Lagoon Construction Guidelines

Alaska Department of Environmental Conservation
February 2009

DISCLAIMER: The following Lagoon Construction Guidelines are internal policy intended to insure program consistency for lagoon construction reviews. These guidelines were developed based on extensive literature research and numerous other state requirements. The guideline is a compilation of lessons learned and best practices of proven design methods which provide reliable treatment for the climatic conditions of Alaska. It is not regulatory in nature but is provided to help streamline the review of lagoon systems. If a plan uses alternative methods to determine the basis of design for a lagoon, a thorough explanation of the supporting data will be required. Please contact your regional wastewater engineer to discuss these construction guidelines prior to plan submittal, if you have any questions.

ADEC Office Locations

Anchorage
555 Cordova St
Anchorage, AK 99501
907-269-7519

Fairbanks
610 University Ave.
Fairbanks, AK 99709
907-451-2177

Juneau
410 Willoughby Avenue Suite 303
Juneau, AK 99803
907-465-5167

Kenai/Soldotna
43335 Kalifornsky Beach Rd, Suite 11
Soldotna, AK 99669
907-262-3405

Mat-Su Valley/Wasilla
1700 E Bogard Rd, Bldg B-Suite 103
Wasilla, AK 99654
907-376-1852

Contents

Section Page

Abbreviations and Acronyms

AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
ADNR	Alaska Department of Natural Resources
ANTHC	Alaska Native Tribal Health Consortium
ASTM	American Society of Testing and Materials
BOD	Biochemical Oxygen Demand
BOD_5	5 day Biochemical Oxygen Demand
DO	Dissolved Oxygen
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
HDPE	high density polyethylene
HRT	hydraulic retention time
Lb	pound
µg/L	micrograms per Liter
µ	Microns
Mg/l	milligrams per liter
Ml	milliliter
pH	hydrogen (ion) concentration
TSS	Total Suspended Solids
VSW	Village Safe Water

Definitions

Bedrock The native consolidated rock underlying the Earth's surface. In this document, bedrock includes any refusal layers such as permafrost.

Impermeable layer A layer of material beneath ground surface that can impede the downward percolation of water.

Maximum groundwater Elevation As determined from at least two readings taken a minimum of 30 days apart. At least one of these readings shall be collected in September or October.

Occupied Building A building within which one or more persons reside, work, or are served for four hours per day: two or more days a week: and eight or more weeks a year. Without limiting the generality of the foregoing, this description includes such developments as school, hospital, food establishment, residences, etc.

Shoreline The fringe of land at the edge of a large body of water, including an ocean, sea or lake.

Tremie tube A concrete feeding tube used to feed concrete grout, or similar substances, underwater.

Introduction and Objectives

This guideline presents the results of a literature search and evaluation of rural lagoon systems in the areas with cold climate conditions. The report was prepared with the assistance of CH2M HILL under contract with the Alaska Department of Environmental Conservation (ADEC). These are the Department's Guidelines for future Wastewater Lagoon Construction.

The overall goal of this guideline is to protect public health by development of these minimum design and operational criteria for use by both the design consultants and regulators.

The following report and guidelines represents recommendations based on common practices and existing regulations in northern communities, regulators concerns, successful lagoon designs and current guidelines.

Lagoon Location

The lagoon design shall investigate the following elements, and adhere to the following limits:

2.1 Separation Requirements

1. The lagoon shall be placed a minimum of 330 feet (100 meters) from all roads and railways.
2. The lagoon shall be placed a minimum of 1,000 feet from an occupied building (see definitions).
3. The lagoon shall be placed a minimum of 200 feet from existing community wells. A greater distance may be required in accordance with ADEC Wastewater Regulations 18 AAC 72.020.(d).
4. The lagoon's distance from any airport shall be coordinated with the Federal Aviation Administration (FAA).
5. The lagoon shall be placed downwind from the community, where possible.
6. The lagoon shall be placed a minimum of 500 feet from any shoreline.

2.2 Topography

1. The lagoon's location shall be out of the floodplain and above the 20 year flood level.
2. The lagoon location shall not intercept surface runoff channels, groundwater shall not surface in any cell, nor shall snowmelt be allowed to drain into the structure.
3. Stormwater runoff shall be diverted around the lagoon.
4. The embankment shall be protected from erosion.
5. The lagoon location shall not be located over a buried channel aquifer.
6. The lagoon location shall avoid hilly or steeply sloping terrain.
7. The lagoon location shall be selected to ensure maximum sunlight (the south side of hills is preferred).

2.3 Geotechnical Requirements

1. Maintain a minimum separation of 4-feet between the bottom of the lagoon and the maximum groundwater elevation.
2. Maintain a minimum separation of 10-feet between the bottom of the lagoon and bedrock (as defined earlier in this document).
3. Maintain a minimum of 6-feet between the bottom of the lagoon and the impermeable layer.

2.4 Permafrost

1. Permafrost shall be avoided wherever possible. When a location on the permafrost is proposed, the design must demonstrate that all other treatment alternatives have been evaluated and are not technically feasible.
2. If construction on permafrost is required, soil bore testing shall be required to determine the ice content of the permafrost and the existence of any massive ice, such as an ice wedge.
3. Thermal modeling shall be conducted to estimate the rate and maximum depth of thaw caused by the dike construction and wastewater impoundment. From these measurements, the lagoon designer shall calculate the stability and settlement of the lagoon. Design shall be completed by a geotechnical engineer with substantial permafrost experience.
4. The lagoon design shall include methods proposed for protection and stabilization of the permafrost during construction.

2.5 Areas of High Precipitation

1. In areas of high precipitation (both rainfall and snow accumulation of more than 20 inches of precipitation as rainfall), a mass balance shall be completed showing that the lagoon has adequate capacity to accommodate the annual precipitation. All other design options that were made in determining the selection that a lagoon is the technically best option for the site must be presented.

Design Requirements

3.1 Service Life

The design service life of the lagoon shall be a minimum of 20 years. The lagoon design shall delineate the method for projecting population growth and changes in wastewater conveyance. (For example: A 2 percent growth in population over 20 years= $(1.02)^{20}$=1.5 design factor)

3.2 Retention Time

The retention time in the lagoon shall be a minimum of 240 days, up to 365 days for a single, seasonal discharge.

3.3 BOD_5 Loading

The loading system shall be designed for a maximum BOD_5 (5 day biochemical oxygen demand) Loading rate of 20 pounds (lbs)/acre/day.

3.4 Wastewater Flows

A value based upon the population expected at the end of the design life for the lagoon shall be used to size the facility. For waste strength a value of 0.17 lbs of BOD_5/person/day will be used.

3.5 BOD_5 /Total Suspended Solids Removal

The lagoon design effluent shall demonstrate an 85 percent removal of BOD_5 and total suspended solids (TSS).

3.6 Pathogen Reduction

The lagoon effluent shall meet pathogen levels stipulated in the selected discharge permit for the site (marine or fresh water).

3.7 Other Parameters

The lagoon shall meet the current ADEC water quality standards for discharge location and use.

Geotechnical Investigation

4.1 Bore Hole Tests

1. The number of test bores shall be sufficient to adequately characterize the soil type and variability and to delineate unsuitable soil areas in the field. A minimum of one borehole per five acres or three boreholes for the entire construction plan, whichever is larger, is required. Although boreholes shall not be drilled on an arbitrary grid, average borehole spacing of 300 feet to 450 feet is recommended. Where permafrost is suspected, sufficient boreholes shall be drilled to fully establish the permafrost characteristics.
2. Boreholes shall be drilled a minimum depth of 20 to 40 feet below the lagoon invert elevation. At least three boreholes shall penetrate the ground water table to provide information on flow direction and gradients, unless the groundwater level is deeper than 40 feet. At least 1 borehole shall be drilled to auger refusal in the bedrock or to a depth of 80 feet, whichever occurs first.
3. Soil sampling shall be performed in accordance with American Society of Testing and Materials (ASTM) D 158699 or ASTM D 158700.
4. Some boreholes may be useful as monitoring wells. All soil borings in which wells are not installed shall be properly abandoned. Boreholes drilled within the proposed lagoon area shall be grouted to prevent preferential seepage paths. Use of a tremie tube is recommended to prevent bridging of grout in the hole and formation of voids. Boreholes located well beyond the containment structure maybe backfilled with available soil. (Monitoring Wells must conform to State Standards (see attachment))

4.2 Soil Tests

1. Sieve analyses performed to determine grain size distribution shall be performed in accordance with ASTM D42263 (2002) e1.
2. Permeability shall be determined using a falling head permeability test. The test shall be performed at the same approximate density as the inplace field conditions. Test on remolded or undisturbed samples are acceptable.
3. The plasticity index shall be determined in accordance with ASTM D42588 (2001).
4. Standard proctor densities shall be determined in accordance with ASTM D69800ae1.
5. In-field percolation testing shall be conducted per EPA design manual (EPA 625/180-012). A minimal of three tests per site is required.

Lagoon Configuration

5.1 General

1. The shape of the lagoon shall be such that there are no narrow or elongated portions. Islands, Peninsulas, or coves will not be approved. Dikes shall be rounded at the corners to minimize accumulation of floating materials. Rectangular lagoons with a length at least three times the width are recommended to limit short circuiting.
2. A minimum of two cells operating in series is required, at least one primary cell followed by at least one secondary cell.
3. Precipitation and evaporation must be considered in the total water balance and sizing.
4. A minimum of 3 feet of free board is required for all cells.

5.2 Sizing of Cells

1. The primary cell shall operate at a maximum depth of 10 feet and a hydraulic retention time (HRT) of approximately 40 to 60 days.
2. Two cells in series are required; the secondary cell shall operate at a maximum depth of 5 feet and an HRT of 240 to 365 days. If three or more cells are used, the secondary cell shall operate at a maximum depth of 5 feet and an HRT of approximately 30 days. The subsequent storage cells shall operate at a maximum depth of 10 feet. The total HRT of the system shall be 240 to 365 days.
3. The bottom 2 feet of the lagoon shall not be used in the calculation of storage volumes to maintain space for the effluent pipe.

Lagoon Liners

6.1 General

1. The permeability for both soil liners and synthetic liners shall not exceed 8.5 by 10^{-5} inches/minute under a head of 6 feet.
2. An engineered liner will be required on the bottom and slopes of any dike structures.
3. Areas where ice rafting against the exposed lagoon lining system may occur shall be identified during the design process. In these areas, the liner shall be reinforced or a mechanism for keeping the ice off the liner shall be developed and included in the proposal.
4. A quality assurance and quality control plan must be included for review. This plan must be signed by the engineer. This plan must meet or exceed the manufactures recommendations. The execution must also be documented and the record drawing must assure this plan was implemented.

6.2 Soil Liners

1. Natural InSitu Liners.
    - InSitu soil with low hydraulic conductivity may meet the seepage control requirements for a lagoon liner.
    - Surface compaction shall be applied.
    - Natural InSitu liners shall a minimum thickness of 3 feet below the entire lagoon bottom and shall be relatively uniform and free of sand and silt.
    - A side slope shall be provided if the horizontal hydraulic conductivity of the InSitu liner does not meet the seepage control criterion or if berms are constructed with fill materials.
2. Compacted Clayey Soil
    - Clay content of a compacted clay liner material shall be a minimum of 25 percent.
    - The liner shall have a minimum thickness of 3 feet on the bottom and 4 feet on the side slope (measured perpendicular to the slope).
    - The liner shall end at least 1 foot higher than the highest operational level.
    - Laboratory conductivity tests on the compacted clay liner shall be required.
3. Admix Liner
    - Bentonite and sand admix liners are to be used only when mixing with native sands or silts allows a uniform admix.
    - Only high-swelling bentonite shall be used.
    - The liner shall be at least 4 inches thick after compaction.

6.3 Synthetic Liners

1. The liner type shall be carefully selected based on environmental conditions, chemical compatibility requirements, expected loads, desired design life, exposure conditions, and any other considerations.
2. All synthetic liners shall have a minimum thickness of 30 mils. High density polyethylene (HDPE) liners shall have a minimum thickness of 40 mils.
3. The liner shall be securely anchored to the dike.
4. The bottom of the liner must be adequately protected by a uniform sand bedding layer compacted to at least 90 percent of the maximum dry density or by a cushioning of geotextile fabric. The bedding surface shall be free of rocks, roots, debris, stake holes, crakes, and any rapid change in elevation.
5. The liner shall be covered with a 12 inch layer of fine grained soil on the pond side slopes to prevent liner damage.
6. Any source of potential wear in the lagoon, such as concrete foundation blocks or concrete anchors, shall be eliminated by protecting the liner with geotextile fabric or similar means. Concrete structures, such as anchor beams or pipe penetrations supports, shall be engineered to ensure liner integrity through the life of the lagoon.
7. PVC and other membrane liner materials that are susceptible to weathering when exposed shall be covered with soil on both the side slope and the bottom.
8. Liner shall be bedded on a relatively permeable layer of soil and/or geotextile to provide a venting medium for gas accumulation. Adequate base grading (a minimum one percent slope toward the edges of the lagoon) and gas vents are required for lined lagoons to ensure that no air or gas is trapped below the base of the lagoon.

Dike Construction

7.1 General

The dike shall be compacted to at least 95 percent of the maximum dry density to avoid settlement, slumping, and erosion, as well as to provide good support for liners, erosion protection, and vehicle traffic as follows:

- Strip the topsoil and any soft, compressible, or otherwise unsuitable materials from the dike areas, and proof roll the scarified surface to at least 95 percent of the maximum dry density.
- Hard, smooth foundation soils shall be scarified and recompacted to ensure a good bond between the fill and the foundation soil.

7.2 Dike Fill Materials

1. The dike fill material shall be free of organics, organic soil, and debris, cobbles greater than 6 inches in diameter, snow, ice, or soft compressible material.
2. The fill shall be placed in level, uniform lifts in a direction parallel to the axis.
3. The maximum loose lift thicknesses shall be 6 to 8 inches.
4. The fill shall be compacted to at least 95 percent of the maximum dry density.

7.3 Slopes

The dike slopes (interior and exterior) shall be 3 to 1 (horizontal to vertical).

7.4 Dike Crest

1. The dike crest shall be a minimum of 10 feet wide to allow vehicle access.
2. An access ramp to the top of the dike shall be provided.
3. The dike crest shall have a slight camber to promote runoff.

7.6 Erosion Control Features

1. Erosion control must be placed on interior slopes with additional protection at all piping Entrances and exits, where an artificial erosion protection system or riprap layer with a minimum thickness of 2 feet of 6 inch to 8 inch rocks or gabions shall be provided.
2. For large lagoons, a minimum of 24 inches of riprap protection is required on the inner side slope from the dike toe to a minimum height of 2 feet above the maximum water level to prevent wave erosion.
3. Riprap shall be generally round or cubic in shape. Slabs or elongated stone pieces having a width or thickness less than one third the lengths shall not exceed 10 percent of the total. No sand, shale, broken concrete, asphalt, or slate is allowed. Extreme care

shall be taken to avoid incorporating fines into the riprap.

4. One layer of geotextile fabric shall be applied under the riprap to separate the fines.
5. Bentonite admix liners and synthetic liners less than 40 mils in thickness require 12 inches of soil cover under erosion protection. The cover for side slopes shall extend onto the bottom well beyond the riprap material.
6. The exterior dike slope shall be properly stabilized. Shrubs and trees shall not be planted on the dike.
7. Riprap may be required on exterior slopes where storm runoff or flooding may cause erosion of the dike.
8. When riprap is not used, the minimum erosion protection may consist of 4 inches of topsoil with an established growth of short rooted grass on the crest and inner slope down to the minimal operating depth before prefilling or to the top edge of the riprap when applicable. The organic layer must be removed from the bottom of the lagoon.

Hydraulic Structures

8.1 General

1. All the influent, effluent, and interconnecting piping shall be freeze protected through means of burial depth, insulation, or heat tape.
2. Generally accepted material for underground sewage construction shall be used for piping in the lagoon. Unlined corrugated metal pipe is unacceptable.
3. Design shall address issues, such as ice damage and discharge scouring.
4. For truck-haul sewage and honey bucket dumping a suitable means shall be provided so that dumping occurs over water surface (3 foot depth of water) and not along lagoon banks.

8.2 Influent

1. The influent lines shall terminate at approximately the midpoint of the lagoon width and at approximately 10 feet from the toe of the dike slope. The influent lines shall be located as far as possible from the effluent structure for as long a length of travel to minimize short circuiting.
2. The lagoon influent effluent axis shall be perpendicular to the prevailing wind direction to minimize short circuiting caused by wind action.
3. The influent line shall be located so that the top of the pipe is no more than 6 inches higher than the finished bottom of the cell for horizontal discharge and no less than 2 feet higher than the finished bottom of the cell for vertical discharge.
4. The end of the influent line shall be maintained above the influent pipe at all times to prevent it from freezing.
5. A minimum water level of two feet shall be maintained above the influent pipe at all times to prevent it from freezing.

8.3 Control Structure

A control structure shall be designed to allow effluent to be transferred from cell to cell or to release a discharge if the effluent treatment limits are meeting. No transfer of settled solids shall be allowed. Transfers and discharges should indicate a significant treatment as the effluent passes through the successive treatment cells. Control structures must provide the engineering means to attain this goal.

8.4 Effluent

1. Effluent pipe intakes shall be located a minimum of 10 feet from the toe of the dike. Pipes with a vertical intake shall be located a minimum of 2 feet higher than the finished bottom height of the cell.
2. The effluent piping shall permit the discharge of the effluent at a minimum 6 inches of cell depth per day at the minimum working level or head.

Miscellaneous

9.1 Fence

A fence is required to prohibit unauthorized access.

9.2 Warning Sign

Warning signs shall be posted on each side of the fence to warn of a public health danger.

9.3 Gate

A vehicle access gate of sufficient width to accommodate maintenance equipment shall be provided. All access gates shall be provided with locks.

9.4 Road

An all weather access road must be built and properly maintained.

Guidance on Discharge

10.1 Discharging Time and Frequency

Discharges in the spring and fall can normally be permitted. Earlier discharges may be allowed under exceptional circumstances to comply with any local conditions. If an earlier discharge is permitted, only enough volume shall be discharged to create enough storage until the fall discharge can take place. The discharge period shall not exceed three weeks unless the local conditions preclude this rate of discharge. Notification of a discharge shall be in conformance with the discharge permit.

10.2 Sampling before Discharge

1. Discrete representative samples must be taken to determine the effluent quality no later than two weeks before discharge. (This is not the Effluent Discharge Samples)
2. Samples must be taken from an aerobic secondary cell. If more than one cell is to be Discharged, separate samples must be taken from each.
3. All samples shall be taken from several locations in the lagoon and at least 8 feet from the dike and 1 foot below the surface.
4. No sample shall be taken during or immediately following excessive wind action.
5. Minimum tests conducted shall include: biochemical oxygen demand (BOD), TSS, and Fecal coliform. Dissolved oxygen (DO) and hydrogen (ion) concentration (pH) may be required depending on the discharge permit and must be tested on site within 24 hours before discharge.
6. Future monitoring of phosphorus and nitrogen levels may be required.
7. All sample tests shall follow the Standard Methods for Water and Wastewater Examination.

10.3 Sampling during Discharge

Sampling during discharge is compulsory according to the discharge permit requirements. Contact the local ADEC office prior to the commencement of any discharge to assure sampling meets the discharge permit requirements.

10.4 Discharge Locations

1. The location shall be determined in coordination with the Alaska Department of Natural Resources (ADNR) Habitat Division.
2. For ocean, river, or lake discharge, special attention shall be taken in the outfall structural design to protect it from ice damage, and ease of sampling.
3. For lake and river discharge, the Do shall be monitored during the discharging period.

The lagoon discharge shall not adversely affect the receiving water DO as stipulated in the discharge permit. A minimum of 2 milligrams per liter (mg/l) DO in the wastewater is required.

4. The discharge area shall be protected and properly signed.

Operations and Maintenance

11.1 Prefilling

After construction, all cells shall be prefilled to a level of 2 feet minimum above the bottom to protect the liner, prevent weed growth, and confirm the integrity of the liner.

11.2 Sludge Removal

Monitoring of the sludge depth in the primary cells shall be conducted in accordance with the permit. Periodic sludge removal is required at a permitted facility.

11.3 Honey Buckets

Regular removal of debris and spills from the honey bucket dumping sites is required.

11.4 Slope Maintenance

Slopes shall be checked regularly for leaks, settlements seeps, springs, and erosion. Repairs shall be applied at least annually. Where erosion is present, placement of additional riprap or other protective material is required.

11.5 Vegetative Control

Growth of trees and shrubs on the exterior slope and interior slope above the water level shall be controlled.

11.6 Monitoring Wells

Sampling of monitoring wells shall be completed in accordance with the ADEC subsurface disposal guidance meeting both the plan review placement locations, and the requirements of the discharge permit.

11.7 Fence

The fence shall be inspected regularly, and any damage shall be repaired.

11.8 Road

Access area and road to the facility must be maintained and cleared of snow.

Lagoon Closure Procedure

12.1 Plan Approval

Lagoons which are determined to be surplus, or located in a sensitive area, must be properly closed out. As this is a change to part of a wastewater system, plan approval per the Wastewater Regulations (18 AAC 72.200. (a)) is required.

12.2 Solid Waste Regulations

If solid waste is to remain on site the requirements of the Solid Waste Regulation must be complied with see (18 AAC 60.470, 18AAC 60.490, 18 aac60.810, 18 AAC 60.820) When Bio Solids are to remain capping requirements must be protective of public health use of final capping for closure of a landfill have been established use of these standards or similar are recommended.

12.3 Bio Solids and Reuse

If Bio Solids remain at a site, development of the property must be restricted:

- Uses that do not create a health hazard maybe authorized. A development plan by the community must be established that will identify and allow a safe use.
- Uses that threaten the public or create a health hazard are restricted. (Building Homes, Parks, Day use areas, Roads, or Trails)

Work Sheets for Wastewater Lagoon Treatment

13.1 Preliminary Review for Feasibility of Design

Provide the Following:

Rainfall per year at Site in inches_____=RF.

Computations => RF-20=_____ Go to correct next step **A, B, C,**

A (If negative number), a lagoon may be an option, will soils support the structure? Y N

B (If positive number) but less than 10 provide the following:

What special engineering are being done to enhance the site? (Like Aeration)

1._____

2._____

3._____

What is the History of lagoon use in the area?

_____

_____

_____

Why does the option of a lagoon out weigh other options? Please do not base any of this on cost.

_____

_____

_____

[Do not provide any lagoon plans of your design, until a review has been completed by your local ADEC office of these findings, and plans are requested]

C (If your original value for Rainfall was over 30 inches per year) provide the following:

List other options that you have reviewed and provide all factors used in evaluating these options other than cost. Include any pertinent documentation that may relate to the justification of any one options.

[Do not provide any lagoon plans with this information. The local ADEC office may contact you concerning your options]

1/3

Work Sheets for Wastewater Lagoon Treatment

Wastewater Computation Sheet—Required Submittal

Depth of Lagoon less free board of 3 feet, and 2 feet for storage on the bottom of the Cells=LED=____Ft.
Current Population=P_____
Number of years for the expected Life of the lagoon from completion date=N=_____
Growth factor is 1.02 unless higher factor is expected.

Design Population= P (1.02^{N}) =DP=_____

(USE) Select use based upon expected use at end of design life.

Gallons used per person per day

Honey Bucket Haul= 25 GPD/Person

Collection by Pump and Haul =45 GPD/Person

Collector Sewer= 75 GPD/Person

The Department finds that Public Health is directly related to this quality of life issue. These values may be adjusted based upon documented site use. Estimated values for altering wastewater use are as shown.

Hydraulic Loading Computation:

(DP)(240 days)(USE)/ [(7.48gallons/ft^3) (43560ft^2/Acre) (LED)] = Hydraulic Loading in Acres_____

Organic Loading Computations:

(DP)(0.17lbs of BOD_5)/ {(20 lbs of BOD_5/Day per Acre)} =Organic Loading in Acres_____OLA_{20}
(DP)(0.17lbs of BOD_5)/ {(30 lbs " " " " ")} =Organic Loading in Acres_____OLA_{30}

*Ten State Standards has a 15-35 range in lbs of BOD… loading but common use is both 20 and 30lbs…

Wis. has two cells of OLA_{20} size: ☐☐

Min. has one primary cell of OLA_{20} size followed by a cell which is $OLA_{20}/2$ size: ☐☐

Nor Dak has a primary cell of OLA_{30} size and an overall size of OAL_{20} size: ☐☐

2/3

Work Sheets for Wastewater Lagoon Treatment

Alaska has used a rule of thumb for sizing which was an acre of lagoon for every 100 people.

At this time the computed Hydraulic loading or the Nor Dak model must be met for size, whichever is larger.

Show size as the surface area of the lagoon's wetted surface area.
First cell area_____ Second cell area_____

This is for a treatment lagoon with a discharge permit.

Percolating Cell

Mont. has sized the seepage rate for their lagoons which have a fast percolation rate, at 3,395 gallons/day/acre or as a value for our computation use 45 people /acre for the loading factor.

(DP)/45 people per acre= required seepage area =_____rspa in acres

Prior Treatment would require as a minimum the OLA_{30}_____ area

Good soils make a difference, this would mean the site is not underlain with permafrost and soils are percolating in the 1 min/inch range. Provide percolation test data and soils information.

3/3