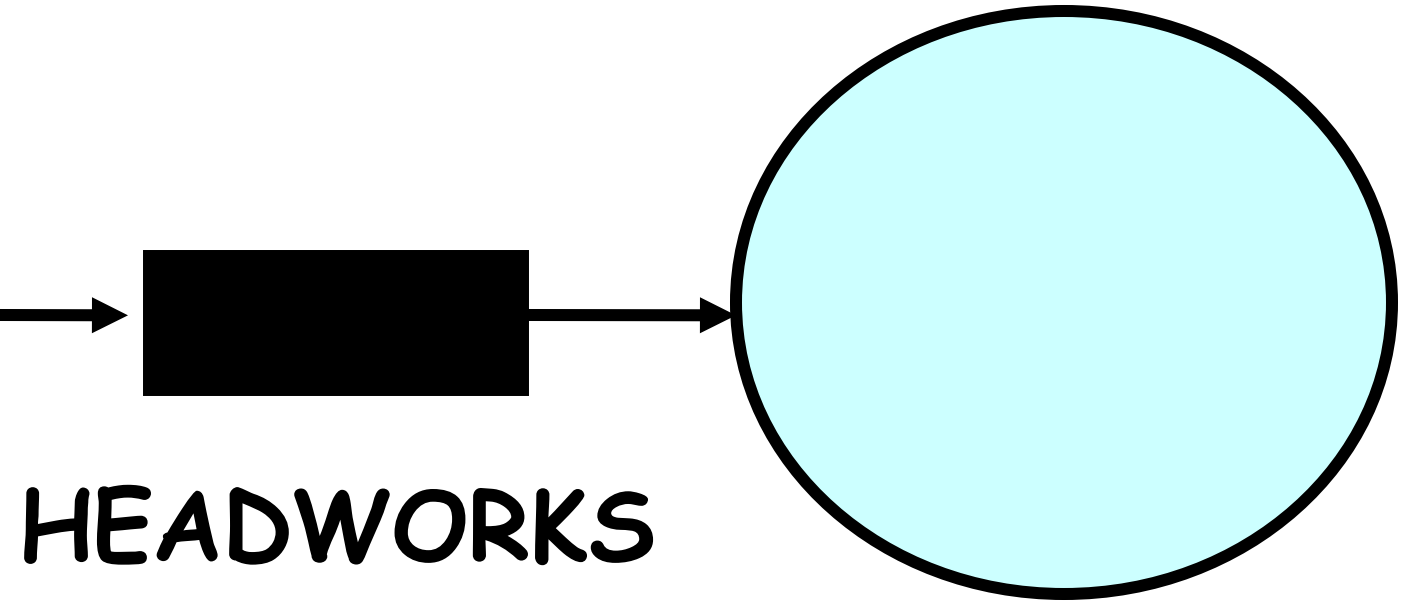
PRIMARY TREATMENT

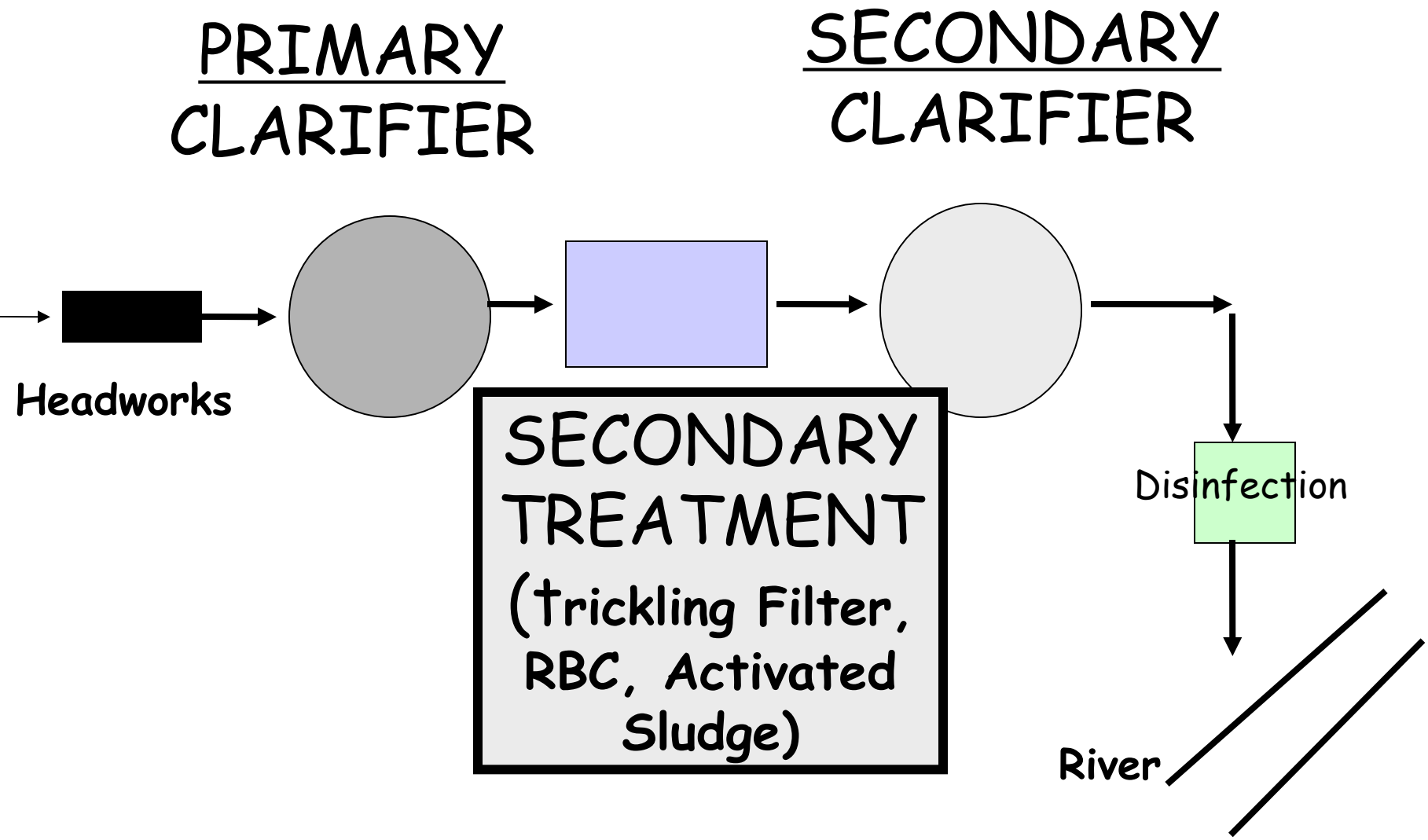
- REMOVES SETTLEABLE and FLOATABLE SOLIDS

- LARGELY A PHYSICAL PROCESS



HEADWORKS

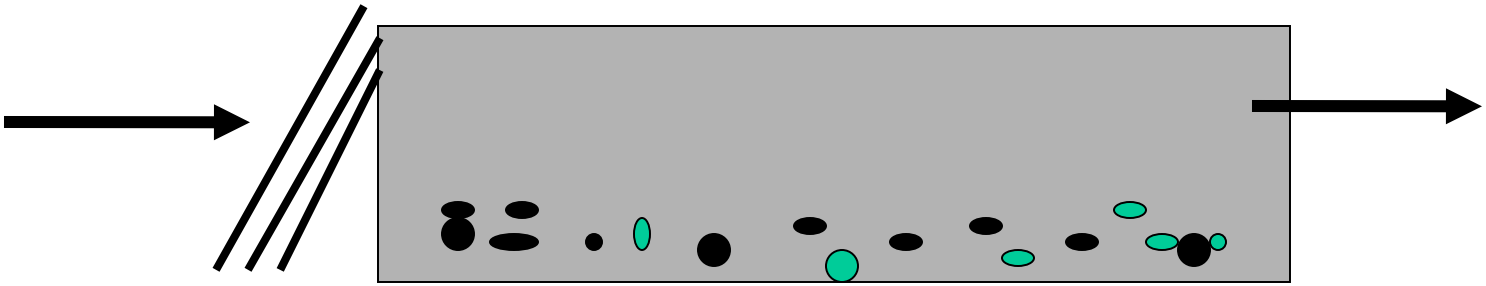
PRIMARY
CLARIFIER


PRIMARY CLARIFIER
SECONDARY CLARIFIER
Headworks
SECONDARY TREATMENT
(trickling Filter, RBC, Activated Sludge)
Disinfection
River

A PHYSICAL PROCESS DEPENDS ON …

- PARTICLE SIZE, SHAPE
- PARTICLE WEIGHT (DENSITY)

REMEMBER…



HEAVY, INORGANIC MATERIAL REMOVED IN GRIT CHAMBER (BY REDUCING THE VELOCITY)

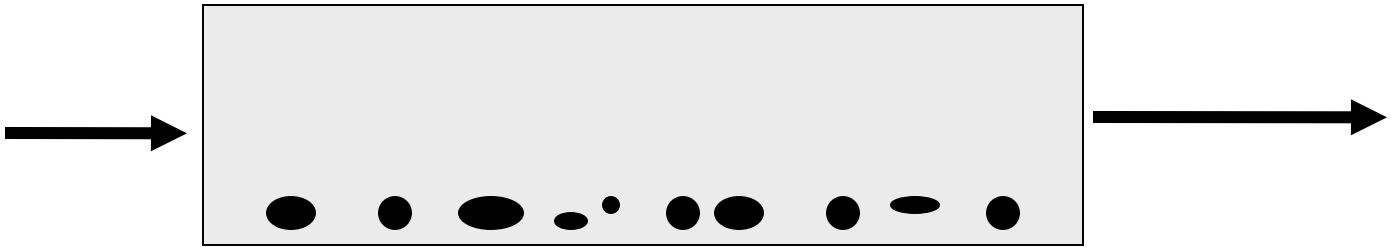
IF THE VELOCITY IS FURTHER REDUCED…

- ORGANIC SOLIDS WILL SETTLE OUT
- THE VELOCITY OF FLOW IN A SETTLING BASIN = 2 ft/min

RECALL…

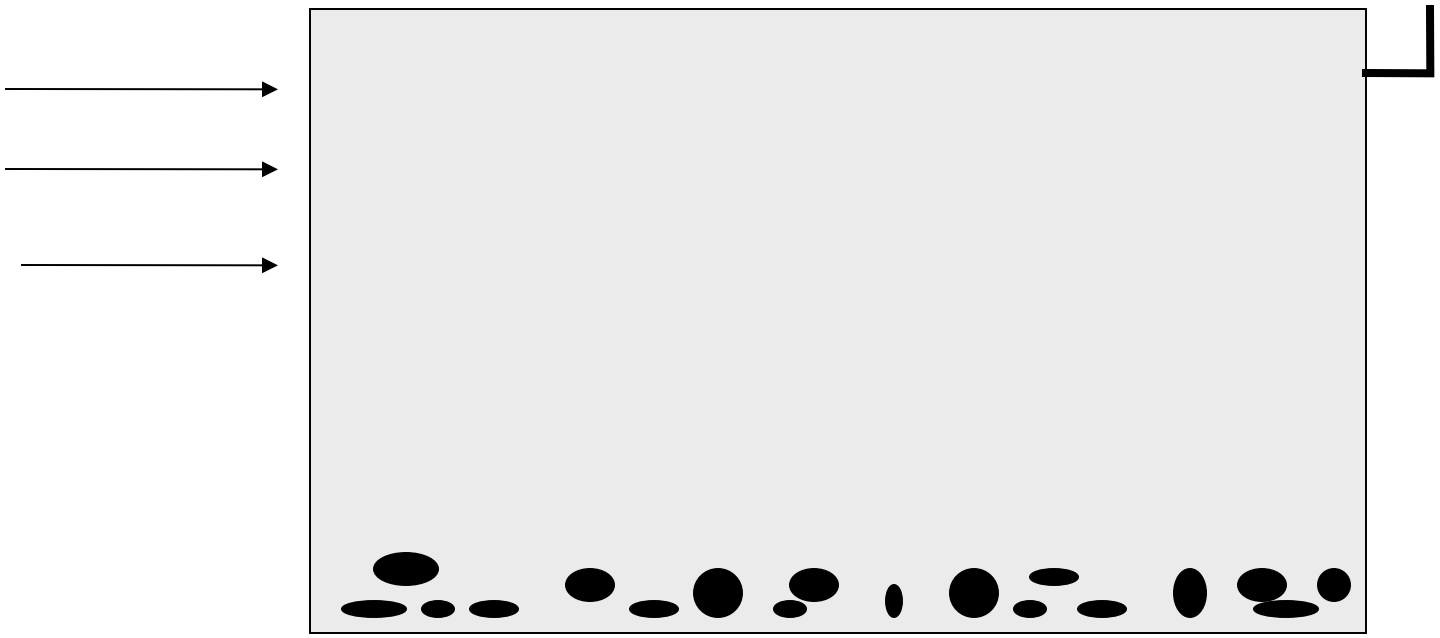
SEWER: 2 fps = 120 ft/min

(NO SETTLING)



GRIT CHAMBER: 1 fps = 60 ft/min

(HEAVY INORGANICS SETTLE OUT)



SETTLING BASIN

VELOCITY = 2 ft/min

(REMOVES SETTLEABLE SOLIDS)

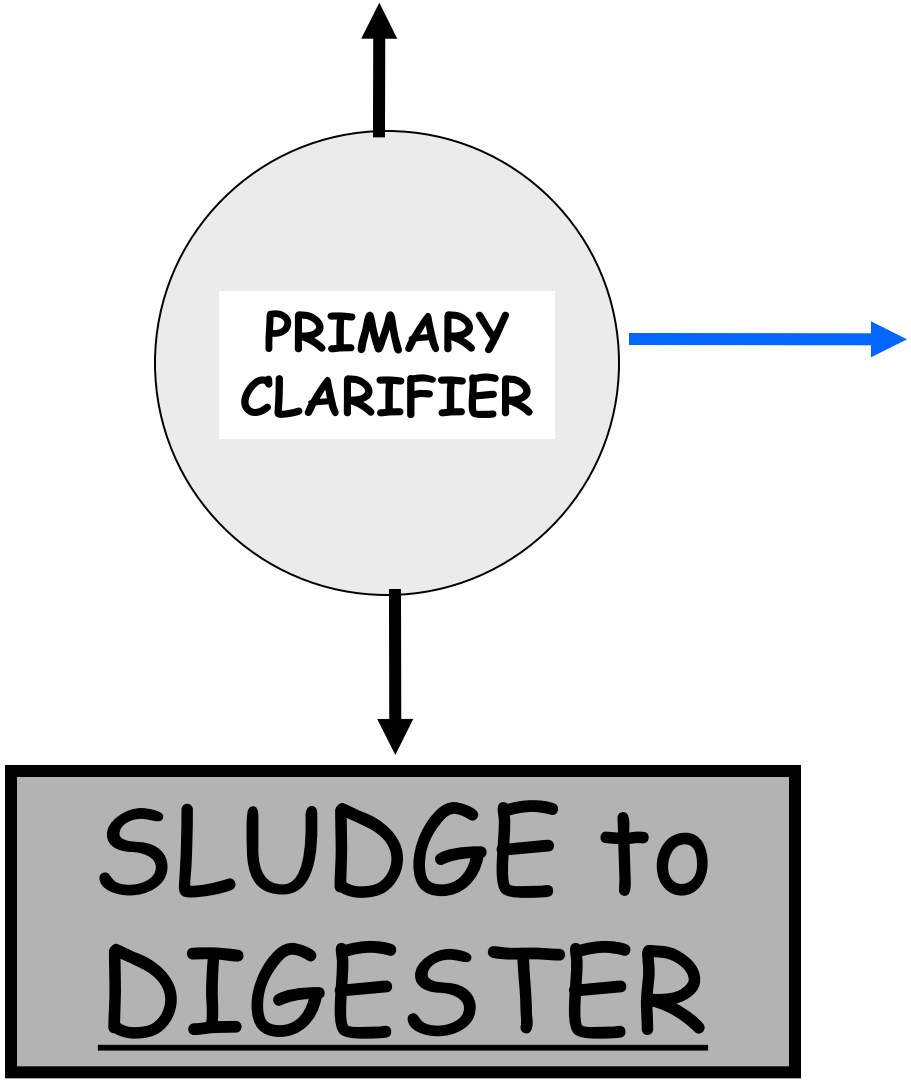
ALSO CALLED "PRIMARY…

- SEDIMENTATION TANK or BASIN
- SETTLING TANK or BASIN

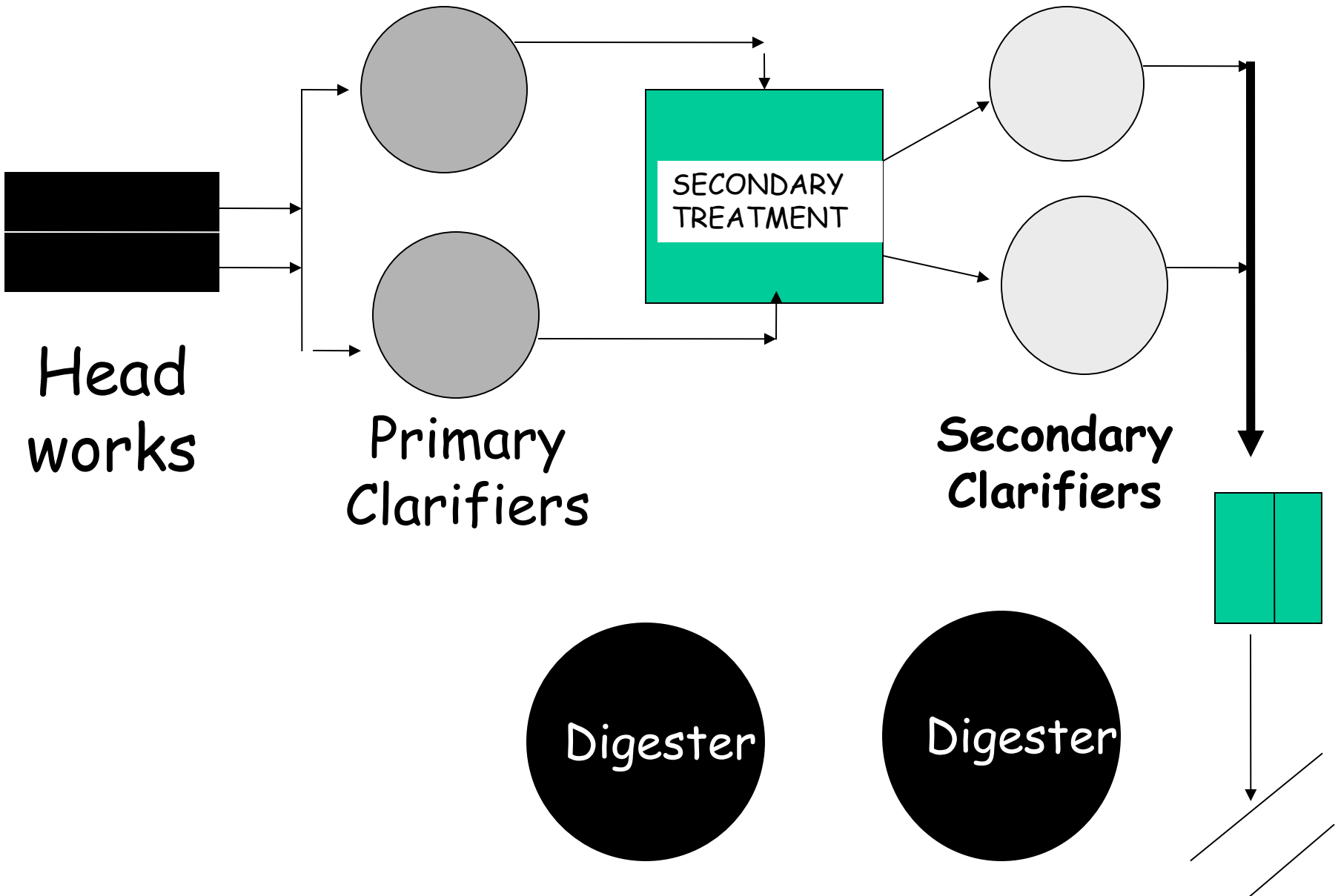
3 things come out of a primary clarifier…

- SETTLED EFFLUENT
- FLOATABLE "SCUM"
- SLUDGE

BURY THE SCUM



BACK-UP UNITS FOR FLEXIBILITY



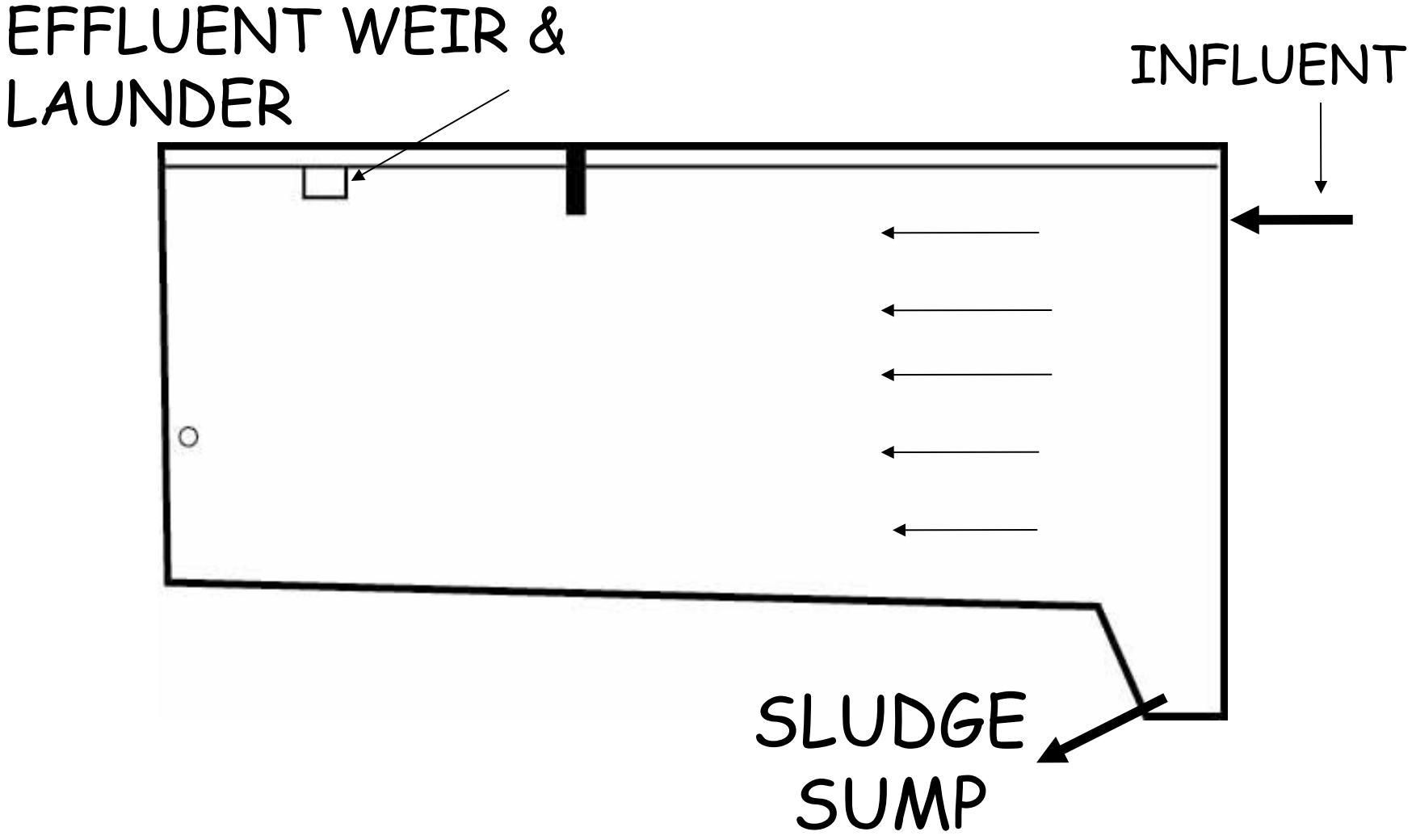
TYPES OF CLARIFIERS

- HORIZONTAL
- CIRCULAR

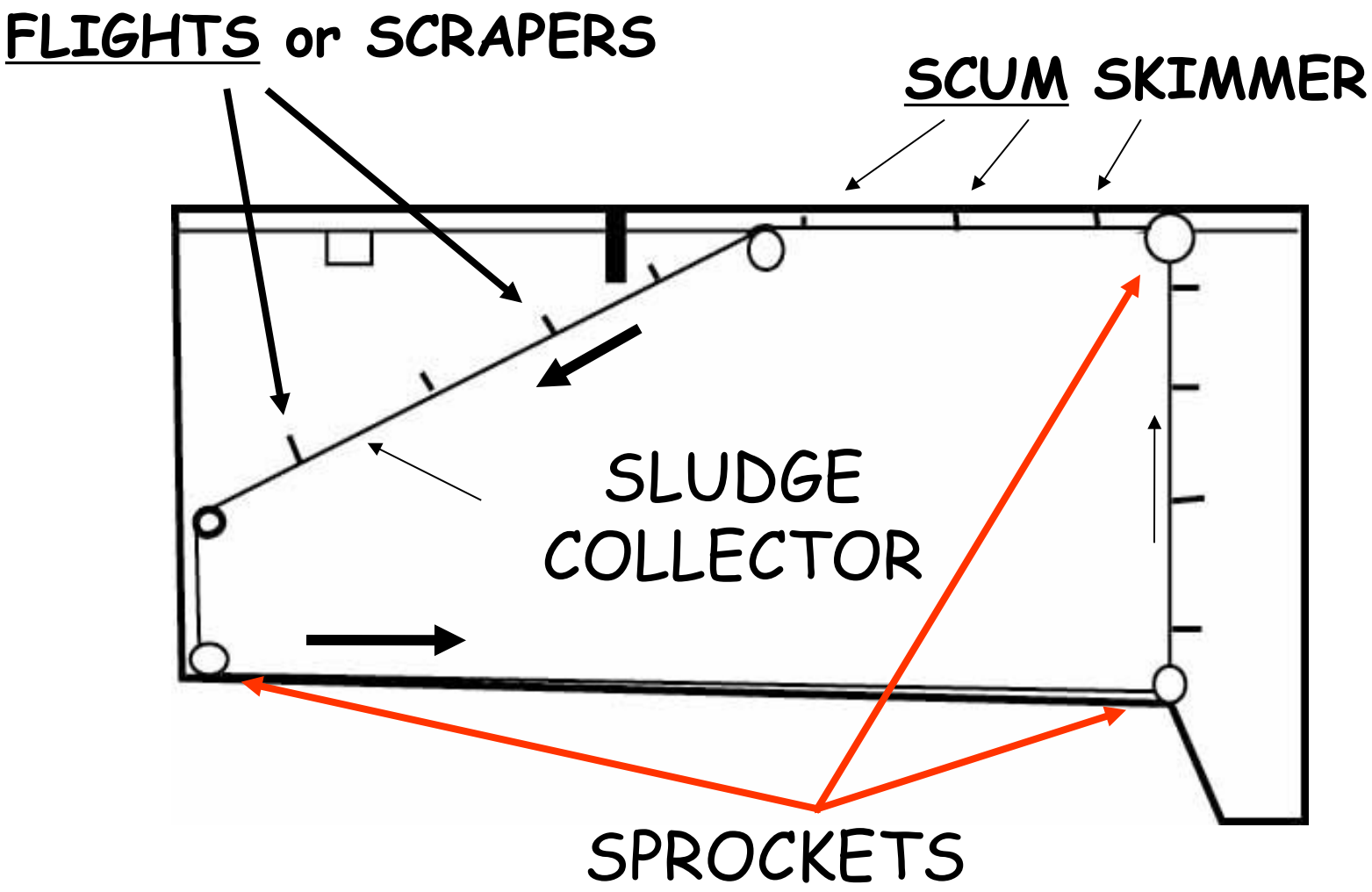
HORIZONTAL CLARIFIERS

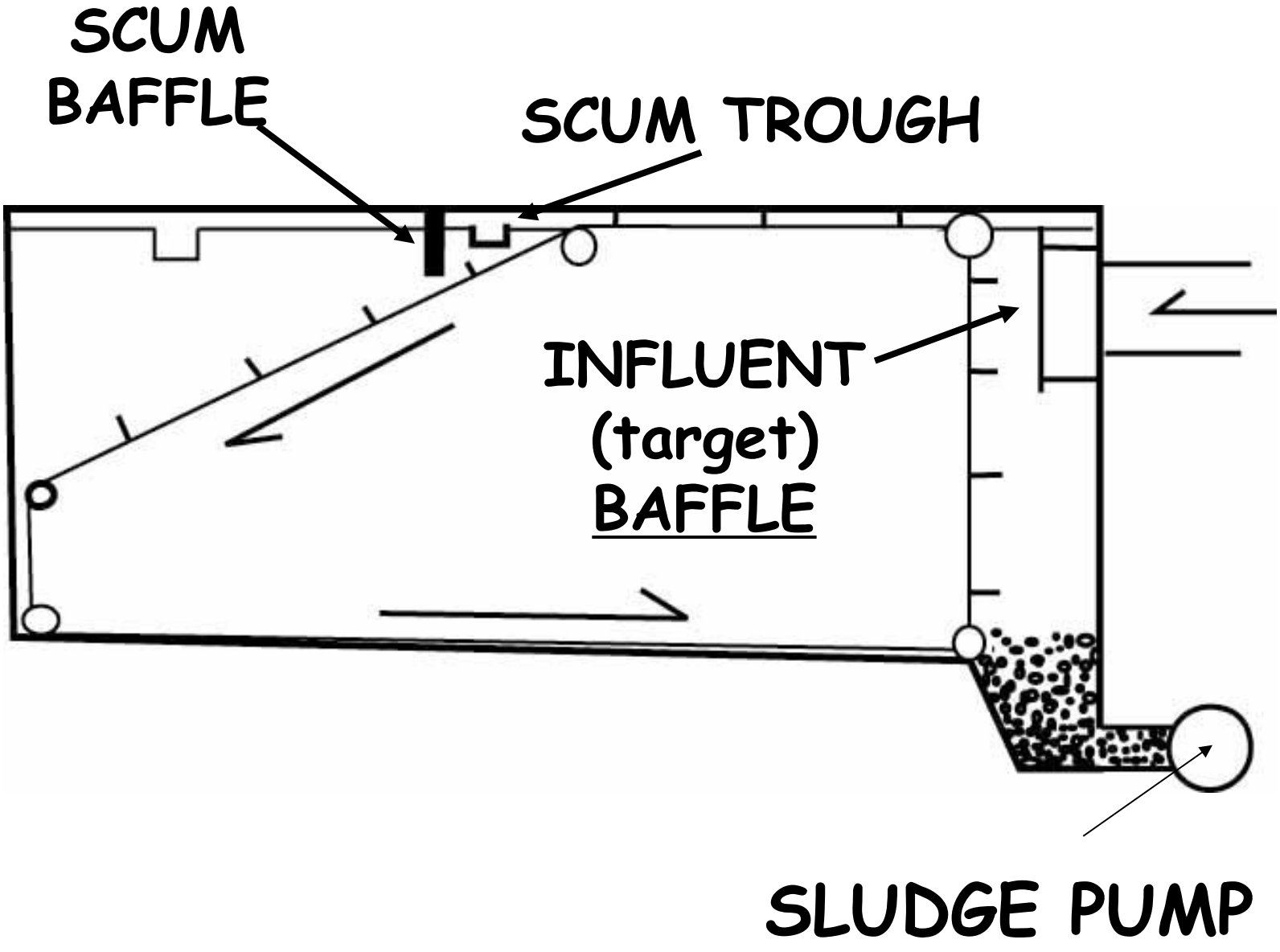
- GENERALLY THE OLDER UNITS
- BUILT WHERE SPACE IS LIMITED
- MAY BE 100 - 200 FEET LONG

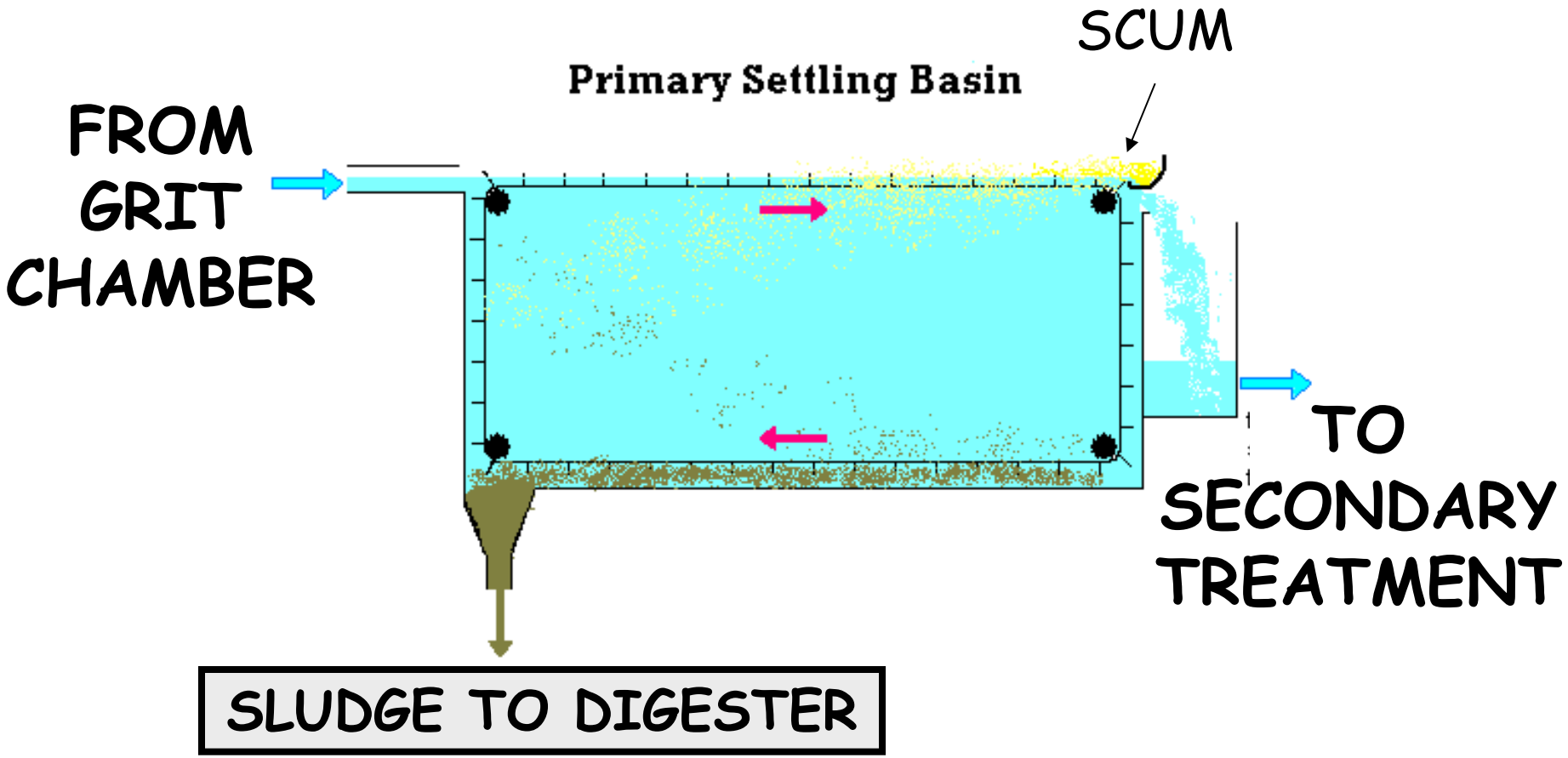
HORIZONTAL CLARIFIERS



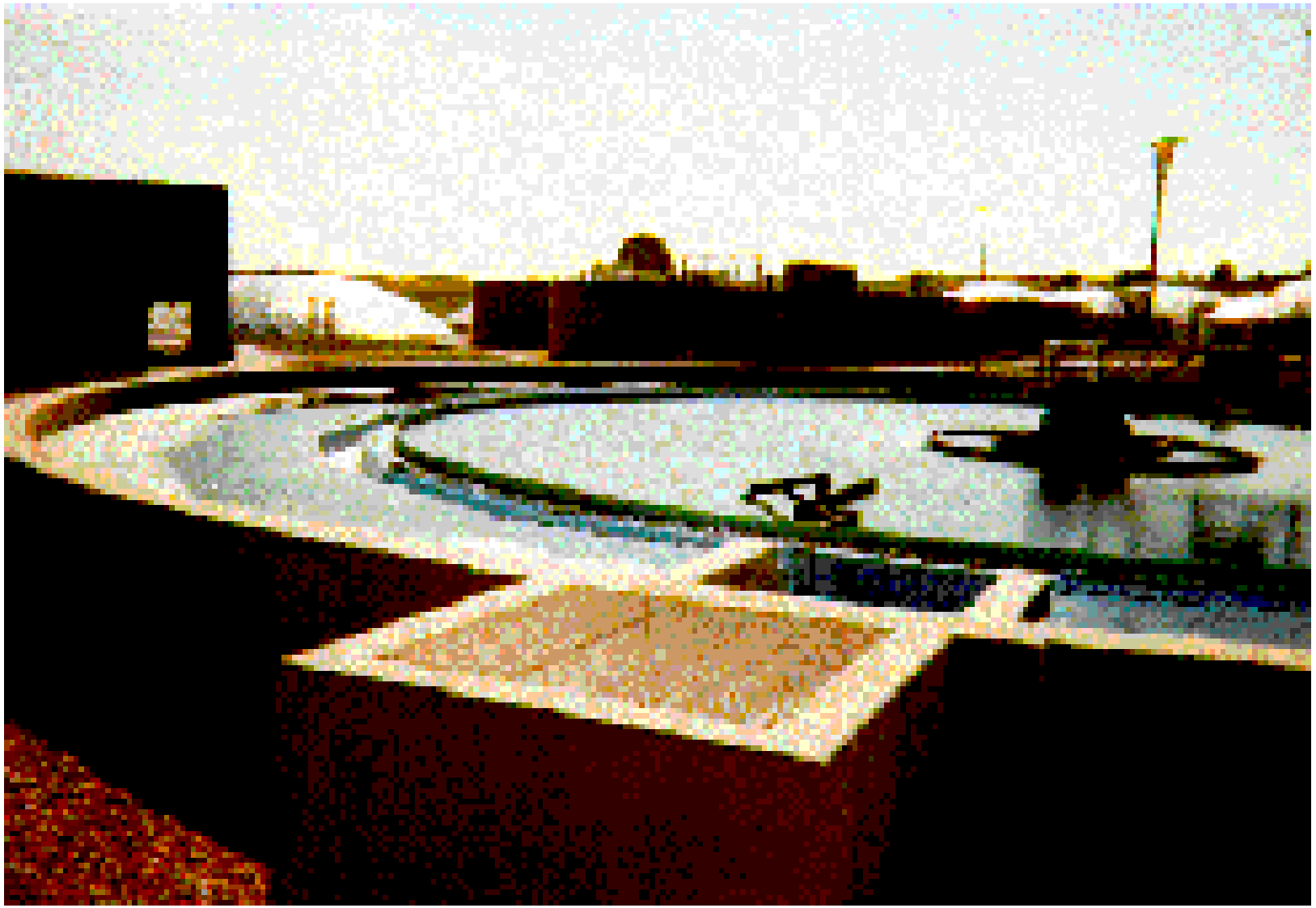
HORIZONTAL CLARIFIER



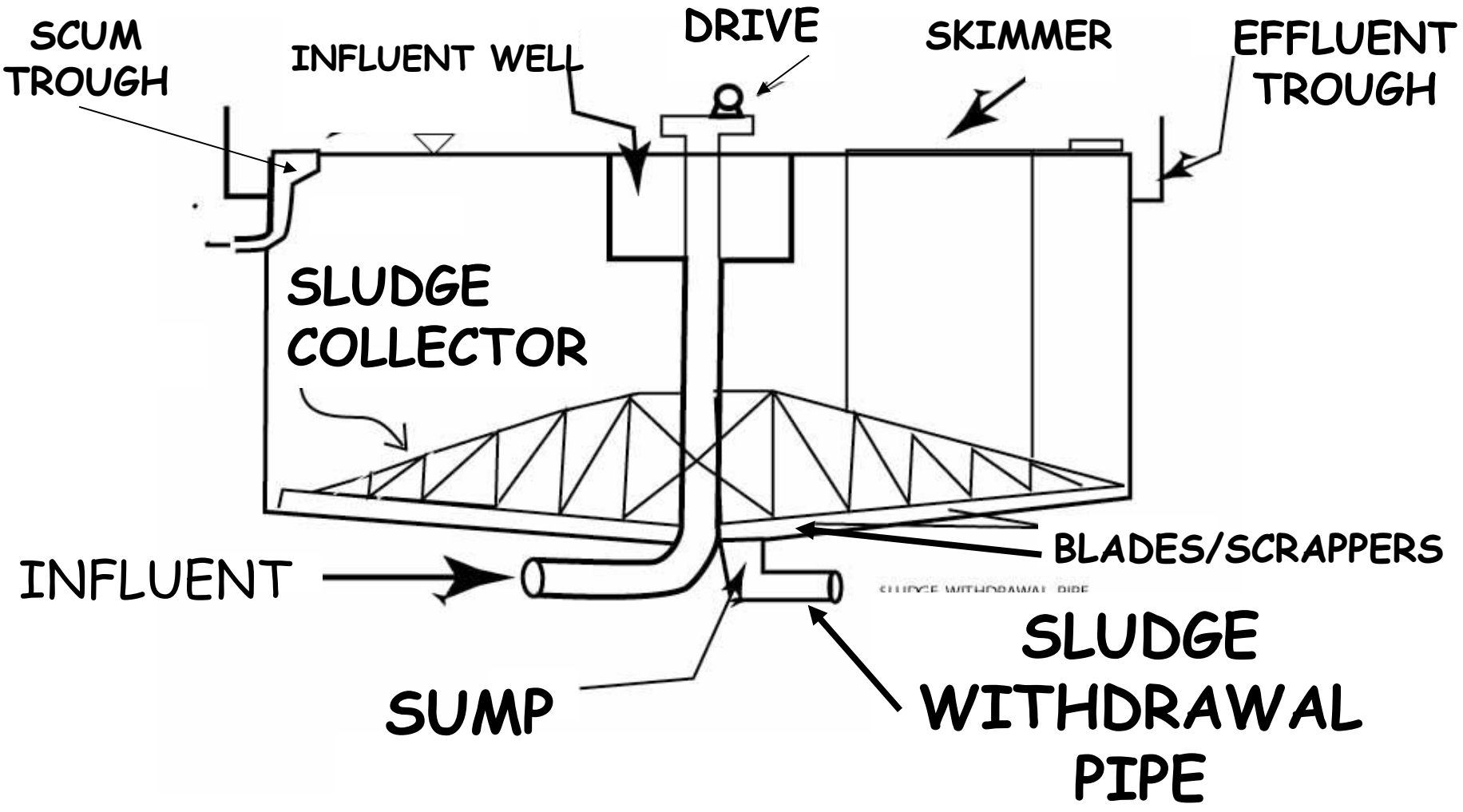

SCUM
BAFFLE
SCUM TROUGH
INFLUENT
(target)
BAFFLE
SLUDGE PUMP

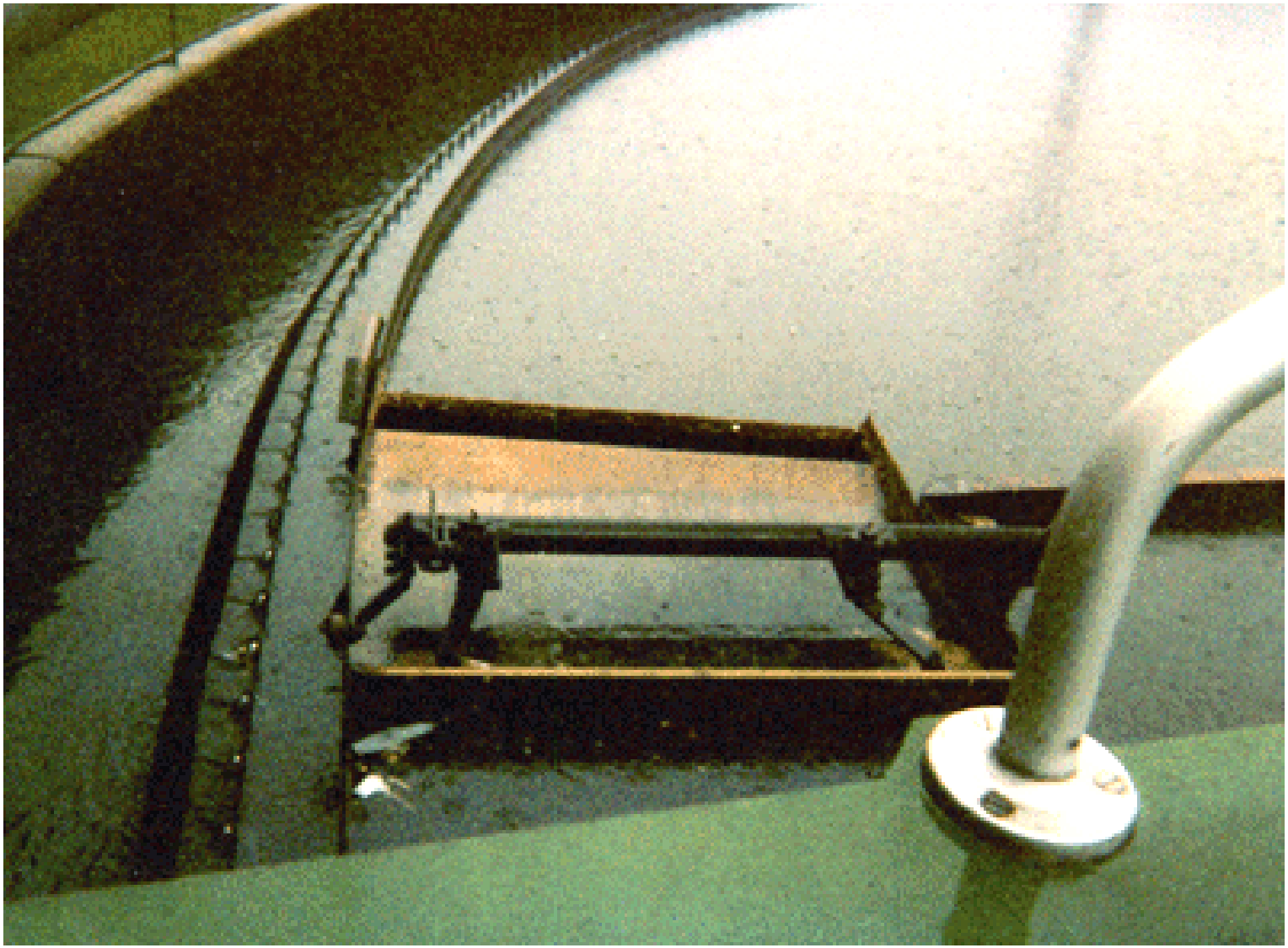

Primary Settling Basin
SCUM
FROM GRIT CHAMBER
TO SECONDARY TREATMENT
SLUDGE TO DIGESTER

CIRCULAR CLARIFIERS



CIRCULAR CLARIFIERS





SCUM REMOVAL

EFFLUENT WEIR

CLARIFIER EFFICIENCY IS AFFECTED BY…

- TYPES OF SOLIDS (industrial? Sewage?)
- **Wastewater freshness (fresh settles better)**
- **Hydraulic loading (actual flow vs design flow)**

CLARIFIER EFFICIENCY, con't

- Sludge withdrawal rate (may be leaving it in tank too long)

- Return solids may be difficult to settle

INDICATORS OF POOR SETTLING

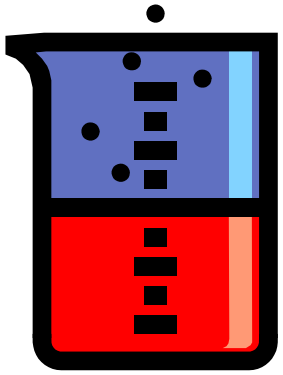
- FLOATING SLUDGE (aka SLUDGE BULKING)
- LOTS OF SCUM
- LOSS OF SOLIDS OVER WEIRS

INDICATORS OF POOR SETTLING

- LOW pH + ODORS
- DEEP SLUDGE BLANKET BUT THIN SLUDGE

SETTLING EFFICIENCY

- BASED ON COMPOSITE SAMPLE



COLLECT A SAMPLE EVERY 2-4 HRS FOR 24 HRS

EFFICIENCY = (IN-OUT)/IN x 100%

SLUDGE "BULKING"

"LIGHT, NON-SETTLING SLUDGE THAT OCCURS IN SECONDARY CLARIFIER BECAUSE OF…

GASIFICATION; INSUFFICIENT SLUDGE REMOVAL; DAMAGED OR TURNED-OFF SLUDGE COLLECTOR; SLUDGE BLANKET TOO DEEP; TOXIC SPILL, (see text)

SLUDGE REMOVAL

- FREQUENCY: 0.5 -24 hrs

- GOOD PRIMARY SLUDGE CONTAINS 4-8% TOTAL SOLIDS

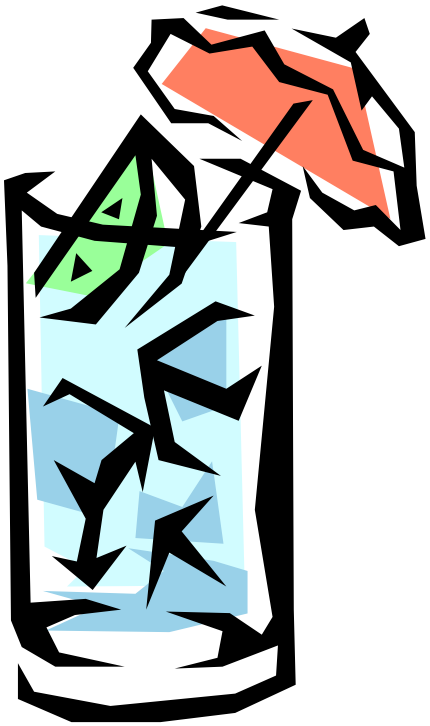
"DRAWING" SLUDGE

- SHOULD BE SLOW TO MINIMIZE WATER CONTENT
- LISTEN TO THE PUMP
- OBSERVE SLUDGE DENSITY GAGE READINGS, SIGHT GLASSES,...

FACTORS AFFECTING SETTLING

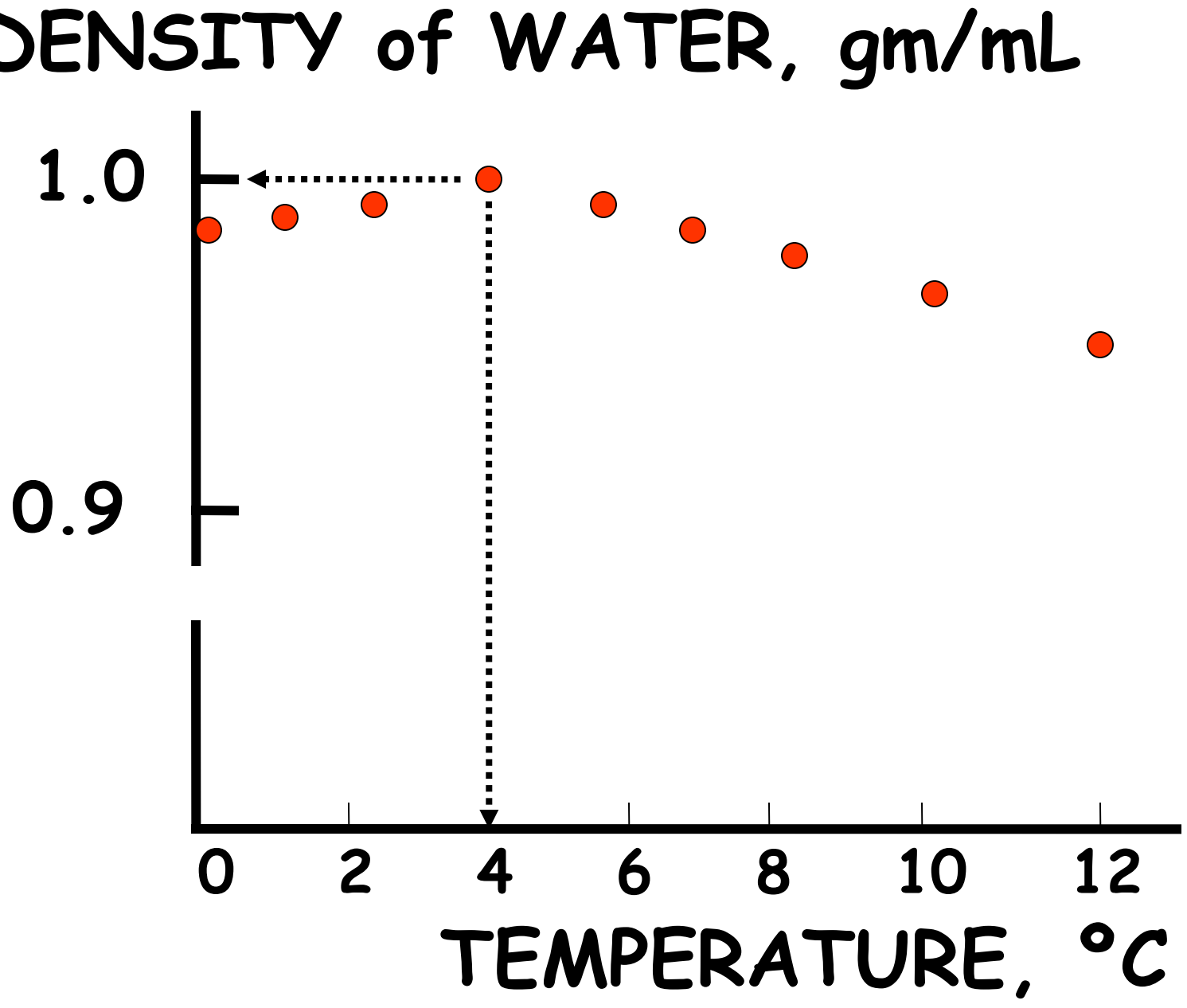
- ORGANICS ARE NOT MUCH HEAVIER THAN WATER- SLOW TO SETTLE

1. TEMPERATURE: SETTLING RATE INCREASES WITH INCREASED TEMPERATURES



WATER IS UNIQUE

H_2O IS MOST DENSE @ 4°C, THEN DENSITY DECREASES


DENSITY of WATER, gm/mL
1.0
0.9
0
2
4
6
8
10
12
TEMPERATURE, °C

SO WHAT??

ALL OTHER LIQUIDS BECOME MORE DENSE AS TEMPERATURE DROPS

FACTORS AFFECTING SETTLING

- TEMPERATURE

- (WOULD YOU EXPECT BETTER SETTLING IN THE SUMMER OR WINTER?)

FACTORS AFFECTING SETTLING

2. SHORT CIRCUITS AND DEAD SPOTS

ENGINEERS TRY TO DESIGN TANKS WITH UNIFORM FLOW ACROSS THE BASIN USING BAFFLES, PORTS, AND PLATES

SHORT CIRCUITS con't

MAY BE CAUSED BY TURBULENCE or DENSITY LAYERS (SALT or TEMPERATURE)

CAUSES REDUCED DETENTION TIME OR AREAS SUBJECT TO SEPTIC CONDITIONS

FACTORS AFFECTING SETTLING

3. DETENTION TIME:

TOO SHORT= SOLIDS IN EFFLUENT

DESIGNED FOR 2-3 HOURS OF D.T.

D.T.= VOL/ FLOW RATE

(ACTUAL WITH DYES, TRACERS)

FACTORS AFFECTING SETTLING

4. WEIR OVERFLOW RATE

- WASTEWATER EFFLUENT FLOWS OVER WEIRS INTO LAUNDERS
- THE LENGTH OF THE WEIR IS IMPORTANT TO PREVENT SHORT CIRCUITING OR HIGH VELOCITIES NEAR THE WEIR

WEIR OVERFLOW RATE

- AMOUNT OF WASTEWATER THAT FLOWS OVER 1 LINEAL FOOT OF WEIR/DAY
- RECOMMEND 10,000-20,000 GPD/FT IN PRIMARY, LESS IN SECONDARY CLARIFIER

OTHER FACTORS…

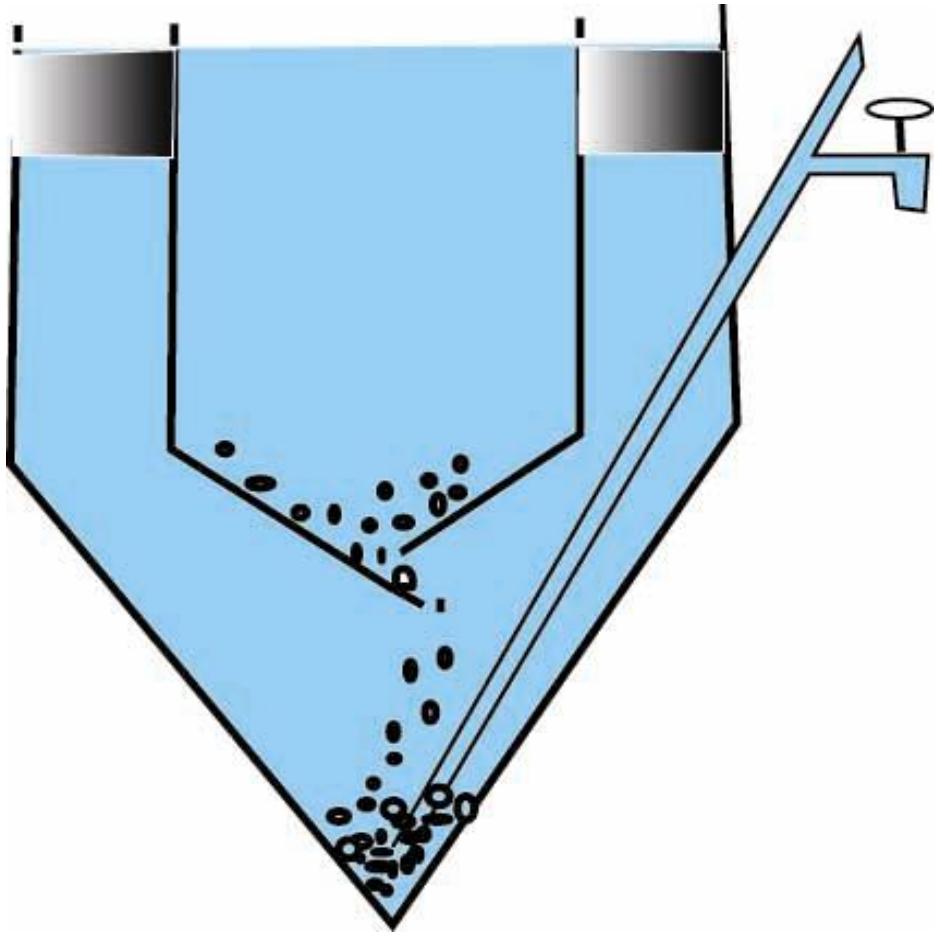
- TOXIC WASTES FROM INDUSTRIAL SPILLS, DUMPS

- SEPTIC OVERLOAD (RV DUMPS, PORTA-POTTY DUMPS, STORM FLOWS, HYDRAULIC OVERLOADS)

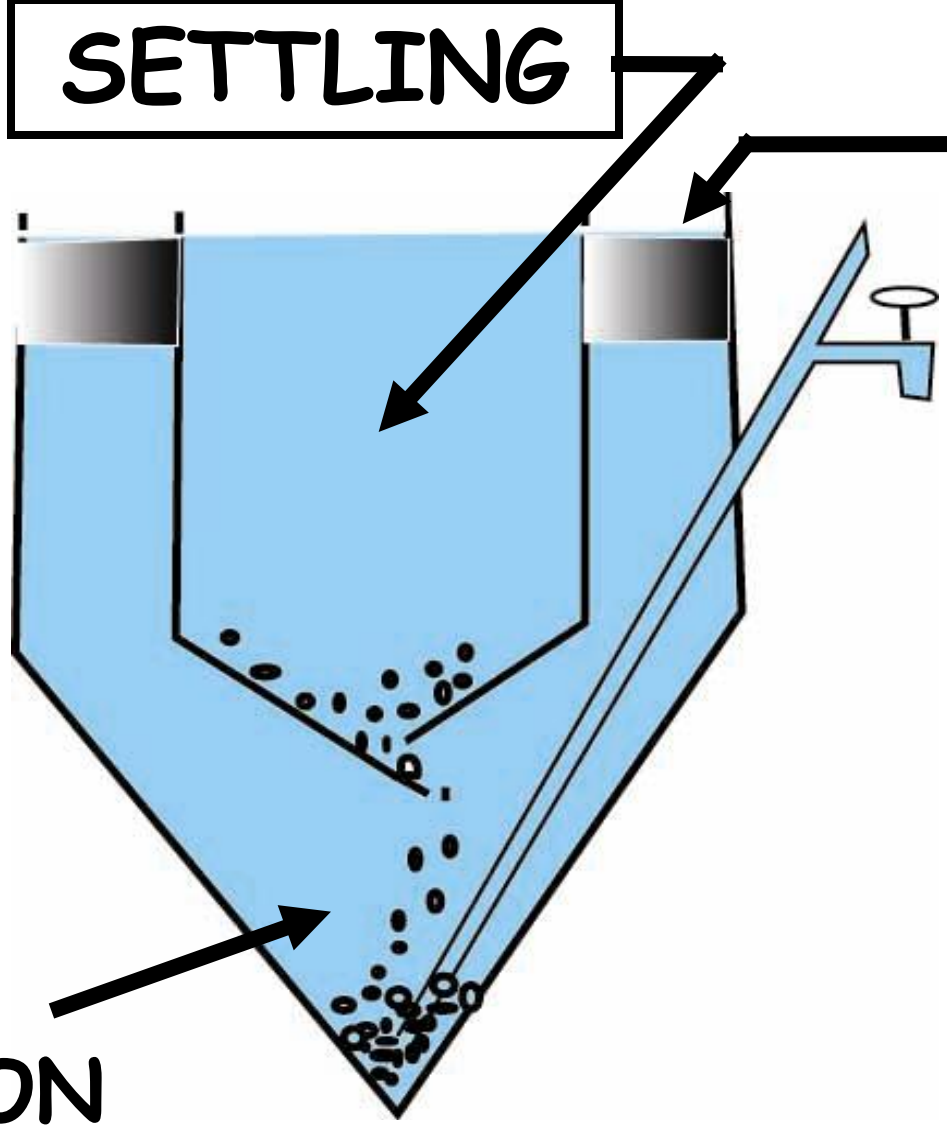
COMBINED SETTLING AND DIGESTION UNITS

- USUALLY CONSIDERED "PACKAGED TREATMENT PLANTS" BECAUSE THEY ARE FACTORY-BUILT AND SHIPPED TO THE SITE AS A PACKAGE

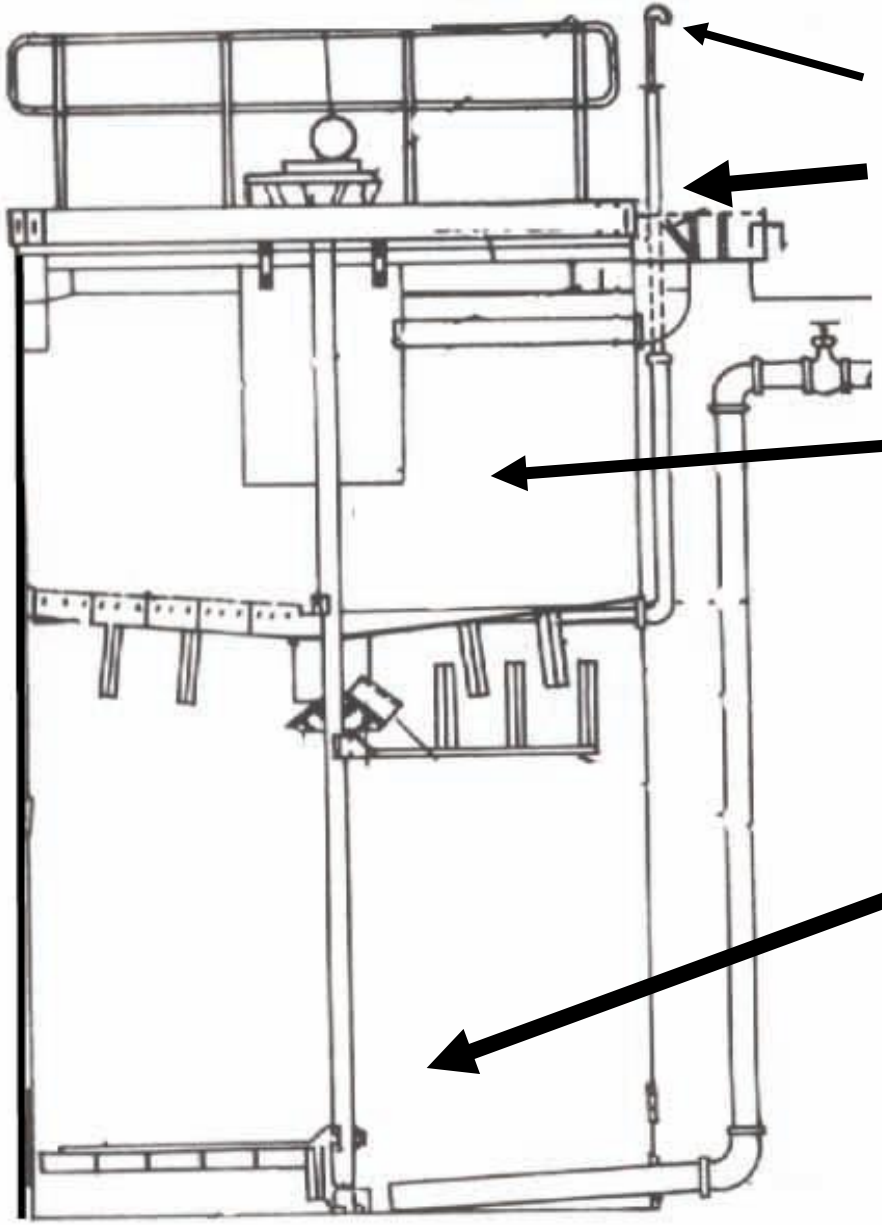
COMBINED SETTLING/DIGESTION



THESE UNITS ARE ALL COPIED FROM THE IMHOFF TANK

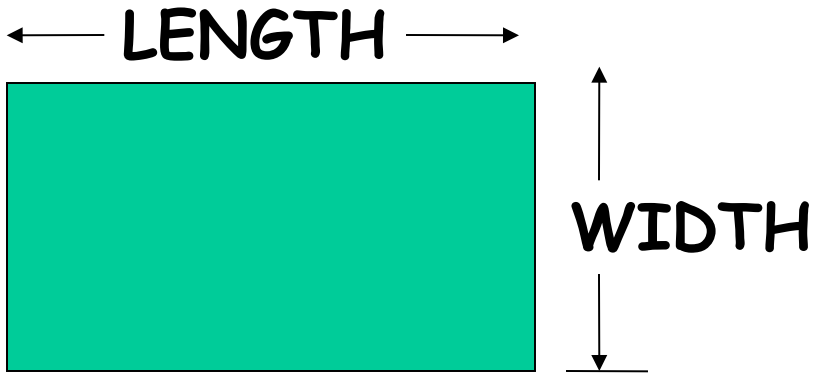


IMHOFF TANK



CLARIGESTER™

REVIEW OF ARITHMETIC

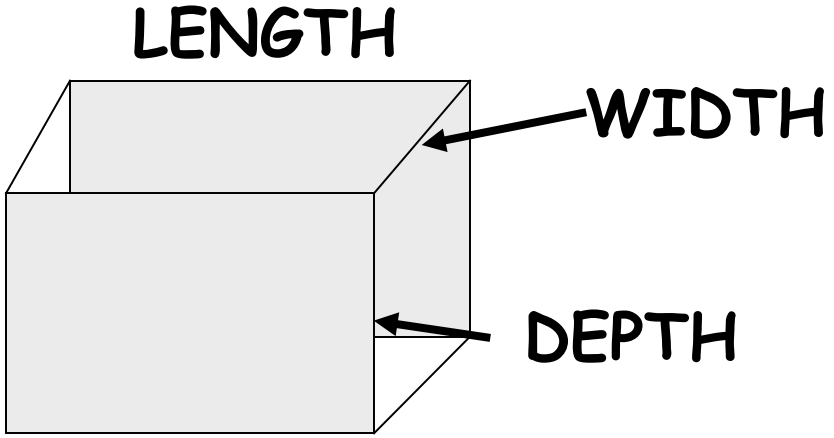


SURFACE AREA = LENGTH x WIDTH

EXAMPLE: WHAT IS THE SURFACE AREA of a 45 ft x 26 ft Tank?

Surface Area = 45' x 26' = 1170 sq-ft

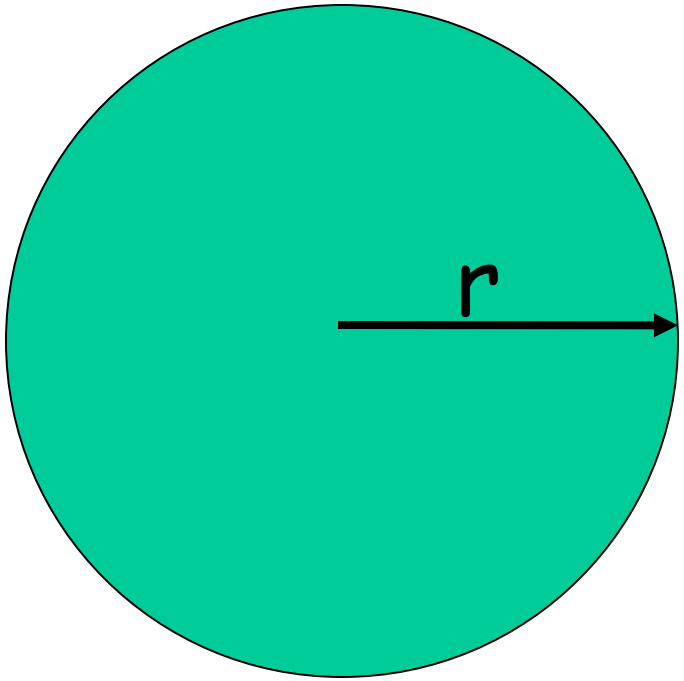
VOLUME = LENGTH x WIDTH x DEPTH



EXAMPLE: WHAT IS THE VOLUME OF A TANK THAT IS 45' LONG, 22' WIDE, AND 12' DEEP?

VOL = 45'x22'x12' = 11,880 cu-ft

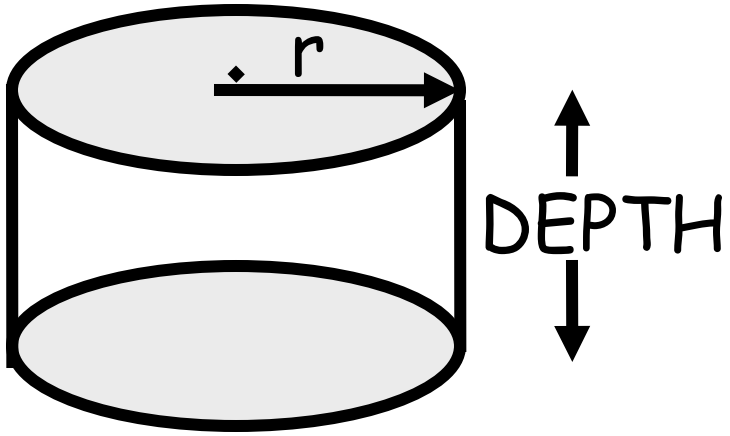
REVIEW OF ARITHMETIC



SURFACE AREA OF a CIRCLE = πr^2

Or, $0.7854 \times D^2$

Example: What is the surface area of a circular tank that is 65' in diameter: SA = 0.7854 x 4225 sq-ft = <u>3317</u> sq-ft



VOLUME = πr^2 x depth

Or; 0.7854 D^2 x depth

EXAMPLE: WHAT IS THE VOLUME of a 45' CIRCULAR TANK with a WATER DEPTH OF 12'?

VOLUME = 0.7854 x $(45\ ft)^2$ x 12 ft =

<u>19,076</u> cu-ft

REMEMBER…

- 1 GALLON OF WATER WEIGHTS 8.34 POUNDS
- 1 CUBIC FOOT HOLDS 7.48 GALLONS

MORE ARITHMETIC…

WHAT IS THE VOLUME in **GALLONS** of a TANK THAT HOLDS 19,076 cu-ft of WATER?

VOL = 19,076 cu-ft x 7.48 gal/ cu-ft = **143,070 gallons**

FOLLOW-UP PROBLEM:

HOW MANY GALLONS DOES A 30' DIAMETER, 9' DEEP TANK HOLD?

VOL = 0.7854 x D^2 x depth = 0.7854 x 900 sq-ft x 9 ft = 6358 cu-ft

VOL, gal = 6358 cu-ft x 7.48 gal/cu-ft

= 47,685 gallons

CLARIFIER OPERATION

THREE IMPORTANT FACTORS:

1. DETENTION TIME

The time it takes for water to flow through the tank

DT = TANK VOL/ FLOW

EXAMPLE: VOLUME = 65,000 gal; FLOW = 550 gal/min then; DT=65,000 gal/550 gal/min =118 min

2. SURFACE LOADING

SURFACE LOADING = FLOW, gal/day DIVIDED BY THE SURFACE AREA, sq ft

EXAMPLE: Flow=790,000 gal/day; 20'x60' clarifier; surface area of clarifier = 1200 sq ft; SURFACE LOADING = 790,000 gal/day/1200 sq-ft = 658 gal/sq-ft

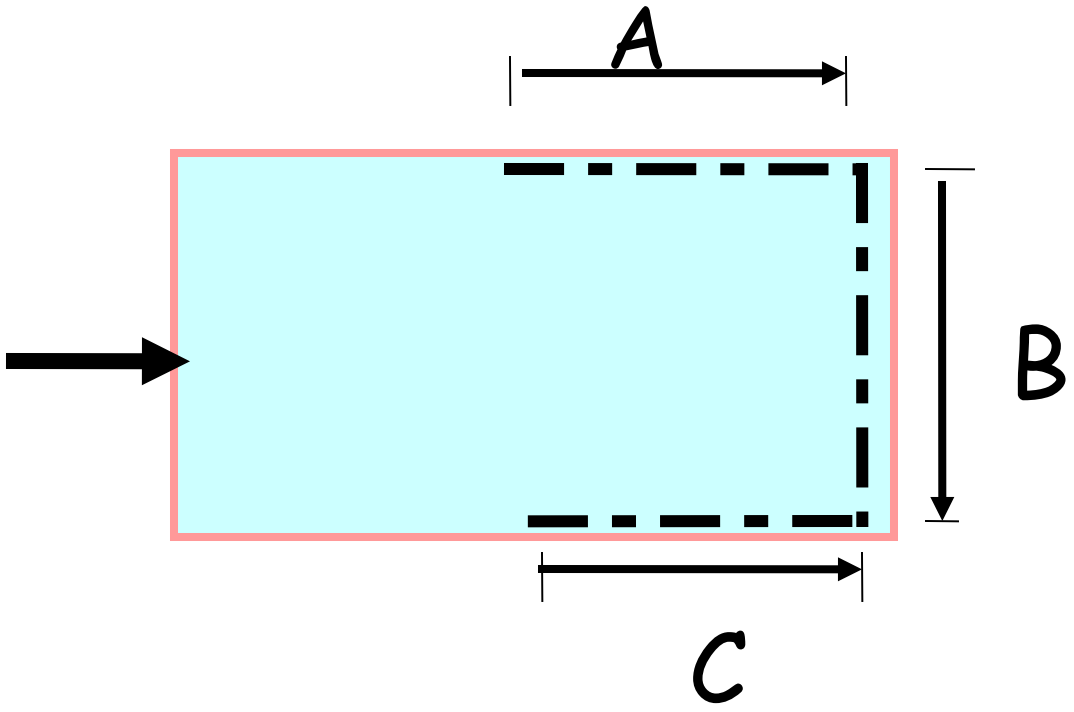
3. WEIR OVERFLOW RATE

WOR = **FLOW**, gal/day/ **weir length**, ft

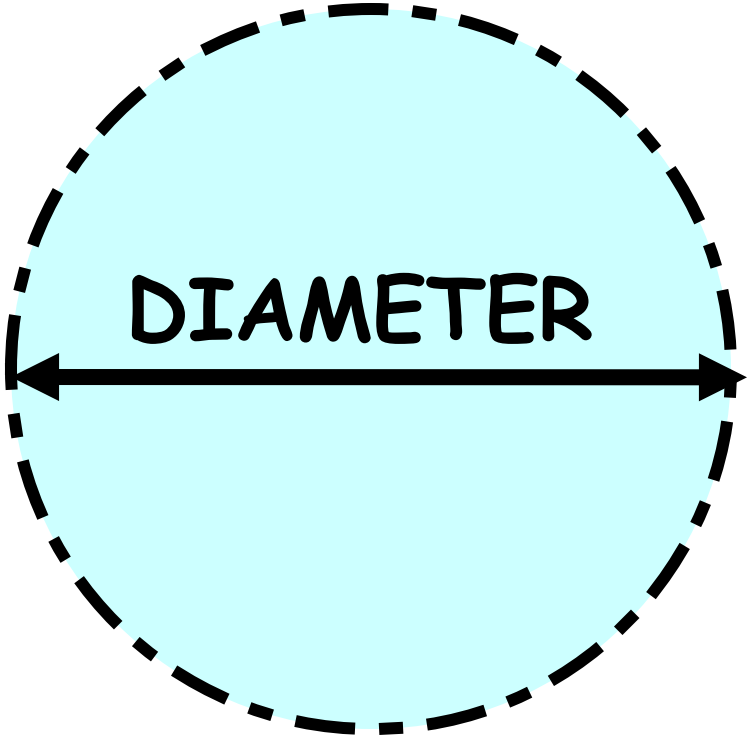
EXAMPLE: WHAT IS THE WEIR OVERFLOW RATE IN A TANK HAVING **80' OF WEIR LENGTH** THAT **RECEIVES 790,000 GPD?**

WOR = 790,000 gpd/80 ft = 9875 gpd/ft

WEIR LENGTHS



Weir Length = A + B + C



WEIR LENGTH on a CIRCULAR BASIN

$$= \underline{\pi D}$$

DETERMINING EFFICIENCIES

$$\% \text{ EFFICIENCY} = \frac{(\text{IN} - \text{OUT})}{\text{IN}} \times 100\%$$

EXAMPLE: Given an **influent** conc. of suspended solids = **220 mg/L**, and an **effluent** conc. of suspended solids = **8 mg/L**, what is the efficiency of the clarifier?

$$\% \text{ Efficiency} = \frac{(220 - 8)}{220} \times 100\%$$

$$= 96\%$$

CLARIFIER OPERATING RANGES

	PRIMARY	SECONDARY
DETENTION TIME, hr	2-3	2-3
Weir overflow rate, gpd/ft	10,000-20,000	5,000-15,000
Surface loading, gpd/ft^2	300-1,200	300-1,200

TYPICAL CLARIFIER EFFICIENCIES

PARAMETER	% EFF	Avg
Settleable Solids	90-99	97
Suspended Solids	40-60	50
Total Solids	10-15	10
BOD	20-50	35
Bacteria	25-75	50
pH	no change	