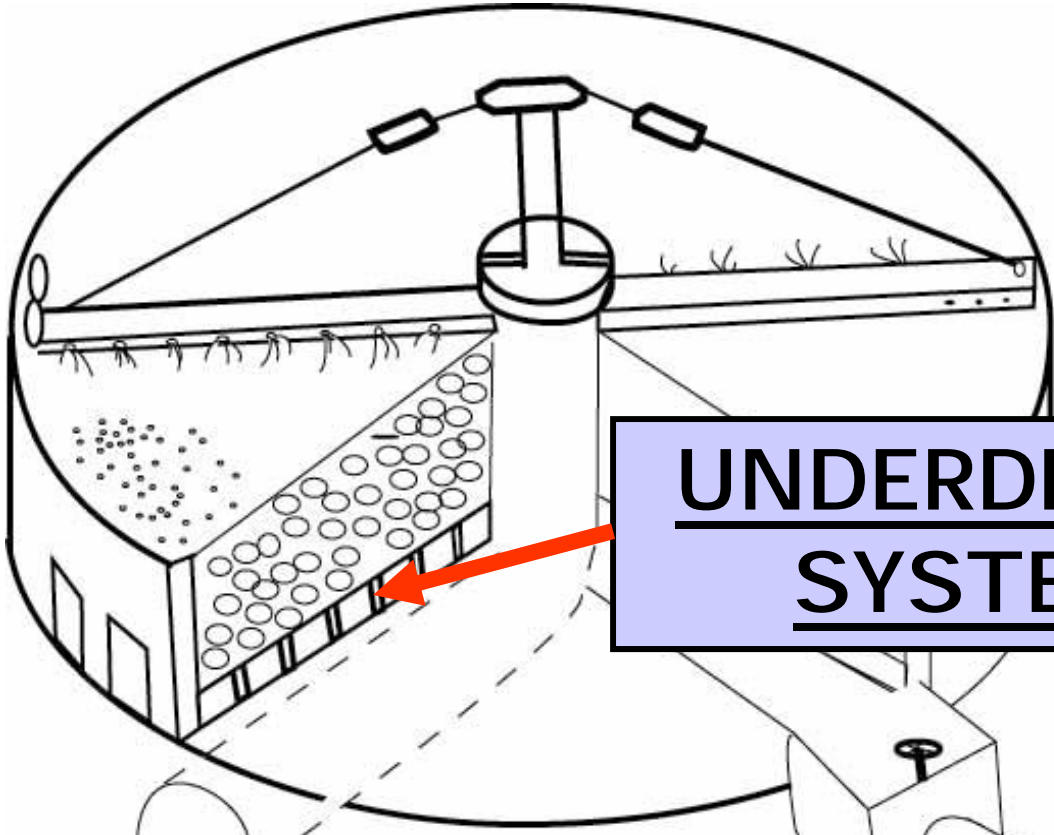
DISTRIBUTOR BEARINGS

**WATCH
OUT FOR
MERCURY**

INFLUENT

EFFLUENT

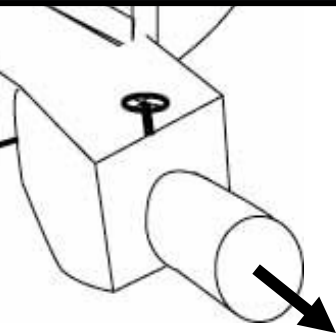
UNDERDRAIN
SYSTEM



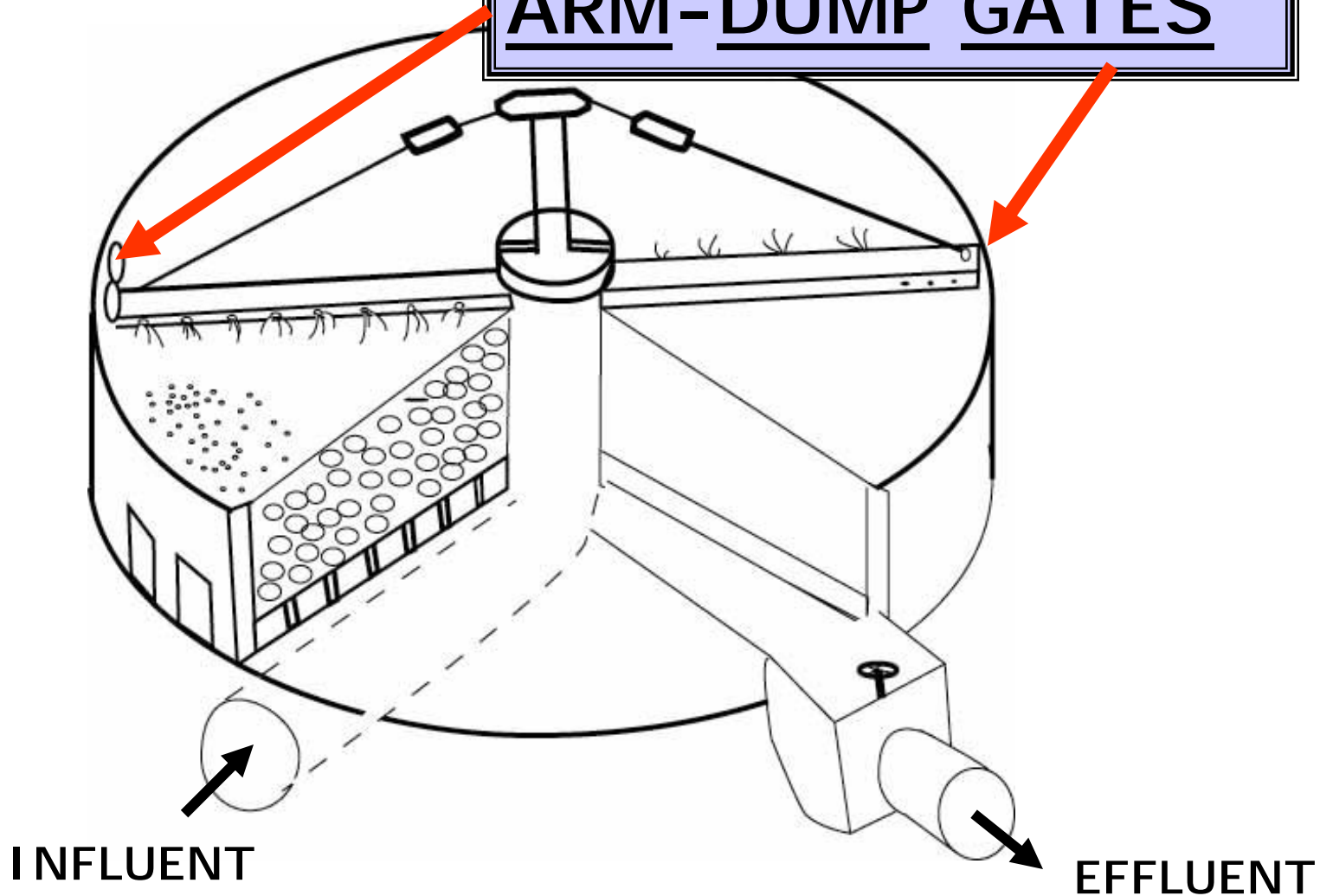
INFLUENT



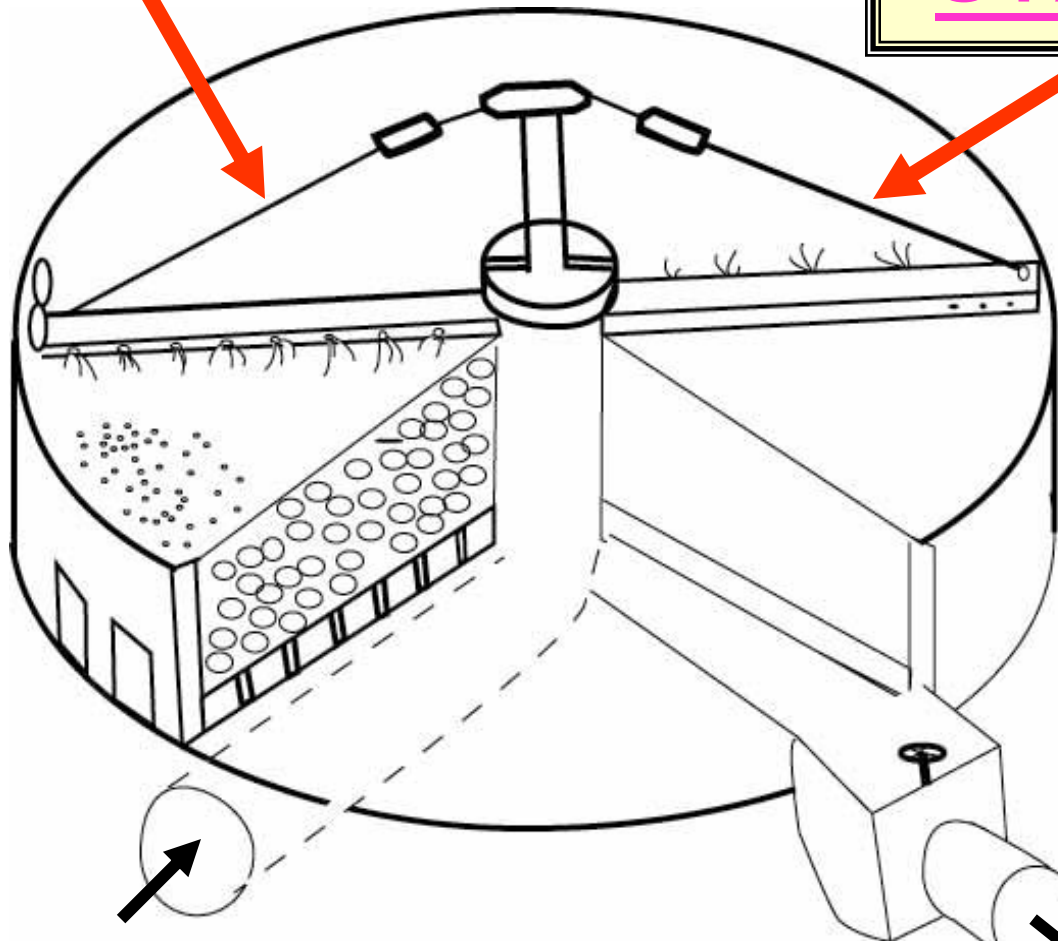
EFFLUENT



ARM-DUMP GATES

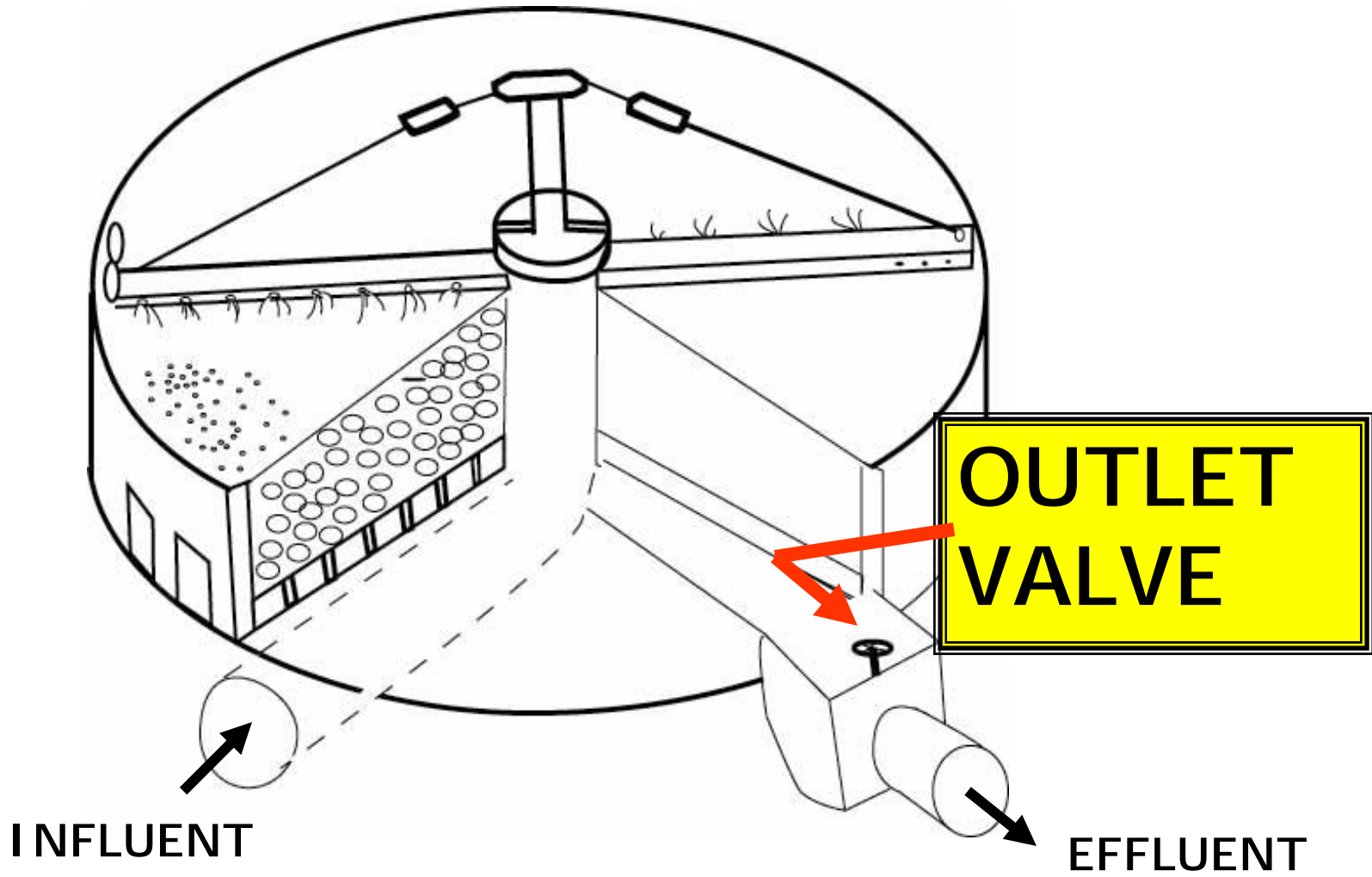


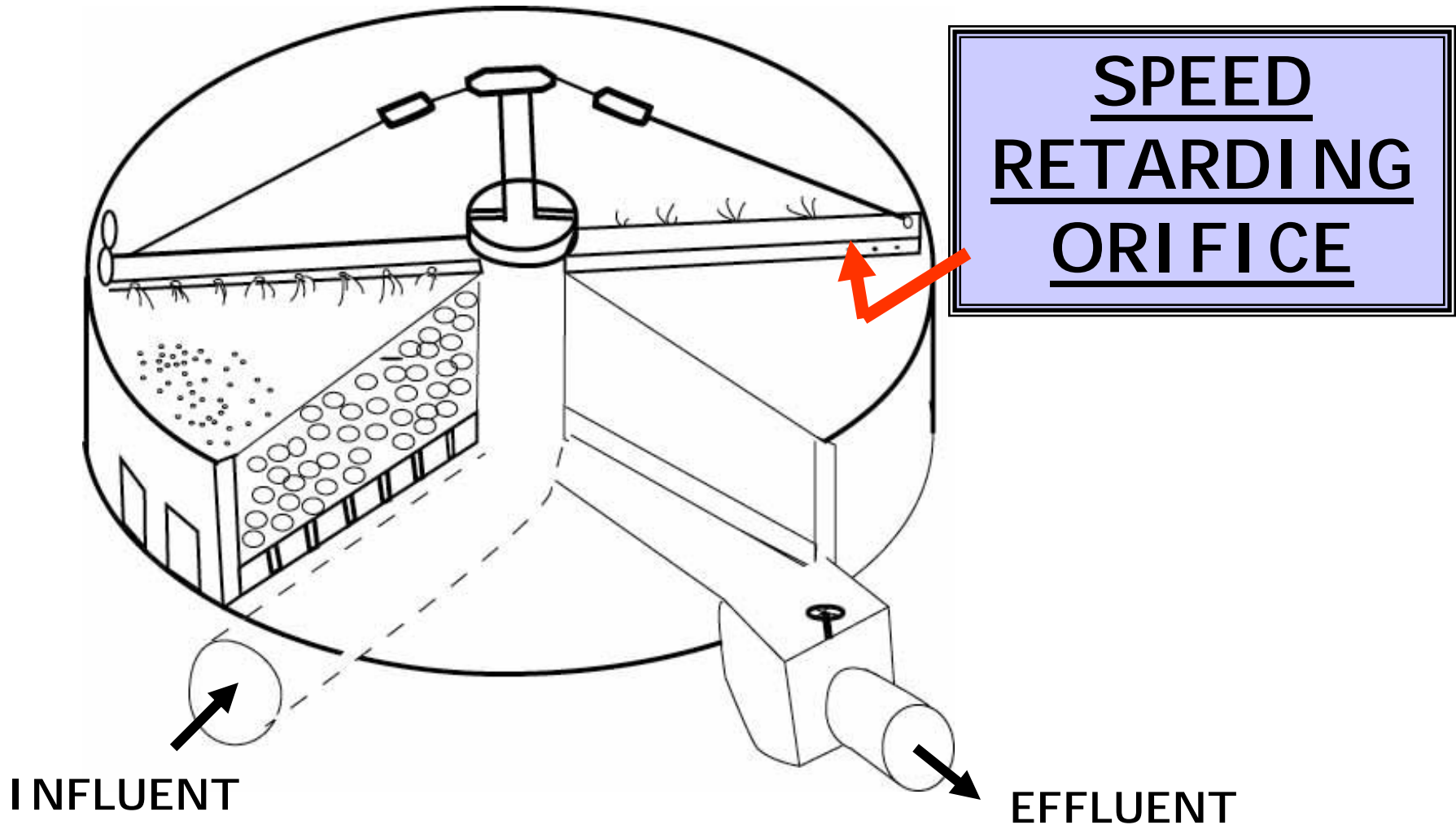
STAY RODS



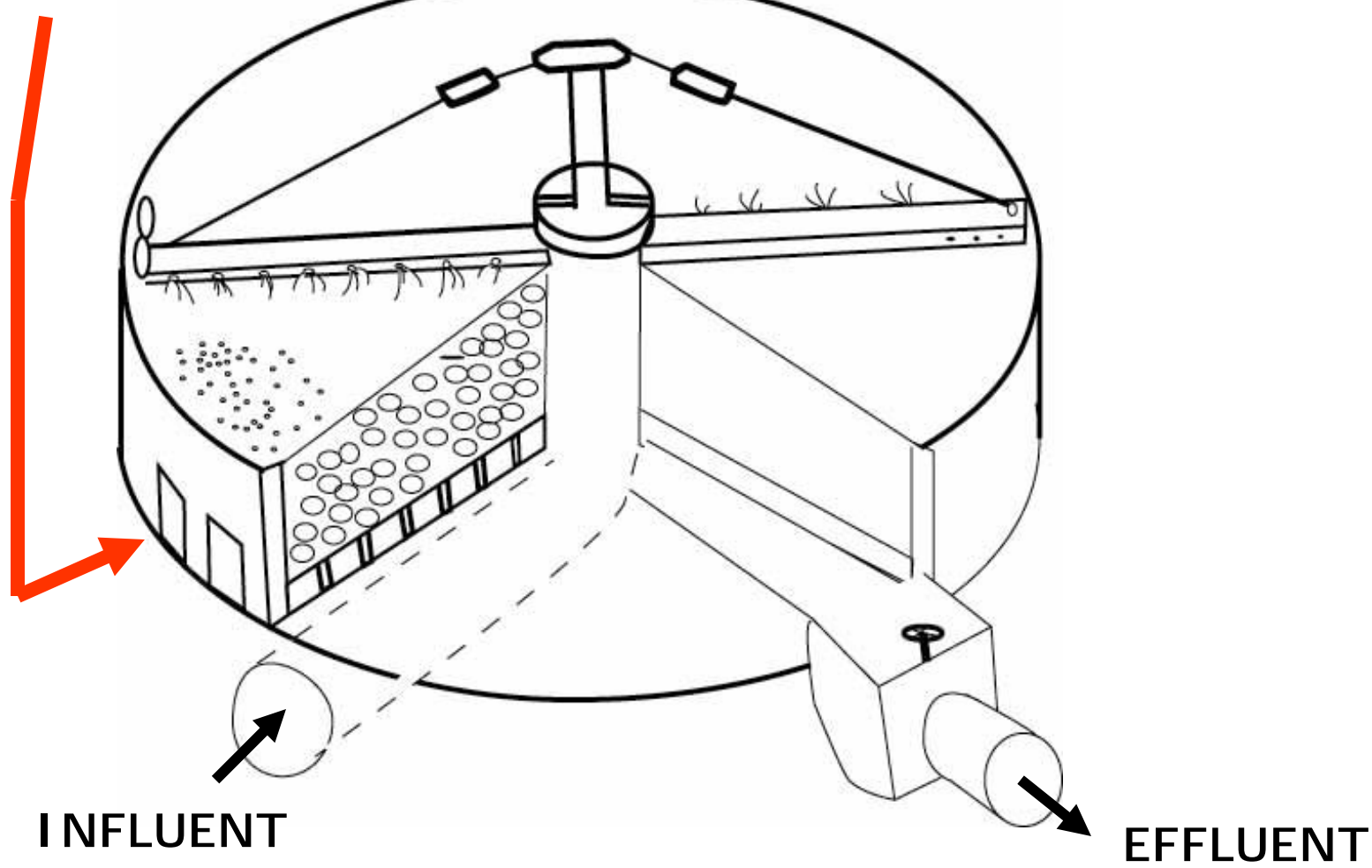
INFLUENT

EFFLUENT





VENTILATION PORTS



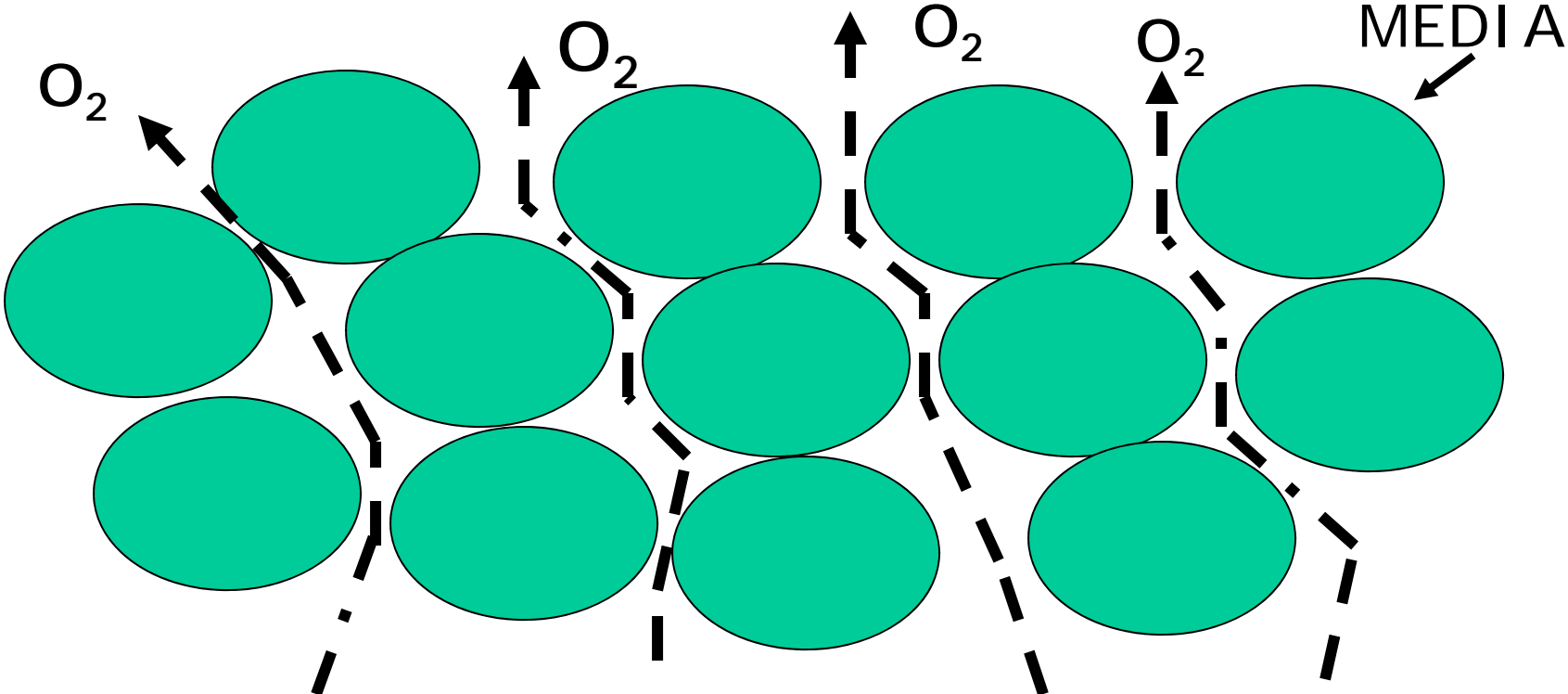
PRINCIPLES OF OPERATION

A TRICKLING FILTER IS NOT
A FILTER...(NO STRAINING ACTION)

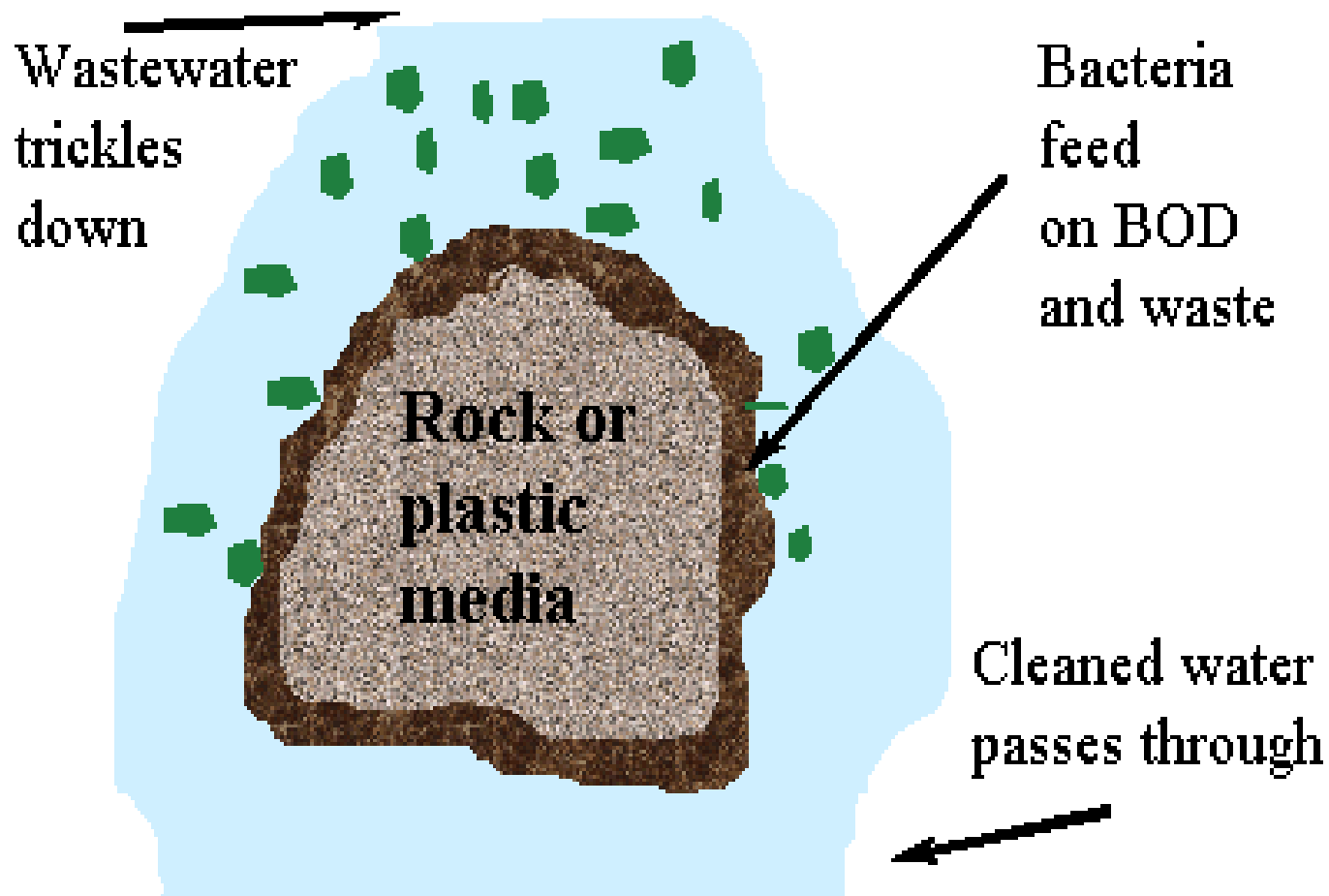
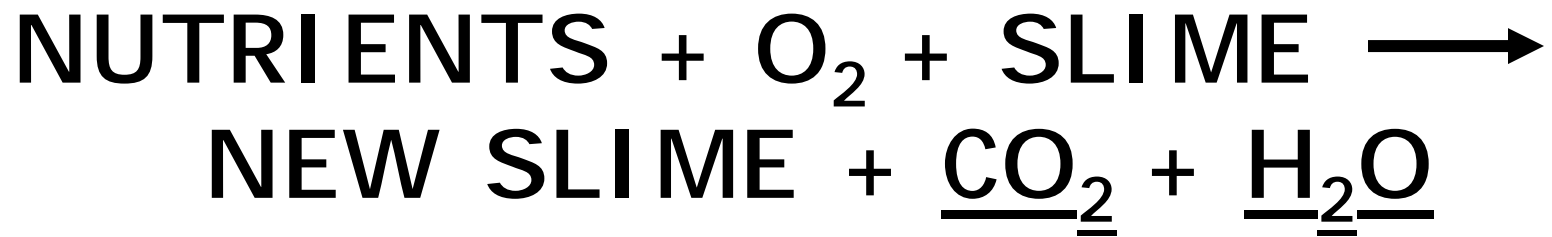
THE "JELLY-LIKE" COATING
ON THE MEDIA USES THE
ORGANICS IN THE WASTE-
WATER AS NUTRIENTS



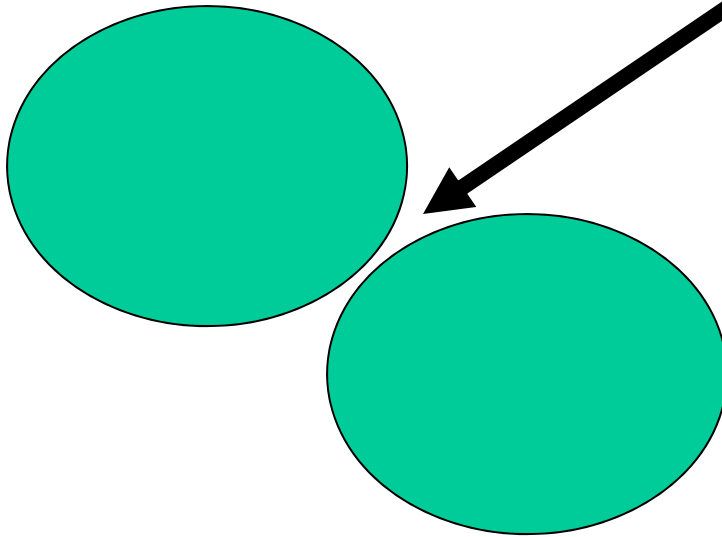
SUSPENDED, COLLOIDAL, & DISSOLVED ORGANICS



AIR FROM VENTILATORS



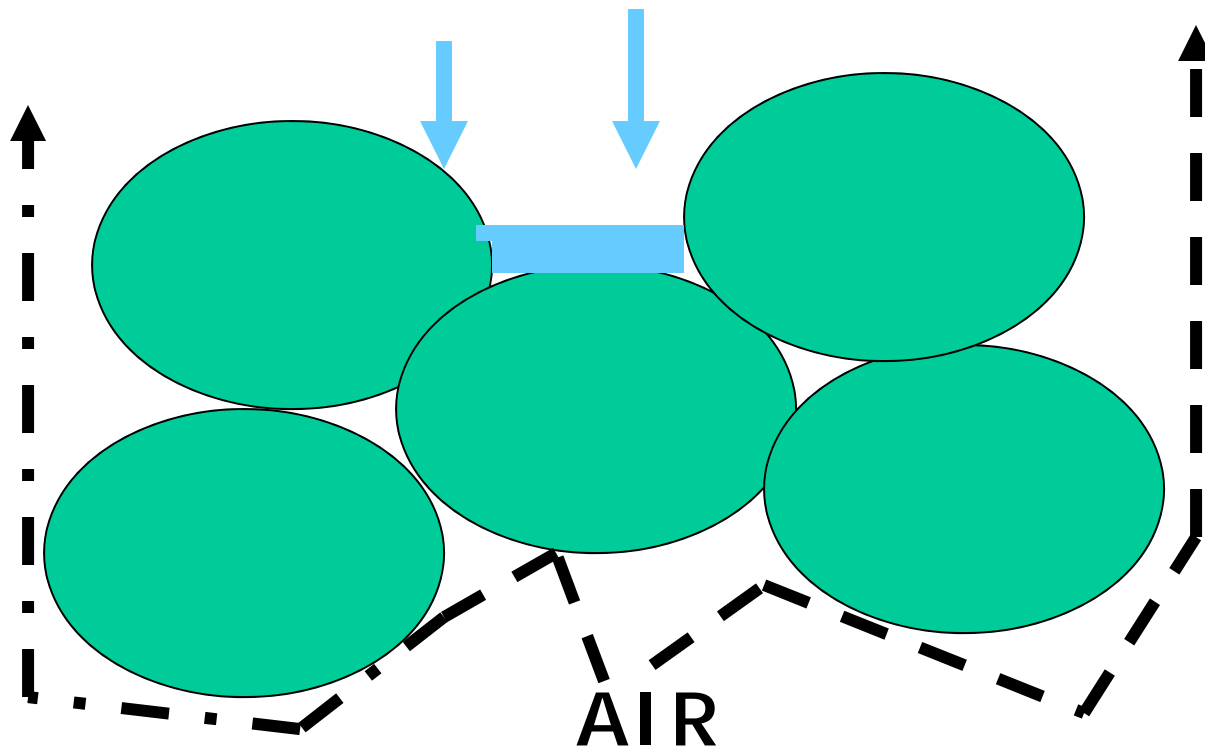
ROCKS PROVIDE
ABOUT 35% VOID
SPACE



SYNTHETIC
MEDIA
PROVIDE
ABOUT 95%
VOID SPACE



PONDING
(CLOGGED VOID
SPACES



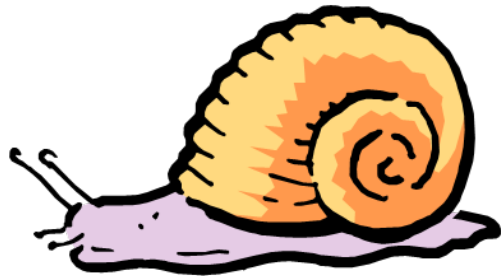
PONDING IS CAUSED BY:

- EXCESSIVE ORGANIC LOADING
- POOR PRIMARY CLARIFICATION
- MEDIA IS TOO SMALL or NOT UNIFORM IN SIZE

(non-uniform media will allow the smaller to fit between the larger and block the void space)

PONDING IS CAUSED BY:

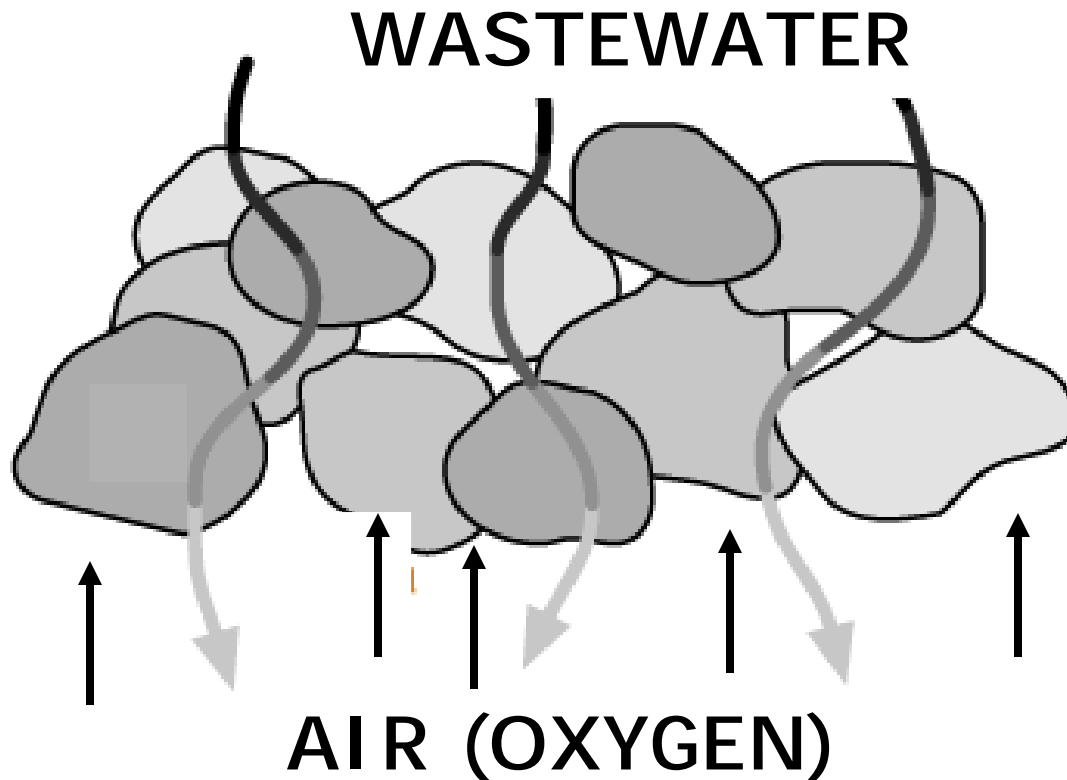
• INSECT LARVAE or
SNAILS



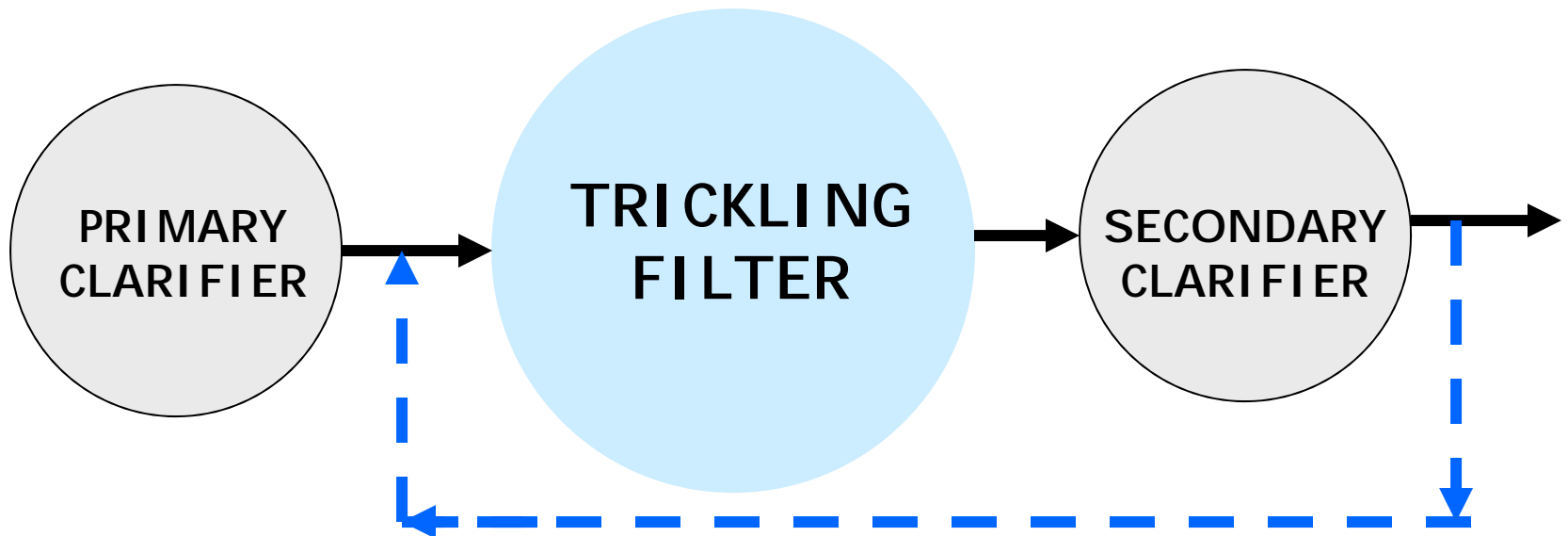
PROBLEM WITH PONDING

**PONDING PREVENTS
AIR CIRCULATION
THAT IS VITAL TO
MAINTAINING AN
ACTIVE SLIME LAYER**

POOR AIR CIRCULATION MEANS POOR BOD REMOVAL



RECI RCULATION



RECYCLING TREATED EFFLUENT

RI CIRCULATION:

- MAY BE CONSTANT OR INTERMITTENT
- MAY BE ONLY DURING LOW FLOWS TO KEEP THE DISTRIBUTORS MOVING
- IMPROVES BOD REMOVAL BECAUSE OF LONGER CONTACT TIMES

RECIRCULATION...

- PRODUCES MORE CONTINUOUS AND UNIFORM SLOUGHING

➤ WHICH PREVENTS PONDING AND IMPROVES VENTILATION

➤ PRESENTS A MORE AGGRESSIVE SURFACE FOR NEW SLIME GROWTH

➤ DECREASES THE PROBLEMS WITH PESTS—FILTER FLIES AND SNAILS



**FLOW TO A TRICKLING
FILTER IS GENERALLY
REGULATED THRU A WET
WELL or DOSING CHAMBER**

**TRICKLING FILTERS CAN
SUCCESSFULLY TREAT
ALMOST ANY WASTE—EXCEPT
THOSE WITH HIGH
CONCENTRATIONS OF...**

- TOXIC WASTES
- PESTICIDES
- HEAVY METALS or EXTREME pH
WASTES

**FOR MAXIMUM EFFICIENCY,
TRICKLING FILTERS SHOULD
BE KEPT AEROBIC BY...**

- **A PROPERLY DESIGNED
COLLECTION SYSTEM (i.e. good
flow to prevent septic conditions)**
- **PROPER OPERATION OF THE
PRIMARY CLARIFIERS**
- **PRETREATMENT WITH AIR OR
RECYCLED FILTER EFFLUENT**

TRICKLING FILTERS ARE ALSO AFFECTED BY:

- TEMPERATURE OF THE
WASTEWATER - -

IN GENERAL, THE
ORGANISMS INCREASE
AS THE TEMPERATURE
RISES



CLASSIFICATIONS OF TRICKLING FILTERS

BASED ON HYDRAULIC AND BOD LOADING...

HYDRAULIC LOADING:

GPD/SQ-FT

BOD LOADING:

Lbs BOD per day / 1000 cu-ft

CLASSIFICATIONS OF TRICKLING FILTERS

BASED ON HYDRAULIC AND BOD
LOADING...

- STANDARD-RATE
- HIGH-RATE
- ROUGHING FILTERS

HIGH-RATE TRICKLING FILTER

<u>PARAMETER</u>	<u>VALUE</u>
• FLOW (ROCK)	<u>100-1000</u> gpd/ sq-ft
• FLOW (SYNTHETIC)	<u>350-2100</u> "

HIGH-RATE TRICKLING FILTER

<u>PARAMETER</u>	<u>VALUE</u>
• BOD (rock)	<u>25-100</u> lbsBOD / 1000 cu-ft
• BOD (synthetic)	<u>50-300</u> "
• BOD removal	<u>90 - 95</u> %

ROUGHING FILTER

<u>PARAMETER</u>	<u>VALUE</u>
------------------	--------------

- **FLOW** (same as high-rate)
- **BOD** 100 - 300 lbs BOD / 1000 cu-ft
- **BOD removal** 80 - 85 %

COMPARISON OF HYDRAULIC LOADINGS—gpd/sq-ft

Standard Rate	25 to 100
---------------	-----------

High Rate (rock)	100 to 1000
------------------	-------------

(synthetic media)	350 to 2100
-------------------	-------------

Roughing	100 to 2100
----------	-------------

**COMPARISON OF ORGANIC
LOADING: lbs BOD/ 1000 cu-ft**

Standard Rate	5 to 25
High Rate (rock)	25 to 100
(synthetic)	50 to 300
Roughing	100 to 300

**ROUGHING FILTER
PRECEEDS SOME OTHER
FORM OF SECONDARY
TREATMENT (SUCH AS
ACTIVATED SLUDGE)**

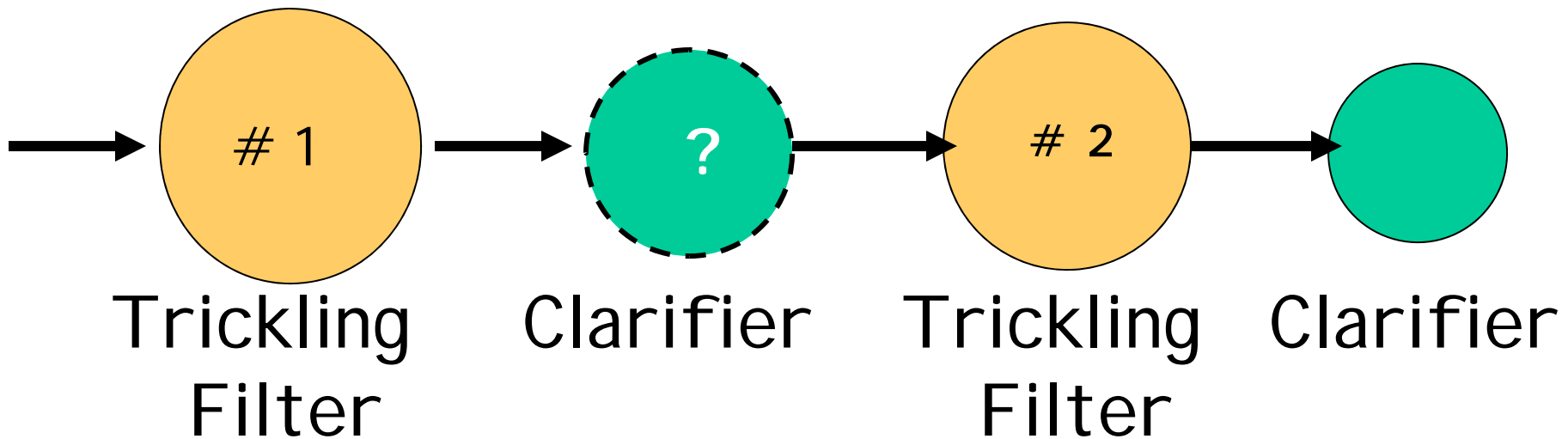




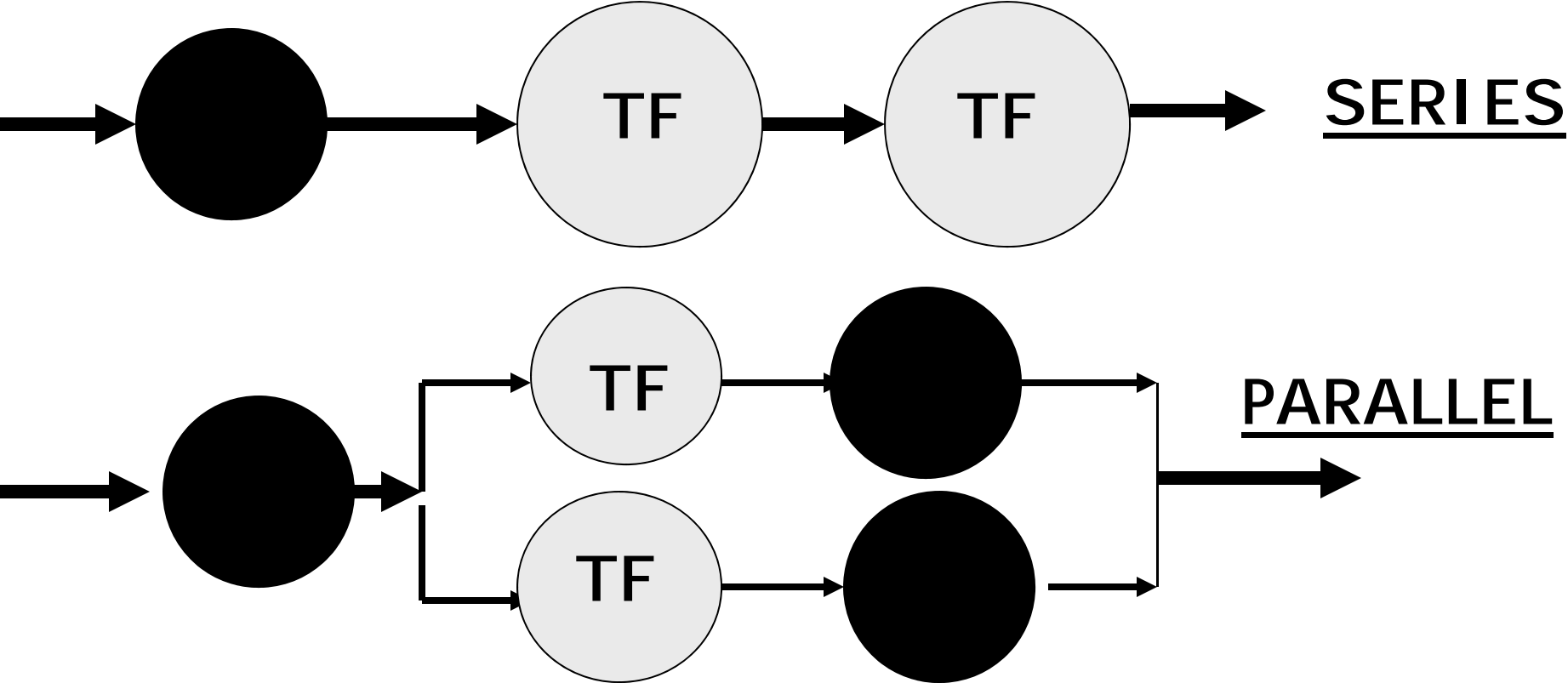
**WOULD
YOU
EXPECT
YOUR
BEST BOD
REMOVAL
DURING
WINTER
OR
SUMMER?**

TWO-STAGE TRICKLING FILTER

(LOTS OF OPTIONS FOR
RECIRCULATION)



TRICKLING FILTERS CAN BE OPERATED...

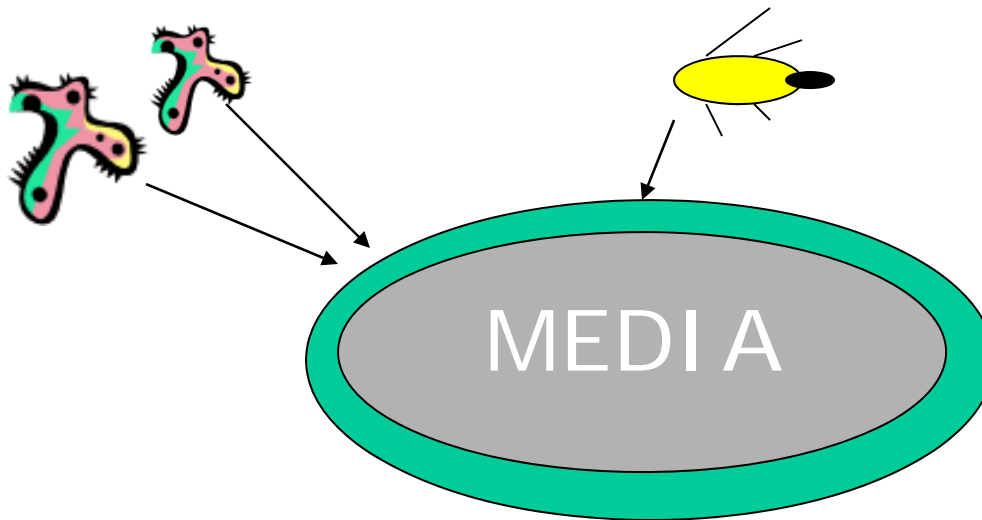


TRICKLING FILTER START-UP

BEST TO START-UP IN
SPRING TO EARLY SUMMER.

TAKES SEVERAL WEEKS FOR
GROWTH TO FULLY
DEVELOP.

GROWTH = ZOOGLEAL FILM



CONSISTS OF BACTERIA, ALGAE
PROTOZOA, FUNGI, WORMS...+?



**ROTATOR
ARMS TURN
ABOUT
1 RPM**

**NEVER STAND
IN FRONT OF
A TURNING
ARM!**

POOR FILTER PERFORMANCE

HIGH SUSPENDED SOLIDS:

- HEAVY SLOUGHING (weather changes)
- FLOW TOO HIGH?
- SOLIDS CARRY-OVER FROM
CLARIFIERS (PRIMARY, SECONDARY,
OR BOTH)
- SHOCK LOAD

DAILY OPERATION

- VERY LITTLE ROUTINE CONTROL NEEDED—VERY RELIABLE PROCESS

- CHECK FOR PONDING, FILTER FLIES, ODORS, PLUGGED ORIFICES, AND SEAL LEAKAGES

DAILY OPERATION (CON'T)

RECIRCULATION

- USE MINIMUM RECIRCULATION
(MEET NPDES LIMITS W/O PROBLEMS)
THAT WILL PROVIDE DISSOLVED OXYGEN
CONCENTRATIONS OF 3-6 mg/L (for rocks)
and 4-8 mg/L (synthetic media)

DAILY OPERATION (CON'T)

PONDING (LOSS OF OPEN
AREA IN THE FILTER)

- **CHECK PRIMARY CLARIFIER**

- **HIGH PRESSURE SPRAY ON
ROCKS; HAND-TURN THE
MEDIA; CHLORINATION;
FILTER FLOODING; SHUT-
DOWN AND LET DRY**



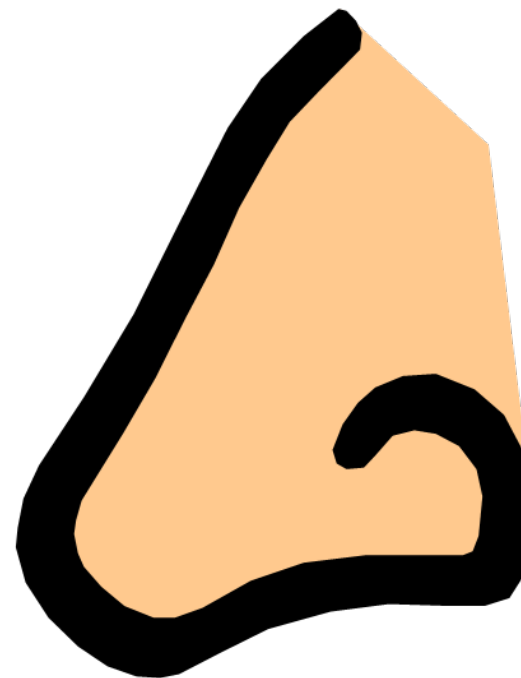
ODOR CONTROL

- SHOULDN'T BE ODORS IF KEPT
AEROBIC

• INCREASE RECIRCULATION RATE
OR USE "MASKING AGENT"

MASKING AGENT

MATERIAL USED
TO COVER UP OR
DISGUISE
UNPLEASANT
ODORS





FILTER FLIES

PSYCHODA (sigh-COAT-AH)

NON-BITING PESTS CONTROLLED BY:

- INCREASING RECIRCULATION
- FLOODING FILTERS FOR 24 hrs
- **GOOD HOUSE-KEEPING** (CUT WEEDS, SHRUBBERY, TALL GRASS)
- PESTICIDES (GROWTH REGULATORS)



**ANOTHER
PROBLEM
PEST- -**

SNAILS





SNAIL REMOVAL

UNCONTROLLED SLOUGHING



ONE OF THE MOST COMMON
PROBLEMS GENERALLY SOLVED
BY INCREASING RECIRCULATION

COLD WEATHER PROBLEMS

- SOMETIMES FREEZING OCCURS NEAR THE DISTRIBUTOR NOZZLES

- CUT BACK ON RECIRCULATION
(RECIRCULATED WATER IS GENERALLY COLDER THAN THAT FROM THE PRIMARY CLARIFIER)

- GO FROM A SERIES TO A PARALLEL OPERATION

IN EXTREME COLD WEATHER...



**MIGHT HAVE
TO ENCLOSE
TRICKLING
FILTERS**

VENTILATION

NEED A TEMPERATURE
DIFFERENCE OF AT LEAST
3°F BETWEEN THE AIR
AND THE WATER THROUGH
THE FILTER TO GET GOOD
NATURAL CIRCULATION

PLANT INFLOW VARIATIONS

(DUE TO STORMS, INFILTRATION, OR INDUSTRIAL DISCHARGES)

3 OPTIONS:

- VARY THE NUMBER OF FILTERS ON LINE
- ADJUST THE RECIRCULATION RATE
- SWITCH FROM SERIES TO PARALLEL
(OR VISA-VERSA)

MAINTENANCE

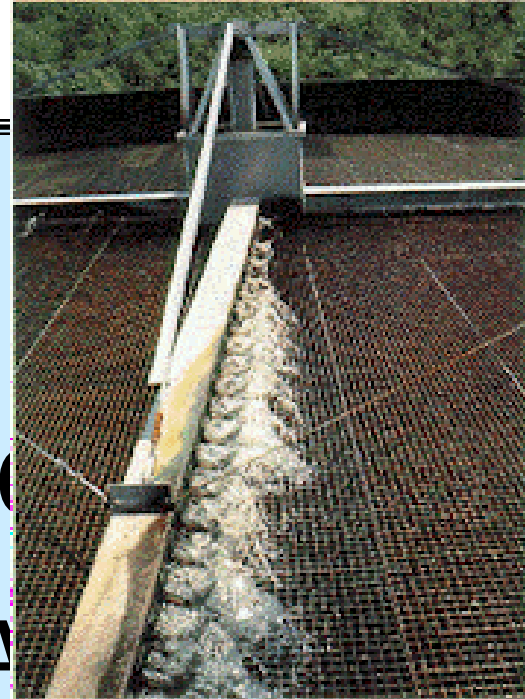
- SEALS: OLD UNITS HAD MERCURY SEALS. NEW UNITS HAVE OIL-BATH SEALS THAT SHOULD BE CHECKED WEEKLY

- CHECK OIL FOR CLEANLINESS AND REPLACE WHEN DIRTY

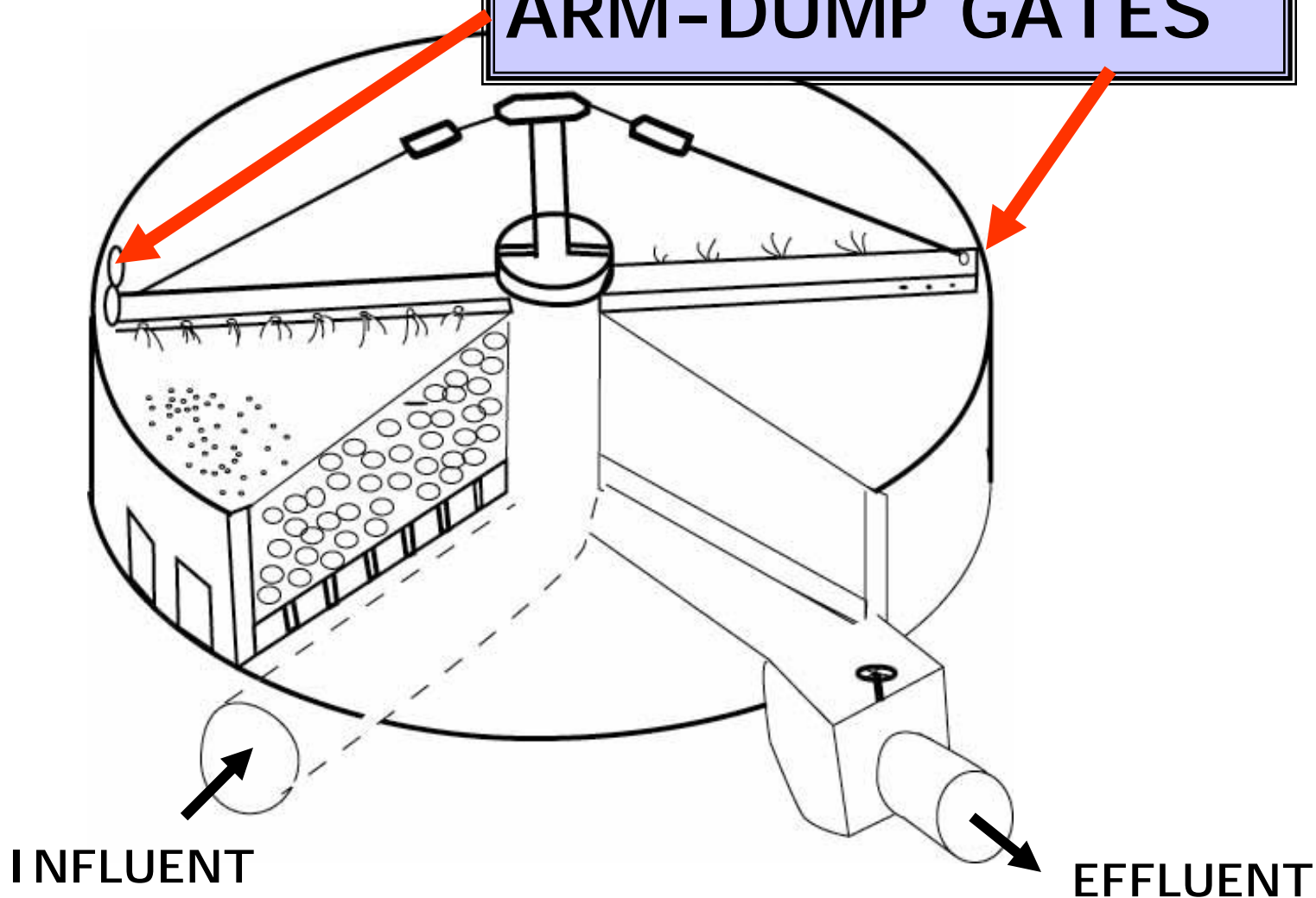
MAINTENANCE

DISTRIBUTOR ARMS:

- FLUSH ARMS WEEKLY BY OPENING THE END FLUSH
- SPEED OF THE ROTATOR A IS GOVERNED BY FLOW FROM THE ORFICES



ARM-DUMP GATES





**ROTATOR
ARMS TURN
ABOUT 1
RPM**

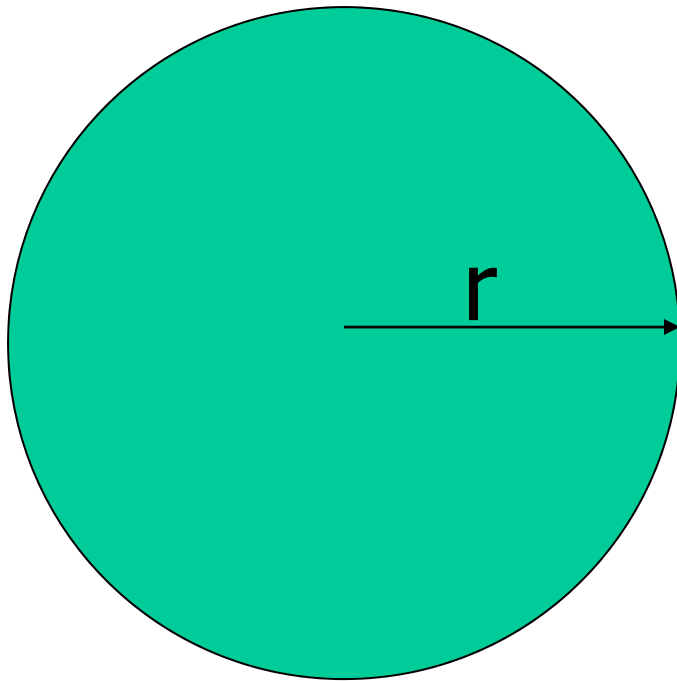
**NEVER STAND
IN FRONT OF
A TURNING
ARM!**

UNDERDRAIN MAINTENANCE

BEST WAY
TO CLEAN IS
TO USE
CITY'S HIGH
VELOCITY
SEWER LINE
CLEANER
EVERY 6 MO.



REVIEW OF ARITHMETIC

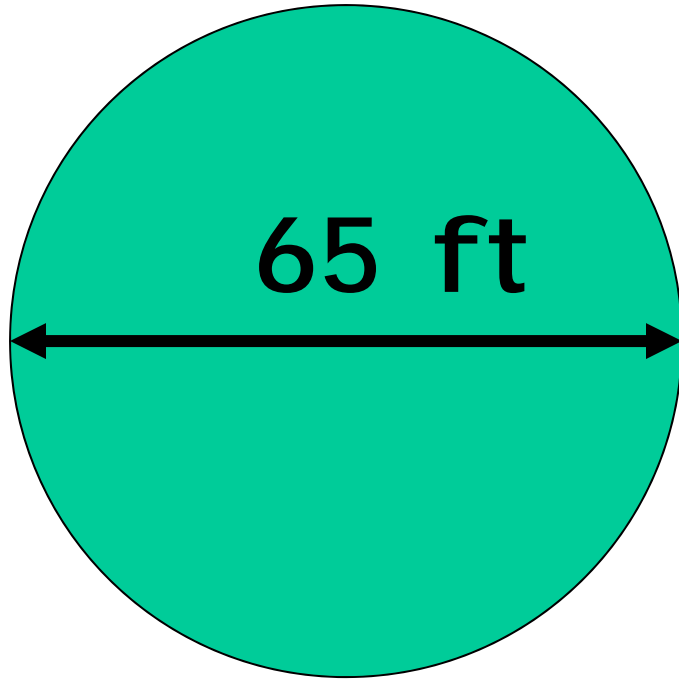


SURFACE AREA
OF A
CIRCLE = πr^2

Or: $\pi D^2 / 4$

Or: $.785 \times D^2$

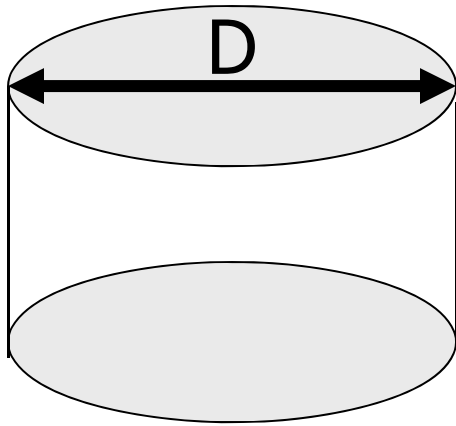
REVIEW OF ARITHMETIC



Example: What is the surface area of a trickling filter that is 65' in diameter:

$$\text{SA} = .785 \times \underline{65} \times \underline{65} = \underline{3317} \text{ sq-ft}$$

REVIEW OF ARITHMETIC



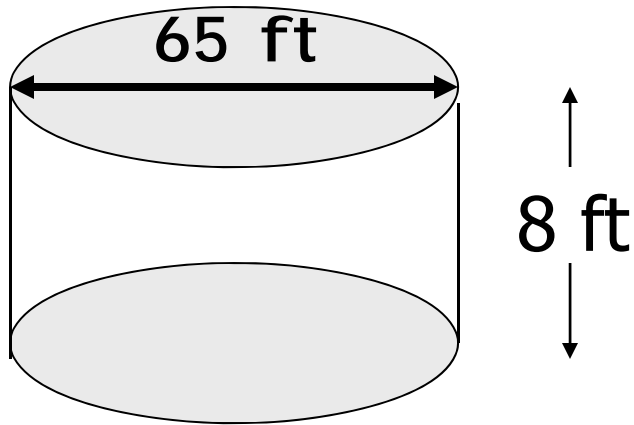
DEPTH

**VOLUME = Surface
Area x Depth**

Or; $\pi D^2/4$ x depth

Or: $.785$ x D^2 x depth

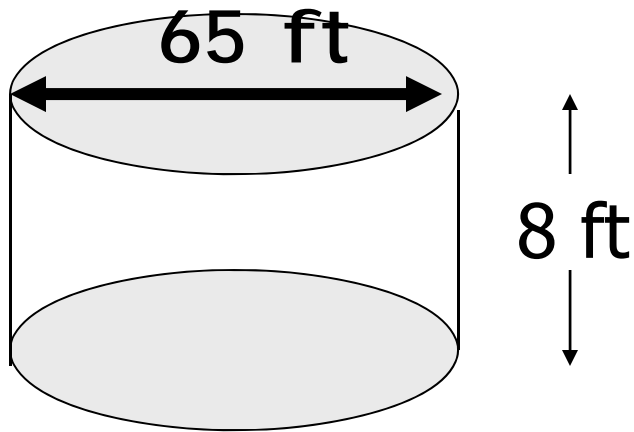
REVIEW OF ARITHMETIC



EXAMPLE: WHAT IS THE VOLUME of a 65' diameter trickling filter with 8 ft of media?

$$\text{VOLUME} = .785 \times 65 \times 65 \times 8 =$$
$$\underline{26,533} \text{ cu-ft}$$

REVIEW OF ARITHMETIC



**HOW MANY 1000 cu ft
ARE THERE IN THIS
FILTER?**

$$26,533 \text{ cu-ft} / 1000 = \underline{26.533}$$

REMEMBER...

- 1 GALLON OF WATER
WEIGHTS 8.3 POUNDS

- 1 CUBIC FOOT HOLDS
7.5 GALLONS

**A TRICKLING FILTER PLANT
RECEIVES 300,000 gal/day,
with a BOD = 230 mg/L**

**The trickling filter is 65 ft in
diameter with 8 ft of rock
media. Is this plant a standard
rate or high rate trickling
filter?**

$$\text{Hydraulic loading} = \text{gpd/sq-ft}$$

$$= 300,000 / .785 \times 65^2$$

$$= \underline{90.4} \text{ gpd/sq-ft}$$

$$\text{Organic Loading} = \text{lbs BOD} /$$
$$1000 \text{ cu-ft}$$

$$= 230 \times .3 \times 8.34$$

$$= 576 / 26.3$$

$$= \underline{22} \text{ lbs BOD} / 1000 \text{ cu-ft}$$

COMPARISON OF HYDRAULIC LOADINGS—gpd/sq-ft

Standard Rate	25 to 100
---------------	-----------

High Rate (rock)	100 to 1000
------------------	-------------

(synthetic media)	350 to 2100
-------------------	-------------

COMPARISON OF ORGANIC

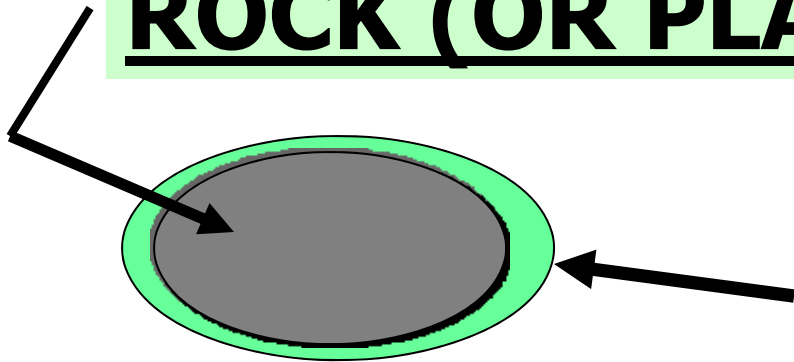
LOADING: lbs BOD/ 1000 cu-ft

Standard Rate 5 to 25

High Rate (rock) 25 to 100

TRICKLING FILTER

ROCK (OR PLASTIC)



HUMUS

HUMUS (SLOUGHING BIOMASS) GOES TO THE CLARIFIER

TRICKLING FILTER CLARIFIER

- **HUMUS IS HIGH IN BOD AND MUST BE REMOVED**

- **EXPECT TO PUMP 30-40% MORE SLUDGE FROM A SECONDARY CLARIFIER (THAN A PRIMARY CLARIFIER)**