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ABSTRACT

This document is an instructional module package designed in the objective format for use by an instructor familiar with lagoon operation. Included are objectives, instructor guide, student handouts, and transparency masters. The module considers basic concepts of design, operation and maintenance, loading and detention time calculations, series and parallel flow and fill and draw operation. (Author/RH)

WASTE STABILIZATION PONDS

Training Module 2.100.1.77

Prepared for the

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by

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September, 1977

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Module No:	Module Title: Lagoons
Approx. Time: 24 hours (3 one-day sessions)	Topics: 1. Design Characteristics 2. Concepts of Treatment 3. Stabilization Pond Geometry 4. Starting the New Pond 5. Operating Waste Stabilization Ponds 6. Operating Problems and Solutions 7. Chemical Additions for Improved Performance 8. Site Evaluation 9. Maintenance Procedures 10. Routine Operation 11. Safety

Overall Objectives:

The student should gain a basic understanding of how the lagoon works, be able to calculate loading and detention times, and discuss problem situations and possible solutions.

Instructional Aids:

1. Handouts
2. Transparancies
3. Course Manual

Instructional Approach:

1. Lecture
2. Discussion
3. In class problem solving
4. Field trip

References:

1. Tentative Controlled Discharge Lagoon Criteria, March 1975, IDEO.
2. Recommended Standards for Sewage Works
3. Water Pollution Control Federation MOP 11
4. Minnesota Pollution Control Authority Lagoon Manual

Class Assignments:

1. Read manual and handouts
2. Solve problems
3. Evaluate lagoon visited on field trip

Module No:	Topic: Lagoons
Instructor Notes:	Instructor Outline:

1. This module of instruction is best delivered in three one-day sessions separated by as much as one week between each session.

2. The second day begins with a field trip. The instructor should make arrangements to visit a lagoon site. The host operator should provide as much data (dimensions, flows, lab data, etc.) as possible for training purposes. A polaroid camera should be taken, also.

3. The Minnesota Lagoon Manual is an excellent reference.

   Minnesota Pollution Control Agency
   1935 West County Road B2
   Roseville, Minn. 55113

4. Recommended Standards for Sewage Works may be obtained from: (Nominal charge)

   Health Education Service
   P. O. Box 7283
   Albany, New York 12224

5. The Water Pollution Control Federation MOP 11 is also an excellent reference.

Module No:	Module Title: Waste Stabilization Ponds
	Submodule Title:
Approx. Time: 1½ hours Day 1	Topic: Design Characteristics of Waste Stabilization Ponds

Objectives:

1. List design hydraulic loading of waste stabilization ponds (lagoons).
2. List design organic loading of lagoons.
3. List number of cells required for controlled discharge lagoons.
4. List design hydraulic detention of lagoons.
5. List maximum organic loading on primary cells of 3 and 2 cell systems.
6. List maximum liquid depths allowed in primary and subsequent cells.

Instructional Aids:

1. Handout

Instructional Approach:

1. Lecture
2. Discussion

References:

1. Tentative Controlled Discharge Lagoon Criteria, March 1975.
2. Recommended Standards for Sewage Works (10 State Standards).

Class Assignments:

Module No.	Topic: Design Characteristics of Waste Stabilization Ponds

Instructor Notes:	Instructor Outline:
1. Student Handout 1 contains highlights of "Tentative Controlled Discharge Lagoon Criteria". (Tent. criteria). The course manual contains information which does not coincide. Tent. criteria takes precedence in all cases.	I. Design loadings A. Hydraulic - at least 100 gal/capita/day Example: Population equal 550 Design flow = 550 x 100 = 55,000 gal/day Exceptions: 1. In small municipalities an additinal 20 gal/cap/day for out of town students attending school. 2. Additional allowance for sewer infiltration if a sewer system evaluation demonstrates that treatment is cost effective. 3. Additional allowance for any wet process industries i.e. other than normal commercial operations. B. Organic loadings At least 0.17 lbs. BOD/capita/day To calculate organic load: Flow (MGD) x BOD (mg/l) x 8.34 = lbs. BOD/day Exceptions: 1. In small municipalities an additional 0.05 lbs. BOD/cap/day for out of town students attending school. 2. Additional allowance for other than normal commercial operations in the municipality.
Transparancy of "typical 2-cell lagoon layout". Figure 1	II. Lagoon Design A. Very small installations (less than one acre)

Student Handout 1

Design Loadings

100 gal./cap/day

0.17 lbs. BOD_5/cap/day

Small municipalities add 20 gal/cap/day and .05 lbs. BOD_5/cap/day for out of town school students.

Lagoon Design

3 cells for controlled discharge systems

2 cells for very small installations

Hydraulic Detention

6 months above the 2 foot liquid level

Organic Loading

25 pounds BOD/acre/day maximum on primary cell of 3 cell system

20 pounds BOD/acre/day maximum on primary cell of 2 cell system

Liquid Depths

6 foot maximum in first cell

8 foot maximum in subsequent cells

Module No:	Topic: Design Characteristics of Waste Stabilization Ponds

Instructor Notes:	Instructor Outline:
	1. Two cells 2. Series and parallel operation capability
Transparency of "typical 3-cell lagoon layout" Figure 2	B. "Normal" controlled discharge type 1. Three cells 2. Cells 2 and 3 approximately equal in size 3. Influent lines shall be provided into at least two cells. 4. Primary cell can be divided into two equal cells with piping for either series or parallel operation for high strength sewage and for large installations.
Transparency of "typical 3-cell lagoon layout" (divided primary cell) Figure 3	C. Hydraulic detention 6 months detention above the two foot level in all cells.
	D. Organic loading 1. 3-cell system: The maximum load on the primary cell shall not exceed 25 lbs. BOD/acre/day 2. 2-cell system: The maximum load on the primary cell shall not exceed 20 lbs. BOD/acre/day
	E. Liquid depth 1. Primary cell - liquid depth shall not exceed 6 feet 2. Subsequent cells - liquid depth shall not exceed 8 feet.

TYPICAL 2-CELL LAGOON LAYOUT - (VERY SMALL INSTALLATIONS)

Provide for 180 days storage above 2 ft. liquid level in both cells - based upon design average flow.

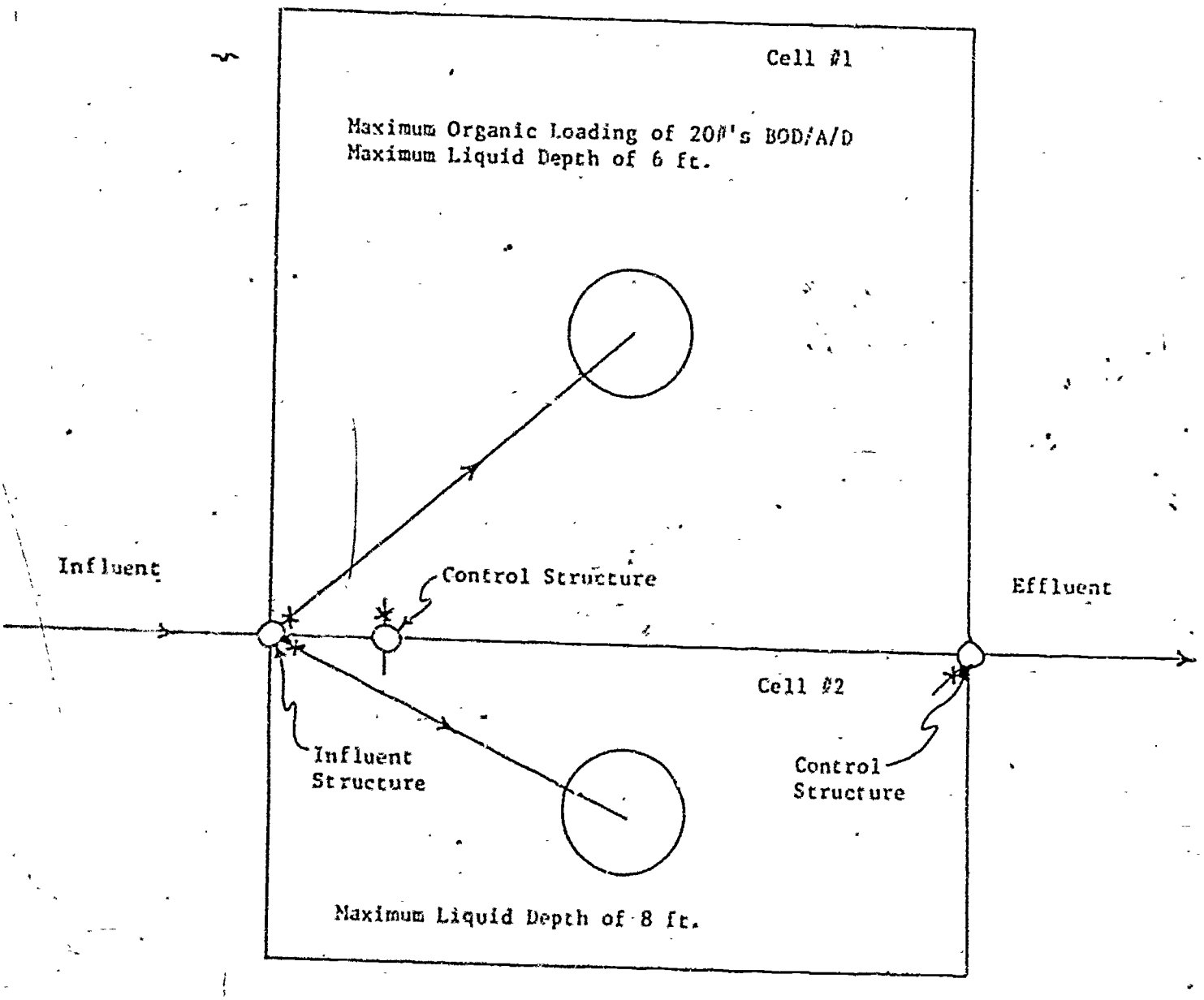

Figure 1

Not to Scale

TYPICAL 3-CELL LAGOON LAYOUT

Provide for 180 days storage above 2 ft. level in all 3 cells - based upon design average flow.

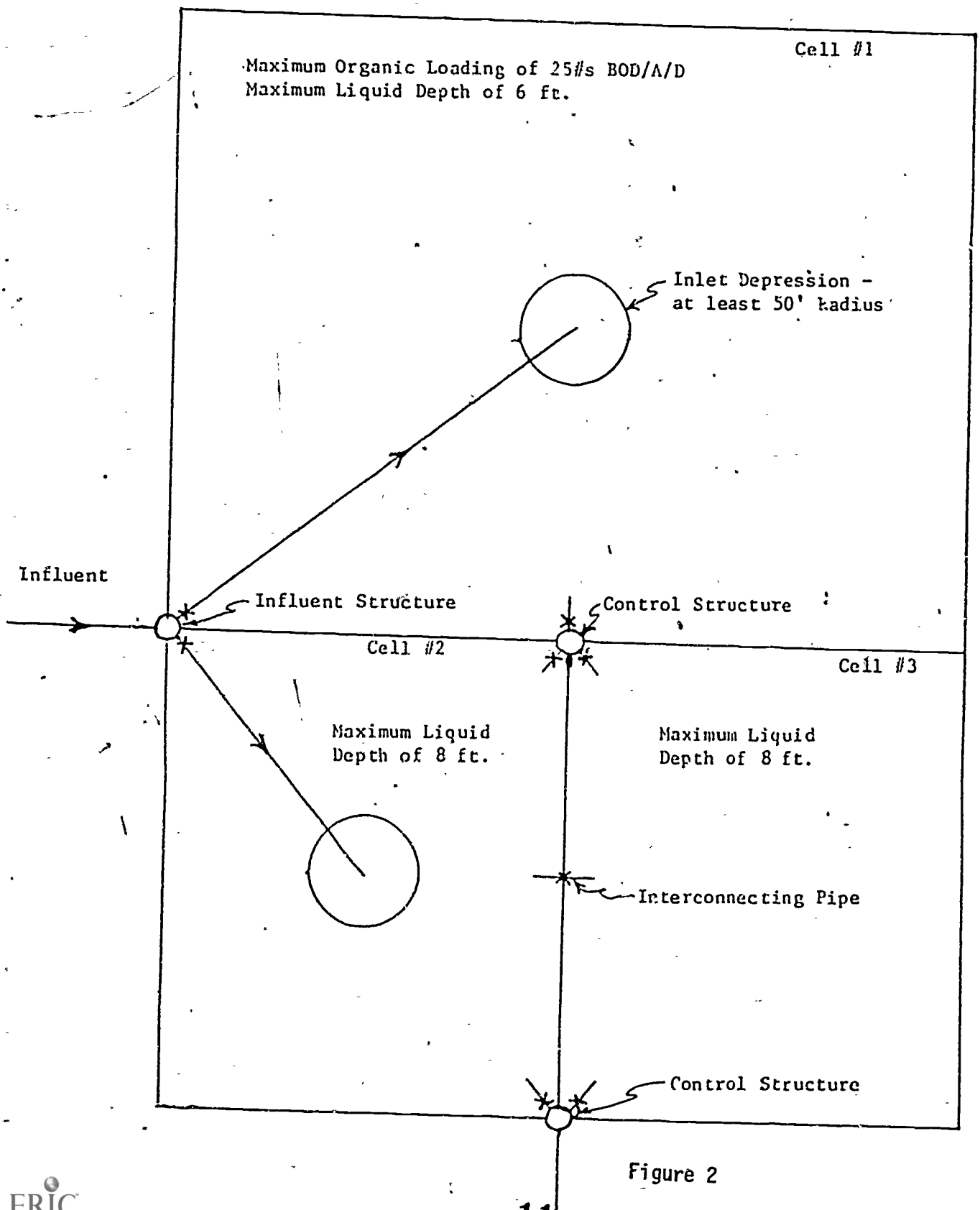

Figure 2

TYPICAL 3-CELL LAGOON LAYOUT - (Divided Primary Cell)

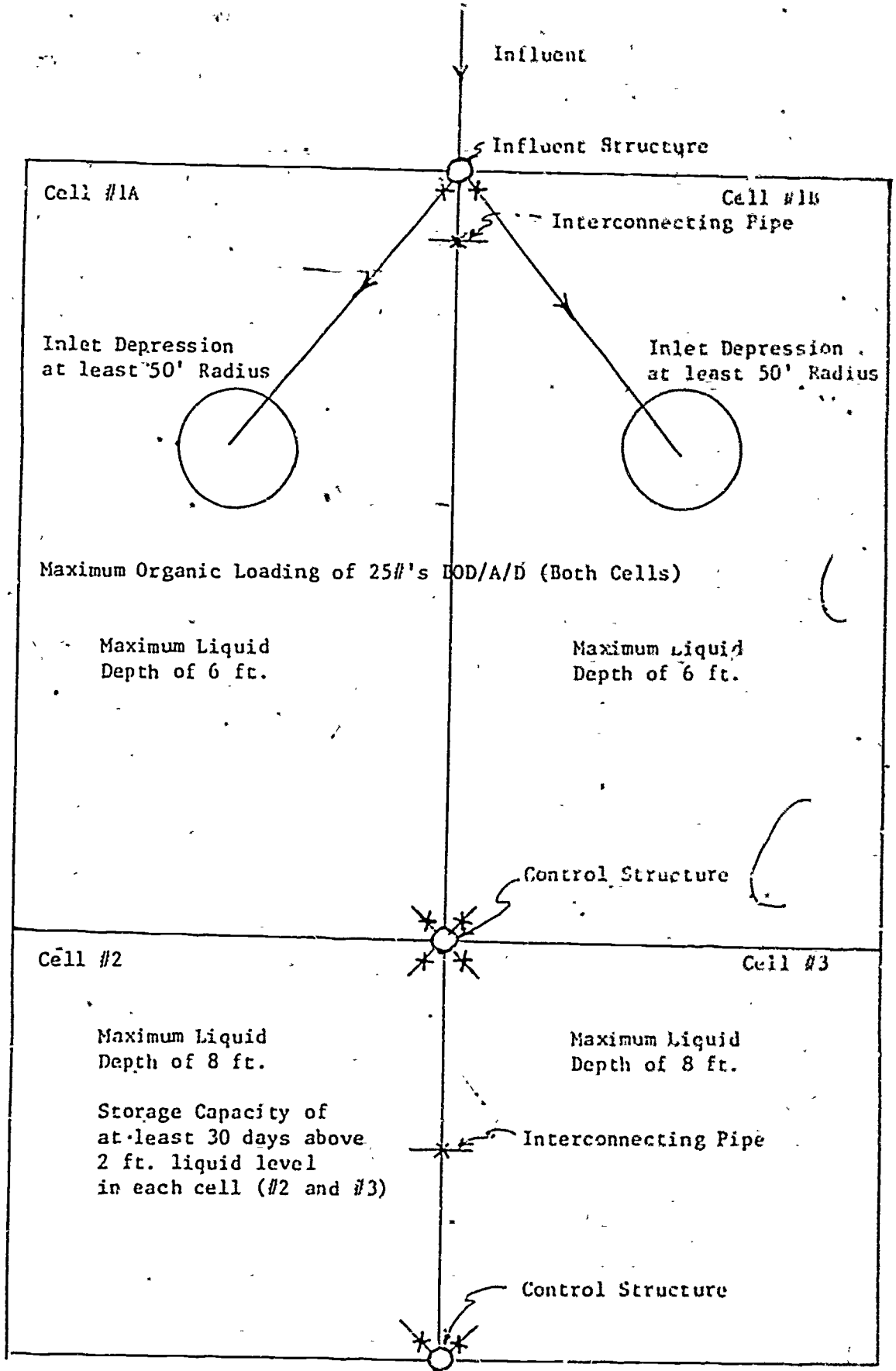

Figure 3

Module No:	Topic: Design Characteristics of Waste Stabilization Ponds

Instructor Notes:	Instructor Outline:
Transparancy of the "typical 3-cell lagoon layout". Figure 1	F. Control structures 1. Primary control structure at Cell 1 with provisions to direct flow to either Cell 2 or 3. 2. Effluent control structure to allow for discharge from Cell 2 or 3 with at least 3 separate drawoff lines between the two foot level and the maximum liquid level. 3. Cell 2 and 3 interconnection at the two foot level.
All other items of lagoon design not covered in the "Tentative Controlled Discharge Lagoon Criteria" shall be in accordance with the applicable portions of Chapter 90 of the "Ten State Standards for Sewage Works".	G. Other considerations 1. Flow measuring device required for measuring raw waste flow and any discharge from the lagoon. 2. Disinfection not required but the system must be designed to facilitate future installation if found necessary to meet discharge standards. 3. Bottom sealing may be required to prevent excessive percolation. Hard packed clay or bentonite may be used. 4. Minimum of 3 foot freeboard. 5. The pond area will be fenced to prevent livestock entering and to discourage trespassing. 6. Warning signs shall be posted.

Module No:	Module Title: Waste-Stabilization Ponds
	Submodule Title:
Approx. Time: 1 hour Day 1	Topic: Concepts of Treatment

Objectives:

1. Identify the three zones of treatment in a non-aerated pond.
2. Describe two ways that oxygen becomes available to the aerobic zone of the pond.
3. Describe two ingredients required for algae to produce oxygen.
4. Describe origin of fecal coliforms and their "assigned role" as indicator organisms.

Instructional Aids:

Transparancy

Instructional Approach:

Lecture
Discussion

References:

1. Course Manual Section B

Class Assignments:

Module No:	Topic: Concepts of Treatment

Instructor Notes:	Instructor Outline:
Course Manual Section B	I. Stabilization pond as a treatment system The lagoon provides a biological treatment facility to the small community. A biological system requires food, microorganisms and oxygen. 1. Food A. Volatile solids B. Organics in solution Generally BOD and volatile suspended solids determinations are the measures of food. 2. Oxygen There are primarily two sources of oxygen. A. From atmosphere This is available at the surface and is one reason for the surface area design criteria (loading as a function of surface - lbs. BOD/acre/day). B. From algae The lagoon provides a suitable environment for algae to flourish. Their growth is stimulated by the presence of carbon dioxide, nitrogen, phosphorous, calcium, and magnesium salts. When sunlight is available the algae utilize CO_2, the carbon for energy, and release oxygen which is then available to the microorganisms attacking the food. 3. Microorganisms There are several ways of catagorizing the microorganisms which exist in the lagoon system. Consider those which accomplish treatment can be catagorized by the zone of the lagoon in which they reside. There are three zones of treatment - aerobic, facultative, and anaerobic.

Module No:	Topic: Concepts of Treatment

Instructor Notes:	Instructor Outline:
Course Manual Figure B4 (Figure 4)	i. Aerobic Zone The organisms in this zone must get oxygen from their surroundings to convert food to new cells, the upper portion of the lagoon. ii. Facultative Zone The middle section of the lagoon where critters reside who have the ability to use available oxygen or are able to produce their own oxygen. iii. This is the bottom of the lagoon. The critters live in the zone of no oxygen. Their by-products are gases such as carbon dioxide, ammonia, methane and hydrogen sulfide. (As the anaerobic zone becomes dominant, when ice cover exists for example, the odors can become a problem.) 4. Indicator Microorganisms Tent. criteria states "Disinfection will not be required initially for lagoons designed in accordance with these criteria. However, the lagoon should be designed to facilitate the future installation of disinfection facilities if found necessary to meet the EPA secondary definition for fecal coliform bacteria or Iowa Water Quality Standards". Fecal coliform have been labelled "indicator" organisms. They are found in the lower bowel of all warm-blooded animals (includes man). The test procedure to determine their presence is not extremely difficult. The rationale for using them as indicators is then: All raw wastewater will include fecal coliform. If they do not survive through the lagoon system it is probable other harmful organisms have not survived.

Schematic

WASTE STABILIZATION POND

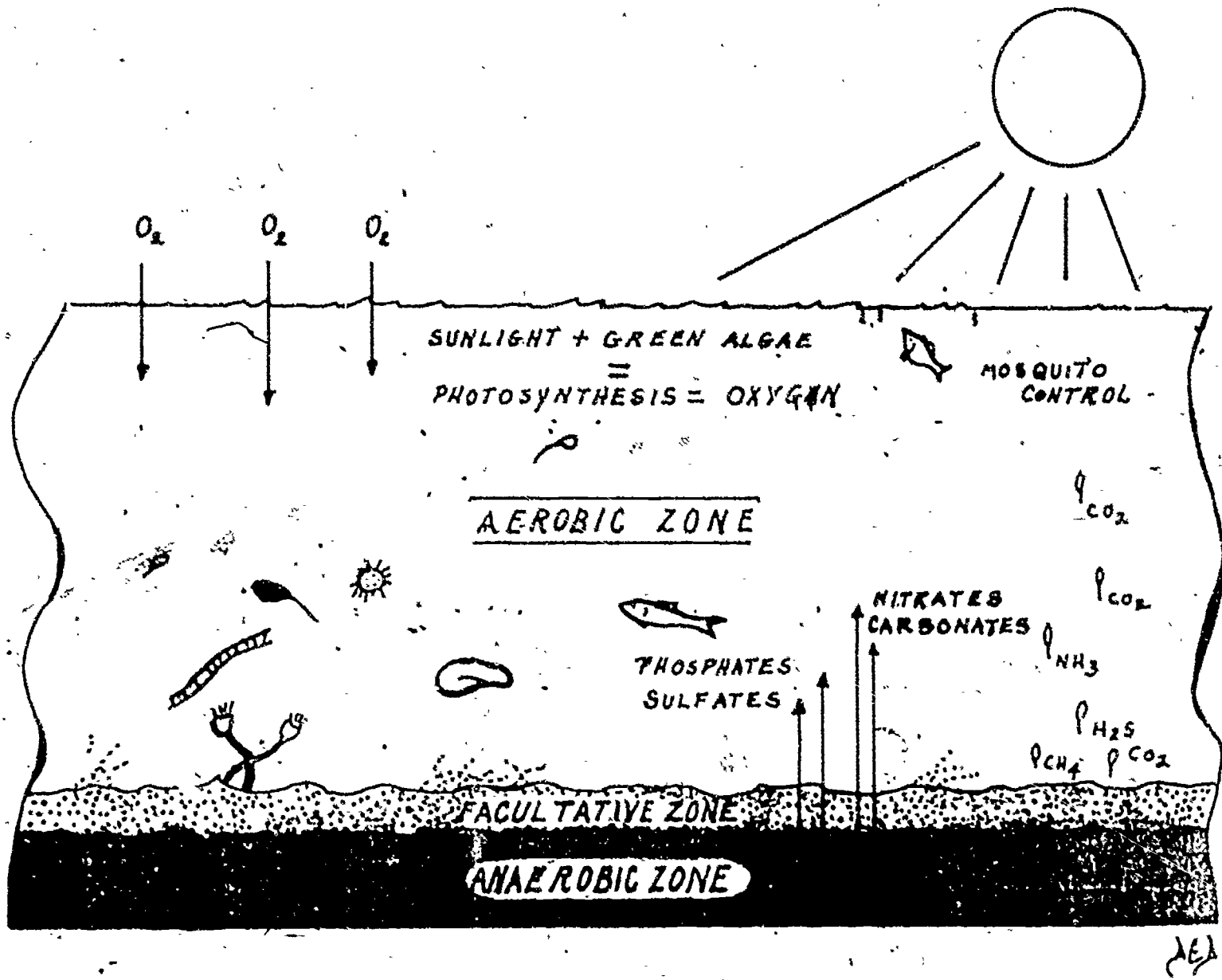

Figure 4

Module No:	Topic: Concepts of Treatment
Instructor Notes:	Instructor Outline:

There are those that disagree with the rationale, however, fecal coliform limits are set in many lagoon discharge permits and are a relative indication of the effectiveness of the treatment accomplished in the lagoon.

Module No:	Module Title: Waste Stabilization Ponds
	Submodule Title:
Approx. Time: ½ hour	Topic: Stabilization Pond Geometry

Objectives:

1. Calculate lagoon cell surface area.

Instructional Aids:

1. Transparancies

Instructional Approach:

1. Lecture
2. In-class problem solution

References:

1. Course Manual

Class Assignments:

1. Complete portions of Figure A-2, Course Manual, for their system, omitting the four lines under "capacity". Figure A-2 should be complete for use during the second and third days of this workshop.

Module No:	Topic: Stabilization Pond Geometry
Instructor Notes:	Instructor Outline:

Course Manual Figure A-2 (Figure 5)

The student should record the dimensions of his lagoon cells on Figure A-2 and bring that information to the second day's session.

A few example problems should be solved in class. Attendees should have an idea of their lagoon approximate dimensions. Use them for in class practice.

There are solved problems in the student "Study Guide".

PLANT DATA SHEET

Waste Stabilization System

Pond No. 1		Pond No. 2	
DIMENSIONS		DIMENSIONS	
*Length	Ft.	*Length	Ft.
Width	Ft.	Width	Ft.
Surface Area	Sq. Ft.	Surface Area	Sq. Ft.
Surface Area	Acres	Surface Area	Acres
CAPACITY		CAPACITY	
Gal. Inch/Depth (avg.)	Gal.	Gal. Inch/Depth (avg.)	Gal.
Gal./Ft. Depth (avg.)	Gal.	Gal./Ft. Depth (avg.)	Gal.
Gal. Max. Depth	Gal.	Gal. Max. Depth	Gal.
Retention @ avg. flow	Days	Retention @ avg. flow	Days

OPERATIONS DATA		COMPLIANCE DATA			
Population Served		Monthly	Monthly Avg.	Weekly Avg.	
Avg. Daily Flow	MGD	B.O.D.	Mg/L	B.O.D.	Mg/L
Avg. Raw B.O.D.	P.P.M.	S.S.	Mg/L	S.S.	Mg/L
Avg. Raw S.S.	P.P.M.	F. Coliform	/Ml	F. Coliform	/Ml
Avg. lbs. B.O.D./D/Raw	lbs.	pH			
Avg. lbs. S.S./D/Raw	lbs.				

Figure 5

Module No	Topic. Stabilization Pond Geometry

Instructor Notes	Instructor Outline:

The surface area of lagoon cells is the first calculation to be mastered. Surface area is as the term states, the area of the surface of the lagoon, or the area of the liquid surface that is visible or exposed to the atmosphere. It is generally expressed in acres.

Figure 6 shows a lagoon that is 260' wide by 850' long. The maximum liquid depth is 5' and the slope of the side walls is 3:1, that is the wall from Point A on Sketch 1 for each 3' horizontal, it rises 1'.

The surface calculation is

260' x 850' = 221,000 square feet

One acre contains 43,560 square feet

Therefore, 221,000/43,560 = 5.07 acres

Figure 7 shows a two-cell lagoon. Each lagoon measures 265' by 370'. The maximum liquid depth is 5' and the slope is 4:1. It is important to calculate each cells surface area. The calculation of the area for each cell will be used in subsequent calculations. Total surface area is the sum of the areas of each cell.

Cell 1 surface area

265 x 370 - 98,050 square feet

98,050/43,560 = 2.25 acres

Cell 2 has identical dimensions; therefore,

Cell 2 surface area = 2.25 acres

Total surface area = 2.25 + 2.25 = 4.50 acres

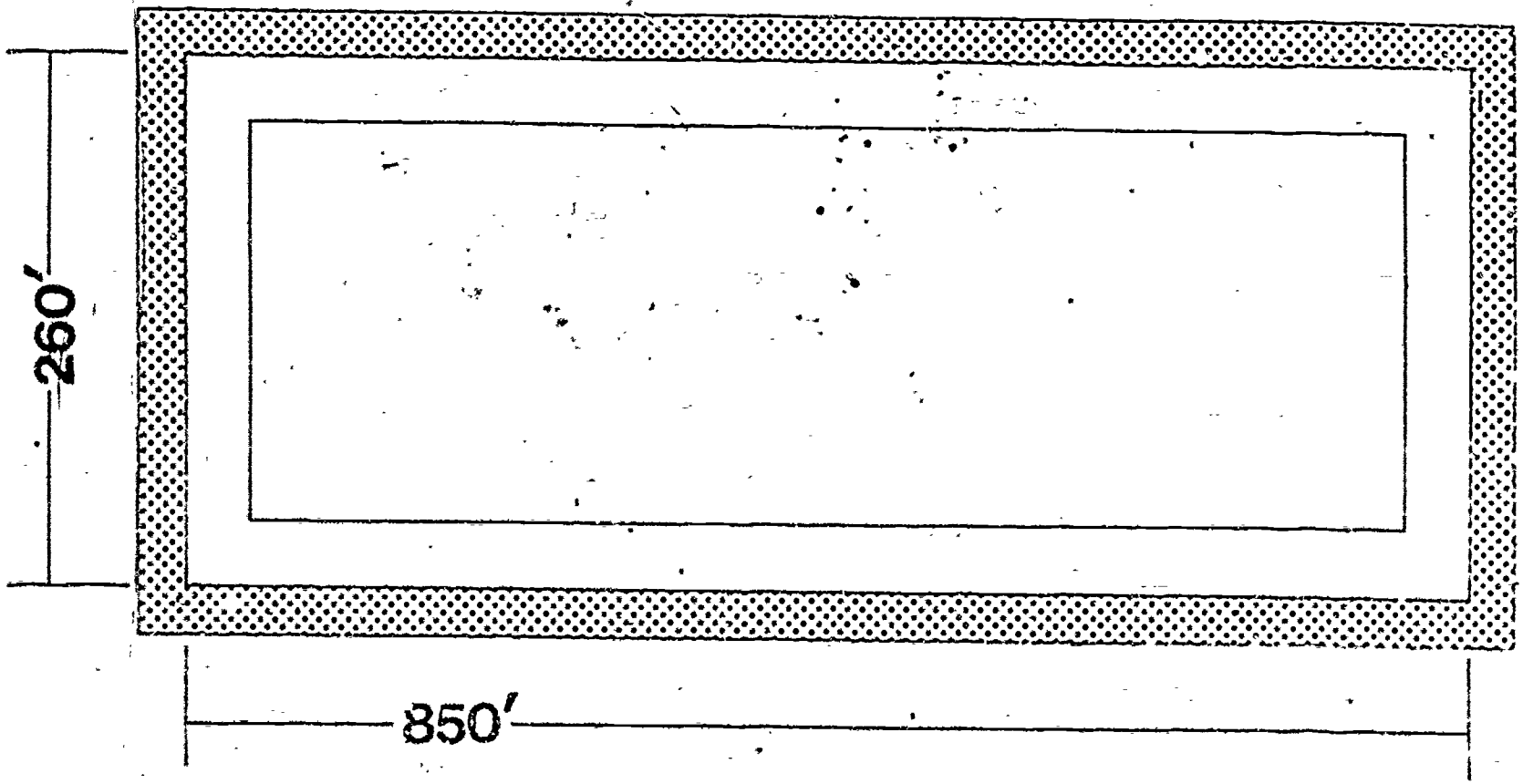

Figure 6

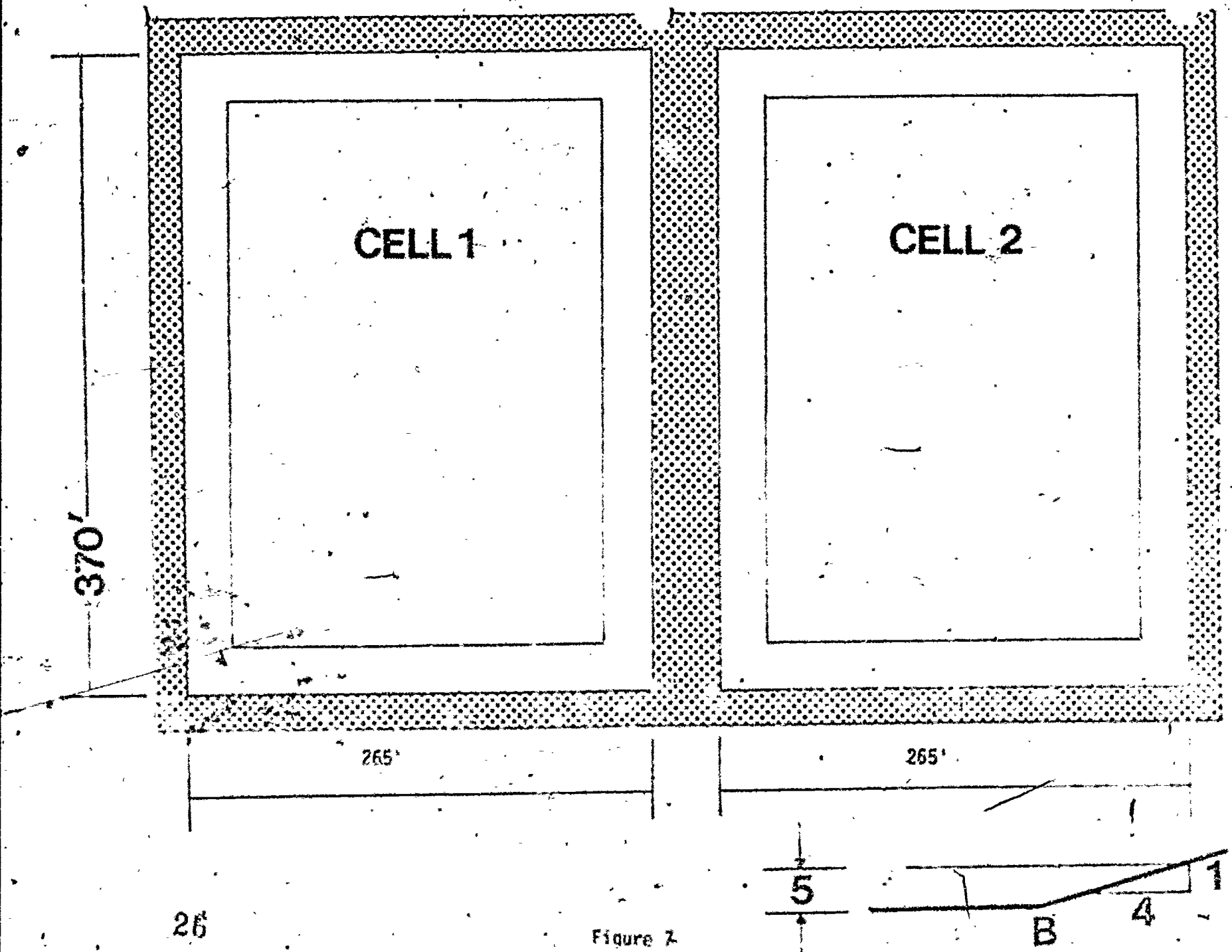

Figure 7

Module No:	Module Title: Waste Stabilization Ponds
	Submodule Title:
Approx. Time: ½ hour Day 1	Topic: Starting the New Pond

Objectives:

1. List one reason a spring or early summer start-up is favored.
2. Describe two reasons that pre-filling ponds is desirable.
3. List one reason that "seeding" a pond is not necessary.
4. Describe typical start-up symptoms, addressing color, pH and dissolved oxygen.

Instructional Aids:

Instructional Approach:

Lecture
Discussion

References:

1. Course Manual
2. WPCF MOP 11

Class Assignments:

Module No:	Topic: Starting the New Pond

Instructor Notes:	Instructor Outline:
1. Starting the new pond, Section C of the manual. The outline includes material from MOP 11.	I. Time of year A. Spring or early summer is best time as treatment will become established in a reasonable time with less potential for odors. B. Fall or winter start up will probably require storage until late spring as little treatment will be accomplished through the winter months. II. Filling the Pond A. Weeds and other vegetation should be removed. B. Fill to two foot level as fast as possible to minimize potential odor and to prevent luxuriant growth of rooted vegetation. C. Prefilling cell one with stream or lake water is desirable to confirm water tightness prior to the system receiving raw waste flow, also dilutes waste. D. In multicell systems fill first cell to two foot level plus enough to fill subsequent cell to a minimum two foot level. Then draw down cell one to two foot level. If three cell system refill cell one with flow above two foot level enough to fill cell three to a minimum two foot level. E. Seeding is not required. The organisms which are both desirable and necessary are available in the environment. The very earth from which the ponds have been constructed, the air, the waste flow itself.

Module No:	Topic: Starting the New Pond
Instructor Notes:	Instructor Outline:

F. Start up Symptoms

1. Color

As raw waste begins to flow into the cell for the first time a milky turbidity is not uncommon. If start up is during late spring or summer, within from two to four weeks the pond should begin to take on a greenish color as algae growth begins. If the milky color goes to a dark gray, overload conditions may exist and testing of pH, dissolved oxygen, and BOD as a minimum should be performed. Chemical addition may be required to add oxygen. A second cell (parallel flow) should be considered to reduce the surface organic loading if overload conditions are confirmed.

Similar color changes will occur each spring as the ice cover breaks up. The color at time of break up will usually be dark gray as the pond has been more in an anaerobic state through the period of ice cover.

2. pH

pH will fall below 7.0 during start up due to the production of CO_2 as a by product of the bacterial action and the production of volatile acids in the anaerobic zone. pH will also be depressed every spring again as a function of the greater portion of the pond being anaerobic during the period of ice cover.

3. Dissolved Oxygen (D.O.)

D.O. levels will also fall during start up. Oxygen is required in the aerobic zone for the microorganisms to convert the "food" into new cells and by-products. Oxygen becomes available at the surface of the pond and from algae, so until the algae

Module No: _	Topic: Starting the New Pond
Instructor Notes:	Instructor Outline:

3. Dissolved Oxygen (D.O.) Cont.

   growth is established, oxygen demand may potentially exceed oxygen available.

4. Other symptoms

   The operator should (must) begin documentation of symptoms, data, and just what is happening in the total system. The solutions to future problems that are inevitable lie in part in orderly data documenting what has occured. Trend charts are a useful tool and their use is encouraged.

Module No:	Module Title: Waste Stabilization Ponds
	Submodule Title:
Approx. Time: 2 hours Day 1	Topic: Operating Waste Stabilization Ponds

Objectives:

1. Calculate discharge rate as a function of change of pond depth.
2. Explain two methods for controlling scum.
3. List at least three conditions which can result in odor problems.

Instructional Aids:

Handout

Instructional Approach:

Lecture
Discussion

References:

1. WPCF MOP 11
2. Course Manual
3. Tent. Criteria

Class Assignments:

Module No:	Topic: Operating Waste Stabilization Ponds

Instructor Notes:	Instructor Outline:
Student handout 2 Should be read and discussed in class.	Student handout 2 details "Lagoon Operation" for controlled discharge type lagoons. This is taken from "Tentative Controlled Discharge Lagoon Criteria", IDEQ. Routine operation also generally includes the following: 1. Scum control Scum usually accumulates in the corners of the cells and can either be removed with a rake and buried or hosed until it breaks up and settles. 2. Odor control Odor control initially means identifying the source of the odor. Sources could be: A. Organic overload in which case the loading should be documented with appropriate laboratory analyses. Correction may require expansion, mechanical aeration, chemical additions or reducing the load coming in. B. Scum - Scum if not removed may generate an odor problem. Removal of the scum will remove the source of odor. C. Oxygen depletion - This could cause an odor problem resulting from organic overload mentioned in A or possibly some waste flow which is toxic to the microorganisms in the lagoon. Toxic waste flows would have to be determined by selective sampling of "unique" waste flow contributors. D. Flow short-circuiting - Dye studies would probably be necessary to confirm that a short-circuiting condition existed which could cause an odor problem. Baffling over the inlet might be appropriate to correct or at least minimize the short-circuit.

Module No:	Topic: Operating Waste Stabilization Ponds
Instructor Notes:	Instructor Outline:

E. Poor Housekeeping - This is probably the most common cause of odors and the most easily rectified. A routine preventive maintenance and clean-up schedule including:

Cleaning structures

Control of weeds

Hosing or raking shoreline for removal of dried algae or scums.

3. Flow Measurement

The operator is responsible for the reporting of daily flow into the lagoon system and discharge flow data.

4. Other Responsibility

Each lagoon system with a discharge permit has routine reporting requirements. The operator is responsible for completing these reports. The discharge permit might set additional testing or other data collection requirements. The operator should thoroughly review the discharge permit as these additional requirements would be his responsibility to ensure that the permit was complied with.

Student Handout 2

Lagoon Operation

1. In general, controlled discharge type lagoons shall be operated to discharge twice a year with such discharges occurring during the spring and the fall. Whenever possible, the discharges should be made during high stream flow periods.

2. Prior to discharge the cell (s) to be discharged shall be isolated for a minimum of one week and the isolation shall be maintained during the discharge period.

3. After at least one week of isolation, analyses shall be performed for BOD_5, suspended solids, ammonia nitrogen, fecal coliform, pH and DO.

4. Effluent discharge can be initiated if the analyses demonstrate that the water quality meets the effluent limitations in the state operation permit and can be continued as long as the quality is suitable. Samples of the discharge shall be collected and analyzed as specified in the monitoring requirements of the state operation permit.

5. If the water quality is not suitable for discharge, the isolation of the cell (s) shall be continued for a longer period until additional analyses demonstrate a suitable quality. If necessary, the water quality may be improved by the broadcast application of a coagulant and/or disinfectant.

From "Tentative Criteria"

Module No:	Topic: Operating Waste Stabilization Ponds

Instructor Notes	Instructor Outline:

One of the main functions of the lagoon operator is to control liquid depth. A lagoon which is allowed to remain at less than three foot may develop heavy weed growth. If the lagoon is allowed to remain full too long, the operator has no reserve capacity. This requires that the operator have knowledge of his lagoon's capacity and the flow coming into the lagoon. Knowledge of flow includes not only the average flow but variations in flow. For example, if there is an infiltration problem in the sewer system, how much does the flow increase during and after rainfall. Another possibilility is seasonal variations in flow. It is the operator's responsibility to document and retain such flow data. Flow data should be displayed graphically. The graph can then include notes which document rainfall, ice cover, dates of drawdown etc. A well maintained graph becomes an excellent tool for the conscientious operator.

Surface area calculation should have now been mastered. The next calculation to be addressed is that of lagoon volume. Page D 2 of the Course Manual has an example of the calculation. Figure 6 will now be used for practice in volume calculations.

Surface area = 221,000 square feet.

221,000 x 1 = 221,000 cubic feet per foot of depth.

There are approximately 7.5 gallons per cubic foot.

221,000 x 7.5 = 1,657,500 gallons per foot of depth.

1,657,000/12 = 138,125 gallons per inch of depth.

With this calculation the operator can calculate reserve capacity. Assume that the flow into this lagoon is 85,000 gallons per day. If the depth of the lagoon is 4 feet 3 inches, how many days reserve capacity remain in the lagoon? (We will assume no losses.)

Module No:	Topic: Operating Waste Stabilization Ponds
Instructor Notes:	Instructor Outline:

We have calculated the number of gallons per inch in the lagoon. The maximum depth for this lagoon is 5 feet. So 9 inches of lagoon remain to be filled.

9 inches x 138,125 gallons per inch = 1,243,125 gallons

1,243,125/85,000 = 14.6 days

We can now also calculate drawdown (discharge) rates. Many lagoons are limited in their allowed rate of drawdown. They are not allowed simply to open a valve and discharge as fast as the flow will come out. Assume that the maximum allowable discharge rate is 700,000 gallons per day. The calculation procedure is similar. How many inches will the lagoon go down if 700,000 gallons are discharged?

700,000 gal./138,125 gal. per inch = 5 inches

But, this is a one cell lagoon. The lagoon is receiving 80,000 gallons per day. We have to take this into account.

80,000/138,125 = 0.6 inches

You must remember then that if figuring drawdown you have to take into account the volume of flow going into the lagoon. In multiple cell systems, it is generally not included. One usually tries not to have any flow going into a cell that is being drawn down.

There is one other calculation the operator should routinely make. That is to check the "per capita flow" coming into the lagoon. This is important even if the operator is fortunate enough to have some type of automatic flow recording device. Why? Automatic recording flow devices can be wrong. A typical lagoon might have a flow of 100 gallons per capita per day. This may range from 50 to 200 dependent on the community (such things as industry, high infiltration may make this number vary.)

Module No:	Topic: Operating Waste Stabilization Ponds
Instructor Notes:	Instructor Outline:

An example: Assume a community of 1,100 people has a lagoon. The flow into the lagoon averages 80,000 gallons per day. What is the per-capita flow?

80,000 gal. per day/1,100 people (capita) =

72.7 gallons per capita per day

Module No:	Module Title: Waste Stabilization Ponds
	Submodule Title:
Approx. Time: 1 hour Day 1	Topic: Operating Problems and Solutions

Objectives:

1. List the three types of plant growths that occur at pond sites and two control methods.
2. List at least four situations that can result in oxygen depletion at the pond site and possible solutions for each.
3. Describe the difference between beneficial and pointless rip rapping of inner slopes.
4. Identify the area of the pond site which is the primary "battleground" for both weed control and insect control.
5. List two methods (approved) for muskrat control.

Instructional Aids:

Handout

Instructional Approach:

Lecture
Discussion

References:

1. Course Manual
2. WPCF MOP 11

Class Assignments:

Module No	Topic. Operating Problems and Solutions

Instructor Notes	Instructor Outline:
1. From Manual Section E 2. Student handout 3 contains additional "problem-solution" information. 3. Stress that the battle-ground for weed and insect control is at water's edge.	I. Weeds and grasses A. May be catagorized as those which: 1. Float 2. Emerge in shallows 3. Thrive at water's edge B. Control 1. Starts the day the ponds are filled 2. Maintaining a minimum depth of at least 2 - 3 feet 3. Manual labor required 4. Rip rap - not boulders II. Insects A. Mosquitoes 1. The culex is associated with encephalitis 2. Control of plant growth is a part of mosquito control as it removes harborage or attachment sites 3. Slopes should never be allowed to develop water "pockets" 4. Insecticides i) Should not be used indiscrimanately or without approval ii) Appropriate safety measures should be taken prior to use iii) Durban (1 mg/l) iv) Nales (1 mg/l) v) Fenthion (1 mg/l) vi) Abate (1mg/l) vii) Diesel oil (6 - 8 gal/acre) viii) Malathion (2% sprayed around edge)

Module No	Topic: Operating Problems and Solutions
Instructor Notes	Instructor Outline:

ix) Abate (2% sprayed around edge)

x) BHC (dust, 3% gamma isomer)

B. Midges

Insecticides for control include:

1. Fenthion (as directed on package)
2. Abate (as directed on package)
3. Sursban (as directed on package)

III. Oxygen Depletion

1. Possible causes include:

   a. Organic overload
   b. Algae bloom
   c. Excess pond depth
   d. High water temperature
   e. Winter freezing
   f. Toxic wastes

2. Potential solutions include

   a. Identify source of increased organic load or toxic flow
   b. Algae control
   c. Reduced operating levels
   d. Use of chemicals to add oxygen or mechanical aerators

IV. Rodents

1. Burrowing animals can damage dikes.

2. Riprap will discourage burrowing

3. State game warden should be contacted for assistance and/or advice as to how to remove them.

ODORS

A. Spring turnover

1. Cause

a. Inevitable. If pond has been ice covered, it has turned anaerobic.

b. Will be of short duration (3-30 days).

2. Correction

a. If no problems are created, take no action.

b. Add supplemental air - sodium nitrate, mechanical or diffused air. (Can be done from the back of a motorboat.)

Sodium Nitrate 100#/AC for 3 days, the

50#/AC for 7 days

B. Extended cloudy weather - not too common a problem

1. Correction

a. No action if problems aren't created - It will take care of itself.

b. Add supplemental air - Sodium nitrate, mechanical or diffused air.

c. Use masking agent

C. Overload or discharge of toxic wastes

1. Cause

a. Industrial accident, seasonal load, process change. This is the most common source of odor problems.

2. Effect

a. Color change usually to a dull green, gray or black.

3. Correction
   a. Find and eliminate source of overload
   b. Activate emergency plan
   c. Add supplemental air - Sodium nitrate, diffused or mechanical aeration.
   d. Recirculation may help.
   e. Chlorinate influent - May do more harm than good.
   f. Use masking agent

D. Condition of raw water
   1. Cause
      a. High sulfates 500 mg/l
      b. Highly saline or brackish water
   2. Correction
      a. Add supplemental air
      b. Chlorinate influent
         (Lagoons are not well suited to this situation)

E. Scum rafts - blue-green algae
   1. Cause
      a. When mowing cuttings may blow into pond.
      b. Dead vegetation
      c. Grease or other improperly pre-treated organic solids.
   2. Effect
      a. Blue-greens may result in offensive decaying odor.
      b. Rafts may harbor botulism organisms causing toxins to be discharging to stream with resulting fish kill.

3. Correction

a. Break-up outboard motor; high pressure hose.

b. Remove - rake, floating boom.

c. Dredge to reduce bottom sludges.

F. Explosive growth of various organisms

1. Cause

a. Daphnia or other zooplankton.

b. Shrimp-like organisms.

c. Chironomid midges.

2. Effects

a. Low D.O. due to consumption by organisms.

b. Algae populations may be depleted.

c. Nuisance from emerging flies spreading to immediate neighborhood.

3. Correction

a. No action if no problems are caused - usually will run its course and take care of itself.

b. Natural elevation of pH may eliminate zooplankton if they become too prevalent.

c. Shrimp-like organisms - dibrom-8 has been used.

d. Midges - insecticides - Parathion, abate, sursban, fenthion. Check with local authorities before using.

G. Acid fermentation

1. Cause

a. Start-up

b. Too much mixing or recirculation.

c. Multiple points of influent discharge spread sludge out too thin.

2. Effects

   a. Lowering pH.

   b. Discharge of unstable organics.

3. Correction

   a. Seed lagoon

   b. Change to single inlet to allow sludge buildup and stable anaerobic digestion.

WEEDS, VEGETATION

A. Aquatic (roots in water)

1. Cause

a. Pond too shallow.

b. Invasion from shore--particularly pondweed.

c. Too slow to fill.

2. Effects

a. Insect harborage

b. Blocks sunlight penetration

c. May cause odors

d. Inhibit reaeration and circulation

3. Correction - keep 3 feet of water in ponds

a. Herbicides - triazine effective (clear with authorities).

b. Cattails - must be dug out.

c. Wade and remove by hand.

d. Drain and remove.

e. Use herbicide prior to filling.

Ureabor (U.S. Borax), Televar or Karmex (DuPont)

f. Fill rapidly from nearby stream

g. Fill first pond then discharge 2 feet to second pond and divide flows to both.

h. Eliminate shallow or sheltered areas (i.e. less than 3 feet

B. Terrestrial

1. Cause

a. Improper preparation and seeding of dikes

b. Inadequate mowing

c. Poor maintenance of water line area

2. Effects

a. Mosquito harborage at waterline

b. Blowing cuttings collect on pond surface

c. Leakage caused by deep rooted plants and grasses

d. Inhibit reaeration and circulation is overhanging pond

3. Correction

a. Don't plant alfalfa, reed canary or other long-rooted grasses

b. Spot kill weeds with herbicide

c. Apply herbicide to an area 1 foot above and 1 foot below normal waterline to prevent problem with mowing at waterline

Module No:	Module Title: Waste Stabilization Ponds
	Submodule Title:
Approx. Time: ½ hour Day 1	Topic: Chemical Additions for Improved Performance

Objectives:

1. List the reason each of the following chemicals might be added to a stabilization pond:

   a. Sodium nitrate
   b. Copper sulfate
   c. Potassium permanganate
   d. Alum
   e. Polymers
   f. Ferrous sulfate
   g. Calcium hydroxide

Instructional Aids:

Handout

Instructional Approach:

Lecture
Discussion

References:

MOP 11

Class Assignments:

Read Section F

Module No:	Topic: Chemical Additions for Improved Performance

Instructor Notes:	Instructor Outline:
These materials taken directly from the manual It should be emphasized that prior to any chemical addition the Regional DEC office should be notified. Chemicals should only be used judiciously as they generally are only treatment of symptoms, not solving the problem.	A. Sodium Nitrate ($NaNO_3$) 1. Common name is saltpeter 2. Used for odor control, more directly to add oxygen to compensate for organic overload or at spring "ice break up" time. 3. Recommended dosage 100 pounds per acre of pond surface 4. Irritating to skin and/or nose membranes. B. Copper Sulfate ($CuSO_4$) 1. Used for algae control 2. Recommended dosage not more than four pounds per acre. 3. Toxic to aquatic organisms in addition to algae. 4. Should only be used as "last resort". C. Potassium Permanganate ($KMnO_4$). 1. Used for algae control. 2. Recommended dosage four to six pounds per acre at three foot depth. 3. Most effective when mixed with heavy accumulations of algae scum. D. Aluminum Sulfate ($Al_2(SO_4)_3$) 1. Common name is alum or filter alum. 2. Recommended dosage 160 pounds per acre at three foot depth. 3. Used for control of suspended solids prior to discharge from a pond.

Module No:	Topic: Chemical Additions for Improved Performance
Instructor Notes:	Instructor Outline:

E. Polyelectmlytes (Polymers)

1. Used for suspended solids control.
2. Dosage must be determined by jar tests.

F. Ferrous Sulfate ($FeSO_4$)

1. Common name is copperas
2. Used for suspended solids control.
3. Dosage must be determined by jar tests (range generally 5 - 10 ppm).

G. Calcium Hydroxide ($Ca(OH)_2$)

1. Common name is slaked lime.
2. Used for suspended solids control and as a "buffer".
3. Dosage must be determined by jar tests.
4. May be combined with alum at a ratio of 9 parts lime to 1 part alum.

Module No:	Module Title: Waste Stabilization Ponds
	Submodule Title:
Approx. Time: 4 hours Day 2	Topic: Site Evaluation

Objectives:

1. To visit a lagoon site
2. To collect sufficient data to evaluate
   a. Detention time
   b. Organic load
   c. Operational problems

Instructional Aids:

1. Polaroid camera
2. Operational data from host site

Instructional Approach:

References:

Class Assignments:

Complete Form A-2 for site visit and bring completed form to third session of workshop.

Module No:	Topic: Site Evaluation

Instructor Notes	Instructor Outline:
The second day of the workshop should begin with a stabilization pond site visit. The instructor should prepare the student for the visit with instructions to obtain all necessary data to "evaluate" the site visited. The instructor should obtain prior approval from the pond operator to share with the students all data to perform the evaluation. This would include: Pond dimensions Flow data Lab data Control capability Operator comments on problems he has and hasn't solved. A polaroid camera should be taken to the site. Additional Figure A-2 sheets should be provided by the instructor. There should be a brief discussion of the site visit upon return to the classroom. Instruct attendees to complete Form A-2 and bring to third session.	

Module No:	Module Title: Waste Stabilization Ponds
	Submodule Title:
Approx. Time: 1 hour Day 2	Topic: Maintenance Procedures

Objectives:

1. Given problem situation (e.g. wet well full, pump motor will not start) dealing with pumps, list possible causes.
2. Differentiate between gate valves and plug valves.
3. List at least three checks to perform on a mercury switch which is not operating.

Instructional Aids:

Instructional Approach:

Lecture
Discussion

References:

Course Manual; Section G

Class Assignments:

Read Section G

Module No	Topic Maintenance Procedures

Instructor Notes	Instructor Outline
From Manual Section G Page G 3 needs further explanation. The sentence following "A full wet well will exert more..." should read "a liquid depth of 8 feet will exert 3.47 pounds per square inch". One cubic foot of water weighs 62.4 lbs. A column of water 1 inch square and 1 foot deep weighs .434 lbs. (62.4/144 = .434). So the .434 is really .434 lbs/ft. of depth/square inch. Now for any depth of water in feet, that depth times .434 gives the pressure in pounds per square inch, psi. The Manual Section G should be used in class. It includes trouble shooting guide, schematics etc. Stress SAFETY and buddy system in performing these tasks.	I. Maintenance areas include A. Lift station 1. Pumps 2. Pump controls B. Gates C. Valves D. Mercury switches E. Slopes of ponds II. Maintenance schedule should be a part of routine operation. III. Manufacturers bulletins on maintenance, trouble shooting, and safety should be adhered to.

Module No:	Module Title: Waste Stabilization Ponds
	Submodule Title:
Approx. Time: 3 hours Day 2 3 hours Day 3	Topic: Routine Operation

Objectives:

1. Explain two reasons for sampling and testing.
2. List at least three analyses which serve to alert the operator to pond status or impending trouble.
3. Calculate organic load.
4. Calculate detention time.
5. Describe series, parallel and fill and draw operation.

Instructional Aids:

Instructional Approach:

Lecture
Discussion
In-class problem solutions

References:

Class Assignments:

Module No:	Topic: Routine Operation

Instructor Notes	Instructor Outline:
Routine operation is broken into two catagories: 1) Systems with three cells and 180 day detention time. 2) Systems not designed for 180 day detention time (Pre 1975). Before the second catagory is discussed additional calculation procedures are introduced as "routine" operation of the shorter detention systems can be somewhat more demanding of operator control.	I. Three cell, 180 day detention time, controlled discharge. A. Twice a year discharge with the fall discharge in late fall to early winter to allow for the spring thaw plus at least one month (preferably more) of "warm" weather to "finish treatment" prior to the late spring discharge. The operator should record the decrease in temperatures of the cells and relate pond characteristics to temperature each year as this data will assist him in learning how late in the year storage is possible with relative "good" treatment. Document also the temperature of the cells through the ice break up in the spring of the year. Record appearance and appropriate data (color, temp., pH, DO as a minimum) and note the return of algae growth to the cells. This will then assist the operator in future years to be able to program discharge in both fall and spring. The required analyses for discharge, BOD, solids, pH, ammonia, etc., as required by the discharge permit then confirm the level of treatment accomplished and suitability for discharge. B. Briefly go over once more Page 4 of "Tentative Controlled Discharge Lagoon Criteria"
Study Guide contains problem solutions for organic load and detention time.	II. Organic Load (lbs. BOD/acre) lbs. BOD/acre = $\frac{\text{Flow (MGD)} \times \text{BOD (mg/l)} \times 8.34}{\text{Surface Area (Acres)}}$ Note: The surface area used is that of the primary cell in series flow, area of two cells if the flow is being fed in parallel.

Module No.	Topic: Routine Operation

Instructor Notes	Instructor Outline:
Emphasize that consistency is the key factor for detention time calculations. Slope correction is a fine thing but unnecessary for operational control. However, be consistent - if slope correction is used continue to use it or vice versa.	III. Detention Time (Days) Total Detention Time (Days) = $\frac{\text{Total Volume of Ponds (Gallons)}}{\text{Average Daily Flow (Gallons/day)}}$ Individual cell detention time (Days) = $\frac{\text{Cell Volume (Gallons)}}{\text{Average Daily Flow into Cell (Gallons/Day)}}$ IV. Systems with less than 180 day detention time (This includes many of the one, two and even some of the older three cell systems). The operator of this type system faces an important task. It is possible that although hydraulic detention time might be less than 180 days, the organic load might be low enough to allow for discharge requirements to be met. The older systems were generally designed for a maximum operating depth of five feet. The potential for possible relatively inexpensive modification to control structures could enable operating the primary cell at a six foot depth. Operating at depths as shown in the "Tentative Controlled Discharge...", should be considered. Of extreme importance is documentation of existing flows, waste strength, loads and detention times. Fall drawdown should occur as late as possible to maximize available storage through the winter months. Pond levels should be closely monitored as a function of flow with the operator checking remaining capacity $\frac{\text{Volume of cells remaining (Gal)}}{\text{Average Flow (Gal/Day}}$ Pond quality should also be closely monitored. Chemical additions may be required in order for discharge quality to be attained.

Module No.	Topic: Routine Operation
Instructor Notes	Instructor Outline:

An operator in this situation should also be looking at the total system for the potential of reducing flow. Possibilities might include:

1. Sections of sewers with excessive infiltration which could be repaired.

2. Customers (light or heavy industry for example) who might be able to reduce waste flow through conscientious use of water. A wash down rack with possibly a one inch line left running between wash operations could well be shut off.

Community awareness and conservation of water can easily reduce waste flow. The operator could very well take a lead roll in community education. Communities faced with water shortages have easily been reducing water usage which in turn results in reduced waste flow.

Module No:	Topic: Routine Operation
Instructor Notes:	Instructor Outline:

Routine operation includes sampling, analysis, and additional calculations for evaluating the lagoons.

Care must be exercised in collecting samples. It is the sample from which analyses are run. These results are then reported on required reports and used to evaluate lagoon performance.

There are two types of samples - grab and composite.

Grab samples are simply a sample taken and then analyzed. The operator should note from where the sample was taken, the time of day, and the date.

Example: Raw wastewater Distribution Box 1
2:00 p.m. 8-13-77

Composite samples are really a collection of grab samples that are collected over a period of time and at measured volumes.

Discharge permits usually state what type of samples are required for given analyses. The operator should check with the appropriate regulatory agency if he has any questions as to what his sampling requirements are.

Section I addresses "Evaluating Pond Performance". The Section lists some of the typical analyses that are run at lagoon facilities.

Surface area and volume calculations should have been mastered by this time. Organic loading and detention time calculations now are to be practiced.

The detention time calculation requires only the total volume of the lagoon and the average daily flow. Correcting the lagoon dimensions for the slope gives a more exact answer, but in reality the slope correction can be ignored if you realize that the true volume is somewhat less than the volume calculated if slope correction is not made.

Module No:	Topic: Routine Operation

Instructor Notes:	Instructor Outline:

Return to Figure 6. If the lagoon is operating at 5 feet and the average flow into the lagoon is 70,000 gallons per day, what is the average detention time?

250 x 850 x 5 = 1,105,000 cubic feet.

1,105,000 x 7.5 = 8,287,500 gallons.

8,287,500/70,000 = 118 days.

The detention time if we make slope corrections:

250 - 15 = 245 feet (See Page I 23)

850 - 15 = 835 feet

245 x 835 x 5 = 1,022,875 cubic feet

1,022,875 x 7.5 = 7,671,562 gallons

7,671,562/70,000 = 110 days

The difference of 8 days only suggests a need for the operator to be consistent. If slope correction is used, always use it.

The next calculation is for organic loading. Tent. Criteria states BOD loading to a primary cell of a 2 cell system should be 25 pounds BOD per acre per day. The lagoon from Figure 6 has an average daily flow of 70,000 gallons per day. We'll assume there is a second cell. The raw wastewater BOD is 200 ppm. What is the organic load? First look at the example problem on the bottom of Page 15. Notice that the flow must be expressed in million gallons per day. The solution is:

0.070 x 8.34 x 200 = 117 pounds BOD per day

117/5 = 23 pounds BOD per acre per day.

More and more lagoon systems are being designed with two or more cells. There remains one important topic to be addressed. That is "Mode of Operation"

Module No.	Topic: Routine Operation
Instructor Notes:	Instructor Outline:

(series or parallel operation). Figure 8 shows the flow schematic for a two-cell lagoon. In series operation all flow enters the first cell and then into the second cell. In parallel operation the flow is distributed between the two cells. How does one determine if the system should be operated in series or in parallel? In fact there are circumstances when parallel operation is more appropriat

Using the lagoon system diagrammed in Figure 7, consider the following:

Surface Area (acres), Cell 1 - 2.25, Cell 2 - 2.25, Total - 4.50

Volume (gallons), Cell 1 - 3,676,875, Cell 2 - 3,676,875, Total - 7,353,750

Average daily raw wastewater flow = 45,000 gal. per day.

Average raw wastewater BOD = 120 ppm (mg/l).

First calculate the raw wastewater load (pounds BOD per day).

0.045 x 8.34 x 120 = 45 pounds BOD per day.

If the lagoons are operated in series, what is the organic load on the first cell?

45/2.25 = 20 pounds BOD per acre per day.

Now recall that during the summer months treatment accomplished is at a maximum due to more hours of sunlight. This results in more algae growth. This results in higher dissolved oxygen levels. This results in more oxygen available for organisms to utilize as they "eat". This means that a single cell can be loaded while the second cell can be allowed to be isolated. The second cell is tested periodically until it can be drawn down. After drawdown, the second cell is then fed raw wastewater and the first cell is then isolated and tested until it is suitable for discharge. This is fill and draw operation. Now during the winter months,

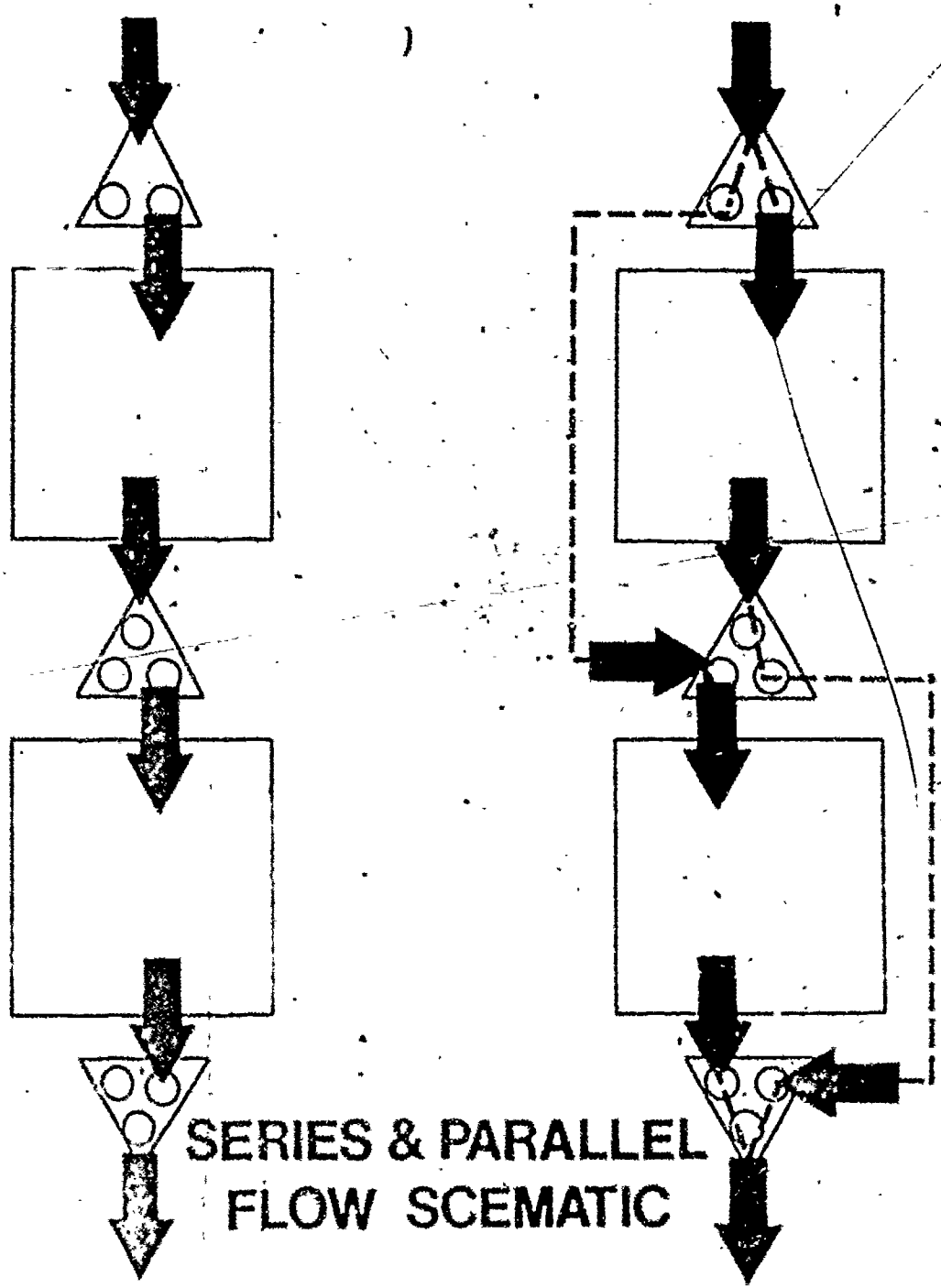

Figure 8

Module No.	Topic.
	Routine Operation

Instructor Notes.	Instructor Outline:
	biological activity is reduced. But consider the loading if the operator operates the lagoons in parallel. 0.045 x 8.34 x 120 = 45 pounds BOD per acre per day. 45/4.5 = 10 pounds BOD per acre per day. The raw load is fed equally to both cells resulting in a reduction in the organic load to each cell. Through the winter months this parallel mode could prevent organic overload which could result in an odor problem, for example. Then when the spring thaw occurs, one cell can be closed and allowed to stand with no additional "food" being added until it's suitable for discharge. During this time the other cell takes all of the waste flow. The operator must be able to determine his reserve capacity. He then will know how long the isolated cell can be allowed to stand before he "runs out of space".

Module No:	Module Title: Waste Stabilization Ponds
	Submodule Title: Safety
Approx. Time: 1 hour Day 3	Topic:

Objectives:

1. List two reasons why pond sites should be securely fenced.
2. List at least ten possible hazards to the pond operator.

Instructional Aids:

Handouts

Instructional Approach:

Lecture
Discussion

References:

Class Assignments.

Module No.	Topic: Safety

Instructor Notes.	Instructor Outline:

The addendum from the Minnesota Pollution Control Authority Lagoon Manual should be gone over in class.

There is in addition a two page addendum listing "High Risk Activities" and "Sources of Danger". This too should be gone over in class.

Stress that the operator should review his total operation for relative hazards and risk activities. Become "safety conscious".

Final Note:

A ten page packet is included which deals with flow measurement. These include:

1. 90° v-notch weir table
2. Rectangular weir table
3. An approximate method of determining stream flow by using a float. This is not an exact determination but does give a reasonable approximation. This should not be done alone or in treacherous streams.

This packet is with the course manual and may or may not be discussed at the instructors discretion.

The following pages are included from which student handouts may be duplicated and transparencies produced:

Figure 1 - Typical 2-cell lagoon layout

Figure 2 - Typical 3-cell lagoon layout

Figure 3 - Typical 3-cell lagoon layout (divided primary)

Figure 4 - Waste Stabilization Pond Schematic

Figure 5 - Plant Data Sheet

Figure 6 - One cell lagoon

Figure 7 - Two cell lagoon

Figure 8 - Series and parallel flow schematic

Student Handout 1 - One Page

Student Handout 2 - One Page

Student Handout 3 - Six Pages

Student Handout 4 - Two Pages

[illegible]

Provide for 180 days storage above 2 ft. liquid level in both cells - based upon design average flow.

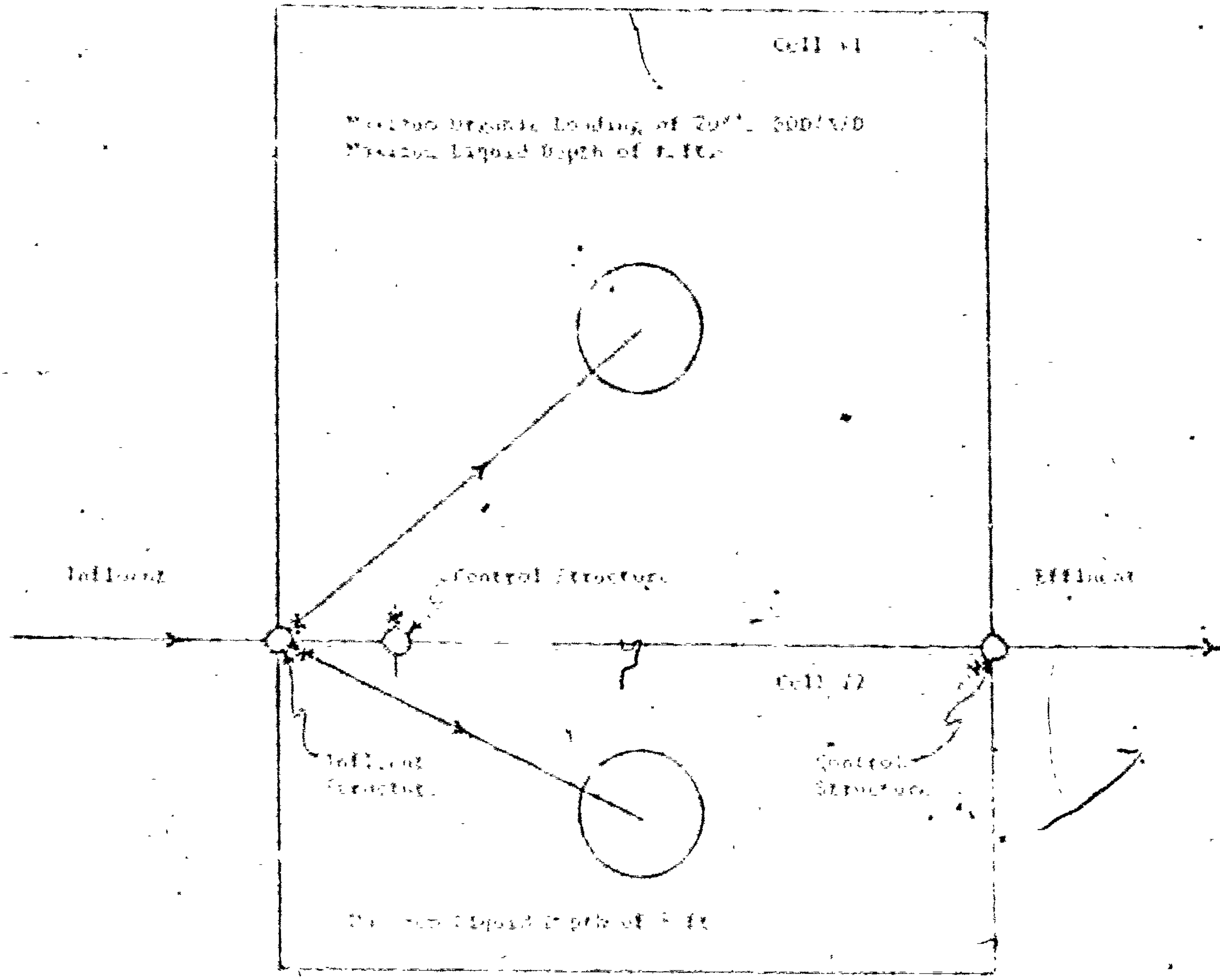

Figure 1

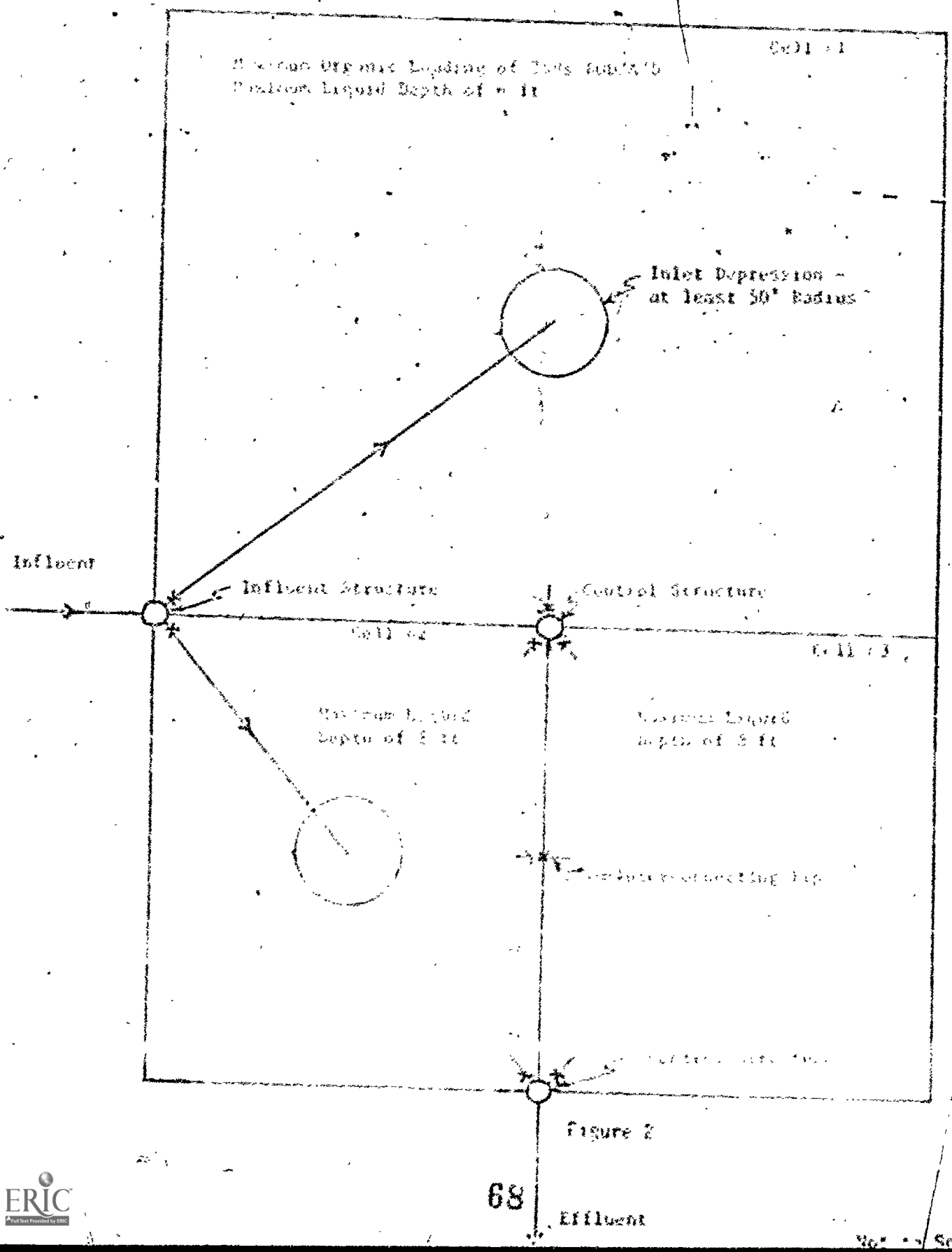
Inlet Depression -
at least 50' Radius
Influent
Influent Structure
Control Structure
Effluent

Figure 2

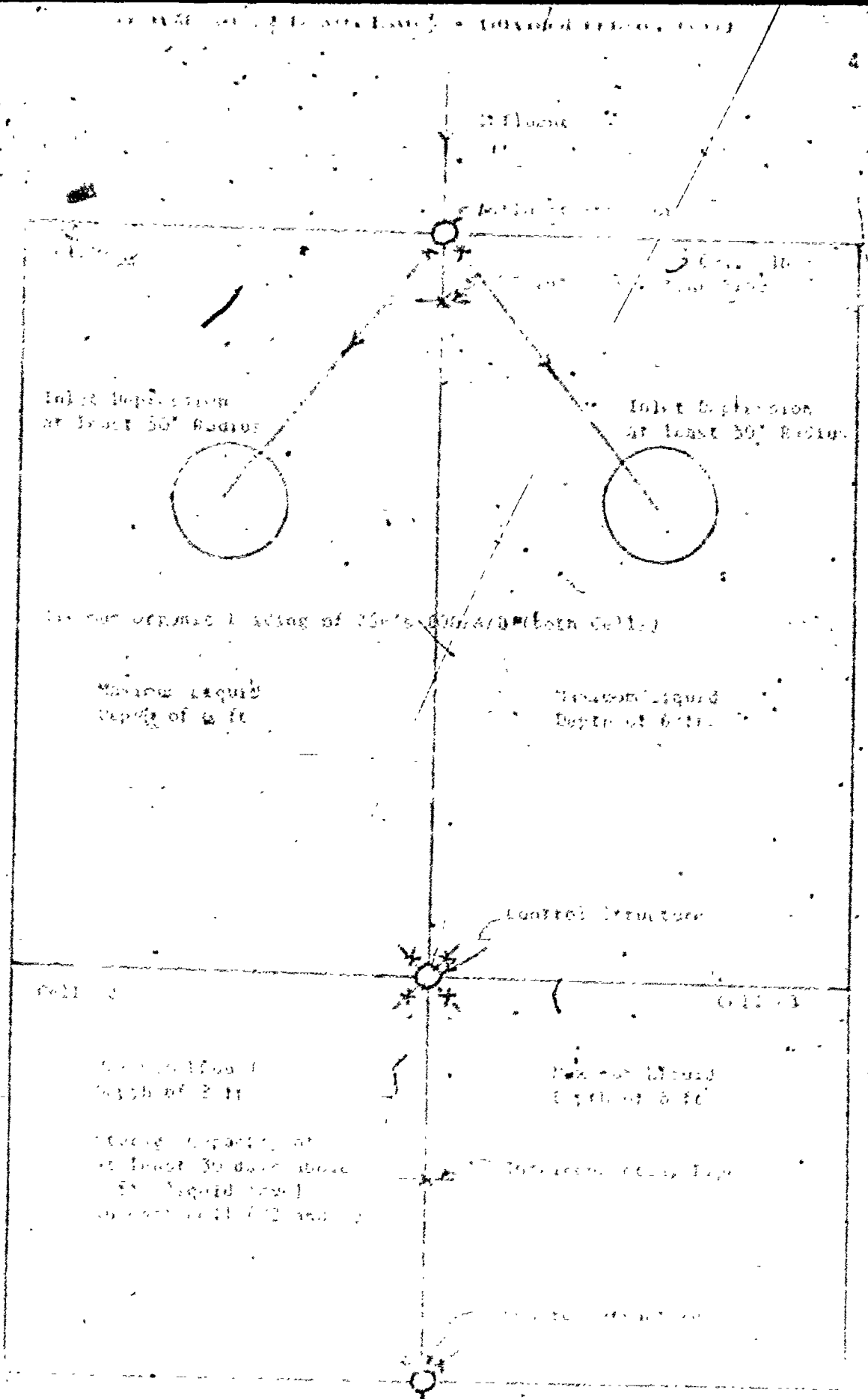

Figure 3

Schematic

WASTE STABILIZATION POND

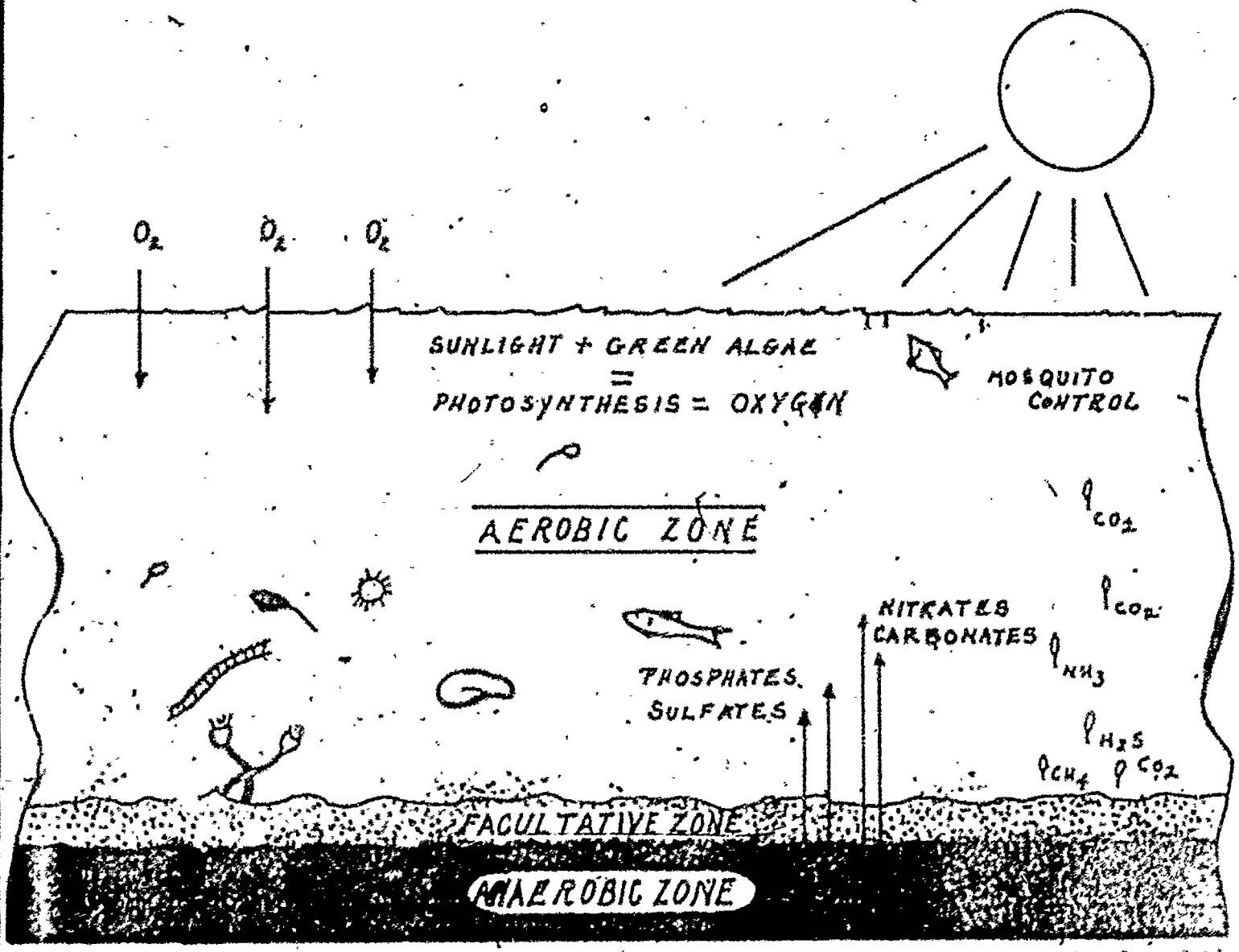

Figure 4

PLANT DATA SHEET

Waste Stabilization System

Pond No. 1		Pond No. 2	
DIMENSIONS		DIMENSIONS	
*Length	Ft.	*Length	Ft.
Width	Ft.	Width	Ft.
Surface Area	Sq. Ft.	Surface Area	Sq. Ft.
Surface Area	Acres	Surface Area	Acres
CAPACITY		CAPACITY	
Gal. Inch/Depth (avg.)	Gal.	Gal. Inch/Depth (avg.)	Gal.
Gal./Ft. Depth (avg.)	Gal.	Gal./Ft. Depth (avg.)	Gal.
Gal. Max. Depth	Gal.	Gal. Max. Depth	Gal.
Retention @ avg. flow	Days	Retention @ avg. flow	Days

OPERATIONS DATA		COMPLIANCE DATA			
Population Served		Monthly	Monthly Avg.	Weekly	Avg.
Avg. Daily Flow	MGD	B.O.D.	Mg/l	B.O.D.	Mg/l
Avg. Raw B.O.D.	P.P.M.	S.S.	Mg/l	S.S.	Mg/l
Avg. Raw S.S.	P.P.M.	F. Coliform	/Ml	F. Coliform	/Ml
Avg. lbs. B.O.D./D/Raw	lbs.	pH			
Avg. lbs. S.S./D/Raw	lbs.				

Figure 5

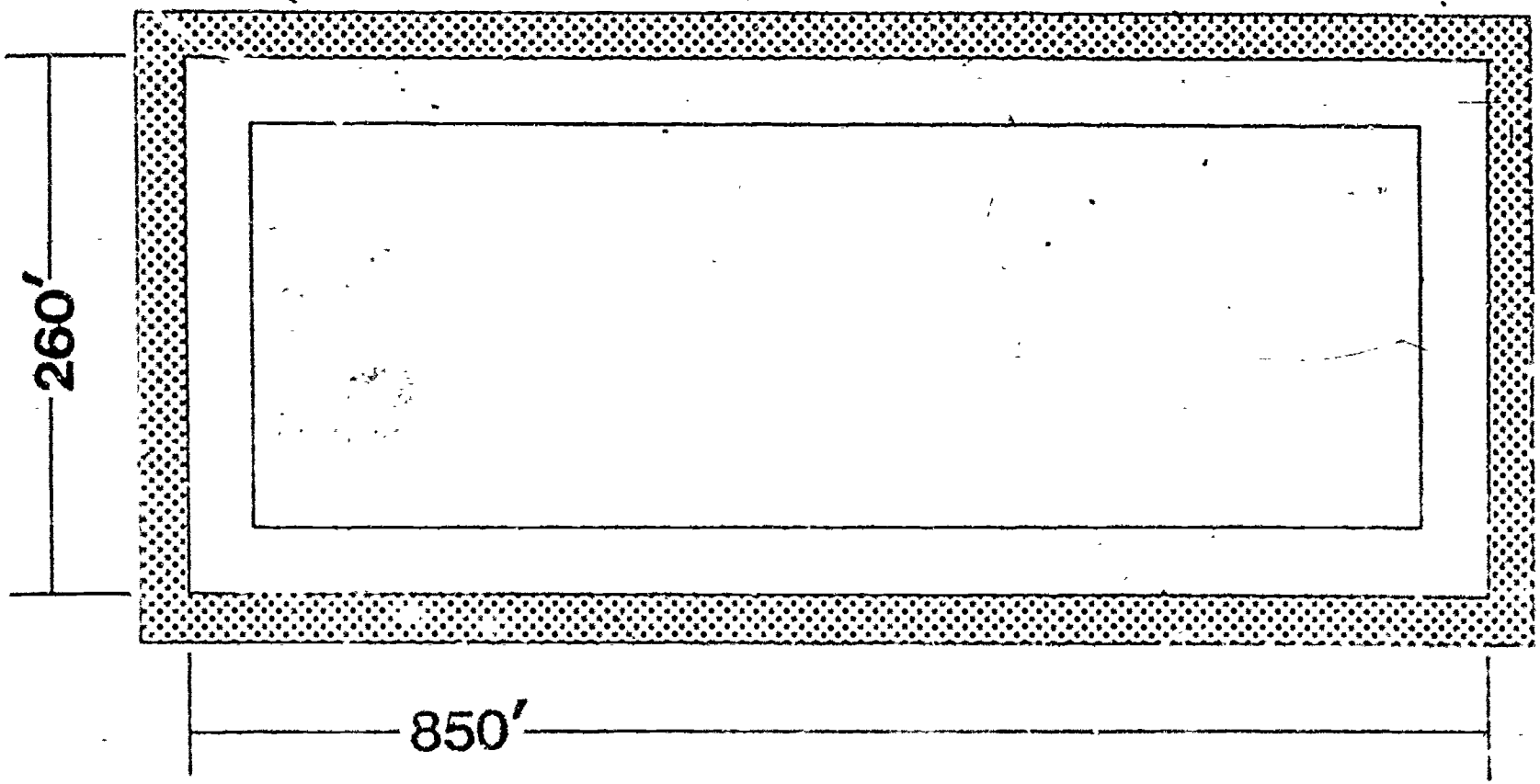

Figure 6

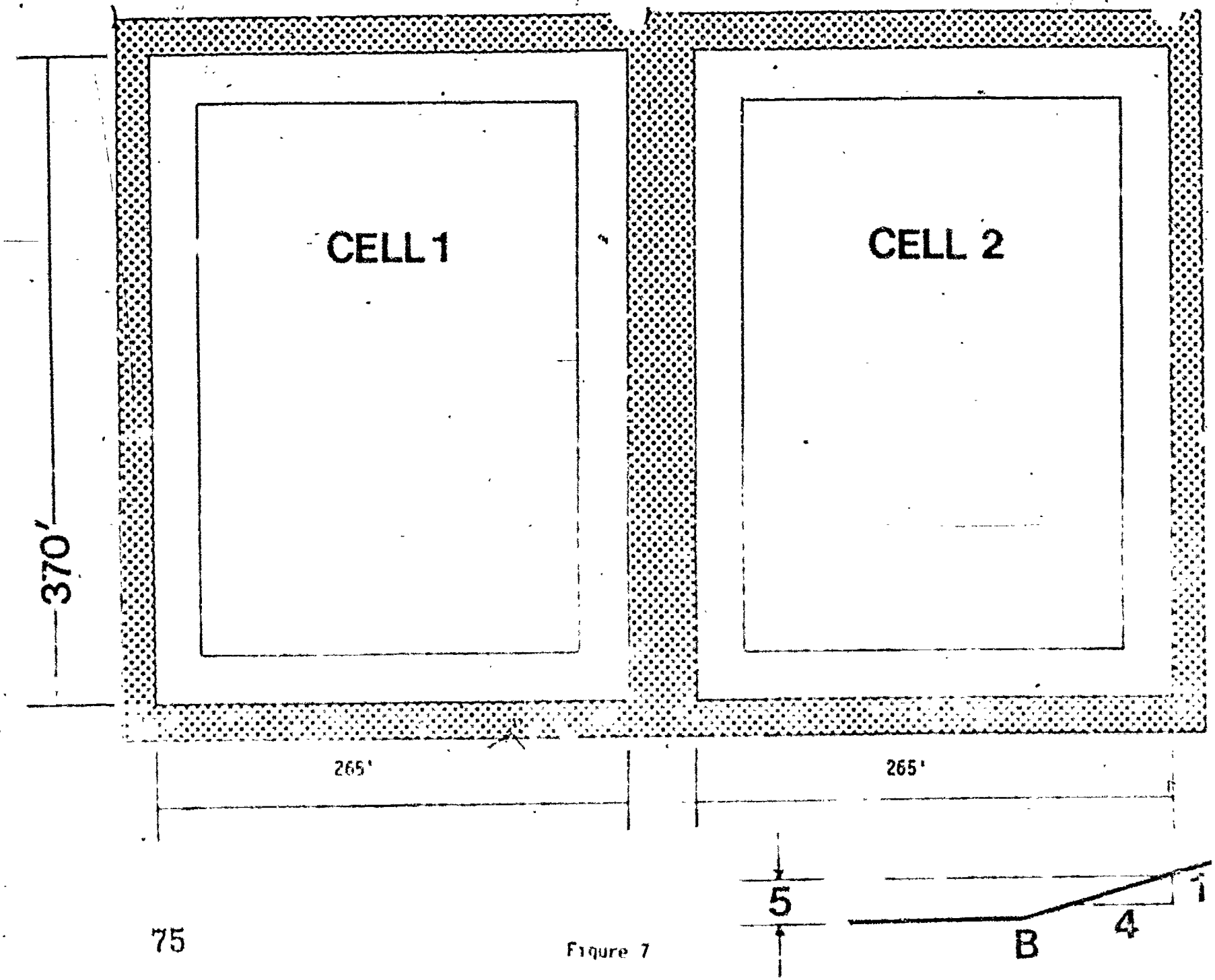

Figure 7

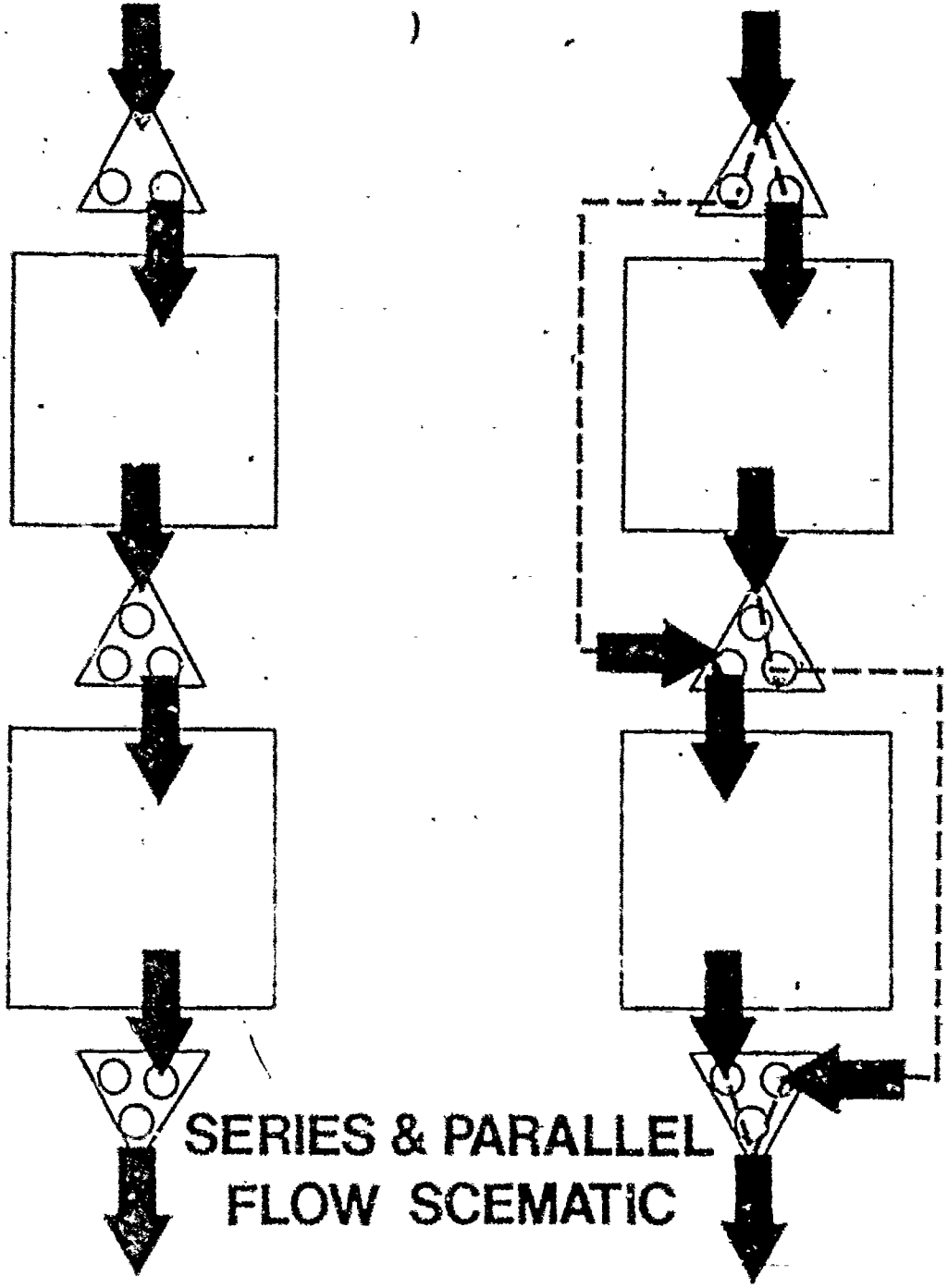

Figure 8

Student Handout 1

Design Loadings

100 gal./cap/day

0.17 lbs. BOD_5/cap/day

Small municipalities add 20 gal/cap/day and .05 lbs. BOD_5/cap/day for out of town school students.

Lagoon Design

3 cells for controlled discharge systems

2 cells for very small installations

Hydraulic Detention

6 months above the 2 foot liquid level

Organic Loading

25 pounds BOD/acre/day maximum on primary cell of 3 cell system

20 pounds BOD/acre/day maximum on primary cell of 2 cell system

Liquid Depths

6 foot maximum in first cell

8 foot maximum in subsequent cells

Student Handout 2

[illegible] Operation

1. In general, controlled discharge type lagoons shall be operated to discharge twice a year with such discharges occurring during the spring and the fall. Where ever possible, the discharge should be made during high stream flow periods.

2. Prior to discharge the cell (s) to be discharged shall be isolated for a minimum of one week and the isolation shall be maintained during the discharge period.

3. After at least one week of isolation, analyses shall be performed for BOD$_5$, suspended solids, ammonia nitrogen, fecal coliform, pH and DO.

4. Effluent discharge can be initiated if the analyses demonstrate that the water quality meets the effluent limitations in the State operation permit and can be continued as long as the quality is suitable. Samples of the discharge shall be collected and analyzed as specified in the monitoring requirements of the State operation permit.

5. If the water quality is not suitable for discharge, the isolation of the cell (s) shall be continued for a longer period until additional analyses demonstrate a suitable quality. If necessary, the water quality may be improved by the broadcast application of a recognized algal disinfectant.

From "Tentative Criteria"

ODORS

A. Spring turnover

1. Cause

a. Inevitable. If pond has been ice covered, it has turned anaerobic

b. Will be of short duration (3-30 days)

2. Correction

a. If no problems are created, take no action.

b. Add supplemental air - sodium nitrate, mechanical or diffused air (Can be done from the back of a motorboat.)

Sodium Nitrate 100#/AC for 3 days, the

50#/AC for 7 days

B. Extended cloudy weather - not too common a problem

1. Correction

a. No action if problems aren't created - It will take care of itself.

b. Add supplemental air - Sodium nitrate, mechanical or diffused air.

c. Use a baking agent

C. Overload or discharge of toxic wastes

1. Cause

a. Industrial accident, seasonal load, process change This is the most common source of odor problems.

2. Effect

a. Color change usually to a dull green, gray, or black.

3. Correction

a. Find and eliminate source of overload

b. Activate emergency plan

c. Add supplemental air - Sodium nitrate, diffused or mechanical aeration.

d. Recirculation may help.

e. Chlorinate influent - May do more harm than good.

f. Use packing agent

D. Condition of sea water

1. Cause

a. High sulfates 500 mg/l

b. Highly saline or brackish water

2. Correction

a. Add supplemental air

b. Chlorinate influent

(Lagoons are not well suited to this situation)

E. Sea rafts - blue-green algae

1. Cause

a. When mowing cuttings may blow into pond.

b. Dead vegetation

c. Grease or other improperly pre-treated organic solids.

2. Effect

a. Blue-green rafts may result in offensive decaying odor.

b. Rafts of tumor colonies of organisms causing toxins to be discharging to stream with resulting fish kill

3. Correction

a. Break-up outboard motor, high pressure nose.

b. Remove - rake, floating boom.

c. Dredge to reduce bottom sludges.

F. Explosive growth of various organisms

1. Cause

a. Daphnia or other zooplankton.

b. Shrimp-like organisms.

c. Chironomid midges.

2. Effects

a. Low D.O. due to consumption by organisms.

b. Algae populations may be depleted.

c. Nuisance from emerging flies spreading to immediate neighborhood.

3. Correction

a. No action if no problems are caused - usually will run its course and take care of itself.

b Natural elevation of pH may eliminate zooplankton if they become too prevalent.

c Shrimp-like organisms - dibrom-8 has been used.

d. Midges - insecticides - Parathion, abate, Sumithion, fenthion. Check with local authorities before using.

G. Acid fermentation

1. Cause

a. Start-up

b. Too much mixing or recirculation.

c. Multiple points of influent discharge spread sludge out too thin.

2. Effects

   a. Lowering pH.

   b. Discharge of unstable organics.

3. Correction

   a. Seed lagoon

   b. Change to single inlet to allow sludge buildup and stable anaerobic digestion.

WEEDS, VEGETATION

A. Aquatic (roots in water)

1. Cause

a. Pond too shallow.

b. Invasion from shore--particularly pondweed.

c. Too slow to fill

2. Effects

a. Insect harborage

b. Blocks sunlight penetration

c. May cause odors

d. Inhibit reaeration and circulation

3. Correction - keep 3 feet of water in ponds

a. Herbicides - triazine effective (clear with authorities).

b. Cattails - must be dug out.

c. Wade and remove by hand.

d. Drain and remove.

e. Use herbicide prior to filling.

Dredge (U.S. Borax), Televar or Farmer (Cyprex)

f. Fill rapidly from nearby stream

g. Fill first pond then discharge 2 feet to second pond and divide flows between

h. Eliminate shallow or sheltered areas less than 3 feet

B. Terrestrial

1. Cause

a. Improper preparation and seeding of dikes

b. Inadequate mowing

c. Poor maintenance of water line area

2. Effects

a. Mosquito harborage at waterline

b Blowing cuttings collect on pond surface

c. Leakage caused by deep rooted plants and grasses

d. Inhibit reaeration and circulation in overhanging pond

3. Correction

a. Don't plant alfalfa, reed canary or other long-rooted grasses

b. Spot kill weeds with herbicide

c. Apply herbicide to an area 1 foot above and 1 foot below normal waterline to prevent problem with mowing at waterline

Student Handout 4-1

STABILIZATION POND OPERATION

High-risk activities

- Removing debris from channels
- Removing debris from pond
- Removing vegetation next to electrical wire
- Working in boat
- Working with switches in automatic position

Sources of danger

- Acid wastes
- Boat and motor
- Caustic wastes
- Muck holes
- Contamination by contact
- Electrical equipment
- Electrical wires in damp areas
- Herbicides
- Holes in fence
- Moving parts
- Open doors and covers
- Pesticides
- Short circuits
- Slippery walks
- Soil sterilizers
- Toxic gases
- Undercut banks
- Underground control panel

Student Handout 4-2

- Wells
- Wet grass
- Wet rocks

Safety equipment

- Adequate lighting
- Barricades
- Enclosed electrical wires
- Fences
- Fire-fighting equipment
- First-aid kit
- Life preserver
- Lockout tags and keys
- Locks
- Protective clothing
- Railings
- Safety equipment in boat
- Signs

Module No:	Module Title:
	Waste Stabilization Ponds
	Submodule Title:
Approx. Time:	
	EVALUATION

Objectives:

The student will demonstrate that he has achieved the objectives of this module by answering 75% of the following questions:

Circle the correct answer in multiple choice questions.

1. The design hydraulic loading for lagoons shall be at least _____.

   A. 50 gal./cap/day

   B. 100 gal./cap/day

   C. 120 gal./cap/day

   D. 200 gal./residence

2. The design organic loading for lagoons shall be at least _____.

   A. 100 mg/l BOD_5

   B. 200 mg/l BOD_5

   C. 0.17 pounds BOD_5/cap/day

   D. 0.05 pounds BOD_5/cap/day

3. The minimum number of cells for controlled discharge lagoons is

   A 1

   B. 3

   C. 5

   D. No minimum number required

4. The design hydraulic detention time for lagoon systems is

   A 6 months

   B. 12 months

   C. 60 days

   D. 120 days

5. The maximum loading on primary cells of 3 cell systems should be _____ and on 2 cell systems _____.

   A. 200 mg/l 100 mg/l

   B. 0.17 pounds BOD . 0.05 pounds BOD

   C. 35 lbs. BOD/acre per day 35 lbs. BOD/acre per day

   D. 25 lbs. BOD/acre per day 20 lbs. BOD/acre per day

6. The maximum depth allowed in primary cells is _____.

   A. 6 feet

   B. 8 feet

   C. 2 feet

   D. No limit

7. The maximum depth allowed in cells following primary cells is _____.

   A. 6 feet

   B. 8 feet

   C. . feet

   D. No limit

8. List the three zones of treatment in a non-aerated lagoon.

9. List two ways oxygen becomes available to the aerobic zone of a lagoon.

10. List two "ingredients" necessary for algae to produce oxyge

11. From where do fecal coliforms originate?

12. True or False. The presence of an indicator organism indicates the lagoon system is operating.

13. One cell of a lagoon system has as its length 850 feet and its width 450 feet. The cell contains _____ acres (43,560 sq. ft./acre).

    A. 4.4 acres

    B. 44 acres

    C. 8.8 acres

    D. 88 acres

14. List one reason for starting a pond in the spring or early summer.

15. List two reasons pre-filling a pond is desirable.

16. Give a reason that "pond seeding" is generally not required.

17. Describe a typical lagoon start up. In your description address color, pH, and dissolved oxygen.

18. A cell has been sampled and the contents have been confirmed as suitable for discharge. The cell is now to have a volume of 80,000 gal./inch. The discharge permit allows this facility to discharge at a rate not to exceed 600,000 gal/day. How many inches of the cell contents may be discharged each day in order not to violate the permit requirements? _____

19. List two methods for controlling scum.

_____ _____

_____

20. List three situations which could cause an odor problem at the lagoon site.

_____ _____

_____

21. List the three types (catagories) of plant growths that occur at lagoon pond sites and two control methods.

_____ _____

_____ _____

_____

22. Match the problem situation with an appropriate operator action. There may be more than one appropriate action.

_____	A.	Organic overload	A. No action
_____	B.	Algae bloom	B. Identify source
_____	C.	Weeds growing on pond bottom	C. Careful addition of chemicals with approval
_____	D.	High waste flow temperature	D. Increase operating depth of cell
_____	E.	Ice cover on cell	E. Document in operator log box
_____	F.	Toxic waste	

23. A section of the interstate highway is being removed. The steel reinforced concrete is being removed in tions that are generally 8 inches thick and about 3 feet square. would this be good riprap for a lagoon's inner slopes? _____

If not, why not? _____

24. Where is the primary "battleground" for both weed control and insect control? _____

25. What are two approved methods for control of burrowing rodents?

_____

_____

26 Match the names of chemicals to the problem statement that the chemical might assist in overcoming. More than one chemical might be used for a given problem.

___A.	Odor from Cell as ice cover is breaking up	A. Alum
___B.	Excessive algae growth	B. Calcium Hydroxide
___C.	Suspended solids are not within discharge permit limitation	C Copper Sulfate
___D.	Change in pH of raw wastewater changes cell pH	D. Ferrous Sulfate
		E. Polymers
		F. Potassium Permanganate
		G Sodium Nitrate

27. A _____ valve used in lagoon applications, control structures, for example, has a tendency to sieze in the position at which its SLT unless periodically moved. Movement of the valve is generally a raising or lowering action.

A. Gate

B. Plug

28. A _____ valve is also subject to seizing if not routinely moved. The movement of the valve is generally horizontal 90 degrees from closed to full open.

A. Gate

B. Plug

29. True or False. A mercury switch is not operating. Any one of the following conditions could be the cause:

Lead wire broken

Loose terminal connecting screws

Bulb has shifted in its mounting clip

Power failure

30. Match the following:

___	A. Wet well full, pump motor will not start	A	Float stuck in high position
___	B Wet well full, pump running, no discharge	B.	Repack according to manufacturer's instructions
___	C Wet well empty, pump running	C	Pump air-locked
___	D. Pump pumping, vibrating and shuddering	D	Breaker tripped
___	E. Packing gland leaking excessively	E.	Loose coupling or bearing failure

31. List two reasons an operator collects and analyses samples from lagoons.

_____

_____

32. List three analyses (tests) which serve to alert the operator to pond status or impending trouble

33. List two reasons why lagoon sites should be securely fenced.

34. List ten potential hazards the lagoon operator should be able to recognize

35. A three cell lagoon facility has the following dimensions

Cell 1 500' x 600' Depth 6'

Cell 2 350' x 350' Depth 7'

Cell 3 350' x 350' Depth 7'

Raw BOD_5 = 145 mg/l

Raw flow = 140,000 gal/day

Calculate the following

	Surface Area	Volume
Cell 1	_____ acres	_____ Gal
Cell 2	_____ acres	_____ Gal
Cell 3	_____ acres	_____ Gal

Detention time _____ days.

Organic load on Cell, I _____ lbs. BOD/acre/day

36. Describe series, parallel, and full and draw operation of a two cell lagoon system. Use words and/or diagrams.

Module No:	Topic: EVALUATION
Instructor Notes:	Instructor Outline:

1. B
2. C
3. B
4. A
5. D
6. A
7. B
8. Aerobic

   Facultative

   Anaerobic
9. From the atmosphere at the surface
10. Sunlight

    Carbon dioxide
11. Bowel of warm blooded animals
12. False
13. C
14. There is less potential for odor as treatment will become established in a reasonable time.
15. Confirms water tightness

    Dilutes waste strength

    Minimizes opportunity for rooted vegetation to get started

Module No:	Topic: — EVALUATION
Instructor Notes:	Instructor Outline:

16. The organisms that are necessary exist naturally in the environment.

17. Color - milky turbidity to green pH - Less than 7.0 then climbs back to 7.0 - 8.0 range.

    D.O. - will be low until algae becomes established.

18. 7½ inches

19. Breaking it up with a hose, scraping it from surface with a rake.

20. Organic overload

    Scum

    Oxygen depletion

    Flow short-circuiting

    Poor housekeeping

21. Those that float.

    Those that emerge in shallow water

    Those that thrive at water's edge

    Maintain a minimum depth 2 - 3 feet

    Manual removal

    Rip rap

    Herbicides

Module No:	Topic: EVALUATION
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22. A. B, E

B. A or C

C. D

D. B, E

E. A, E

F. B, E

23. Probably not

Steel rods sticking out would make weed control difficult and dangerous. If the chunks were just dumped there would be large void spaces.

Allowing water to pond and result in an insect problem and potentially an odor problem.

24. The edge of water (inner slope)

25. Riprap

Trapping (with game warden approval)

Other means as directed by game warden

26. A. G

B. C, F

C. A, B, D, E

D. B

27. A

28. B

29. True

Module No:	Topic: EVALUATION
Instructor Notes:	Instructor Outline:

30. A. D
    B. C
    C. A
    D. E
    E. B

31. Evaluate lagoon performance and to complete required discharge reports

32. Dissolved oxygen
    pH
    Temperature
    Solids

33. To keep out people
    To keep out livestock

34. Check against student handout

35. Surface area
    Cell 1 6.9 acres
    Cell 2 & 3 2.8 acres
    Volume
    Cell 1 13,464,000 gal.
    Cell 2 & 3 6,414,100 gal.
    Detention time 188 days
    Organic load 24.5 lbs. BOD/acre/day

SECTION I

PUBLIC HEALTH ASPECTS

I-1 PUBLIC HEALTH ASPECTS

STABILIZATION PONDS, LIKE OTHER WASTEWATER TREATMENT FACILITIES, MUST BE TREATED WITH CAUTION AND RESPECT FROM A SAFETY AND PUBLIC HEALTH STANDPOINT BY OPERATORS AND THE GENERAL PUBLIC ALIKE. THIS MEANS THAT STABILIZATION PONDS MUST BE UTILIZED FOR THEIR DESIGNED PURPOSE ONLY, AND NOT FOR PUBLIC RECREATION.

THE RELATIVE AREA OF WATER SURFACE OF STABILIZATION PONDS IS INSIGNIFICANT IN COMPARISON TO THE MANY NATURAL BODIES OF OPEN WATER IN MOST AREAS. IN SOME AREAS, HOWEVER, STABILIZATION PONDS REPRESENT THE ONLY SIZEABLE AREA OF OPEN WATER AND HAVE BEEN SOURCES OF ATTRACTION TO CHILDREN AS WELL AS ADULTS FOR RECREATION PURPOSES. INCIDENTS OF BOATING, ICE-SKATING, EXTENSIVE WATERFOWL HUNTING AND EVEN SWIMMING IN PONDS HAVE BEEN REPORTED. THIS RECREATIONAL USE MUST BE DISCOURAGED AND SAFETY PRACTICES ENCOURAGED FOR SEVERAL IMPORTANT REASONS.

FIRST, EVEN THOUGH THE EFFICIENCY OF BACTERIAL REMOVAL AS MEASURED BY THE MPN METHOD IS VERY HIGH, THE POSSIBILITY OF CONTAMINATION OR INFECTION FROM PATHOGENIC ORGANISMS DOES EXIST WHEN ONE COMES IN CONTACT WITH WASTEWATER IN A STABILIZATION POND.

SECOND, ALTHOUGH MOST STABILIZATION PONDS ATTAIN A DEPTH OF ONLY FIVE FEET, THERE IS STILL SUFFICIENT DEPTH TO DROWN A PERSON. ALSO, THE CLAY LINER USED IN SEALING THE POND BECOMES VERY STICKY WHEN WATER IS ADDED. SHOULD ANYONE FALL IN THE POND, THIS CLAY LINER WOULD MAKE IT EXTREMELY DIFFICULT FOR ANYONE TO GET OUT.

ONE NATURAL FACTOR WHICH DISCOURAGES THE USE OF STABILIZATION PONDS FOR RECREATIONAL PURPOSES IS THE MOSQUIT; HOWEVER, ON A WELL MAINTAINED POND SYSTEM, MOSQUITOES USUALLY DO NOT CAUSE ANY NUISANCE.

ACCORDING TO STUDIES MADE BY THE U. S. PUBLIC HEALTH SERVICE, THE DENSITY OF MOSQUITO POPULATION IS DIRECTLY PROPORTIONAL TO THE EXTENT OF WEED GROWTH IN THE PONDS. WHERE WEED BROWTH IN THE PONDS AND ALONG THE WATER LINE OF THE DIKES IS NEGLIGIBLE AND WHERE WIND ACTION ON THE POND IS NOT UNDULY RESTRICTED, THE PRODUCTION OF MOSQUITOES IN STABILIZATION PONDS IS OF LITTLE CONSEQUENCE.

I-2 PERSONAL HYGIENE

IT IS IN THE INTEREST OF YOUR HEALTH AND THE HEALTH OF YOUR FAMILY THAT THIS LIST OF DO'S AND DON'TS FOR PERSONAL HYGIENE IS MADE. USE, IT DON'T ABUSE IT!

1. NEVER EAT YOUR LUNCH OR PUT ANYTHING INTO YOUR MOUTH WITHOUT FIRST WASHING YOUR HANDS.

2. REFRAIN FROM SMOKING WHILE WORKING IN TANKS, ON PUMPS, TRUCKS, FILTERS ETC. REMEMBER, YOU INHALE OR INGEST THE FILTH THAT COLLECTS ON THE CIGARETTE FROM DIRTY HANDS. SAVE YOUR SMOKING TIME FOR LUNCH HOURS OR AT HOME.

3. A GOOD POLICY IS NEVER PUT YOUR HANDS ABOVE YOUR COLLAR WHEN WORKING ON ANY PLANT EQUIPMENT.

4. DON'T WEAR YOUR WORK COVERALLS OR RUBBER BOOTS TO THE DINING AREA.

5. ALWAYS WEAR YOUR RUBBER BOOTS WHEN WORKING IN TANKS, AROUND SLUDGE, WASHING DOWN ETC. DON'T WEAR YOUR STREET SHOES.

6. KEEP YOUR STREET SHOES IN YOUR LOCKER, REMEMBER THAT WHAT YOUR SHOES PICK UP AT THE PLANT THEY WILL LEAVE ON THE FLOOR OF YOUR HOME.

7. DON'T WEAR YOUR COVERALLS OR RUBBER BOOTS IN YOUR CAR OR HOME.

8. ALWAYS CLEAN ANY EQUIPMENT SUCH AS SAFETY BELTS, HARNESS, FACE MASKS, GLOVES, ETC., AFTER USING. YOU OR SOMEONE MAY WANT TO USE IT AGAIN.

9. HAVE A COMPLETE CHANGE OF CLOTHING TO WEAR WHEN GOING HOME.

10. ALWAYS WEAR RUBBER OR PLASTIC COATED GLOVES WHEN CLEANING OUT PUMPS, HANDLING HOSES OR WHEN WORKING ANYWHERE AROUND THE PLANT.

11. AVOID PUTTING ON WORK GLOVES WHEN YOUR HANDS ARE DIRTY - WASH FIRST.

12. WASH WITH PLENTY OF WATER OR TAKE A SHOWER IMMEDIATELY AFTER BEING SPLASHED WITH SLUDGE OR ANY CHEMICAL - DON'T DELAY.

13. DON'T JUST WASH YOUR HANDS BEFORE GOING HOME, WASH YOUR FACE THOROUGHLY TOO.

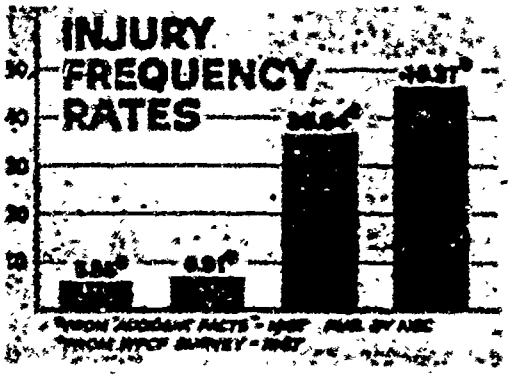
14. WEAR A HARD HAT WHEN WORKING AROUND MANHOLES OR LIFT STATIONS.

15. KEEP YOUR FINGERNAILS CUT SHORT AND CLEAN AS THEY ARE EXCELLENT CARRYING PLACES FOR DIRT AND GERMS.

I-3 SAFETY

THIS MANUAL WOULD NOT BE COMPLETE UNLESS SOMETHING WAS SAID ABOUT SAFETY.

THE WASTEWATER AND POLLUTION CONTROL INDUSTRY HAS THE HIGHEST EMPLOYEE ACCIDENT RATE OF ALL INDUSTRIES IN THE UNITED STATES. A 1967 WATER POLLUTION CONTROL FEDERATION SURVEY SHOWED THAT WASTEWATER SYSTEMS HAD AN INJURY RATE NEARLY EIGHT TIMES THAT OF THE GAS UTILITY INDUSTRY WHICH HAS MOST OF THE SAME HAZARDS. THE INJURY RATE FOR WASTEWATER SYSTEMS WAS OVER SIX AND ONE-HALF TIMES THAT OF THE AVERAGE INDUSTRY, AND NEARLY 25 PERCENT MORE THAN THAT OF THE VERY WORST AMONG THE INDUSTRIES REPORTING TO THE NATIONAL SAFETY COUNCIL !



WE WILL ATTEMPT TO BRIEFLY OUTLINE SOME IMPORTANT SAFETY RULES WHICH SHOULD BE FOLLOWED BY A WASTEWATER TREATMENT FACILITY OPERATOR.

A. SEWER MAINTENANCE SAFETY PRECAUTIONS.

1. REMOVE AND REPLACE HEAVY MANHOLE COVERS CAREFUULY AND ONLY WITH THE PROPER TOOLS. AFTER REMOVAL, LAY THE COVER FLAT ON THE GROUND AT LEAST TWO FEET AWAY FROM THE OPEN MANHOLE.
2. DESCEND INTO ANY MANHOLE CAUTIOUSLY TO GUARD AGAINST SLIPPERY, LOOSE, CORRODED, BROKEN OR OTHERWISE DEFECTIVE STEPS OR RUNGS. REMEDY SUCH DEFECTS IMMEDIATELY, TOGETHER WITH ANY CRACKS OR BREAKS IN THE MANHOLE WALL.
3. WEAR AN APPROVED TESTED SAFETY BELT WITH ATTACHED LIFELINE WHEN ENTERING A SEWER DEEPER THAN 8 FEET. AT LEAST TWO MEN SHOULD STAND BY OUTSIDE THE MAN-

HOLE TO HANDLE THE LIFELINE IN CASE OF EMERGENCY. EXTRA LENGTHS OF ROPE MUST BE READILY AVAILABLE.

4. ASSIGN A TRAINED PERSON TO SUPERVISE THE CLEANING AND MAINTENANCE OF SEWERS AND ALERT ALL OTHER PERSONNEL TO POSSIBLE HAZARDS AND TO PRECAUTIONS AGAINST THEM.

5. ERECT BARRICADES AND SIGNS AT A SUITABLE DISTANCE FROM OPEN MANHOLES TO ALERT TRAFFIC COMING FROM ANY DIRECTION THAT MEN ARE AT WORK.

B. PUMPING STATION AND STABILIZATION POND SAFETY PRECAUTIONS.

1. MAINTAIN A HIGH LEVEL OF GOOD HOUSEKEEPING. THIS INVOLVES KEEPING FLOORS, WALLS AND EQUIPMENT FREE FROM DIRT, GREASE AND DEBRIS. KEEP TOOLS PROPERLY STORED WHEN NOT IN USE. MAKE MINOR REPAIRS TO STRUCTURES AND APPURTENANCES IMMEDIATELY TO AVOID FURTHER DAMAGE AND POSSIBLE ACCIDENTS.

2. KEEP WALKWAYS CLEAN AND FREE FROM SLIPPERY SUBSTANCES. IF ICE FORMS ON WALKS, APPLY SALT OR SAND OR COVER WITH EARTH OR ASHES THAT CAN BE REMOVED LATER.

3. BE ESPECIALLY CAUTIOUS WHEN WORKING WITH AN ELECTRICAL DISTRIBUTION SYSTEM AND RELATED FACILITIES. NEVER WORK ON ELECTRICAL EQUIPMENT AND WIRE WITH WET HANDS OR WHEN CLOTHES OR SHOES ARE WET. ALWAYS WEAR APPRO-

PRIATE SAFETY GLOVES FOR ELECTRICAL WORK. NEVER USE A SWITCHBOX FOR ANYTHING OTHER THAN A SWITCHBOX.

4. KEEP ALL PERSONNEL SAFETY CONSCIOUS BY REMINDING THEM OF SPECIFIC SAFETY INSTRUCTIONS. SUCH INSTRUCTIONS SHOULD INCLUDE INFORMATION ON HOW TO CONTACT THE NEAREST MEDICAL CENTER AND FIRE STATION, RESCUE TECHNIQUES, RESUSCITATION AND FIRST AID TECHNIQUES.
5. MAKE CERTAIN THAT A SUFFICIENT NUMBER OF CAPABLE PERSONNEL WITH PROPER EQUIPMENT ARE ASSIGNED AND PRESENT WHENEVER IT IS NECESSARY TO PERFORM ANY HAZARDOUS WORK.
6. A LIFE PRESERVER MUST BE USED WHEN USING A BOAT ON STABILIZATION PONDS. ALSO, NEVER WORK ALONE AROUND THE PONDS TO PREVENT DROWNING AND OTHER ACCIDENTS. ONE OF THE REQUIREMENTS FOR A POND OPERATOR SHOULD BE THAT HE CAN SWIM AT LEAST 100 FEET IN NORMAL WORK CLOTHING.
7. WARNING SIGNS SHOULD BE INSTALLED NEAR DANGEROUS MACHINERY OR AT ANY LOCATION INVOLVING A STUMBLING HAZARD. THE SIGNS SHOULD BE DESIGNED AND LOCATED TO CALL ATTENTION TO A SPECIFIC DANGER AND DISCRETION MUST BE USED IN DETERMINING THE NUMBER AND PLACEMENT OF SIGNS SO PERSONNEL WILL PAY MAXIMUM ATTENTION TO THEM.
8. SUFFICIENT FIRE EXTINGUISHERS (UNDERWRITER'S LABORATORIES APPROVED) SHOULD BE PLACED IN READILY ACCESSIBLE

LOCATIONS.

C. BODY INFECTION AND DISEASE SAFETY PRECAUTIONS.

1. TREAT ALL CUTS, SKIN ABRASIONS AND SIMILAR INJURIES PROMPTLY. WHEN WORKING WITH WASTEWATER, THE SMALLEST CUT OR SCRATCH IS POTENTIALLY DANGEROUS AND SHOULD BE CLEANED AND TREATED IMMEDIATELY WITH A 2% SOLUTION OF TINCTURE OF IODINE.
2. SEE A DOCTOR FOR ALL INJURIES.
3. PROVIDE FIRST AID TRAINING FOR ALL PERSONNEL.
4. BE INNOCULATED FOR WATERBORNE DISEASES, PARTICULARLY TYPHOID AND PARATYPHOID FEVER. KEEP A RECORD OF ALL IMMUNIZATIONS IN AN EMPLOYEE HEALTH RECORD TO ASSURE YOURSELF OF RECEIVING UP TO DATE BOOSTERS, ETC.
5. KEEP FINGERS OUT OF NOSE, EYES AND MOUTH BECAUSE THE HANDS CARRY MOST INFECTIONS IN THIS FIELD OF WORK.
6. AFTER WORK, BEFORE EATING AND AT OTHER CONVENIENT TIMES, WASH HANDS THOROUGHLY WITH PLENTY OF SOAP AND HOT WATER. KEEP FINGERNAILS SHORT AND REMOVE ALL DIRT AS OFTEN AS POSSIBLE WITH A NAIL FILE, OR A STIFF, SOAPY BRUSH.
7. IN LABORATORY WORK, USE PIPET BULBS RATHER THAN THE MOUTH SO AS NOT TO INTRODUCE CONTAMINATION TO THE MOUTH. DON'T DRINK WATER FROM LABORATORY GLASSWARE. PAPER CUPS SHOULD BE PROVIDED IN LABORATORIES FOR

DRINKING PURPOSES. NEVER PREPARE FOOD IN A LABORATORY.

8. KEEP HANDS OUT OF WASTEWATER, SLUDGE OR GRIT AS MUCH AS POSSIBLE. WHEN SUCH CONTACT IS UNAVOIDABLE, WEAR RUBBER GLOVES.

9. EMERGENCY FIRST AID KITS TO TREAT ANY MINOR ON THE JOB INJURY SHOULD BE READILY ACCESSIBLE.

10. RUBBER GLOVES SHOULD BE USED WHEN CLEANING CLOGGED PUMPS, PIPES AND IN CLEANING THE WET WELL. SUCH PROTECTION IS PARTICULARLY IMPORTANT WHEN THE SURFACE OF THE SKIN IS BROKEN OR IRRITATED.

11. COVERALLS OR A COMPLETE CHANGE OF CLOTHES FOR WORKING HOURS SHOULD BE USED. BOOTS AND RUBBERS SHOULD BE USED TO KEEP FEET CLEAN AND DRY WHEN IN CONTACT WITH WASTEWATER.

D. NOXIOUS GASES, EXPLOSIVE MIXTURES AND OXYGEN DEFICIENCY.

1. SEWER GAS. THE PRINCIPAL GAS HAZARDS ASSOCIATED WITH WASTEWATER TREATMENT ARE ACCUMULATIONS OF SEWER GAS AND ITS MIXTURE WITH OTHER GASES OR AIR WHICH MAY CAUSE DEATH OR INJURY THROUGH EXPLOSION OR BY ASPHYXIATION AS A RESULT OF OXYGEN DEFICIENCY. THE TERM SEWER GAS IS GENERALLY APPLIED TO THE MIXTURE OF GASES IN SEWERS AND MANHOLES CONTAINING HIGH PERCENTAGES OF CARBON DIOXIDE, VARYING AMOUNTS OF METHANE, HYDROGEN, HYDROGEN SULFIDE AND LOW PERCENTAGES OF OXYGEN. SUCH

MIXTURES SOMETIMES ACCUMULATE IN SEWERS AND MANHOLES WHERE ORGANIC MATTER HAS BEEN DEPOSITED AND HAS UNDERGONE DECOMPOSITION. THE ACTUAL HAZARDS FROM SEWER GAS EXIST IN THE EXPLOSIVE AMOUNT OF METHANE OR IN OXYGEN DEFICIENCY.

2. CHLORINE. CHLORINE GAS, WHICH IS IRRITATING TO THE EYES, RESPIRATORY TRACT AND OTHER MUCOUS MEMBRANES, MAY SETTLE IN LOW, STILL AREAS. THE GAS ESCAPES BY LEAKAGE FROM CYLINDERS AND FEED LINES AND FINDS ITS WAY TO THESE PLACES.

SAFETY PRECAUTIONS TO FOLLOW IN SITUATIONS WHERE THE PRESENCE OF GAS IS POSSIBLE SHOULD INCLUDE:

1. PROHIBIT SMOKING AND OPEN FLAMES IN AND AROUND OPEN MANHOLES, SEWERS AND WETWELLS, AS GASOLINE OR PETROLEUM VAPORS, ILLUMINATING GAS AND METHANE ARE COMMON IN THESE AREAS. USE ONLY PERMISSIBLE EXPLOSION PROOF LIGHTS, ELECTICAL FIXTURES, MOTORS AND OTHER EQUIPMENT IN ALL SUCH DANGEROUS AREAS.
2. MAKE PERIODIC CHECKS FOR GAS LEAKS IN CHLORINE ROOMS TO PRECLUDE ACCIDENTS.
3. VENTILATION SHOULD BE PROVIDED WHEN ENTERING WET WELLS, LIFT STATIONS, CHLORINE ROOMS AND MANHOLES.
4. USE OXYGEN DEFICIENCY INDICATORS AND HAVE GAS MASKS WITH AN O_2 SUPPLY ON HAND WHEN WORKING IN ANY LOCATION THAT HAS A POTENTIAL GAS HAZARD.

5. USE EXTREME CAUTION WHEN HANDLING CHLORINE. THE TEST FOR A CHLORINE LEAK IS TO SOAK A RAG IN AMMONIA AND HOLD IT IN THE AREA OF A SUSPECTED LEAK. IF A LEAK HAS OCCURRED, A WHITE CLOUD WILL EMINATE FROM THE AMMONIA SOAKED RAG.

I-4 SAFETY EQUIPMENT

THE TYPES OF SAFETY EQUIPMENT WHICH A WASTEWATER FACILITY SHOULD HAVE ARE AS FOLLOWS:

1. DETECTION EQUIPMENT (FOR GASES AND OXYGEN DEFICIENCIES).
2. MASKS (SELF CONTAINED AIR PACKS FOR OXYGEN DEFICIENCIES).
3. SAFETY HARNESSES, LINES AND HOISTS.
4. PROPER PROTECTIVE CLOTHING, FOOTWEAR, AND HEAD GEAR.
5. VENTILATING EQUIPMENT.
6. NON-SPARKING TOOLS.
7. COMMUNICATIONS EQUIPMENT.
8. PORTABLE AIR BLOWER.
9. EXPLOSION-PROOF LANTERN AND OTHER SAFE ILLUMINATION.
10. WARNING SIGNS AND BARRIERS.
11. EMERGENCY FIRST AID KITS.
12. PROPER FIRE EXTINGUISHERS.
13. EYE WASH AND SHOWER STATIONS IN LABORATORY AREAS.
14. SAFETY GOGGLES FOR WORK IN LABORATORIES AND OTHER DANGEROUS AREAS.

ADDITIONAL SOURCES OF INFORMATION

- NEW YORK MANUAL, CHAPTER 14
- WPCF, MOP #1, SAFETY IN WASTEWATER WORKS
- TEXAS MANUAL, CHAPTER 35
- SACRAMENTO STATE HOME-STUDY COURSE, CHAPTER 12.