IOWA WASTEWATER FACILITIES DESIGN STANDARDS

CHAPTER 21

Land Application Of Wastewater

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21.1 GENERAL DESIGN CONSIDERATIONS

The following design considerations apply to two methods of wastewater application on land: slow rate (irrigation), and overland flow. The engineering report shall contain pertinent information on the proposed site(s) including: location, geology, soil conditions, area for expansion, groundwater conditions and any other factors which may affect the feasibility and acceptability of the proposal. The engineering report shall also include pretreatment and storage requirements, a management program stating the objectives of the land application, the design application rates and monitoring. The source should be given for any information used by the consultant in design.

21.1.1 Site Considerations

21.1.1.1 Site Identification

The following information concerning the site shall be provided:

a. Legal description of the disposal site.

b. The location, use, and ownership of all existing and proposed residences, commercial or industrial developments, roads, ground or surface water supplies and wells within one-half mile of the proposed site.

c. Available land area, both gross and net areas (i.e., excluding roads, right-of-way encroachments, stream channels, and unusable soils).

d. Distance from the pretreatment and the storage facilities to the application site, including elevation differential.

e. Proximity of site to industrial, commercial, residential developments; surface water streams; potable water wells; public use areas such as parks, cemeteries, or wildlife sanctuaries.

f. Present and future land and groundwater uses.

g. Location, depth and outlet of known field drain tiles on the site.

h. A summary describing the existing vegetation of the area.

i. A description, including maps showing elevations and contours, of the site and adjacent areas which may be suitable for expansion. Specific information on the maximum and average slopes of the site must be provided.

21.1.1.2 Site Criteria

a. Wetted Disposal Area

The wetted disposal area must conform to the following criteria. For the distance requirements below, the wetted disposal area is the land area which is normally wetted by wastewater application.

1. Flood prone areas which flood at a frequency greater than once every ten (10) years should not be the sole source of land disposal. (Information on which land is subject to flooding more frequently than once in ten (10) years is available from this Department.)

2. The wetted disposal area shall be established at least 300 feet from existing dwellings or public use areas. Public use areas do not include roads or highways. In addition, the wetted disposal area shall be at least 50 feet inside the property line on all sides of the land application site. Distances may be reduced depending upon the extent of pretreatment and operational techniques such as ridge and furrow irrigation.

3. The wetted disposal area shall be at least 400 feet from any existing potable water supply well not located on the property. Adequate protection shall be provided for wells located on the disposal site.

4. The wetted disposal area shall be at least 300 feet from any structure, continuous flowing stream or other physiographic feature that may provide direct connection between the ground water table and the surface.

5. The disposal area shall be posted along roads and public use areas. A minimum of one sign shall be placed on each side of the disposal area. The perimeter distance between any two signs shall not exceed 500 feet. Each sign shall clearly identify the nature of the facility and advise against trespassing in letters not less than 2 inches high.

21.1.2 Groundwater

21.1.2.1 Fieldwork Determination

As a minimum, fieldwork shall determine:

a. Depth to normal groundwater

b. General groundwater flow conditions.

c. Depth, area and duration of maximum groundwater.

d. Direction of flow.

21.1.2.2 Initial Groundwater Quality

Groundwater tests for the following constituents shall be conducted at sufficient locations to provide information on the initial groundwater quality. The number, location, and depth of monitoring wells needed to monitor these constituents shall be included.

a. Total organic carbon (TOC).

b. Total dissolved solids, sodium absorption ratio, and electrical conductivity.

c. Total nitrogen, ammonia nitrogen, organic nitrogen and nitrate nitrogen.

d. Total phosphorus.

e. Chloride.

f. pH.

g. Alkalinity.

h. Hardness.

i. Trace elements.

(1) Aluminum
(2) Arsenic
(3) Berylium
(4) Boron
(5) Cadmium
(6) Chromium
(7) Cobalt
(8) Copper
(9) Fluoride
(10) Iron
(11) Lead
(12) Lithium
(13) Manganese
(14) Molybdenum
(15) Nickel
(16) Selenium
(17) Zinc

j. Coliform Bacteria.

21.1.3 Geological Information

21.1.3.1 Soil Profile

a. Soil Testing

1. A description of the material underlying the proposed site is required. This shall include stratigraphic sections based on a number of borings adequate to accurately determine the geology of the proposed site, unless the department agrees that an equivalent description may be obtained without borings. A drilling location plan and drilling log shall be submitted for each series of samples. Soil borings shall be conducted by a qualified organization normally engaged in soil testing activities to determine subsurface soil characteristics. Additional information, including additional borings, may be required for any additional locations of specific concern to the department.

2. The stratigraphic sections shall be described from the surface to a depth 25 feet or to bedrock, whichever is less.

3. The soil at a potential site shall be identified in each soil layer in terms of its hydraulic, physical, and chemical characteristics. Required physical characteristics include texture, structure, and soil depth. Required hydraulic characteristics are infiltration rate and permeability of the most restrictive layer. Chemical characteristics required include pH, cation exchange capacity, nutrient levels, the adsorption and filtration capabilities for various inorganic ions, heavy metals, and phosphorous adsorption. These characteristics shall be identified from the surface to a depth of 5 feet. An explanation of these various tests are provided in Appendix "F" of the EPA Process Design Manual for Land Treatment of Municipal Wastewater (EPA 625/1-77-008).

b. Other Profile Information

The geological information shall also provide the degree of weathering of any shallow bedrock; the local bedrock structure, including the presence of faults, fractures and joints; and in limestone terrain, additional information about sinkholes and solution openings.

21.1.3.2 Soil Requirements

a. Wetted Disposal Area

The wetted disposal area shall have a soil mantle of at least 5 feet overlaying any sand or gravel strata.

b. Erosion Control

The topography of the site and adjacent land shall be evaluated for areas of potential erosion. The effects of both applied wastewater and storm runoff shall be considered. Special consideration should be given to the period of construction and system startup, when vegetative cover may be lacking or not fully developed.

21.1.4 Initial Wastewater Analysis

An initial analysis of the untreated wastewater must be conducted. The analysis shall consist of at least one week of daily composites. The constituents to be monitored are those listed in 21.1.2.2.

21.1.5 Preapplication Treatment

As a minimum, treatment prior to land application, shall provide treatment equivalent to that obtained from a primary lagoon cell constructed and designed in accordance to Chapter 18C of these standards. The maximum organic loading on the primary cell(s) (based upon the total water surface area of the primary cell(s) at the maximum water depth of six feet) shall not exceed 25 pounds BOD_5/acre/day. The minimum drawoff level of the primary cell shall be at the two foot level. Drawoff for direct wastewater application must be from the storage cells. Piping shall be arranged such that the drawoff from the primary cell cannot be used for direct wastewater application.

Additional treatment may be required to obtain and maintain the limitations determined or stated in the remaining portion of this section. The additional treatment will be weighed against the alternative of increasing the amount of land.

21.1.6 Land Application Facility

21.1.6.1 Hydraulic Loading Rate

The hydraulic loading rate shall be determined by utilizing a water balance per month of operation. This shall contain sufficient supporting information for its use.

The hydraulic loading is based on a water balance that includes precipitation, infiltration rate, evapotranspiration, soil storage capabilities, and subsoil permeability. Generally, the total monthly application should be distributed uniformly, but considerations must be made for planting, harvesting, drying, and other

nonapplication periods. The application rate must then be balanced as shown in the following equation:

$$L_w + Pr = ET + W_p + R$$

where L_w = wastewater hydraulic loading rate, in./mo.
Pr = design precipitation, in./mo.
ET = evapotranspiration, in./mo.
Wp = percolating water, in./mo. [must = 0 for overland flow systems]
R = net runoff, in./mo. [must = 0 for slow rate system]

The relationship in the above equation can be used for a weekly balance, a monthly balance as shown, or an annual balance. Design precipitation is calculated from a 10 year return frequency analysis of wetter-than-normal conditions using data available from the Soil Conservation Service, the National Oceanic and Atmospheric Administration (NOAA), local airports or newspapers. Evaporation estimates can be obtained from extension specialists and from the sources listed above.

The option presented in section 21.1.7.4 may alter the above balance. Use of the option will require a full explanation of changes to this balance.

System design calls for an application schedule broken up into months. Utilizing the above equation the applicant must calculate the amounts of wastewater to be applied each month. For evapotranspiration to be used, the applicant must consult an extension service and use no more than the evapotranspiration expected for the appropriate crop and application technique.

For slow rate systems, percolating water (Wp) shall be restricted to a maximum of 10 inches per month unless the applicant submits documentation from an agronomist or soil specialist verifying a greater percolating value.

21.1.6.2 Nitrogen Loading

a. Nitrogen Balance

The total nitrogen from wastewater, commercial fertilizer or any other source shall be balanced against the expected nitrogen demand of the crop. The total poundage of nitrogen loading shall be calculated from the total volume of wastewater applied per year and the concentration of nitrogen (Kjeldahl plus nitrate) in the wastewater. Due to denitrification in soil, a maximum loss of 20% of the applied nitrogen annual loading is allowed. The annual nitrogen balance shall be calculated by the following equation:

$$L_n + K = U + D + 2.7\ WpCp$$

where $L_n = 2.7\ C_n L_w$ = wastewater nitrogen loading (lb/acre-yr.).

where C_n = applied nitrogen concentration from the pretreatment facility (mg/l).

L_w = wastewater hydraulic loading, ft/yr.

2.7 = conversion factor.

K = All other nitrogen sources, lb/acre-yr.
U = Crop nitrogen uptake, lb/acre-yr.
D = Denitrification, lb/acre-yr.
2.7 = Conversion factor
Wp = Percolating water, ft/yr.
Cp = Percolate nitrogen concentration, mg/l.

b. Percolate

The total nitrogen in the percolate shall not exceed 10 mg/l.

21.1.6.3 Phosphorus Loading

Phosphorus loading is to be addressed when both (1) the concentration of applied phosphorus exceeds 15 mg/l and (2) when the soil pH after association with the wastewater is less than six. When the above applies, the potential of soil plugging and site longevity with respect to phosphorus must be evaluated.

21.1.6.4 Trace Element Loading

The total individual trace element loadings shall not exceed the following. Application rates shall be based on a minimum site-life of 30 years.

Metal	Soil cation exchange capacity (21-A) (meq/100 g)*		
	< 5	5 to 15	> 15
	Maximum amount of metal (lb/acre)		
Lead (Pb)	500	1,000	2,000
Zinc (Zn)	250	500	1,000
Copper (Cu)	125	250	500
Nickel (Ni)	50	100	200
Cadmium (Cd)	5	10	20

* Determined by the pH 7 ammonium acetate procedure.

If the treatment works has other toxic constituents in its wastewater, the wastewater shall not contain the other toxic constituents in excess levels determined by the Department to pose a threat to human, animal or plant life.

21.1.6.5 Salinity Restrictions

The wastewater classification $C_1 - S_1$ (Figure 1) is an acceptable range for applying waste water to soil. Classifications $C_1 - S_2$, $C_2 - S_2$ and $C_2 - S_1$, will also be acceptable provided that the applicant demonstrates that there is sufficient leaching available to eliminate salinity problems. The remaining classifications will generally not be acceptable for land application in Iowa.

Table 1, Table 2 and Figure 2 are to be used when determining leaching. Interpolation may be necessary to obtain the electric conductivity of the appropriate crop.

21.1.6.6 Disinfection

Disinfection shall be provided for all land application systems which intend to employ any type of spray application technique. Disinfection must precede actual spraying of the wastewater on to a field area and must not precede storage. The design shall provide a minimum contact time of 15 minutes with equipment necessary to maintain a residual chlorine level of 0.5 mg/l.

21.1.6.7 Crops and Vegetation

a. Crop Information

A description of the crops or vegetation to be grown are required for all systems in which vegetation is to be an integral part of the treatment system. This includes all slow rate and overland flow systems. The use of wastewater for irrigation of truck farms growing vegetables is prohibited. There shall be no direct consumptive use of the crop. The following information shall be provided:

1. Compatibility of the crop with site characteristics and design hydraulic loading rates.

2. Nutrient uptake.

3. Cultivation and harvesting requirements.

4. Crop management.

b. Crop Removal

The aerial or leafy shoot portion of the vegetative cover of grasses or forbs, if such are the main cover, shall be harvested at least annually.

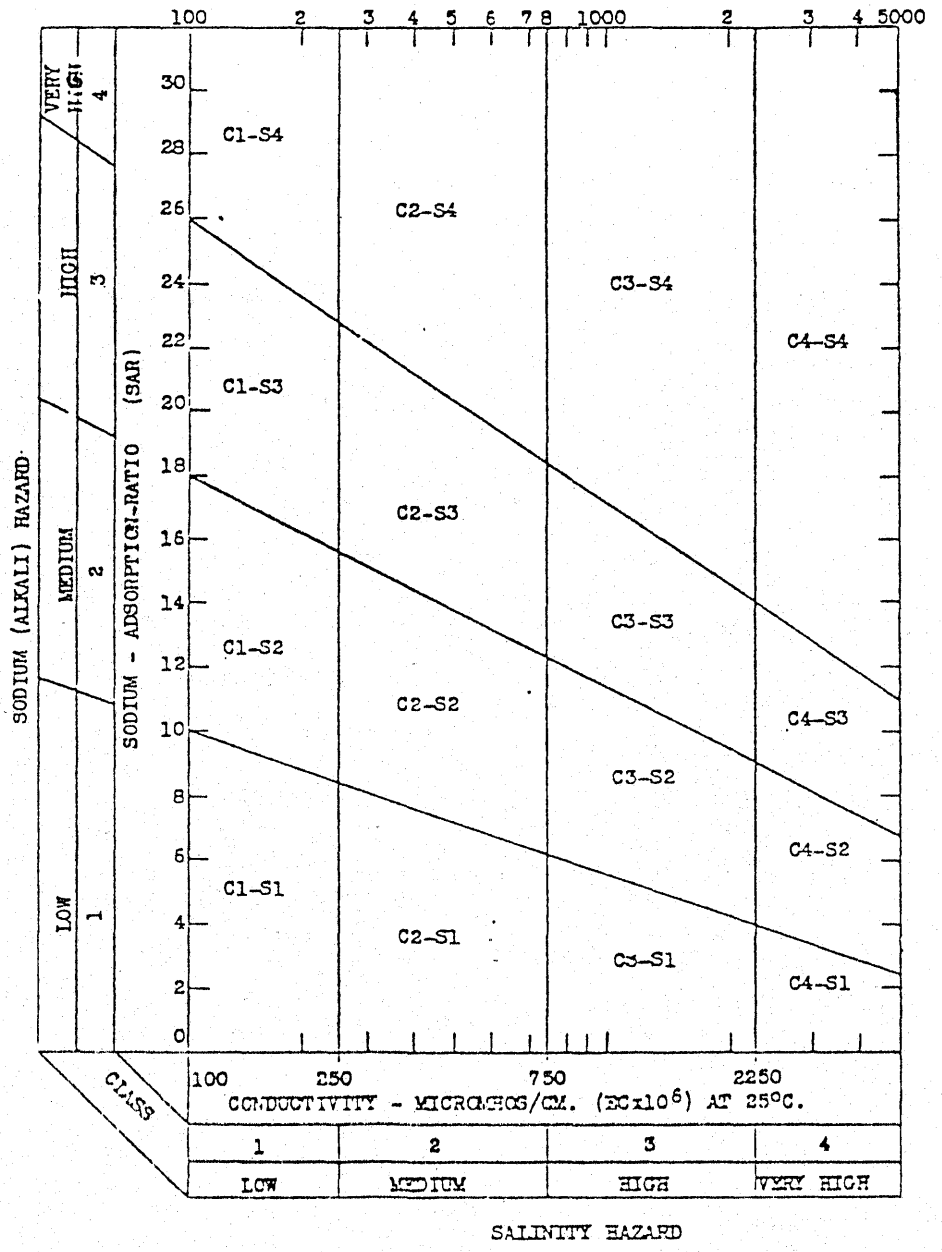


FIGURE I
Diagram for the classification of irrigation waters. (21-B)

TABLE 1. THE SALT TOLERANCE OF FORAGE CROPS (AS INDICATED BY THE ELECTRICAL CONDUCTIVITY OF SATURATED SOIL EXTRACT) (21-C)

High Tolerance 18,000 micromhos/cm	Medium Tolerance 12,000 micromhos/cm	Low Tolerance 4,000 micromhos/cm
Saltgrass	White sweetclover	White Dutch clover
Bermuda grass	Yellow sweetclover	Meadow foxtail
Canada wildrye	Perennial ryegrass	Alsike clover
Western wheatgrass	Sudan grass	Red clover
Barley (hay)	Hubam clover	Ladino clover
Birdsfoot trefoil	Alfalfa (Calif. common)	
	Tall fescue	
	Rye (hay)	
	Wheat (hay)	
	Oats (hay)	
	Orchardgrass	
	Meadow fescue	
	Reed canary	
	Smooth brome	
12,000 micromhos/cm	4,000 micromhos/cm	2,000 micromhos/cm

TABLE 2. THE SALT TOLERANCE OF FIELD CROPS (AS INDICATED BY THE ELECTRICAL CONDUCTIVITY OF SATURATED SOIL EXTRACT) (21-D)

High Tolerance 18,000 micromhos/cm	Medium Tolerance 10,000 micromhos/cm	Low Tolerance 4,000 micromhos/cm
Barley (grain)	Rye (grain)	Field beans
Sugar beet	Wheat (grain)	
Rape	Oats (grain)	
Cotton	Rice	
	Sorghum (grain)	
	Corn (field)	
	Flax	
	Sunflower	
	Castor beans	
10,000 micromhos/cm	6,000 micromhos/cm	

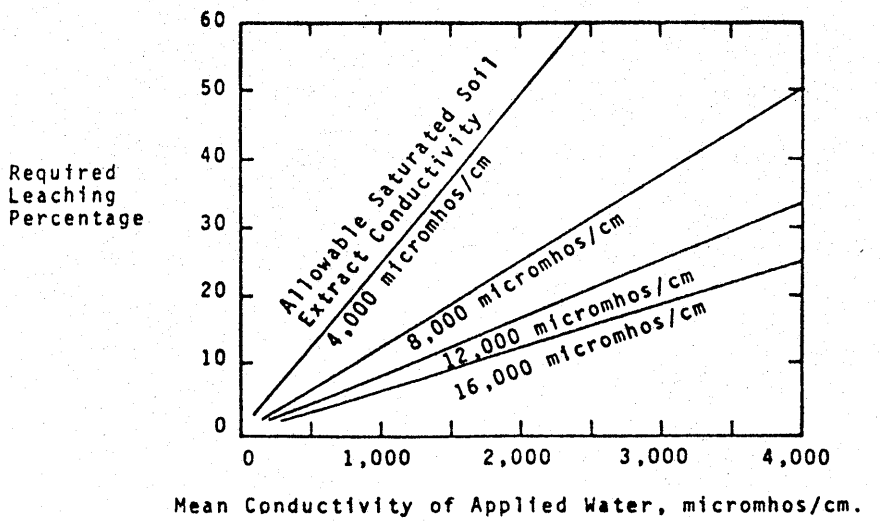


Figure 2 Required Leaching Percentage (21-C)

21.1.7 Storage Facility

21.1.7.1 Storage Time

Figure 3 depicts the minimum days of storage based on climatic restraints. In some cases the minimum number of storage days (see figure 3) may have to be increased to accommodate months in which the precipitation exceeds or equals the percolate plus evapotranspiration.

An exception to this is a system where flows are generated only during the application period. A storage capacity of 45 days or the flow generated during the period of operation, whichever is less, must be provided.

21.1.7.2 Construction

In general, the construction of a storage lagoon shall conform with 18C of these standards. The maximum total water depth shall not exceed 10 feet. The minimum drawoff shall be at the two foot level.

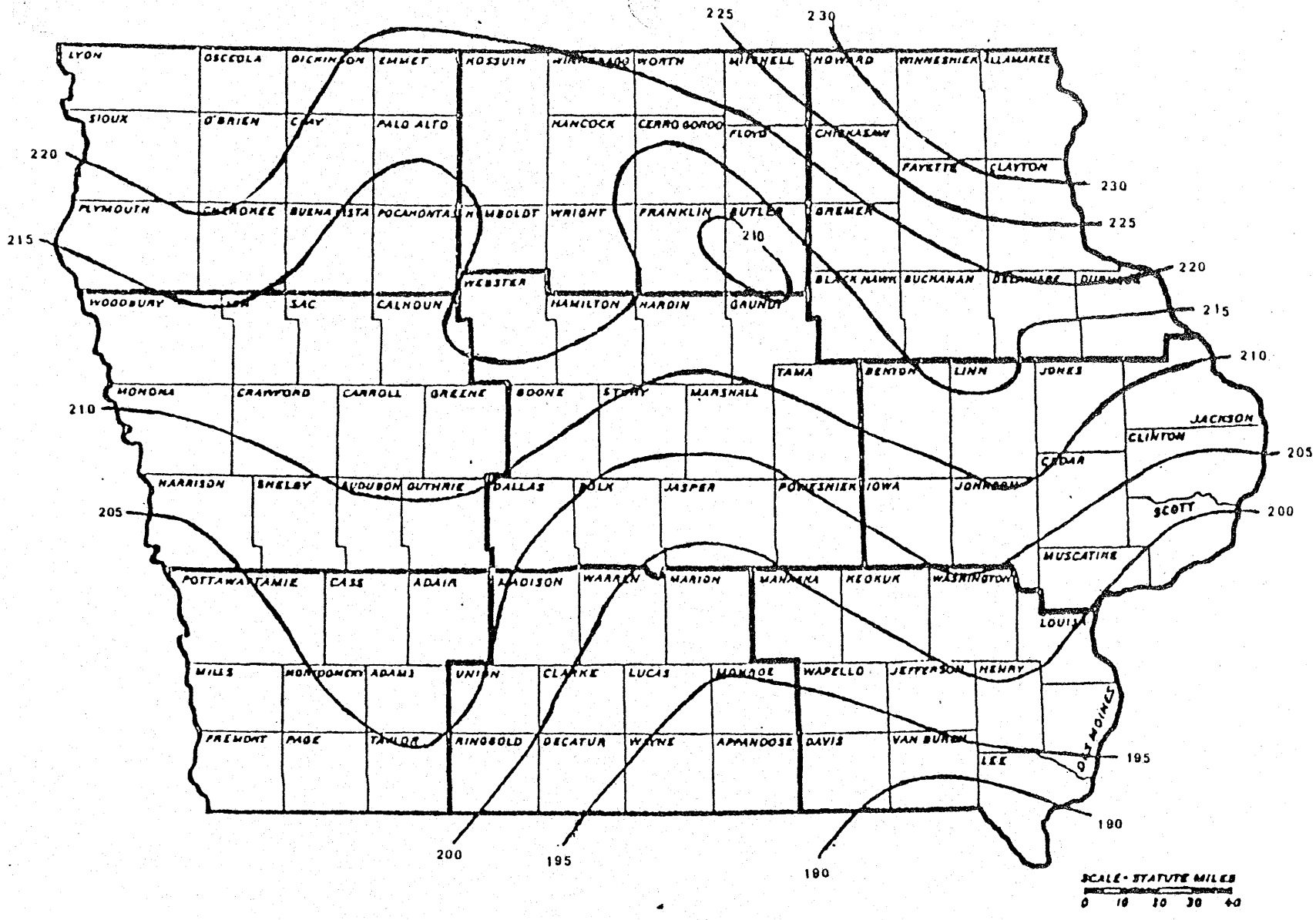
21.1.7.3 Reliability

There shall be a minimum of two storage cells with the capability of series and parallel operation.

21.1.7.4 Storage Option

Because of the lengthy storage requirement, an option to discharge from the storage facility to a receiving waterway on a periodic basis may, in some cases, be cost effective. To utilize this option the applicant will be required to provide storage for 180 days of average wet weather flow. However, the storage facility shall be designed in accordance with Chapter 18C of these standards (i.e. 8 foot maximum operating depth in the storage cells). This option will require an Iowa NPDES Operation Permit as well as a schedule noting the time of expected discharge and volume. The volume discharged must not reduce the volume of the remaining wastewater to less than that necessary for full utilization of land application.

Discharge from a storage facility to a waterway will be acceptable only if (1) the storage facility has obtained an Iowa NPDES Operation Permit (2) the limitations listed in the Iowa NPDES Operation Permit are met and (3) land application has already been utilized to its maximum potential.



MINIMUM DAYS OF STORAGE
DUE TO CLIMATIC RESTRAINTS (21-E)

FIGURE 3

21.1.8 Reliability

21.1.8.1 General

The applicant shall submit a feasible alternative plan of wastewater treatment if and when the largest application area is out of service due to system breakdown.

21.1.8.2 Equipment

a. Any spray application equipment specified shall minimize the formation of aerosols.

b. A parts inventory for the application equipment shall be specified to expedite repair.

c. The system shall be designed to assure uniform distribution of wastewater over the application area.

d. Provisions should be made for draining the pipes to prevent freezing if pipes are located above the frost line.

21.1.8.3 Manpower

The applicant shall estimate the necessary manpower for proper operation, maintenance, and monitoring of the operation. Availability of such manpower should be established.

21.1.9 Monitoring Systems

21.1.9.1 Frequency

As a minimum, the reporting frequency shall be in accordance with the following:

a. Every three months for less than 0.5 mgd

b. Every two months for 0.5 - 2.0 mgd

c. Every month for greater than 2.0 mgd

21.1.9.2 Parameters

The parameters stated in 21.1.2.2 of these standards shall be monitored unless the applicant has demonstrated their insignificance in the influent wastewater. Additional parameters may require monitoring if found in significant concentration in the wastewater.

21.1.9.3 Location

a. Effluent; the location of monitoring shall be prior to site application.

b. Groundwater; the location of monitoring shall be adjacent to the site both up and down stream of the site in reference to the general groundwater flow direction.

21.1.9.4 Operational

a. Date of application.

b. Location of area and acreage used for the wee.

c. Precipitation, snow cover, and temperature on the day of application.

d. Volume of wastewater applied from pretreatment facility.

e. Volume of wastewater applied from storage facility.

f. Total volume of wastewater applied.

g. Duration of application for each cycle.

h. Type of crop grown.

i. Harvesting of crop (if used).

j. Ultimate use of the crop (if used).

21.1.10 Effluent and Groundwater Limitations.

21.1.10.1 Effluent

If discharged to a stream, monitoring of the recovered water from pumped withdrawal, underdrains, or collected runoff from overland flow shall be in accordance with the requirements listed in the Iowa NPDES Operation Permit.

21.1.10.2 Groundwater Limitations

The following requirements shall apply to all subsurface waters such as a ground water aquifer.

a. The groundwater resulting from the land application of wastewater after dilution with the affected native ground water shall meet this Department's standards for drinking water supplies as defined in 400-22 of the Iowa Administrative Code Section 22.3 (455B). If the existing concentration of a parameter in the native ground water exceeds the drinking water standards, there shall not be an increase in the concentration of the parameter due to land application of wastewater.

b. Any significant detrimental change in the groundwater at or near the site shall constitute grounds for requiring additional pretreatment and/or abandonment of the disposal site.

c. The applicant shall submit a feasible alternate plan of wastewater treatment if and when the contaminant levels of the ground water exceed the maximum allowable concentration.

21.2 SLOW RATE LAND APPLICATION

In a slow rate land treatment system, surface application includes ridge-and-furrow, border strip flooding and surface spraying. The applied wastewater is treated as it flows throught the soil matrix. A portion of the flow is taken up by the vegetation and the remaining flow percolates to the groundwater. Vegetation is a critical component for managing water and nutrients.

21.2.1 Site Criteria

In addition to the site criteria presented in 21.1.1.2, slow rate systems must also abide by the following:

a. The wetted disposal area shall be at least 1000 feet from any shallow public water supply well.

b. The wetted disposal area shall be at least 500 feet from any public lake or impoundment.

c. The wetted disposal area shall be at least 1/2 mile from any public lake or impoundment used as a source of raw water by a potable water supply.

21.2.2 Groundwater

21.2.2.1 Groundwater Table

The maximum anticipated elevation of the groundwater table shall be at least 5 feet below the surface within the disposal area.

The applicant must identify the following factors for all slow rate systems:

a. The extent of the recharge mound.

b. The need for underdrainage or pumped withdrawal.

c. The effects of the system on direction and rate of groundwater flow.

21.2.2.2 Underdrain

Where the site is to be underlain by field tile and the percolate is intercepted for discharge to surface waters, the minimum vertical distance between the surface of the irrigation field and the field tile shall be 3 feet.

21.2.3 Geology

Soils having permeability rates of 0.6 - 6.0 inches/hour are suitable for irrigation. Values below 0.2 inches/hour will generally require artificial drainage or overland flow approach.

The wetted disposal area shall have a soil mantle of at least 15 feet overlaying any rock, limestone or impermeable strata.

21.2.4 Topography

The maximum allowable slope of the wetted disposal area is 5%. When the site has slope in excess of 5%, a runoff control plan must be submitted to the local Soil Conservation District for approval. Soil conservation plans are developed with the assistance of a Soil Conservation Service conservationist.

21.2.5 Trace Element Limitations

Heavy metals and other toxic elements from the storage or treatment facility shall not exceed the maximum concentration found in the following table:

MAXIMUM CONCENTRATIONS OF TRACE ELEMENTS IN APPLIED WASTEWATER (21-F)

Element	Limits mg/l
Aluminum	10.00
Arsenic	0.20
Beryllium	0.20
Boron	1.40
Cadmium	0.02
Chromium	0.20
Cobalt	0.10
Copper	0.40
Fluoride	1.80
Iron	10.00
Lead	10.00
Lithium	2.50
Manganese	0.40
Molybdenum	0.02
Nickel	0.40
Selenium	0.04
Vanadium	0.10
Zinc	4.00

21.2.6 Storage Requirements

The minimum amount of storage following pretreatment shall be determined from Figure 3. These days are considered minimum and should be increased by adding days required for crop planting, crop management, land management and crop harvesting.

21.2.7 Application Restrictions

21.2.7.1 Application Based on Permeability

The application rate should not exceed one half the design sustained permeability rate and in no case should be greater than 1 inch per hour.

21.2.7.2 Application Based on Limiting Factor

If nitrogen is the limiting factor in application, then the application of wastewater must stop upon harvest of the crop or the application must be reduced to assimilate the removal rate of the soil.

However, if the limiting factor affecting the application rate is water, the application of wastwater may continue until such a time that another limiting factor is reached, such as nitrogen or field capacity. The addition of wastewater after harvest must take into account the following year limitation. That is, if corn is planted this year and the limiting parameter is hydraulics and the nitrogen application is 20 pounds per acre less than the upper limit of crop uptake, then the nitrogen addition of 20 pounds per acre following harvest will be acceptable provided that some other limiting value is not exceeded.

21.2.7.3 Application During Frost and Runoff

Application of wastewater will not be allowed during periods of ground frost or during rainfalls.

21.2.7.4 Application to Public Use Areas

a. The public shall not be allowed into an area when spraying is being conducted.

b. Any drinking water fountains located on or near the application area must be protected from direct or wind blown reclaimed wastewater spray.

c. For golf courses utilizing wastewater, notice of its use shall be given on scorecards. Water hazards should have warning signs to warn against drinking of the water by the public. All piping and sprinklers associated with the distribution or transmission of wastewater shall be color coded and labeled or tagged to warn against the consumptive use of contents.

21.2.8 Resting or Drying Period

The application cycle, or the combination of application and resting periods, shall be defined in the form of an operating schedule. The length of the cycle and the ratio of wetting to drying depends on site-specific factors and may include seasonal variations.

21.2.9 Land Owner Agreements

Any party utilizing the slow rate irrigation method on an area owned by another party shall provide the Department with signed copies of documents establishing their legal rights to utilize the area for not less than five years. Such documents shall include provisions for option renewals specifying that at least one years notice is given to the party utilizing the area for disposal if the owner does not intend to renew the agreement. If the documents are not signed within 18 months following the selection of a land application system as the treatment facility, the Department may require that an alternative type of treatment be employed.

21.2.10 Water Rights

Any existing faciltiy with a permitted discharge which intends to irrigate any of its effluent must receive approval from the Iowa Natural Resource Council prior to issuance of an Operation Permit from this Department.

21.3 OVERLAND FLOW

Overland flow distribution is accomplished by applying wastewater uniformly over relatively impermeable sloped surfaces which are vegetated. Part of the flow percolates into the ground, a portion is lost to evapotranspiration while the remaining is collected and either discharged to a stream or reapplied on land.

21.3.1 Groundwater

The maximum ground water elevation shall be at least 2 feet below the application surface.

21.3.2 Geology

Soils having a percolation rate of greater than 0.2 inches/hr. will not be acceptable.

21.3.3 Topography

21.3.3.1 Slope

The land slope should be relatively uniform to prevent ponding and be in the range of 2 - 8%. If slopes greater than 8% exist, terracing shall be provided. For all overland flow systems, the slope must be as nearly equal to a plane surface as possible and sloped in such a way as to prevent short-circuiting of the wastewater. No swales, depressions, or gullies are permitted.

21.3.3.2 Length of Travel

300 feet is the maximum length over which distribution of wastewater can be maintained.

21.3.4 Storage Requirements

The minimum amount of storage following pretreatment shall be determined from Figure 3. The applicant shall increase the storage facility to accommodate rainfall on the application site. The above storage is then to be increased to accommodate any recirculation needed to comply with the limitations in the Iowa NPDES Operation Permit.

21.3.5 Overland Flow Facility Design

21.3.5.1 Hydraulic Loading

The maximum hydraulic application rate is 3 inches/week. The distribution system shall be designed to permit application on each field for 6 to 8 hours/day. Optimum wetting to drying cycle should range from a maximum of 6 to 8 hours on and a minimum of 16 to 18 hours off.

21.3.5.2 Nitrogen Loading

For overland flow systems, the denitrification of 20% of the applied nitrogen may be conservative. To utilize a value greater than 20%, the applicant must either have documentation from an agronomist and soil specialist, or run a pilot plant to verify a greater denitrification value. If a value greater than 20% is verified, the applicant must submit data which will specify the percent denitrification expected for the various temperatures in which the system will be operated.

21.3.5.3 Distribution System

a. General

The system must be valved and manifolded to permit a portion of each application area to be taken out of service for grass mowing and/or harvesting.

b. Sprinklers

Sprinklers shall be placed downslope from the highest point on the application area at a distance equal to the radius of the sprinkler, unless one-half circle sprinklers are used.

c. Surface Distribution

For surface distribution methods such as gated pipe or bubbling orifice, gravel may be necessary to dissipate energy and insure uniform distribution of water.

21.3.5.4 Vegetation

a. Crop Cover

Grasses must be selected for their resistance to continuously wet root conditions. Also, their growth should not be in clumps as this will result in the formation of rivulets of flow rather than a uniform sheet flow. Common grasses for this purpose have been reed canary grass, Italian rye, red top, tall fescue, and Bermuda grass. Application is not allowed until a full grass cover has been established.

b. Crop Removal

Vegetation harvest and removal is required. The vegetation must be cut just prior to maturity (every 4 to 6 weeks) and physically removed from the site.

21.3.5.5 Access

Site access requires special equipment with broad tires having low pressure (less than 10 lb/in.^{2}) to avoid creating ruts that would short-circuit the flow.

21.3.5.6 Collection Ditches

A network of ditches must be constructed to intercept the runoff and channel it to the point of discharge or storage. They must be graded to prevent erosion, yet, at the same time, they must have sufficient slope to prevent ponding in low spots. The collection system must be designed to accept the added flow from rainfall runoff.

If the collection ditch discharges to a stream, the effluent must meet the limitations and monitoring required in the Iowa NPDES Operation Permit. If the collected water cannot comply with the permit limitations it will be required that the flow be either returned to the top of the application area for additional treatment or transmitted to storage.

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