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A Licence issued under the authority of The Environment Act is required by any individual, corporation or entity who wishes to construct and/or operate a wastewater treatment lagoon in Manitoba. A professional engineer licensed to practice in Manitoba should be consulted for the design of a facility, the preparation of detailed drawings and the preparation of an Environment Act Proposal or Notice of Alteration.

**1. Basis of Design** Wastewater treatment lagoons are normally designed for a life of at least 20 years. The design will include present day and estimated future organic and hydraulic loading from all sources. For facultative facilities, the maximum depth of liquid in cells is 1.5 m.

- a) Land Acquisition:** In acquiring the land parcel to be used for the construction or expansion of a facility, consideration should be given to future expansion that may be required due to population growth or anticipated additional industrial or commercial wastewater.
- b) Organic Loading:** Primary Cell: Five day biochemical oxygen demand (BOD<sub>5</sub>) loading of 56 kg/ha/d should not be exceeded. Higher loadings may be approved for installations designed for summer operation only or for aerated cells or specialty lagoon configurations. Because higher loadings are likely to generate odour complaints, proposed higher loadings must include a rationale for the higher loading rate and include odour mitigation strategies.
- c) Hydraulic Loading:** Provision shall be made for winter storage based on holding liquid from at least November 1 to June 15. Greater storage, however, may be required depending upon the receiving environment. Storage capacity shall be based on the operating volume of secondary cells that is available above the invert of the discharge pipe, usually 0.3 metres above the cell floor. Primary cell capacity may be considered in estimating hydraulic storage, but should be limited to one-half (1/2) the actual operating volume. If an extended discharge period is being considered as a nutrient reduction strategy (i.e. trickle discharge), the cells of the facility must be sized to accommodate inflows during the period that a secondary cell is isolated for discharging. The primary cell and other secondary cells cannot be surcharged above their maximum operating depth of 1.5 m during the discharge period of the isolated cell.
- d) Truck Hauled Wastewater:** Truck hauled wastewater may include wastewater from holding tanks and/or septage. Holding tank wastewater is considered to have the same organic loading as wastewater from a municipal wastewater collection system. Septage consists of the sludge periodically removed from septic tanks, and is considered to have a substantially larger organic loading. The delivery of septage to a conventional facultative wastewater treatment lagoon is normally prohibited during the period October 15 – June 1 due to the reduced ability of the facility to treat high strength wastewater during cold weather conditions.

- e) Industrial Wastes:** Consideration must be given to and provisions made for the type and effects of industrial wastes on the treatment process.
- f) Multiple Units:** Where more than two cells are provided, the designer may consider both series and/or parallel operation. The organic and hydraulic loading criteria above are to be followed.
- g) Shape of Cells:** Cell shapes should not be narrow or elongated. Round, square, or rectangular cells are desirable. Dykes should be rounded at corners to minimize accumulation of floating materials.
- h) Size of Cells:** Erosion due to wave action should be considered in cell sizing.
- i) Effluent Quality Requirements:** All wastewater treatment lagoons must meet the following requirements:
- i. Five-day carbonaceous biochemical oxygen demand (CBOD<sub>5</sub>) – not to exceed 25 milligrams per litre;
  - ii. Total suspended solids (TSS) – not to exceed 25 milligrams per litre unless caused by algae;
  - iii. Fecal coliform content or *Escherichia coli* (*E. Coli*) content as indicted by the MPN index - not to exceed 200 per 100 millilitres;
  - iv. Un-ionized ammonia content expressed as nitrogen (N), at 15°C ±1°C – not to exceed 1.25 milligrams per litre for intermittently discharging facilities<sup>1</sup>; and
  - v. Total phosphorus – not to exceed one milligram per litre; or a demonstrated nutrient reduction strategy for facilities discharging less than 820 kg/year of total phosphorus (a population equivalent of under 2000 people.) For facilities proposing a nutrient reduction strategy, strategies will be evaluated on a site specific basis, and strategies which do not offer a reasonable likelihood of attaining a total phosphorus content of one milligram per litre at a significant downstream waterway will not be approved.

## **2. Location**

- a) Distance from Habitation:** A lagoon site should be as far as practicable from habitation or any area which may be built up within a reasonable future period. Lagoons should not be located any closer than 460 metres from any center of population; individual residences should not be any closer than 300 metres. The above distances are to be measured from the outer toe of the nearest dyke.
- b) Winds:** Preference should be given to sites which will permit an unobstructed wind sweep across the cells of the lagoon. Consideration should be given to lagoon location such that prevailing winds will be in the direction of uninhabited areas.
- c) Surface Runoff:** Location of lagoons in areas receiving significant amounts of runoff water is discouraged unless adequate provisions are made to divert storm water around the cells and otherwise protect embankments of the lagoon. Areas which are habitually inundated shall be avoided.

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<sup>1</sup> Ammonia limits for continuously discharging facilities are applied as for wastewater treatment plants, usually with site –specific monthly limits.

- d) **Groundwater Pollution:** Proximity of lagoons to water supplies and other facilities subject to contamination and location in areas of porous soils and fissured rock formations should be critically evaluated to avoid creation of health hazards or other undesirable conditions. The possibility of chemical pollution from adjacent sources should be addressed in the design if relevant.

### **3. Lagoon Construction Details**

#### **3.1 Embankments and Dykes**

- a) **Material:** Embankments and dykes shall be constructed of relatively impervious materials and compacted sufficiently to form a stable structure. Vegetation and topsoil should be removed from the area upon which the embankment is to be placed.
- b) **Top Width of Berm:** The minimum embankment top width should be three metres to permit access of maintenance vehicles and equipment.
- c) **Maximum Slopes:** Embankment slopes should not be steeper than:
- i. Inner - four horizontal to one vertical
  - ii. Outer - three horizontal to one vertical
- d) **Minimum Slopes:** Embankment slopes should not be flatter than:
- i. Inner - six horizontal to one vertical. These flatter slopes are sometimes specified for larger installations because of wave action, but have the disadvantage of added shallow areas conducive to emergent vegetation.
  - ii. Outer - not applicable, except significant volumes of surface water should not enter the cells of the lagoon.
- e) **Freeboard:** A minimum freeboard of one metre is required for all facilities.
- f) **Minimum Depth:** The minimum normal liquid depth should be thirty centimetres. This provides storage below the outlet pipe of a cell for sludge so that it is not carried through the pipe. For soil liners, it also ensures that the cell floor is covered by liquid at all times, preventing desiccation cracking.
- g) **Maximum Depth:** The maximum normal liquid depth should be one and a half metres. If this depth is exceeded, the facility is not considered to be facultative. Greater maximum depths are permissible for aerated facilities.
- h) **Seeding:** Earth embankments shall be seeded above the water line. Perennial type, low growing, spreading grass that withstands erosion, occasional submergence and drought and can be kept mowed is most satisfactory for seeding of embankments. In general, alfalfa and other long rooted crops should not be used in seeding, since the roots of this type of plant may impair the water-holding efficiency of the dykes. Additional protection for embankments (riprap) may be necessary if soil conditions and cell sizes warrant.
- i) **Vegetation Control:** A method of control shall be specified which will prevent vegetation growth over the bottom of the lagoon, and along the inside dyke. Normally vegetation on dykes is controlled by mowing.

### **3.2 Lagoon Bottom**

- a) *Uniformity:*** The cell bottoms should be as level as possible at all points. Finished elevations should not be more than ten centimetres from the average elevation of the bottom. Shallow or feathering fringe areas usually result in locally unsatisfactory conditions.
- b) *Vegetation:*** The cell bottoms should be cleared of vegetation and debris. Organic material thus removed should not be used in the dyke core construction. However, suitable topsoil relatively free of debris may be used as cover material on the outer slopes of the embankment.
- c) *Soil Formation:*** The soil formation or structure of the cell bottoms should be relatively tight to avoid excessive liquid loss due to percolation or seepage. The minimum hydraulic conductivity for use of in-situ soils is  $1 \times 10^{-7}$  cm/s. Soil borings and tests to determine the characteristics of surface soil and subsoil shall be made a part of preliminary surveys to select lagoon sites. Gravel and limestone areas and areas with high water tables will require additional design considerations.
- d) *Percolation:*** The ability to maintain a satisfactory water level in the cells of a lagoon is one of the most important aspects of design. Removal of porous topsoil and proper compaction of subsoil improve the water-holding characteristics of the bottom. Removal of porous areas, as gravel or sandy pockets, and replacement with well compacted clay or other suitable material may be required. Where excessive percolation is anticipated, sealing of the bottom with a clay blanket, bentonite, geosynthetic liner, asphaltic coating or other sealing material should be given consideration.

### **3.3 Materials for Containment**

- a) *Soil Liners:*** All soil materials designated as lagoon liner materials must have a hydraulic conductivity of  $1 \times 10^{-7}$  cm/s or less and be at least 1 metre in thickness. This can be achieved in several ways.
- i. *General Cut and Fill:*** When the material available at the chosen location is suitable (hydraulic conductivity of less than  $1 \times 10^{-7}$  cm/s without remoulding) a cut and fill cell may be the desired design. Areas of lesser quality materials must be removed, but the earthwork required is greatly reduced if suitable material is available in-situ.
  - ii. *Clay Liners at the Surface:*** When the material available at the selected site can achieve the required hydraulic conductivity when reworked, or if there is not sufficient material available on site, a clay liner with a minimum thickness of 1 metre (perpendicular to any surface) may be selected for the containment structure.
  - iii. *Cut off Walls:*** In the event of a site with suitable underlying clay materials at a reasonable depth, and more porous material at the surface, a cut off wall may be selected. The compacted clay cut off wall is designed to penetrate through the

lesser quality material close to the surface to the depth of the underlying clay to create a barrier. The cut off wall is usually located near the centre of the dykes of the cell or cells it surrounds.

- b) **Synthetic Liners:** When suitable in-situ or local materials are not available, typically synthetic liners are utilized to line the cells of the lagoon. Synthetic liners can be shaped in many sizes and shapes from materials such as high density polyethylene (HDPE), geosynthetic clay, bitumen or polyvinyl chloride (PVC). Special care, design and operational requirements may be necessary depending upon the type of synthetic liner installed. Gas collection systems are required under synthetic liners, and consideration should be given to hydrostatic pressure on the underside of the liner.
- i. **Liner test requirements:** The liner installer must complete a report after the liner has been installed and tested, and the approval of the assigned Environment Officer must be received prior to the covering of the liner and the use of the lined cell. The installation report must include a location plan showing all panels of the liner, and, typically in tabular form, the dates of panel installation, a description of each panel including its size and origin, the names of persons seaming and testing each panel, a reference to the testing method, a list of liner penetrations for inlet and outlet pipes, and a list of repairs, including type, location, reason, and repair technician. The Environment Officer normally inspects the liner during the construction process.
  - ii. **High density polyethelene (HDPE) liners:** The liner thickness must not be less than 60 mils (60/1000 inches). Cover material with a thickness not less than 300 mm is required on all HDPE material that is not ultraviolet stabilized to prevent deterioration of the material in sunlight. Cover material with a thickness not less than 300 mm is required on the floor of primary cells, and on the floor of secondary cells where sludge removal will be required in the future. (i.e., where phosphorus will be precipitated in secondary cells.) Where no cover material is used on dyke sideslopes, more stringent fencing requirements may be imposed to prevent access to the cells by people and animals, since uncovered HDPE material may be slippery and prevent escape. Where a continuous liner is proposed without cover material over an intercell dyke and operator access to an intercell pipe valve is needed, operator safety should be considered and slipping hazards should be prevented. Consideration should be given to emergency egress routes at corners of the cells.
  - iii. **Polyvinyl Chloride (PVC) liners:** The liner thickness must not be less than 30 mils (30/1000 inches). Cover material with a thickness of not less than 300 mm is required on all PVC liner surfaces for ultraviolet light protection and puncture protection. Note: PVC liners are generally no longer selected by designers for new facilities due to installation and performance limitations. The applicable design considerations apply to repairs of the liners of existing PVC lined facilities.

### **3.4 Influent Lines**

- a) **Material:** Any generally accepted material for underground sewer construction will be given consideration for the influent line to the lagoon. The material selected should be adapted to local conditions. Special consideration must be given to the character of the wastes, possibility of septicity, exceptionally heavy external loading, abrasion, the necessity of reducing the number of joints, soft foundations, and similar problems. Surcharging of the sewer upstream from the inlet manhole (on gravity lines) is not advised.

- b) **Point of Discharge:** The influent line to the primary cell should be essentially center discharging. Each cell of a multiple celled lagoon operated in parallel shall have its own near center inlet, but this does not apply to those cells following the primary cell when series operation alone is used. Influent lines or interconnecting piping to secondary cells of multiple celled lagoons operated in series may consist of pipes through the separating dykes. Influent and effluent piping should be located to minimize short-circuiting within the lagoon.
- c) **Inlets:** Inlets used for gravity flow should enter the lagoon at a relatively steep slope and may discharge horizontally onto a splash pad. When upward discharging lines are used, the discharge end of the pipe should be located not more than 30 centimetres above the bottom of the cell to avoid ice. Force mains shall be valved at the lagoon.
- d) **Discharge Apron:** The end of the discharge line should rest on a suitable concrete or appropriate apron with a minimum size of 1 metre square.
- e) **Manholes:** Manholes or cleanouts are recommended where pipes pass through the embankment to facilitate sampling, inspection, and maintenance.

### **3.5 Interconnecting Piping**

- a) **Material:** Interconnecting piping should be of suitable material considering structural detail, design detail, and operational performance.
- b) **Primary Cell Overflow Structure:** No overflow structures should be included on external dykes; these structures may facilitate uncontrolled releases of effluent from a facility.
- c) **Interconnecting Piping:** Interconnecting piping for multiple unit installations operated in series should be valved or provided with other arrangements to regulate and isolate flow between cells and permit flexible depth control. The interconnecting pipe to the secondary cell should discharge horizontally near the lagoon bottom to minimize need for erosion control measures.
- d) **Outlet:** The outlet invert should be at least thirty centimetres above the cell bottom to control eroding velocities and avoid the pickup of bottom deposits.

### **3.6 Wastewater Haul Accommodations**

- a) **Spillway:** If the facility is to accept truck hauled wastewater, a concrete or equivalent spillway must be installed to channel the wastewater to enter the cell without causing erosion or negative effects on the interior dykes of the facility. The spillway must have a hard smooth surface that will not retain solids.
- b) **Manhole Truck Dumping Facility:** The discharge of truck hauled wastewater into a manhole at the facility or into a gravity sewer upstream of the facility should be avoided. Operating experience indicates that this practice leads to plugging of the pipe between the manhole and the lagoon, and costly maintenance.
- c) **Roadway and Turnaround:** An all weather access road to the spillway and suitably sized area to reverse and turn around vehicles must be provided to prevent deterioration of the berm by access of loaded vehicles.

### **3.7 Miscellaneous**

- a) *Fencing:*** The lagoon shall be enclosed with a suitable fence to exclude livestock, wildlife and discourage trespassing. A vehicle access gate of sufficient width to accommodate mowing equipment and wastewater hauling trucks should be provided. All access gates should be provided with locks, and gates should be locked at all times to prevent unauthorized access. Access is normally provided to authorized users by key or by a cardlock system.
- b) *Warning Signs:*** Appropriate signs should be provided along the fence around the lagoon to designate the nature of the facility and advise against trespassing.
- c) *Landscaping:*** Shrubs and other arboreal growths may be used for landscaping and shielding purposes, but should be located outside, not on, the embankment.
- d) *Location on Property:*** Lagoons should be located such that sufficient distance is available between the lagoon and the property line or the lagoon and the fence line for access of maintenance equipment. It is recommended that a minimum distance of 30 metres be maintained between the outside toe of the embankment and the fence line or property line.