MISSOURI
NATURAL RESOURCES

Missouri
Industrial Nutrient Management Technical Standard (INMTS)
for Industrial Wastewater and Wastewater Treatment Residuals

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Division of Environmental Quality

Water Protection Program

Introduction

Purpose

This Industrial Nutrient Management Technical Standard (INMTS) has been developed to provide a framework for the protocol(s) and method(s) that facilities must utilize when determining the form, source, amount, timing, and method of application on individual land application fields. This INMTS establishes procedures for ensuring nutrients and other elements or compounds land applied will be utilized through the agricultural practices in place. This framework seeks to achieve realistic production goals while ensuring appropriate agricultural utilization of the nutrients in the process wastewater while also minimizing movement of nitrogen, phosphorus, and other potential water contaminants into surface and/or ground water.

This INMTS will be used by the department as a guide for determining when precipitation-related discharges from permitted industrial wastewater land application fields are exempted as "Agriculture Stormwater Discharge," in accordance with Chapter 644.059 Revised Statutes of Missouri (RSMo). Land application of wastewater, process wastewater treatment residuals, and process waste will qualify for the Agriculture Stormwater Discharge exemption when they can demonstrate substantial compliance with this INMTS at the time of a precipitation-related discharge from land application areas.

All land application must provide a benefit to the soils, vegetation, or a specific agricultural commodity (nutrients) without harmful impacts to soils, crops, surface waters, groundwater, human health and the environment.

Applicability

In Missouri, any person land applying industrial wastewater, industrial wastewater treatment sludge, or related process wastes must follow the requirements set forth in this INMTS in accordance with the regulations found in 10 CSR 20-6.015, unless the department has approved, in writing, an alternative Land Application Management Plan. Manure that is regulated as industrial wastewater or process waste may follow the Concentrated Animal Feeding Operation (CAFO) Nutrient Management Technical Standard in place of this document. This document is not intended for domestic wastewater, domestic biosolids, or stormwater systems.

Definitions

- Access – Permission to enter, approach or pass through a location. For the purposes of this INMTS, access is divided into three classifications:
    - Public Contact Site – Land with a high potential for contact by the public, including parks, golf courses, and other areas with unrestricted access.
    - Non-Public/Non-"Agricultural Operation" – Land with moderate potential for contact by the public, including university owned lands, and community gardens
    - Agricultural Operation – Land with a low potential for contact by the public, as trespass is prohibited. The field must be used for farming, tillage of the soil, dairy farming, ranching, production or raising of crops, poultry or livestock, breeding, pasturing, training or boarding of equines or mules, or the production of poultry or livestock products in an unmanufactured state. These lands may or may not be under the full operational control of the permittee.
    - Controlled Field with Land-Use Agreement – Land with minimal potential for contact by the public, as the site access is restricted, and use of the field is controlled (requirements established for necessary deferments of use). These fields must be under the operational control of the permittee or under an agreement to comply with access and use restrictions.
- Commingled offsite Industrial Wastewater or Wastewater Residuals open storage basin or open storage vessel – An open earthen basin or open storage vessel (as defined in 644.016 RSMo) in which process wastes from other operating location(s) are brought in, stored, and mixed prior to land application.
- Field Management Plan – a field-specific plan of agronomic practices, including intended crops, pasture, hay or related vegetation, planned fertilizer or nutrient needs, and field management (e.g. single or double harvest).
- Food Processing Residuals – A food processing residual (FPR) is an incidental organic material generated by processing agricultural commodities for human or animal consumption. The term includes food residuals, food coproducts, food processing wastes, food processing sludges, or any other incidental material whose characteristics are derived from processing agricultural products. Examples include: process wastewater from cleaning slaughter areas, rinsing carcasses, or conveying food materials; animal feed production residuals; process wastewater treatment sludges; blood; bone; fruit and vegetable peels; seeds; shells; pits; cheese whey; off-specification food products; hides; hair; and feathers.
- Industrial wastewater – any water which, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, byproduct, or waste product, including discharges from a land application field. This does not include stormwater unless explicitly defined as wastewater in rule.
- Industrial Wastewater Treatment Residuals – sludges, biosolids or other residuals generated during manufactured or processing, or results from the production or use of any raw material, intermediate product, finished product, by-product, or waste product.
- Material – used herein, refers to process wastewater, process wastewater treatment residuals and process wastes, as defined in 10 CSR 20-2.010 and 10 CSR 20-6.015, intended to be land applied. For the purposes of this document, domestic wastewater, domestic biosolids, and manure are excluded.

- Missouri Soil Test Phosphorus Rating – The soil test phosphorus rating is found on a Missouri Soil Test laboratory report and indicates the relative level of plant-available phosphorus in the soil for a particular field. The soil test rating will indicate the probability that an application of phosphate on a particular field is likely to result in an increase in crop yield. A soil test phosphorus rating must be obtained from a lab accredited by the Missouri Soil Testing Association (list of accredited labs can be found at https://extension.missouri.edu/programs/soil-and-plant-testing-laboratory/spl-missouri-soil-accreditation-program) using procedures recommended by the University of Missouri (MU) Soil Testing Laboratory.
- Saturated Soil – Saturated soil conditions means that soil in which voids are filled with water. Saturation does not require flow. For the purposes of this INMTS, soils shall be considered saturated if standing water is present or the pressure of a person standing on the soil causes the release of free water.
- Surface Application – Land application method by which the material is broadcast or sprayed via mechanical equipment onto the ground surface. Surface application does not include material that is injected into the soil profile.
- Subsurface Injection – used for underground injection. Class V wells are sub-surface dispersal or injection of any industrial wastewater. UIC systems may be described as having "septic tanks" or "lateral lines" in addition to the traditional well type of injection. This action requires special permitting action and is not addressed herein.
- Subsurface Land Application – is an application method that furrows soil to place nutrients closer to the root zone or otherwise places the material in the shallow soils beneath the surface. Examples might include blading or knifing in. This practice is conducted across the full expanse of agricultural fields.
- Vegetated Buffer – A permanent strip of dense perennial vegetation established parallel to the contours of and perpendicular to the dominant slope of the field for the purposes of effectively slowing water runoff, enhancing water infiltration, and minimizing the risk of any potential nutrients or pollutants from leaving the field and reaching surface waters.

SECTION A – LAND APPLICATION RATES

Land application fields in the land application management plan shall use the following protocols to determine the field-specific placement, timing, and rate of material application so that the treatment capacity of the field is not exceeded.

In Missouri, land application rates shall be based on the three following criteria, with the most stringent result being the final land application rate:

- Pollutant Loading Rate – Material may not have pollutants present that exceed limits in Table 1.
- Hydraulic Loading Rate – the amount of water that the soil can hold without runoff.
- Nutrient Loading Rate – will be the primary focus of this Industrial Nutrient Management Technical Standard for Wastewater and Wastewater Treatment Residuals. In short, you cannot land apply more nutrients than is needed for the crops, pastures, or other agronomic purpose. Nutrient needs are determined by crop uptake (rates of nutrient removal known) and crop yields (data available by county at United States Department of Agriculture).

A1. Pollutant Loading Rates

Table 1. Maximum Pollutant Concentrations.
(Other pollutants of concern believed present will be addressed in a permit)

Pollutant	Limit
Arsenic	19 mg/kg
Cadmium	18 mg/kg
Chromium	258 mg/kg
Copper	692 mg/kg
Lead	138 mg/kg
Mercury	8 mg/kg
Nickel	194 mg/kg
Selenium	46 mg/kg
Silver	103 mg/kg
Zinc	1291 mg/kg
Pathogens	
E. coli (public contact site)	126 cfu/100mL
Salmonella (public contact site)	3 Most Probable Number per 4 grams of solids
Other enteric viruses (public contact site)	1 plaque-forming unit per 4 grams of solids
Fecal coliform (Non-Public/Non-Agricultural Operation)	2,000 Most probable Number per 1 gram of solids (dry weight basis) or per 100 mL
Fecal coliform (Agricultural Operation)	2,000,000 cfu or MPN/1 gram of solids (dry weight basis)**
Fecal coliform (Controlled field with land-use agreement)	No limit – Setbacks are doubled and material must be incorporated into the soil ***

** Materials have harvesting and grazing deferments and other restricted access that can address health concerns.

*** If Fecal Coliform is at or below 2,000,000 cfu or MPN/1 gram of solids, use original setbacks as shown in Table 3 below.

Animal/Organic Oil and Grease: Oil and grease application should not exceed 10,000 pounds oil/acre/year for subsurface land application or soil incorporation during tilling. For surface application to growing vegetation, the sludge shall not exceed 15 percent oil and grease content and shall not exceed 1,000 pounds oil/acre. Avoid surface and heavy application of oil and grease within 30 days before planting and after new growth is appearing for row crops. For fertilizers with high oil and grease concentration, care should be taken to avoid application for 72 hours before and after a rain event, as oil and grease are not absorbed well into saturated soils and lead to an increase in water runoff. Land application of petroleum impacted materials is not addressed in this INMTS; contact the Operating Permits Section for more information. Visible petroleum sheen is not permissible within agricultural runoff discharges. At the time a petroleum sheen discharge is observed, the agricultural runoff exemption is rescinded, and the facility will be required to report that to the department.

Chloride: Chloride phytotoxicity is highly variable and can be affected by vegetation type, soil, soil moisture, pH, crop growth (new growth versus established), and other factors. As such, a numeric limit is not established. However, care must be taken to minimize runoff into waters of the state, and to also eliminate plant toxic effects. Fields must be monitored to ensure that no phytotoxicity is occurring. If plant toxicity is observed, either reduce the application rate or avoid further application on the affected field.

Sulfur: If sulfur-laden materials are applied to fields while precipitation is taking place, the material may runoff into nearby waters, as sulfur is highly mobile. Additionally, high levels of sulfur can result in decreased seedling survival, thus land application of sulfur-containing material should be avoided 30 days prior to planting until new growth has appeared. The microbial oxidation and dissociation of sulfur compounds in soil solutions results in an increased level of acid (lowered pH), and thus fields must be monitored for signs of phytotoxicity.

pH: pH levels can potentially impact crop or forage growth and viability. A variety of shifts in solution concentration or nutrient availability to a plant may occur when the soil pH is changed. For several essential nutrients, both high and low pH reduce the availability to the plant. The application of low/high pH material must not cause phytotoxicity in crops. Fields must be monitored to ensure no phytotoxicity is taking place.

Other pollutants: May be evaluated with limits established through permitting, as needed, as long as they do not cause harmful impacts to soils, crops, surface waters, groundwater or human health and the environment. For some pollutants of concern, such as, aluminum, background concentrations may be used.

CERCLA/RCRA: Missouri State Operating Permits issued under the authority of the Missouri Clean Water Law cannot authorize land application of potential pollutants in amounts, concentrations, or quantities that would violate the limits, thresholds or requirements of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) hazardous substances or Resource Conservation and Recovery

Act (RCRA) hazardous waste. To satisfy this requirement, the department may establish site-specific permit limits for some pollutants that may be regulated under these authorities.

Certain pollutants are not able to be treated using land application. Please consult with your permit writer to determine whether land application is an acceptable treatment for any pollutants not addressed herein. Limits may be established in permit for pollutants not specifically listed herein.

A2. Hydraulic Loading Rates

The hydraulic loading rate must be based on the soil moisture holding capacity, antecedent rainfall, and depth to the most restrictive soil permeability. The hydraulic loading rate must meet one of the following:

(1) Default hydraulic loading rate not to exceed twenty-four inches per year (24"/yr), three inches per week (3"/wk) and one inch per day (1"/day).
(2) Site specific hydraulic loading rate cannot exceed the values determined in a soils report and loading design, signed by a soils scientist. The maximum application rate cannot exceed ten percent (10%) of the design sustained soil permeability rate for the number of days per year when soils are not frozen.

A3. Process for Establishing Nutrient Loading Rates

There are three options for determining Nutrient Loading Rates (see A3. 4 below):

(1) Annual Soil Sampling and Analysis Method (recommended)
(2) P-Index Method with minimum 5-year field management plan
(3) P-Index Method for fields not under operational controls (of permittee)

Material sampling is required for each option. The following formula is the basis for the derivation of the nutrient loading rate:

NUTRIENTS IN SOIL + NUTRIENTS IN MATERIAL = NUTRIENT UPTAKE FROM CROP

A3. Subsection 1. Material Sampling

The following protocols describe how and when sources of industrial wastewater and wastewater treatments residuals should be sampled and how testing results will be used to estimate nutrient concentration in the material:

a. Operators are required to sample each unique source of material at least once per year for materials from facilities operating under a Missouri State Operating permit issued under the Missouri Clean Water Law or quarterly for out-of-state material or unpermitted source material. Materials shall also be sampled when processes have changed.
b. All material samples should be tested for total nitrogen, ammonium nitrogen, total phosphorus, and total potassium along with the pollutants outlined in Subsection A.1 and any other pollutant that may be associated with the material as determined by the department to ensure protection of soils, crops, surface waters, groundwater, human health or the environment. When lab results are reported on a dry basis, samples should also be tested for dry matter or total solids (moisture content).

c. When possible, sample and analyze material just prior to the time of land application so current results are available for calculating application rates. Permits may establish whether sampling should be grab or composite sampling based on the types and variability of the material.

A3. Subsection 2. Conducting Soil Sampling

Regardless of which Nutrient Loading Rate Calculation method used, soil sampling should be based on the following criteria and protocols:

a. MU Extension publications G9215 (for pastures) and G9217 (for hayfields and row crops);
b. The average field area represented by a soil sample should be approximately 20 acres and no larger than 80 acres;
c. Each soil sample should be comprised of a well-mixed subsample derived from at least 15 representative cores (aliquots) from the sampled field area; more cores are recommended on pastures or where phosphorus has been land applied;
d. As an alternative to the conventional soil sampling approach in A3. Subsection 2(c), operations may elect to use a geo-referenced grid soil sampling method instead. Grid size should be less than three acres and at least 10 cores should be obtained from within 15 feet of the central grid point;
e. Soil sampling depth should be six to eight inches;
f. Fields should be re-sampled before wastewater and treatment residuals application when the test is greater than one year old;
g. If using Nutrient Loading Rate Calculation P-Index methods, soil samples should be analyzed at soil testing laboratories accredited by the Missouri Soil Testing Association (see a current list of accredited labs at https://extension.missouri.edu/programs/soil-and-plant-testing-laboratory) using procedures recommended by the University of Missouri Soil Testing Laboratory.

Note: Soil sample results that meet all the above criteria shall be considered "current soil test results".

A3. Subsection 3. Foundation for Establishing Nutrient Need

Nutrient needs (treatment capacity) must be based on the following:

a. Justified field-specific yield goals. Yield goals should be based on crop yield records from multiple years for the field. Good judgment should be used to adjust yield goals to counteract unusually lower high yields. When a field's yield history is not available, another referenced source may be used to estimate yield goal.
b. Current soil test results, if appropriate for Nutrient Loading Rate Calculation method.
c. Fertilizer recommendations provided in a field-specific soil analysis conducted by the University of Missouri Agricultural Soil Laboratory may be utilized.
d. Crop nutrient uptakes rates provided below in Table 1 must be used. For crops not included, or for alternative crop uptake rates, a justification for the crop nutrient uptake rate must be submitted to the Department and approved prior to use.
e. Field-Level Nutrient Applications – Fertilizer recommendations used to develop nutrient budgets shall be based on 20-acre field areas. When fertilizer recommendations are similar (within 10% or 10 pounds per acre, whichever is greater) for adjoining 20-acre field areas, they may be combined for purposes of fertilizer application and nutrient budgeting. Field areas of up to 80 acres may be combined using this guidance. Larger field areas may be combined if justification for this decision is documented in the land application management plan.
f. The nitrogen removal capacity may be based upon the Plant-Available Nitrogen (PAN) when the PAN rate is the appropriate land application rate, in accordance with this guidance. The nitrogen contribution of material should be based on a calculation of plant-available nitrogen (PAN). Plant-available nitrogen is calculated by adjusting the inorganic and organic nitrogen concentrations using procedures outlined in MU Extension publication G9186 and is available on the Web at https://nmplanner.missouri.edu/pan-calculator/.

Table 2. Anticipated nutrient uptake by crop

Crop	Nitrogen Removal	Phosphorus Removal
Alfalfa Hay	45 lb/ton	4.3 lb/ton
Barley	0.96 lb/bushel	0.016 lb/bushel
Buckwheat	0.02 lb/ton	0.003 lb/ton
Bermudagrass	50 lb/ton	6 lb/ton
Corn, grain	0.9 lb/bushel	0.2 lb/bushel
Corn, silage	9 lb/ton	1.6 lb/bushel
Eastern gamagrass	40 lb/ton	6.6 lb/ton
Oat	0.64 lb/bushel	0.11 lb/bushel
Popcorn	0.016 lb/ton	0.003 lb/ton
Rye	1.18 lb/bushel	0.15 lb/bushel
Sorghum, grain	0.014 lb/ton	0.004 lb/ton
Sorghum, silage	13 lb/ton	2 lb/ton
Sorghum-Sudan grass	40 lb/ton	6 lb/ton
Soybeans, grain	3.75 lb/bushel	0.37 lb/bushel
Sunflower	0.026 lb/bushel	0.004 lb/bushel
Wheat, grain	1.26 lb/bushel	0.26 lb/bushel
Cool season grass hay	45 lb/ton	7 lb/ton
Cool season grass pasture	0.6 lb per cow days	.02 lb per cow days
Warm season grass hay	32 lb/ton	4 lb/ton
Warm season grass pasture	0.36 lb per cow days	0.004 lb per cow days

Additional crop uptake values may be considered based on an approved nutrient uptake analysis Select nutrient needs, including zinc, potassium or calcium, may be established on a field-specific basis as approved by the Department.

A3 Subsection 4. Nutrient Loading Rate Calculation Methods

The following three methods are allowed to calculate nutrient loading rates.

(1) Annual Soil Sampling and Analysis Method (recommended)
This method utilizes annual sampling and analysis through the University of Missouri (MU) Agricultural Soil Laboratory. The MU Agricultural Soil Laboratory soil report includes an assessment of the nutrient loading and soil needs based on many factors, including upcoming field usage.

a. PAN annual land application rates can be based solely on nitrogen criteria (nitrogen-based management) if the Missouri soil test phosphorus rating from a current soil test is very low, low, or medium.
b. Annual land application rates cannot exceed the annual planned phosphorus removal capacity of the crop by more than 10 pounds per acre or 10 percent, whichever is greater (phosphorus-based management) if the Missouri soil test phosphorus rating from a current soil test is "high".
c. Land application is prohibited if the current soil report phosphorus rating is "very high" or "excess."

P-Index based land application rate methods

The next two methods utilize the P-Index for determining nutrient loading rates. Use of the P-Index requires:

- *Field* Soil Test Phosphorus Level (and sampling depth)

- *Field* management plans
- *Field* Hydrologic soil group (may be based on County Soil Survey)
- *Field* Hydrologic condition
- *Field* Intended land usage or cover
- RUSLE value, which must be based on the RUSLE2 2016, available for download on the U.S. Department of Agriculture webpage: https://www.ars.usda.gov/southeast-area/oxford-ms/national-sedimentation-laboratory/watershed-physical-processes-research/research/rusle2/revised-universal-soil-loss-equation-2-download-rusle2/. RUSLE2 calculations require the following:
    - The above field-specific data
    - Digital elevation model / site specific elevation information
    - Other soil and rainfall information but may use county-specific data.

To use either P-Index method, the Department requires retention of the documentation of the above listed data. If the participant opts to use phosphorus solubility (see below), documentation must also include phosphorus solubility for materials to be land applied and annual, spring, pre-land application soil phosphorus analysis, incorporating soil phosphorus content into soluble phosphorus based land application rates.

(2) P-Index Method with minimum 5-year field management plan

This method allows the land application of multiple years of nutrients under the following conditions:

a. Each field must have and adhere to a minimum 5-year management plan detailing planned crops, expected crop yields, and calculated nutrient needs. This plan must be provided with the permit application and updated or submitted in accordance with applicable permit conditions.
b. Annual records must be maintained of actual crop yields and submitted in accordance with applicable permit conditions.
c. Changes to the management plan must be approved by the department and may require a permit modification, as determined by the Department.
d. Use of the P-Index rating, as calculated using the 2005 P-Index developed by the University of Missouri.
e. PAN land application rates can be based solely on nitrogen criteria (nitrogen-based management) if the Missouri P-Index rating is low or medium.
f. Land application rates based on soluble phosphorus cannot exceed the annual planned phosphorus removal capacity of the crop by more than 10 pounds per acre or 10 percent, whichever is greater (phosphorus-based management) if the Missouri P-Index rating is “high.”
g. No material will be applied on a land application field if the Missouri P-Index rating for the field is “very high”.
h. Multi-year land application plans – Land application rates based on multi-year nutrient needs may be considered. However, application rates must comply with the following conditions:
    i. Rates shall not exceed the recommended nitrogen application rate during the year of application, or estimated nitrogen removal capacity in the harvested crop during the year of application when there is no recommended nitrogen application.
    ii. The amount of phosphorus banked in the soil will not exceed four years of crop removal/nutrient needs for the planned rotation.

iii. The actual application rate shall not exceed 10 pounds per acre or 10 percent of the planned multi-year phosphorus application rate, whichever is greater.
iv. A field-specific agronomic plan must be developed and followed, including planned crop rotations, calculated nutrient requirements based on expected yields and nutrient uptake, and all nutrient sources must be included.
v. Annual reporting of crop yields is required, and
vi. Soil sampling is required before commencement, and upon completion, of the multi-year cycle.

(3) P-Index Method for fields not under operational controls (of permittee) – single year application plans

The P-Index is intended to assess long-term potential for phosphorus impacts from agricultural activities under a nutrient management plan. This specific method, though, allows use of the P-Index on fields that are not under the operational control of the permittee or are not under a binding agreement for agricultural plans, practices and restrictions for field and nutrient management. As such, this specific method of the P-Index accounts for the absence of long-term field and nutrient management plans. This method allows the land application of nutrients under the following conditions:

a. Use of the P-Index rating, as calculated using the 2005 P-Index developed by the University of Missouri-Columbia (must be based on all the P-Index required criteria listed above).
b. No more than one year's nutrient (appropriate nutrient) needs, based on the upcoming reported planned crop for the field, may be land applied. The appropriate limiting nutrient is determined as provided in d.-f. below.
d. Land application is allowed if the Missouri P-Index rating is low; agronomic rates must be calculated based on both nitrogen and phosphorus in the material, soil content of both nutrients, and crop uptake of both nutrients.
e. No material will be applied on a land application field, under this method, if the Missouri P-Index rating for the field is "high" or "very high".
f. Phosphorus-based land application rate must be used if the field rating is "medium" and may be based on soluble phosphorus content, but land application based on soluble phosphorus data may only occur between spring soil analysis and the end of the first growing season. Land application rates may only be based on the first growing season on fields not under the operational control of the permittee.
    a. If a second growing season is planned, additional land application based on soluble phosphorus-based rates may occur but only based on soluble phosphorus demand of cover or fall growth intended to be harvested or removed from the field (not tilled into the soil). Soil sampling is not required prior to the second or fall planting, but is required prior to the next spring application and growing season.

A3 Subsection 5. Phosphorus and Plant-Available Nitrogen Land Application Rates

As determined in accordance with A3. Subsection 4 above, PAN land application rates can be established:

- based solely on nitrogen criteria (nitrogen-based management)

- crop plant available nitrogen need, based on field or county crop yields and nutrient needs established in accordance with A3.3. above.
- PAN can be determined as follows:
  (Nitrate + nitrite nitrogen) + (organic nitrogen x 0.2) + (ammonia nitrogen x volatilization factor[1]).

[1] Volatilization factor is 0.7 for surface application and 1 for subsurface application. Alternative volitalization factors and mineralization rates can be utilized on a case-by-case basis.

Phosphorus land application rates cannot exceed the annual planned phosphorus removal capacity of the crop by more than 10 pounds per acre or 10 percent. This calculation must be based on:

- the phosphorus soil content
- crop phosphorus need, based on field or county crop yields and nutrient needs established in accordance with A3.3. above.

For land application of materials with a single nutrient (e.g. nitrogen or zinc), application rates will be determined on a case-by-case basis based on nutrient needs of the agricultural field.

Land application is not allowed for materials with pollutant concentrations in excess of the limitations in Table 1.

SECTION B – LAND APPLICATION PRACTICES

The timing, soil conditions and placement of all wastewater and wastewater treatment residuals land applications shall meet the following criteria:

a. All land application shall be conducted by the permittee or its contractors.
b. No land application shall be conducted on public use areas.
c. Land application rates cannot exceed nutrient, pollutant or hydraulic loading rates.
d. Runoff and ponding are prohibited.
e. Material shall be spread even across the application area.
f. Land application shall comply with all setbacks defined in Table 3 below.
g. All land application setbacks must be identified with flags or other physical markers.
h. Grazing and harvesting of forage crops shall be deferred, in accordance with 10 CSR-20-8.200(6)(E), as follows (these requirements apply to fields under the operational control of the permittee and must be communicated to owners of fields not under operational control of the permittee):
    i. May 1 to October 31, the minimum grazing or forage harvest deferment shall be fourteen (14) days from application.
    ii. November 1 to April 30, the minimum grazing or forage harvest deferment shall be thirty (30) days from application.
i. Temporary stockpiling of material to be land applied shall be bermed or otherwise prevent runoff. No location shall be used for stockpiling for more than two weeks unless the storage area is covered and all runoff is contained.
j. No surface application is allowed if a 50% chance of any precipitation is forecasted to occur within 24 hours of the planned application. No subsurface land application is allowed if a 50% chance of greater than one-half inch (0.5”) of precipitation is forecasted to occur within 24 hours of the planned application.
k. Material will not be applied on land with a slope greater than 20 percent.

l. Land application fields shall be checked daily during land application for runoff.
m. Site utilizing spray irrigation shall monitor for the drifting of spray across property lines. Spray drift is not permissible.
n. Land application shall not occur to frozen, snow-covered, or saturated soils. Surface land application is prohibited when 2-inch soil depth temperatures are 32° F or lower; subsurface land application is prohibited when 4-inch soil depth temperatures are 32° F or lower.
o. Land application must be monitored such that target application rates are met and any malfunction in the operation of the equipment is detected and corrected before any over application of material occurs on the land-application site.
    i. Wastewater and liquid waste material applications must be conducted to prevent surface runoff of wastewater and liquid material beyond the edge of the field during land application. Steps to ensure no runoff of material during land application include:
        a. Adjusting surface application rates to meet infiltration rate and water holding capacity of the soil.
        b. Irrigation systems must have automatic shut-off devices in case of pressure loss and/or an operator on-site at all times during operation to monitor application equipment.
    ii. ii. Sludge, semi-solids, and solid-laden wastewater may be applied to build soil, amend soil, improve drainage, provide nutrients, provide micronutrients, increase oxygenation, provide slow-release nutrients, or for substrate for microbes; however:
        a. Material shall be spread evenly on to the surface,
        b. Dissolve Air Floatation (DAF) skimmings or other heavy oil and grease mixtures must be knifed in, chiseled in, or tilled into the soil,
        c. Between seeding/planting and harvest, solids depth can be no more than ¼ inch immediately after land application. At all other times, depth of solids cannot exceed ½ inch immediately after land application.
    iii. All land application equipment shall be calibrated at least annually.
    iv. The perimeter of all land application fields must be checked regularly during operation of land application equipment to confirm material is not running off the field or entering waters of the state.

Table 3. Land application setback distances. For streams, lakes, and wetlands the setback distance is measured from the defined edge of the water feature.

Setback Feature	Application Conditions	Setback Distance (feet)
Public or private drinking water well or other wells including un-plugged abandon wells[1]	All applications methods	300
Public or private drinking water lake or impoundment	All applications methods	300
Public or private drinking water intake structure	All applications methods	300
Classified waters of the state not used as water supply as defined in 10 CSR 20-7.031(1)F	Permanently vegetated buffer[2]	35
	No or insufficient vegetated buffer	100
Other public and privately owned lakes and impoundments not used as a water supply including impoundments with no outlet	Permanently vegetated buffer[2]	35
	Up-gradient, no or insufficient vegetated buffer	100
	Down-gradient, no or insufficient vegetated buffer	35
Other perennial streams, other intermittent streams, canals, drainage ditches and wetlands	Permanently vegetated buffer[2]	35
	Up-gradient, no or insufficient vegetated buffer	100
	Down-gradient, no or insufficient vegetated buffer	35
Tile line inlet (if left un-plugged during material application)	Upgradient, permanently vegetated buffer[2]	35
	Up-gradient, no or insufficient vegetated buffer	100
	Down-gradient	0
Losing stream	All applications methods	300
Cave entrance	All applications methods	300
Spring	All applications methods	300
Active sinkhole	All applications methods	300
Non-owned occupied residence	All applications methods	150
Public use area including non-owned businesses	All applications methods	150
Public road	All applications methods	50
Property boundary	All applications methods	50

[1]If the exact well location is unknown; all private residences shall be assumed to have a well within 300 feet of the residential structure(s).

[2] See definition of vegetative buffer in the definitions section of this document.

SECTION C – Geohydrological Evaluations

Geohydrological evaluations must be conducted on new land application fields per 10 CSR 20-8.200(2)(B). If a land application field is found to have a significant potential for the contamination of groundwater, the following will be required:

a. Setbacks from wells, sinkholes, losing streams, and other sensitive features remain in place.

b. Any field which is found to have a significant potential to contaminate groundwater may not apply more than a year's worth of nitrogen. This should minimize the risk of exceeding the groundwater standard for nitrates.

c. Should wells within 300ft of the field be sampled for nitratesand nitrates are found in excess of 8 mg/L, no land application will occur until an evaluation of the source of nitrates and any well impacts has been evaluated.

d. No land application shall occur if the gradient is greater than 10 percent on fields which have a significant potential to contaminate groundwater.

SECTION D – RECORDKEEPING

Operations shall maintain the following records to document implementation of appropriate land application management plan protocols.

D1. Annual land application management monitoring and record keeping requirements.

(1) **Land-Use Agreements** – Land application is only authorized on fields under permittee's operational control or on fields under agreements restricting access. All land-use agreements must be submitted with the permit application and maintained by the permittee.

(2) **Field Maps** – A 1:1,000 aerial image of each field shall be created and contain the following:

a. Locational information (ie: Lat/Long, UTM, Decimal Degrees)
b. Property boundaries
c. Set-back features identified, measured and marked
d. Slope of field (if multiple slopes, use the steepest)
e. Field identification (numbers or names)

(2) **Material Storage Operational Monitoring** – Record the following information for each waste material storage structure:

a. Weekly records of the depth of material and process wastewater in liquid storage structure(s).
b. The date, time, and estimated volume (gallons) of any overflow(s) from the storage structure.
c. Record the following information for every material application event from a material storage structure:
    i. Date of material application
    ii. Source of material (identify the storage structure)
    iii. Weather and soil condition at time of application
    iv. Field ID receiving material

v. Rate of material application per acre (tons/acre, gallons/acre, or inches/acre).
vi. Plant Available Nitrogen (PAN) and phosphate in material applied to field (pounds/acre)
vii. Method of application (blading, spray, surface applied, etc.)
viii. Acres receiving material
ix. Total daily material applied (tons or gallons)

(3) **Nutrient Monitoring** - For each unique source of material:

a. Date(s) for material sampling
b. For each sampling date report total nitrogen, total phosphorus, and if applicable ammonium nitrogen, total phosphate (P2O5), total potash (K2O); report percent moisture or dry matter and nitrate nitrogen when appropriate and relevant.
c. Report or identify the actual material nutrient concentration used for calculating land application rates. If different material sampling results were used for different parts of the year, then provide all dates of sampling and when each sample result was used.

(4) **Field Soil Test Monitoring** - For each individual field in the land application area that receives material, record the following:

a. Date of the last soil test,
b. Current soil test results from the University of Missouri soil laboratory, and
c. Nutrient recommendations (pounds/acre)

(5) **Land Application Operational Monitoring** - For each individual field in the land application area that receives material, record the following:

a. Field ID receiving material
b. Total acres in each field receiving material
c. Planned crop(s) (corn, soybeans, fescue, pasture, etc.)
d. Projected yield
e. Actual yield
f. For each field complete an annual nitrogen inventory including:
    i. Total Planned Fertilizer Nitrogen Requirement for the crop in pounds/acre (fertilizer nitrogen for non-legumes or the nitrogen removal capacity for legumes as described in section A2 (1) of this standard)
    ii. Plant Available Nitrogen (PAN) from material applied to field (lbs N/acre)
    iii. Nitrogen applied from other sources (lbs N/acre)
    iv. Total applied plant available nitrogen from all sources (lbs N/acre)
    v. Difference between total applied plant available nitrogen from all sources and planned crop nitrogen requirement (lbs N/acre)
g. For each field complete an annual phosphorus inventory including:
    i. The soil test phosphorus rating for the field
    ii. The Missouri Phosphorus Index (P-Index) rating, if applicable
    iii. Actual phosphorus applied (lbs /acre)
    iv. Actual phosphorus applied from other sources (lbs /acre)
    v. Planned phosphorus removal from crops harvested this year (lbs /acre)
    vi. Actual phosphorus removal from crops harvested this year (lbs /acre)
    vii. Phosphorus balance for the year (actual applied minus planned removal; lbs /acre)

viii. On fields where "multi-year phosphorus application" is utilized, report the cumulative phosphorus balance for the multi-year planning period (the cumulative balance equals the actual phosphorus applied minus planned phosphorus removed in lbs phosphate /acre).

SECTION E – Application Materials Required

Form A – https://dnr.mo.gov/document-search/form-application-nondomestic-permit-under-missouri-clean-water-law-mo-780-1479

Form C – https://dnr.mo.gov/document-search/form-c-application-discharge-permit-manufacturing-commercial-mining-silviculture-operations-stormwater-mo-780-1514

LAMP – https://dnr.mo.gov/document-search/updated-draft-land-application-management-plan-template-aug-9-2024

Signed land-use agreements

Geohydrologic evaluations for each new permitted irrigation site – https://dnr.mo.gov/land-geology/geology/environmental-assistance/geologic-evaluation-data-gateway-exchange-geoedge

Source materials sampling results

Soil sample results

References:

Fulhage, Charles. November 2018. Land Application Considerations for Animal Manure. MU Extension Publication EQ202.

Lory, John. November 2018. Phosphorus Best Management Practices for Biosolids and Other Organic Residuals. MU Extension Publication G9183.

Lory, John. November 2018. Agricultural Phosphorus and Water Quality. MU Extension Publication G9181.

Lory, John, Robert Kallenbach, Craig Roberts. October 2000. Managing Manure on Alfalfa Hay. MU Extension Publication G4555.

Lory, John, Glenn Davis, Darrick Steen, Ron Miller, Barbara Li and Charles Fulhage. December 2007. Calculating Plant-Available Nitrogen and Residual Nitrogen Value in Waste Material. MU Extension Publication G9186.

Lory, John and Steve Cromley. January 2006. Soil Sampling Hayfields and Row Crops. MU Extension Publication G9217.

Lory, John and Steve Cromley. February 2005. Soil Sampling Pastures. MU Extension Publication G9215.

Zhiqiang Hu. February 2023. Biosolids Standards for Metals and other Trace Substances. MU Extension Publication WQ425.