Division of Environmental Public Health

Department Technical Guidance for Contaminants of Emerging Concern in Wastewater

May 2025

Prepared by
Wastewater Management Program
Environmental Public Health Division

Washington State Department of HEALTH

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Preface

This technical guidance is applicable for statewide application. Regional differences may require variations in the application of the technology. The differences may also create a need for greater or more restrictive allowances than those described here. In either case, the local health officer has full authority in the application of this technology, consistent with Chapter 246-272A Washington Administrative Code (WAC) and local code. If any provision of these recommended standards is inconsistent with local codes, regulations, ordinances, policies, procedures, or practices, the local standards take precedence.

Local application of this technical guidance may be:

1) **Adopted as part of local rules, regulations, or ordinances.** When the recommended standards, either as they are written or modified to reflect local conditions more accurately, are adopted as part of the local rules, their application is governed by local rule authority.

2) **Referred to as technical guidance in the application of the technology.** The recommended standards, either as they are written or modified to reflect local conditions more accurately, may be used locally as technical guidance.

Application of these recommended standards may combine the two approaches above. The local health officer and board of health dictate the application of these recommended standards without deviating from Chapter 246-272A WAC.

The typical rule language provided here assists local health jurisdictions wanting to adopt these recommended standards in local rules. Additional information and guidance are presented in text boxes to distinguish it from the recommended standards.

Glossary of Terms: The Washington State Department of Health (the department) website provides a glossary of common terms for all DS&Gs and technical guidance documents at http://www.doh.wa.gov/Portals/1/Documents/Pubs/337-028.pdf.

The recommended standards found here support the design of on-site sewage systems (OSS) with design flows less than 3,500 gallons per day (GPD) but may also be applied to large on-site sewage systems (LOSS). However, some provisions for LOSS are not appropriate or allowed with the 2011 adoption of the revised LOSS rule, Chapter 246-272B WAC. The LOSS requirements from the DS&G have already been included in the rule. Design engineers and others interested in LOSS should consult the rule and LOSS program staff.

Introduction

Wastewater contains not only harmful pathogens that can impact human health, but it also contains nutrients and chemicals that must be treated as well. This document is divided into three sections. Section 1 covers nitrogen; Section 2 covers phosphorus; and Section 3 covers all other chemicals and contaminants that are of emerging concern. (At the time of this publishing, section 3 is in development.)

Nitrogen and phosphorous have gained attention as contaminants of emerging concern (CEC) due to their widespread production and use, as well as their significant environmental and human health impacts. On-site wastewater treatment system discharges, agricultural applications, and various industrial processes contribute to elevated levels of both nutrients in surface and groundwater. The mobility of nitrogen and phosphorus in the environment leads to the development of management strategies and policies to mitigate their impact. This document specifically addresses management strategies for on-site septic systems (OSS).

Section 1: Nitrogen

Nitrogen is a naturally occurring element that cycles through the environment in different forms. The way in which nitrogen moves through the air, soil, water, and living organisms is called the nitrogen cycle. The basic steps of the nitrogen cycle are highlighted in Figure 1.

The form of nitrogen in human and animal waste is ammonia (NH_3), which undergoes transformation into different nitrogen forms once in the environment. Much of it is converted to nitrate (NO_3^-) during the nitrification process, which releases energy for soil microbes and is a bioavailable plant nutrient. Eventually, nitrates are carried into surface water through stormwater runoff. Nitrates can also seep into groundwater.

In most ecosystems, nitrogen is a limiting nutrient, meaning the natural amount in the ecosystem determines the degree of growth and productivity of organisms. Too much nitrogen acts as a pollutant and disrupts the nutrient balance in ecosystems. Nitrate is often a limiting factor in plant growth, meaning that plants will absorb more nitrate, if available, and use it for growth.

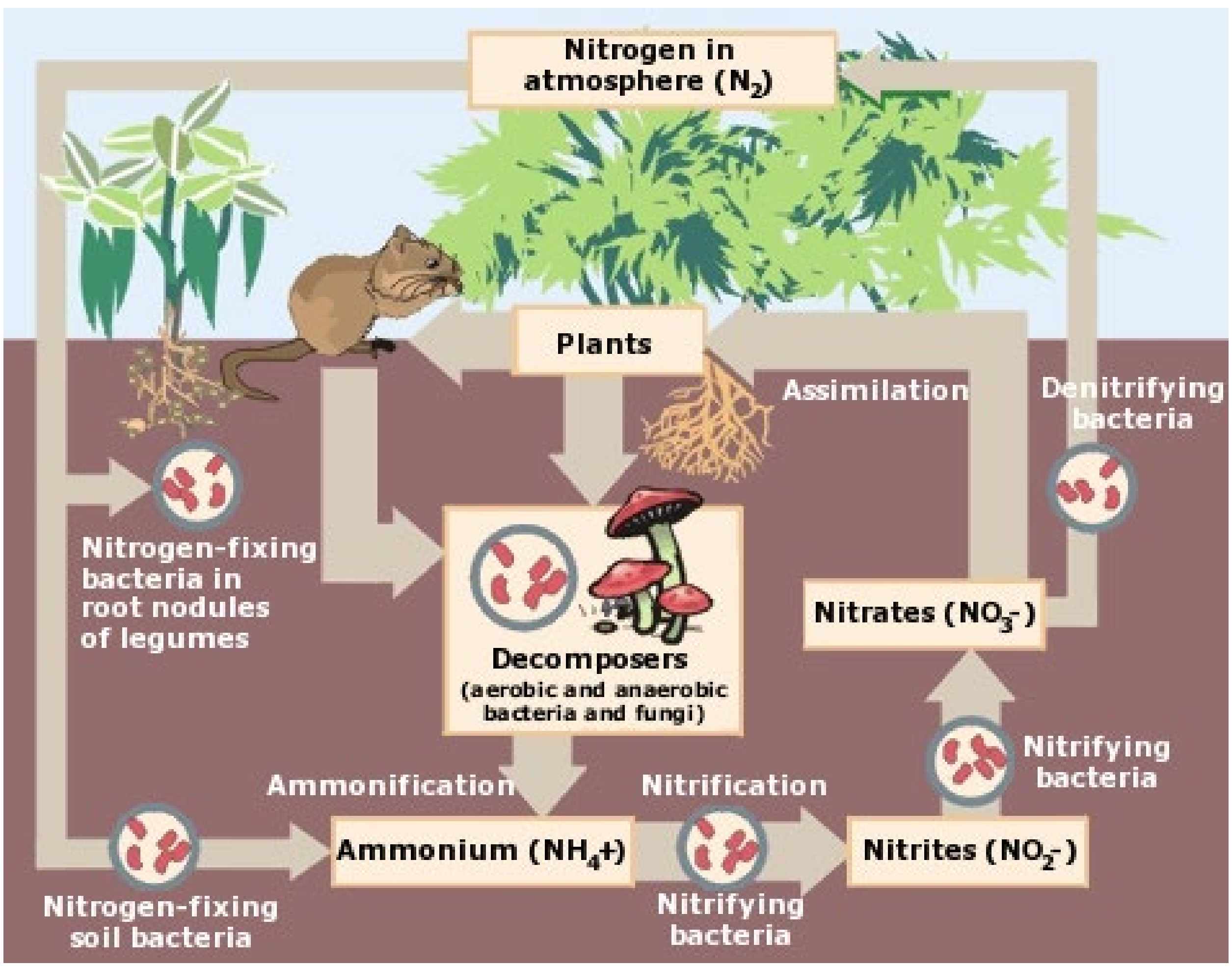

Figure 1: Nitrogen Cycle Steps. Biologydictionary.net Editors. "Nitrogen Cycle." Biology Dictionary. Biologydictionary.net, May 16, 2017. https://biologydictionary.net/nitrogen-cycle/.

The soil may be a long-term sink, or storage space, for ammonia and nitrate in some soils. Soil microbes consume some of the ammonia stored on soil surfaces, converting it to harmless organic matter.[9] All soils have a maximum storage capacity, which is highly variable between soil types, for storage of any attached molecules, including ammonium or nitrate.[10] Once at capacity, continued nitrogen inputs will move with water toward the path of least resistance. Most eventually leads to groundwater or surface water. And, as shown in agronomic sciences, nitrate stored in the vadose zone, the undersaturated portion of the soil above the groundwater table, can be released to and impact groundwater and surface water for decades, even in the absence of new inputs.[10]

If conditions are right, denitrification, the process of nitrate being converted into diatomic nitrogen gas (N_2), can occur in the soil or in groundwater. This requires that the nitrified effluent pass-through anoxic conditions with an available source of carbon. Under these conditions, bacteria, which use oxygen when it is available, will use nitrate as an energy source, converting it to N_2 gas in the process.

The following equation describes this process:

$$5(CH_2O) + 4NO_3 + 4H^+ \rightarrow 5CO_2 + 2N_2 + 7H_2O$$

Nutrient pollution resulting from excess nitrogen (and phosphorus, discussed in Section 2) is a leading cause of degradation of water quality in the US.[13] Nitrate becomes a problem when levels in groundwater reach a level that makes the water unsafe for drinking. Nitrate is the most common contaminate in drinking water wells in Washington.[12] Consumption of nitrate in drinking water is a causal factor in methemoglobinemia in infants. In a Washington State study, EPA found that infants consuming water, often mixed in formula, with nitrate levels higher than 5 mg/L are at a significantly and substantially higher risk of methemoglobinemia. They found that about 4% of infants were exposed to these levels.

Nitrogen pollution is a known contributing factor in eutrophication in surface water.[13] Excess nitrates lead (or contribute) to eutrophication in surface water that negatively impacts habitats and supports algae blooms, some of which are dangerous for human and animal contact. Eutrophication degrades surface water quality and habitats by supporting blooms of harmful algae. These harmful algal blooms (HABs) lower oxygen levels in the water, decrease sunlight penetration into the water. OSS have been implicated in eutrophication and harmful algal blooms.[18, 19]

Some cyanobacteria species can introduce toxic byproducts, which can contaminate fish and shellfish tissue, making them unsafe to eat. This creates a public health threat and can have a significant economic impact.[16] These toxins can also make the water unsafe to swim in, unsafe for animals, and, for communities relying on these waters for drinking water, unsafe for drinking.[17] At least one community in Washington has regular public health warnings advising residents to not drink their water due to HABs, and nitrogen from OSS is suspected to be a contributing factor.[15]

Nitrogen and On-site Septic Systems

Every septic tank has a unique chemical makeup. However, basic nitrogen inputs, conversions, and fates in on-site septic systems (OSS) are well understood and broadly agreed upon by industry and academic communities.[1, 2] Conventional OSS effectively treat pathogens but do not effectively treat nitrogen. Instead, nitrifying bacteria in the infiltrative surface's biomat and upper vadose zone (unsaturated zone below the drainfield) convert ammonium (NH_4^+) and organic nitrogen (N) in the effluent into bioavailable nitrate (NO_3^-) in aerobic conditions, which plants absorb.

Microbes convert and cycle nitrogen in the septic tank and the soils in the dispersal area/drainfield. Ammonium and organic nitrogen are inputs to these processes, which naturally occur in soil with or without effluent from OSS or other human influence in the area. They are complex processes and vary depending on inputs and environmental conditions, but the overall processes are well documented and understood. The result of microbial and physical processes is, in general, a net increase of nitrates passing through the soil to groundwater and surface water over baseline levels. Individual OSS usually contribute a relatively small amount to the overall cycle, as long it is sited, designed, and maintained properly.

Widely accepted studies characterize septic tank effluent as having a range of 50 to 70 mg N/L, with 75% as ammonium and 25% as organic nitrogen.[3] Direct sampling by the Water Environment Research Foundation (WERF) found the range to be 33 to 171 mg N/L, while a broad-based literature review found the range to be 12 to 453 mg N/L, with percentages of ammonium and organic nitrogen similar to the findings mentioned above.[3,4,5]

The U.S. Environmental Protection Agency's (EPA) *Onsite Wastewater Treatment Systems Manual (*2002) provides the following estimates for nitrogen in residential wastewater, which is the reference Washington State uses to set nitrogen limits:

- An average of 11.2 grams of nitrogen per person per day:
    - 70 - 80% as toilet waste (predominately urine)
    - 10 - 15% is food preparation (garbage disposals)
    - Remainder is household cleaning products

A widely accepted average stated in the EPA manual for total nitrogen concentration in domestic sewage is 60 mg N/L. This is the established value in Chapter 246-272A WAC.

Nitrates are considered harmless at low concentrations but become a dangerous pollutant that can impact both at higher ones. It becomes an issue when the receiving waters already have high nitrate levels or when many or high concentration nitrogen sources are impacting these waters at the same time. Nitrate concentration increases when there are multiple direct discharges of un- or under-treated effluent into these waters. Many states and localities use a regulatory approach to limit the density of OSS on a given land area as a means of limiting the loading of nitrate to receiving waters to prevent this from occurring.

OSS receive nitrogen inputs in the form of urea (urine) and organic nitrogen (fecal matter, food materials, etc.).

The enzyme *urease* catalyzes the hydrolysis of urea to ammonia in anaerobic conditions (and in contact with water) of the septic tank via the following reaction:

$$(NH_2)_2CO + H_2O \xrightarrow{\text{urease}} CO_2 + 2NH_3$$

The ammonia (NH_3) and most of the organic nitrogen are converted to ammonium by heterotrophic bacteria in a process called ammonification:

$$NH_3\,(aq) + H_2O \rightarrow NH_4^+ + OH^-$$

When the NH_4^+ and organic nitrogen in effluent exits the septic tank and enters into the soil of the drainfield, it undergoes a process called nitrification. This process is carried out by two autotrophic aerobic nitrifying bacteria. The first step uses *Nitrosomonas* bacteria and the second uses *Nitrobacter*. These bacteria are found in the soil and rapidly convert ammonium to nitrite (NO^-_2) and then nitrate (NO_3^-) via the following a two-step reaction:

$$NH^+_4 + O_2 \rightarrow NO_2^- + O_2 \rightarrow NO_3^-$$

Broken into two steps, the reaction is represented by the following (unbalanced) equations:

Step 1: $NH_4^+ + O_2 \rightarrow NO_2^- + H^+ + H_2O$ (*Nitrobacter*)

Step 2: NO_2^- - + $O_2 \rightarrow NO_3^-$ (*Nitrosomonas*)

The process happens so quickly that it can be considered a single step, and it is highly effective at preventing ammonium from reaching groundwater. Little, if any, ammonium reaches receiving waters if the effluent passes through sufficient aerobic soil conditions, significantly reducing impacts to aquatic ecosystems. Nitrate is not toxic in low concentrations; however, it is highly water soluble and mobile in groundwater and surface water.

The WERF report provides a range of 25 - 112 mg N/L for ammonium sampled from septic tank effluent.[4] They found that ammonium levels sampled at the interface between the vadose zone and the water table under septic drainfields are generally very low or undetectable.[6] Other research found that nitrate samples collected from septic tank effluent contain generally <2 mg/L but that **at the interface between the vadose zone and the water table nitrate levels typically range between 25 and 80 mg N/L.**[5,7]

Sampling, however, shows that 75-90% of nitrogen inputs into an OSS ends up as nitrate in groundwater in shallow groundwater situations[9]. This nitrate joins natural (and other sources of) nitrate migrating in groundwater, increasing nitrate levels in groundwater, and sometimes moving toward drinking water wells or offsite.[9] It also moves with groundwater into surface water at natural seeps and springs.[11]

These results agree with traditional understanding of the processes at work. The biota and natural processes in the septic tank and soil convert almost all the ammonium to nitrate. Studies indicate there is extensive variability between sites, based on soil types and site conditions. This impacts the fate of ammonium and nitrate but, overall, most nitrogen from OSS has been shown to mix into groundwater as nitrate and move with it as a plume.[5,8]

In reality, however, nitrogen processes occurring in the soil of drainfields are more complex and nuanced than described above. Figure 2 shows several processes that convert nitrogen into its different forms. While most ends up as nitrate through the nitrification process, nitrogen has many pathways in the soil. If conditions in the soil are alkaline enough, a small portion of the (un-nitrified) ammonium may be converted to ammonia and eventually lost to the atmosphere as ammonia gas.[5]

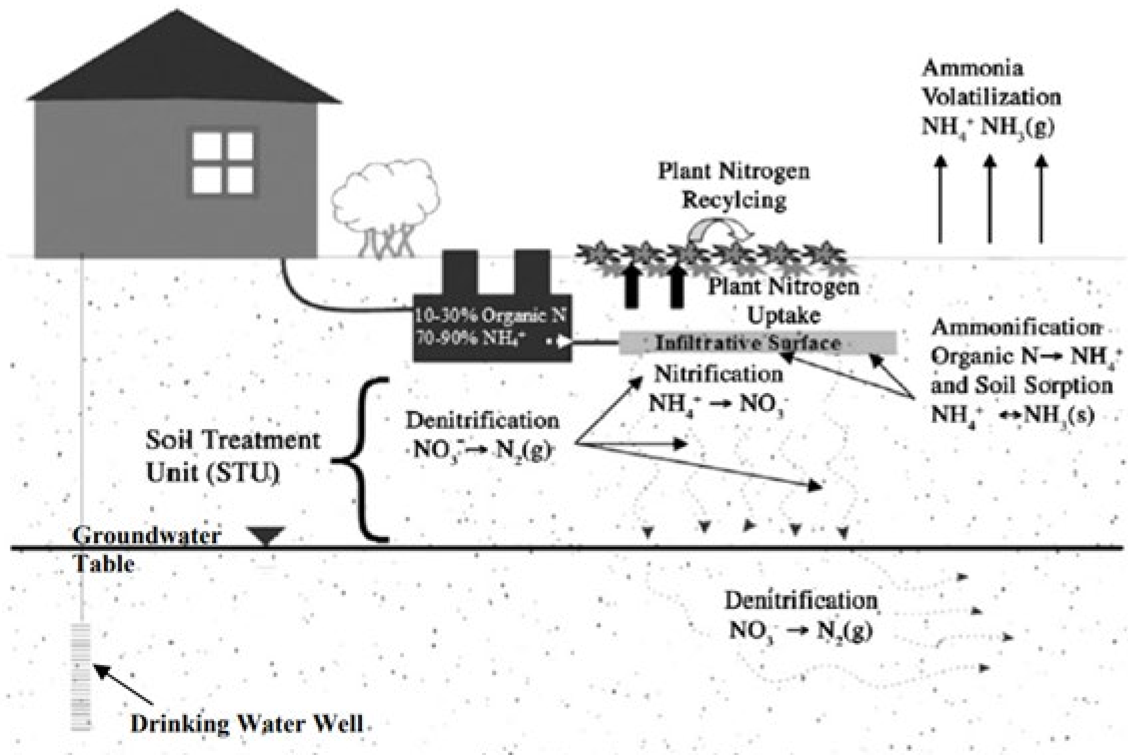

Figure 2. Schematic of an onsite wastewater system and subsurface nitrogen transformation and removal processes. Heatwole, Kirkley K., and John E. McCray. "Modeling Potential Vadose-Zone Transport of Nitrogen from Onsite Wastewater Systems at the Development Scale." Journal of Contaminant Hydrology 91, no. 1–2 (April 2007): 184–201. https://doi.org/10.1016/j.jconhyd.2006.08.012.

As mentioned, nitrogen is a limiting factor in plant growth, meaning that plants will absorb more nitrate, if available, and use it for growth. Historically, the OSS industry assumed plants use a significant portion of the increased nitrate. While this may be the case on some sites, a limited number of plant roots will be in contact with the plume of nitrates. Most plant roots cannot penetrate the anaerobic conditions of the saturated zone. Consequently, a significant portion of the nitrate from most OSS will not be used by plants.

While nitrification has great potential to reduce levels of nitrate from OSS impacting groundwater and surface water, natural or existing conditions do not often facilitate significant denitrification of septic tank effluent. A carbon source and anoxic conditions are necessary for this reaction to occur. Carbon sources are often limited at depths where conditions are anoxic. However, each site is different, and variables and factors are too complex to predict without modeling.

Some septic treatment technologies can reduce nitrogen in septic tank effluent by 50%. Any component added for treatment level N (TLN) must be selected from DOH's *List of Registered On-site Treatment and Distribution Products*.

Several independent studies verified or determined there is nitrogen loading from OSS to the

Puget Sound.[14] OSS have also been implicated in adding nitrogen to certain lakes in Washington.[15] , For this reason, it is prudent to appropriately site and design OSS, including maximizing setbacks to wells and surface water from drainfields. It is also critical to determine maximum OSS densities to account for nitrogen loading to these receiving waters. This is the primary purpose of the minimum land area (minimum lot size) requirement in WAC 246-272A.

Applying WAC 246-272A-0320: Tables XI and Table XII

WAC 246-272A-0320(1) requires that, prior to approving any development, the local health officer (LHO) determine the minimum land area required using Table XI or Table XII.[1]

Table XI

Table XI provides the minimum land area required for development made up of a single new single-family residence <u>or</u> a single unit volume of sewage, based on soil type and the type of water supply (public or nonpublic). Table XI is the default minimum size (based on soil type) for each new OSS on new and existing lots. In general, the LHO may approve developments under Table XI only if the lot of record is at least as large as the listed size in Table XI.

The LHO may allow inclusion of land area other than the lot the OSS will be installed on if:

- The OSS will be installed on a different lot than the lot served, or
- Multiple lots will be used to fulfill Table XI's requirements

In either case, the LHO may require a notice to the deed of all properties included. This notice to the deed may include items such as maintenance and/or service requirements, easement language, notification of failures, or other items as deemed necessary by the LHO or any other agencies involved in the permit approval.

<u>Minimum Usable Land Area</u>

Table XI also includes a requirement that each lot contains a minimum usable land area, which is determined based on soil type. Minimum usable land area is defined as "the minimum land area within the minimum lot size required per development using an OSS, which is based on soil type and type of water supply. Minimum usable land area is free of all physical restrictions and meets minimum vertical and horizontal separations."

The usable land area is part of the lot's total area (i.e. it is not in addition to minimum lot size) and must be suitable for installation of all components of an OSS, including sewage tanks, piping, drainfields (both primary and reserve), and typical proprietary products. If the area is non-contiguous, the separate areas should be able to connect via typical piping methods.

This area cannot include portions of the lot that are unsuitable for the installation of an OSS due to horizontal setbacks (per Table IV), vertical separations (per Table VI), or existing or planned site uses (such as buildings, roads, parking areas, or any other features that would render the area unusable for an OSS).

In cases where the usable land area cannot be met, a waiver may be granted with appropriate mitigation measures. A waiver for this requirement is separate from the waiver limitations described in WAC 246-272(3)(d)(iii).

WAC 246-272A-0320(1)(e) and Table XII

WAC 246-272A-0320(1)(e) provides the minimum land area requirements for any proposed developments, including new subdivisions and existing lots, that do not meet Table XI's requirements[1]. They include requirements to:

- Minimize public health and environmental impacts
- Consider:
  - Topography, geology, and ground cover
  - Climatic conditions
  - Sewer availability
  - Current and future land use and growth patterns
- Comply with planning and zoning requirements
- Prohibit development on new lots smaller than 13,000 ft^2 that are served by nonpublic waters supplies
- Comply with Table XII's requirements

There are criteria where the LHO may permit OSS not meeting Table XI and XII requirements. See the WAC 246-272A-0320(3) Requirements subsection below, specifically the information subsection (3)(d) of WAC 246-272A-0320.

Lots failing to meet Table XI requirements must not exceed the nitrogen limit per land area as identified in Table XII. Table XII establishes the maximum allowable nitrogen as Total Nitrogen or TN. Therefore, Table XII allows lots smaller than Table XI's requirements to be developed if the development's nitrogen output is reduced by the same proportion than the lot size is smaller than Table XI's requirements.

Table XII's requirements are based on the following assumptions[2]:

- Most homes (i.e. the median home) are a 3-bedroom home with 360 gpd flow. Table XI does not require more land area for homes with more than 3 bedrooms or allow less land area for homes with less bedrooms.
- Wastewater effluent coming from a typical home contains 60 mg/L TN.

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[1] LHOs may permit OSS not meeting Table XI and XII requirements. See the WAC 246-272A-0320(3) Requirements subsection below, specifically the information for subsection (3)(d) of WAC 246-272A-0320.

[2] The first two of these assumptions are expressed in Table XII's Footnote 1.

- N-loading rates resulting from OSS built at the maximum density allowed in Table XI will not significantly impact water quality because there is enough land area to effectively assimilate, treat, and dilute the nitrogen in the effluent.

The relationship between the minimum land area required in Table XI and the allowable TN in Table XII, using a lot with public water and a Type 2 soil as an example, can be seen here:

To find the amount of nitrogen in wastewater, multiply the daily flow (360 gpd for a 3-bedroom home) by the nitrogen concentration in effluent (60 mg N/L): 360 gpd x 60 mg N/L.

Convert mg/L to mg/gal: $\frac{60\ mg}{1\cancel{L}} \times \frac{1\cancel{L}}{0.264\ gal} = 227.27\ mg\ N/gal$

Convert mg/gal to mg/day: $\frac{360\ \cancel{gal}}{Day} \times \frac{227.27mg}{\cancel{gal}} = 81{,}817.2\ mg\ N/day$

A home with a daily flow of 360 gpd will produce 81,817.2 mg N/day. This value is then divided by the minimum square feet from Table XI to find the maximum allowable TN per square foot on a lot with public water supply and Type 2 soil:

$$81{,}817.2\ mg\ N/day\ \div 13{,}000\ sq\ ft = 6.3\ mg\ N/sq\ ft/day$$

All loading rates in Table XII are based on 81,817.3 mg N being produced each day for a home with a flow of 360gpd. Therefore, the above formula was used to calculate the value for each soil type in Table XII.

There are a few practical computations with Table XII, reviewed below.

Can a lot meet the requirements of Table XII?

As seen above, a home with a daily flow of 360 gpd will produce 81,817.2 mg N/day. This is the basis for determining the proportional loading rates in Table XII.

To determine if a lot can meet the requirements of Table XII:

First, determine lot size, water supply, and soil type and associated maximum allowable TN load for each mg/ft^2 value given by Table XII.

Example: 10,500 sq. ft. lot with public water and Type 2 soil. The maximum allowable TN for Type 2 soil is 6.3 mg/ft^2.

Next, determine maximum allowable mg N/sq ft/day by multiplying the lot size by the maximum allowable TN from Table XII:

$$10{,}500\ sq\ ft\ \times 6.3\ mg\ N/sq\ ft/day = 66{,}150\ mg\ N/day$$

Finally, divide the total mg N per day by the typical amount of nitrogen in a 3-bedroom home, which is 81,817.2, by the lot size to determine nitrogen loading per square foot:

81,817.2 mg N/day ÷ 10,500 sq ft = 7.8 mg N per sq ft per day

This development exceeds nitrogen loading limits set in Table XII with a TN load of 7.8 mg N/square foot. To develop this property, the TN in the effluent must be reduced. Again, Table XII allows the minimum land area required to be reduced by the same proportion that nitrogen in the effluent is reduced.

One method to reduce effluent nitrogen is to incorporate a nitrogen-reducing component on DOH's *List of Registered On-site Treatment and Distribution Products* list into the OSS.[2] Treatment Level N (TLN)-registered products are assumed to provide a 50% reduction in Total Nitrogen (TN). This effectively reduces the minimum lot size by 50%. This applies across (the minimum land area values in) Table XI and provides a simplified view of the effect of applying Table XII to TLN-registered products. Other options are described in the "WAC 246-272A-0320(1)(f) Requirements" section below.

Can a lot meet the requirements of Table XII using a TLN registered product?

Using the example from above for a 10,500 square foot lot with public water, and soil Type 2 that requires a TLN-registered product as a component of the OSS:

First, use the formula in the WAC 246-272A-0320(1)(e) and Table XII section above to find the amount of nitrogen in wastewater by multiplying wastewater flow (based on 360 gpd for a 3-bedroom home) by the nitrogen concentration in effluent, but reduce the concentration from 60 mg/L in the equation to 30 mg/L to calculate a 50% reduction:

Convert mg/L to mg/gallon: $\frac{\mathbf{30\ mg\ N}}{\mathbf{1\cancel{L}}} \times \frac{1\cancel{\mathrm{L}}}{0.264\ \mathrm{gal}} = 113.64\ \mathrm{mg/gal}$

Convert mg/gal to mg/day: $\frac{360\ \cancel{\mathrm{gal}}}{\mathrm{Day}} \times \frac{113.64\ \mathrm{mg\ N}}{\cancel{\mathrm{gal}}} = 40{,}909.09\ \mathrm{mg\ N/day}$

This is the amount of nitrogen an OSS with a nitrogen reducing TLN component is expected to produce based on the above assumptions (30 mg N/L and 360 gpd).

Now, determine the maximum allowable mg N/day by multiplying the lot size by the maximum allowable mg N per sq ft per day value given by Table XII. For a public water supply, soil Type 2 lot, the value is 6.3.

$$10{,}500\ sq\ ft\ \times 6.3\ mg\ N\ per\ sq\ ft\ per\ day = 66{,}150\ mg\ N\ per\ day$$

This is the maximum amount of nitrogen this lot can produce without needing TLN.

Next, compare this number to the nitrogen in the wastewater of the proposed home before TLN technology is added (81,817.2 mg N/day). Adding a TLN component in the system reduces this amount to 40,909.1 mg N/day. This value can be calculated by dividing the amount of nitrogen in mg/day at the reduced amount by the lot size in sq ft:

40,909.1 mg N/day ÷ 10,500 sq ft = 3.9 mg N/sq ft/day

This is lower than the 6.3 mg N/sq ft/day allowed for Type 2 lots using a public water supply, meaning the site can support an OSS with a flow of 360 gpd when a TLN component is added to the system.

The LHO may consider proposals utilizing a different number of bedrooms in the calculations. This may be appropriate for subdivisions.

Minimum land area can also be found working in the opposite direction. Here is an example using a different soil type and daily flow. This lot uses a public water supply, has Type 3 soil, and is a 2-bedroom home. This lot does not meet minimum land area requirements in Table XI, so a TLN component would be required to reduce nitrogen loading.

First, find the nitrogen in the wastewater for this lot by multiplying the wastewater flow (240 gpd for a 2-bedroom home) by the expected nitrogen concentration in effluent (30 mg N/L) for TLN:

240 gpd x 30 mg N/L:

Convert mg/L to mg/gallon: $\frac{30\text{ mg}}{1\cancel{\text{L}}} \times \frac{1\cancel{\text{L}}}{0.264\text{ gal}} = 113.64\text{ mg/gal}$

Convert mg/gal to mg/day: $\frac{240\ \cancel{\text{gal}}}{\text{Day}} \times \frac{113.64\text{ mg}}{1\ \cancel{\text{gal}}} = 27{,}272.73\text{ mg N/day}$

We find the minimum lot size by dividing this value by the maximum allowable TN for a lot with public water and type 3 soil (5.1)

$$27{,}272.73 mg\ N/day \div 5.1\ mg\ N/day\ = 5{,}347\ sq\ ft$$

*Please note, this calculation is only to determine if a lot can be developed. Drainfield sizing and location requirements still apply.

See Appendix A for more examples of land area calculations.

WAC 246-272A-0320(1)(f) Requirements

WAC 246-272A-0320(1)(f) requires lots be 13,000 square feet or larger for new developments unless the proposal includes:

1. A finalized assessment roll for OSS within the boundaries of a recognized sewer utility, or
2. A planned unit development with a signed, notarized, and recorded deed covenant restricting any development of lots or parcels above the approved density with the overall density meeting the minimum land area requirements of (d) or (e) of WAC 246-272A-0320(1) in perpetuity or until the OSS is no longer needed as identified in WAC 246-272A-0200(6).

The first exception allows an OSS to be developed on a lot that is smaller than 13,000 square feet if the lot is within a sewer utility's boundaries. This is meant to allow developments that will be served by OSS temporarily and converted to sewer at a time determined beforehand. Impacts from OSS developed at higher density are expected to be insignificant if the OSS is used for a limited amount of time and properly abandoned. The LHO must ensure OSS installations are protective of public health and plans to connect to sewer are reasonable and timely and the likelihood of funding the infrastructure is high.

The second exception allows development using an OSS on a lot smaller than 13,000 square feet if the lot is included in a planned unit development with the overall density meeting the requirements of (d) or (e). This means that the previous examples where the lot size was smaller than 13,000 sq ft but met Table XII's requirements would need to be part of a planned unit development that requires the overall density to either meet subsection (d) or (e).

The reference to subsection (d) establishes that the <u>average of all lots</u> in a subdivision under the planned unit development must meet the minimum lot size requirements in either Table XI or Table XII. This is meant to clarify that within the planned unit development some lots can be smaller than the appropriate minimum from Table XI or but no less than those in Table XII, if the average of all lots within the planned unit development is at least as large as the minimums in Table XI for the most restrictive soils found in the planned unit development.

The reference to subsection (e) establishes that the requirements listed in (e)(i)-(v) apply to all planned unit developments that do not meet the minimum land area requirements in Table XI. These are developments meeting Table XII. This means that lots included in these planned unit developments meeting the requirements of Table XII must, on average, meet all the requirements described in subsection (e)(i)-(v). It is acceptable if some lots within the planned unit development do not completely comply with these requirements if overall, they do.

It's important to note that the requirement in subsection (d) for every lot to meet the requirements in either Table XI or Table XII is a standalone requirement independent from the exceptions in subsection (f). In other words, the allowances in subsection (f) apply only to lots that also comply with subsection (d), <u>they are not an alternative to them</u>.

Subsection (1)(f) allows subdivisions with planned unit developments to develop OSS on small lots (smaller than the minimum in the respective table) if other lots in the subdivision are larger and the average meets the requirements of the applicable table for the most restrictive soils found in the subdivision. It also allows subdivisions in planned unit developments sized using Table XII to use the entire land area of the subdivision, excluding impervious surfaces without stormwater facilities, to comply with the minimum lot size requirement. A large green space, park, and all other areas (excluding impervious surfaces without stormwater facilities) can be averaged with OSS on lots smaller than allowed by Table XII to meet the table's maximum nitrogen per square foot requirements[3].

WAC 246-272A-0320(1)(g) Requirements

WAC 246-272A-0320(1)(g) establishes the minimum land area requirement for developments that are not single-family residences[4]. Subsection (g)(i) requires that the minimum land area for non-single-family residence developments is determined by the unit volumes of sewage created by the development.

WAC 246-272A-0010 defines a unit volume of sewage as:
(a) Flow from a single-family residence;
(b) Flow from a mobile home site in a mobile home park; or
(c) Four hundred fifty gallons of sewage per day where the proposed development is not single-family residences or a mobile home park.

Subsection (g)(ii) requires that non-single-family residence developments served by public water supplies do not exceed 3.35-unit volumes of sewage per acre per day. This value is derived from dividing an acre (43,560 square feet) by the smallest lot size in Table XI (13,000 sq ft). This reflects that Table XI is sized for a single single-family residence development, which matches the (a) part of the definition of unit volume of sewage. Part (c) of the definition requires that non-single-family residence (or mobile home park) developments are defined as 450 gallons of sewage per day. Since subsection (g)(ii) allows up to 3.35-unit volumes of sewage (for non-single-family residence developments served by public water), this means that 450 gallons per day times 3.35-unit volumes of sewage (450 x 3.35 = 1,507.5 gallons per day) are allowed per acre for these developments.

Subsection (g)(iii) requires that non-single-family residence developments served by nonpublic water do not exceed one unit volume of sewage per acre, or 450 gallons per day.

WAC 246-272A-0320(1)(h) Requirements

[3] See the Minimum Land Area Workbook for examples and calculators.
[4] Single-family residence is not defined by WAC 246-272A. Local or RCW definitions should be used.

WAC 246-272A-0320(1)(h) requires that the use of reduced-size dispersal components does not result in reductions to the minimum lot size requirements in Table XI or Table XII. This means that minimum lot size requirements associated with Table XI and Table XII are not impacted by dispersal method used in the OSS. While minimum lot size requirements are beneficial to drainfield and subsurface soil adsorption system (SSAS) placement, they are secondary reasons for minimum lot size requirements. The primary reason for minimum lot size requirements is nutrient mitigation.

WAC 246-272A-0320(2) Requirements

WAC 246-272A-0320(2) has specific requirements for subdivisions. Subsection (a) requires all subdivisions served by individual OSS are recommended for approval as required by RCW 58.17.150.

Subsection (b) sets requirements for subdivisions served by nonpublic wells. Subsections (b)(i) and (b)(ii) require that the lot lines be either:

1. Configured to allow the supply protection zone around each well to be contained entirely within the lot lines of the lot the well is located on, or
2. Configured to where the supply protection zone around each well may cross into other lots (is not contained entirely on the lot with the well) if the person proposing the subdivision provides a copy of a recorded restrictive covenant to each property containing any part of the well's supply protection zone. Lots included in the restrictive covenant cannot later develop within the supply protection zone.

Subsection (b)(iii) requires each existing and proposed well site in the subdivision have a water supply protection zone of at least 100 feet.

WAC 246-272A-0320(3) Requirements

WAC 246-272A-0320(3) provides examples of what the LHO <u>may</u> require or allow using their individual discretion. This is not an exclusionary list of requirements the LHO may add but is meant to provide clarity on important points.

Subsection (3)(a) clarifies the LHO may require detailed site plans and OSS designs prior to approving subdivision proposals. The LHO has this authority without this statement in the rule; this statement is meant to clarify this authority. The LHO should take measures to ensure subdivision proposals, and the OSS designs meet the requirements rule, are protective of public health, and are reasonable. DOH recommends the LHO require detailed site plans and OSS designs prior to approving subdivision proposals.

Subsection (3)(b) clarifies the LHO may require larger lot sizes to protect public health. The LHO has this authority without this statement in the rule; the statement serves is meant to clarify this authority. Requiring larger lot sizes is an evidence-based and scientifically supported method to protect public health and the environment from impacts from OSS. The LHO should carefully consider where larger lot sizes may be appropriate, particularly in areas determined to be impacted by nitrogen, phosphorus, or other contaminants of emerging concern, shoreline areas, and areas identified in the local management plan as requiring enhanced OSS management.

Subsection (3)(c) clarifies the LHO may prohibit development on some lots within an approved subdivision if the proposed OSS design does not meet the requirements of the rule. The LHO has this authority without this statement in the rule; it is meant to clarify this authority. An approval for a subdivision does not ensure that every newly created lot is developable with an OSS. It is the owner's responsibility to ensure the lots are developable, not the LHO's. The condition of the lot and regulatory requirements may change after the subdivision is approved and even pre-approved OSS designs may not meet the requirements at the time of proposed development.

Subsection (3)(d) allows the LHO to permit an OSS on a lot that does not meet the requirements of either Table XI or Table XII <u>only</u> if the three criteria described in subsections (3)(d)(i) - (iii) are met:

- The lot was registered as a lot of record prior to the effective date of the rule. In other words, the lot must have been created and registered before April 1, 2025.
- The lot is not within an area identified in the local management plan where minimum lot size is identified as a design parameter needed to protect public health. In other words, the lot must not be in an area where the local management plan requires a larger minimum lot size.
- The proposed OSS meets all requirements of the rule without the use of a waiver under WAC 246-272A-0420. This means the proposed OSS must meet all requirements of the rule, other than the minimum lot size requirement, without using a waiver. If the OSS needs a waiver for a setback requirement due to its small size, it cannot meet this requirement.

Section 2: Phosphorus

Phosphorus is typically found as a compound, not in its elemental state. The phosphorus cycle is millions of years long, and as rocks erode, phosphate and orthophosphate materials are released. Orthophosphate, the simplest phosphate compound, is readily used as a key plant nutrient. Phosphorus, not used by plants or otherwise precipitated and immobilized, travels via water and eventually may enter surface water either in a dissolved state or as a suspended sediment. Ultimately, it ends up on the ocean floor where it is compressed and consolidated into rocks. When there is a geologic uplift above sea level, the newly formed mountains once again begin the weathering process and release of phosphate compounds.

Phosphorus is a nutrient of concern to the environment. It contributes to eutrophication, which is when excessive amounts of nutrients in a body of water cause an excessive growth of plant life, including algae. This causes a lack of oxygen in fresh waters such as rivers, lakes, and ponds, causing animals to die off. A simplified explanation is that algae become dense on the surface of the water, and it blocks out the sun and photosynthesis cannot occur below it. This results in depleted oxygen levels lower in the water column and fish die-off.

The median value of total phosphorus (TP) concentration leaving a septic tank is approximately 10.4 mg/L (WERF, 2009). The natural levels of phosphate in surface water range from 0.0005 to 0.05 mg/L.

Phosphorus is found in toilet, bath, laundry, and kitchen wastewater. “Approximately 50% of the phosphorus generated in the home is in the urine” (Stone Environmental, Inc. June 2005). Washington banned the use of phosphates in detergents in 2006 and in residential products throughout the state effective July 1, 2010.

Phosphorus contamination of surface waters has been linked to wastes derived from on-site septic systems (OSS) (Bowes et al. 2010; Edwards and Withers 2008; Corbett et al.2002). The processes phosphorus undergoes in the soil are:

1. *Precipitation.* Negatively charged phosphate anions react with positively charged cations to form immobilized minerals such as iron (Fe), aluminum (Al), and calcium (Ca). Other factors involved are soil, pH, redox of the soil, availability of cations and whether a soil is calcareous or non-calcareous (i.e., amount of lime). Non-calcareous soils are more acidic in nature with Fe and Al. These minerals are more available to react with phosphorus and more effective at phosphorus immobilization.
2. *Adsorption*. Phosphate anions bind to positively charged mineral surfaces. This process is also more effective in acidic soils which contain Fe, Al, and clay minerals. Calcareous soils are more likely negatively charged so adsorption will not occur to any significant level. When all the available attachment sites are used, the phosphate travels further in the plume.

In both cases, the unsaturated zone (vadose zone) is an area of phosphorus accumulation. Some phosphorus passes through and into groundwater, but this is minimal compared to nitrate. Overall, phosphorus is not very mobile and is effectively retained in the vadose zone below the drainfield and is not readily released to surface waters. It is not currently regulated in WAC 246-272A.

Problems:

- The soil holding capacity of phosphorus may be reduced when binding sites on the minerals are taken, and the phosphorus can travel freely to water. The capacity of the soil to hold phosphorus is finite.
- Soil type impacts binding. Coarse, gravelly, well-drained soils have rapid flow rates and chemical reactions will be less than in other soil types.
- Calcareous soils will not bind/react as strongly as non-calcareous soils.
- Shallow soils/high water table means less soil for adsorption accumulation.
- Effluent not uniformly distributed may yield areas of excess accumulation.
- Dense/clustered drainfields may yield areas of excess accumulation leading to further movement of the phosphorus to a water source. In areas where phosphorus is a concern, it may be advisable to increase the drainfield setback requirements.
- Older systems in proximity to surface water may be an issue when the attachment sites are taken, and the phosphorus migrates further towards water.
- Older, substandard systems that may contact ground water at least part of the year may flush some of the phosphorus into the ground water.

W. D. Robertson, et al. monitored phosphate distribution in 10 mature OSS plumes in central Canada by Their conclusion was phosphate concentrations in the plumes appear to be strongly controlled by the mineral precipitation reactions that occur near the drainpipes. The systems were in use for 6 years. At all sites, ground water concentrations were lower than effluent values, which ranged from 23% to 99%.

- Six systems had calcareous soils with phosphorus concentrations ranging from 0.5 to 5.0 mg/L with a 10-meter plume. Phosphorus movement was very slow compared to the water movement, however, over time, as the potential sites become used, there will be a higher concentration of available phosphorus, and the plume will extend. The distance to surface water may be an important factor.
- The four systems with acidic soils (non-calcareous silt and clay rich sediments) had plumes of approximately 3 meters. At one site where effluent loading was ongoing for 44 years, approximately 85% of the total sewage phosphorus remains retained within the 2-meter-thick vadose zone (under the drainpipes)

"In calcareous terrain, PO_4 (phosphate) concentrations (2 to 5 mg/L P) exhibit only minor attenuation compared to effluent concentrations, whereas in non-calcareous terrain almost complete attenuation of phosphate appears possible if acidic conditions develop."

Phosphorus Abatement

The following information is for educational purposes only. There are currently no minimum testing parameters for public domain or proprietary treatment products that remove phosphorus outlined in WAC 246-272A. The Department of Health (DOH) does not have a list of products nor approved mitigation measures. Local health jurisdictions (LHJs) may sample water bodies for phosphorus and determine additional requirements for impacted areas.

Abatement of phosphorus of an individual OSS is a relatively new endeavor. Phosphorus removal may occur by microbial, chemical, or physical processes. However, it is not broken down chemically and does not volatilize into the atmosphere. Phosphorus can chemically bind to the soil or precipitate out of the effluent. Microorganisms will metabolize 10 to 20% of the influent phosphorus, which is subsequently removed as sludge (EPA *Onsite Wastewater Treatment Manual*, 2002). Phosphorus is retained in the soil until the binding ability of the soil declines, which results in phosphorus migration.

Toilet wastewater (blackwater) contains 60 to 75% phosphorus. Removing the blackwater will greatly reduce the amount of phosphorus in the wastewater stream. This can be accomplished with composting toilets, urine diversion toilets and holding tanks. Another method for phosphorus removal is to use media filters. The media typically contains a combination of iron, aluminum, or calcium compounds to react by either adsorption or precipitation. The media may be natural, manufactured, or industrial by-products. Some natural media include peat and iron-rich soils, limestone, bauxite (aluminum ore), bentonite and lignocellulose fibers.

Technical abatement practices include timed, pressurized dosing to equalize the flow over the entire drainfield thus eliminating the localized saturated flow. Another method is to use subsurface drip distribution. In drip systems, the effluent is dispersed within the root zone of plants which then use the phosphorus for growth. Sequencing batch reactors (SBR) show reductions in phosphorus concentrations but require frequent maintenance.

Intermittent sand filters enhanced with iron have been studied for phosphorus abatement in storm water. "Dissolved phosphorus removal in iron enhanced sand filters (IESF) exceeded 80% in laboratory-scale studies. Limited field studies indicated reduced or variable performance, however, which may result from IESF clogging, fouling, cementing, sorbate competition, or other loss of iron-binding capacity" (Erickson and Gulliver, 2010). The lifespan of the media is unknown. Until a national testing standard has been reviewed and approved, and included in WAC 246-272A-0110, intermittent sand filters will not be tested and approved to provide this level of treatment.

Another possible technique for phosphorus abatement is the addition of a layer of material with a high capacity of immobilizing phosphorus in the drainfield trench such as limestone and tire chips. The reactive component of the tire chips is iron. The material is placed between the gravel below the distribution pipe and the soil. The lifespan of this material and whether it contributes to potential clogging is unknown. At the time of this publication, there are no known or approved products or common construction practices that support this type of design in Washington State.

Manufactured material commonly used to abate phosphorus include light-weight clay aggregates processed to expand the clay to provide greater surface area. Another source of media are industrial by-products such as blast furnace or steel furnace slags and alkaline fly ash from coal fired power plants. Some slags require another treatment step to neutralize the pH. The sequence train is unclear. All that was found were laboratory experiments. Nanomaterials are being considered due to their extremely small size. The smaller particle size yields a greater total surface area, giving a higher capacity for phosphorus removal than other media. However, small particles generally lead to drainfield clogging.

Appendix A: Example Calculations

Overall, the steps are the same for any new development. At a minimum, a single-family residence (SFR) must have a design flow of 240 gallons/day. These calculations are meant to assist in determining if a lot/design meets the minimum land area requirements. Other setback requirements and minimum usable land area requirements are separate from this.

Please note: The expected average concentration of nitrogen in septic tank effluent is 60 mg/L and is the basis of the Table XII calculations using the first formula in Step 1 below assuming a 360 gallon per day (gpd) design flow.

Step 1:

Without TLN requirements, use 60 mg N/L to convert mg/L to mg/gal:

$$\frac{60\text{ mg}}{1\cancel{\text{L}}} \times \frac{1\cancel{\text{L}}}{0.264\text{ gal}} = 227.27\text{ mg/gal}$$

If you are working with a lot that does not meet Table XI requirements, you must reduce the 60 mg/L to 30 mg/L to calculate the assumed 50% reduction offered by TLN products:

$$\frac{30\text{ mg}}{1\cancel{\text{L}}} \times \frac{1\cancel{\text{L}}}{0.264\text{ gal}} = 113.64\text{ mg/gal}$$

Step 2:

Multiply the amount of nitrogen in mg/gal by the daily design flow for the system (ex. 360 gpd):

$$\frac{\text{x \# }\cancel{\text{gal}}}{\text{day}} \times \frac{\text{(amount from Step 1) mg}}{\cancel{\text{gal}}} = \text{(expected mg N/day)}$$

This development is expected to produce **X mg N/day.**

Step 3:
Determine maximum allowable mg N/day the lot can support by multiplying the lot size by the maximum allowable mg N/sq ft/day value given by Table XII. For a public water supply, soil Type 4, the value is 4.3

(Available lot size) x (value of max nitrogen loading from table XII for soil type) = mg N the proposed lot can support

Then compare the development's expected loading and the load the lot can support:
(Development's expected mg N/day) against (mg N/day that the lot can support)

Step 4:
Check the value in Step 2 by dividing the value from Step 2 by the proposed lot size in square feet to find the maximum allowable TN per square foot on a lot with water supply type and soil Type 4:

$$\text{X\# mg N/day development is expected to produce} \div \text{X\# sq ft of proposed lot size} = \text{mg N/sq ft/day}$$

Now, check this against the values in Table XII:

X# mg N > value from Table XII

If the value calculated is more than the value in Table XII, the lot cannot be developed as is. TLN must be considered.

Example 1

A 3-bedroom SFR on a 21,000 square foot lot, soil Type 5.

Step 1:
Determine the amount of nitrogen in 1 gallon of wastewater without a TLN product:

Convert mg/L to mg/gallon: $\frac{60\text{ mg}}{1\cancel{\text{L}}} \times \frac{1\cancel{\text{L}}}{0.264\text{ gal}} = \mathbf{227.27\ mg\ N/gal}$

Step 2:
Multiply the amount of nitrogen per gallon by the daily design flow for the system (360 gallons):

Convert mg/gal to mg/day: $\frac{360\ \cancel{\text{gal}}}{\text{day}} \times \frac{227.27\text{ mg}}{\cancel{\text{gal}}} = 81{,}817.2\text{ mg N/day}$

This 3-bedroom design is expected to produce 81,817.2 mg N/day.

Step 3:
Determine maximum allowable mg N/day by multiplying the lot size by the maximum allowable mg N per square foot per day value given by Table XII. For public water supply, soil Type 5 lot, the value is 3.9.

(Lot size) 21,000 sq ft x 3.9 mg N/day = 81,900 mg N

The 21,000 sq ft lot can support 81,900 mg of N per day because:

81,900 mg N > 81,817.2 mg N

Yes, this lot meets the requirements of Table XII and can be developed.

Step 4:
Use the value found in *Step 2* and divide by the proposed lot size in square feet to find the maximum allowable TN per square foot on a lot with public water supply and Type 4 soil:

$$81{,}817.2\ mg\ N/day\ \div 21{,}000\ sq\ ft = 3.896\ mg\ N\ /sq\ ft\ /day$$

Check this against the values in Table XII. As expected, this lot does not exceed Table XII loading rates.

Example 2

A 3-bedroom SFR on a 10,500 square foot lot with Type 3 soils. This lot size does not meet Table XI requirements for Type 3 soils, so a TLN product is required.

Step 1:
Determine the TN in 1 gallon of wastewater using the 60mg/L average concentration in septic tank effluent:

Convert mg/L to mg/gallon: $\frac{60\ \text{mg}}{1\cancel{\text{L}}} \times \frac{1\cancel{\text{L}}}{0.264\ \text{gal}} = 227.27\ \text{mg/gal}$

Because this development must use a TLN product, which is assumed to treat 50% of the TN, the TN concentration changes from 60 mg/L to 30 mg/L:

Convert mg/L to mg/gallon: $\frac{30\ \text{mg}}{1\cancel{\text{L}}} \times \frac{1\cancel{\text{L}}}{0.264\ \text{gal}} = 113.64\ \text{mg/gal}$

Step 2:
Take the reduced TLN amount of 113.64 mg/gal and multiply it by the daily design flow:

Convert mg/gal to mg/day: $\frac{360\ \cancel{\text{gal}}}{\text{day}} \times \frac{113.64\ \text{mg}}{\cancel{\text{gal}}} = 40{,}909.09\ \text{mgN/day}$

This development is expected to produce 40,909.09 mg N/day using TLN.

Step 3:
Determine maximum allowable mg N/day by multiplying the lot size by the maximum allowable mg N per square foot per day value in Table XII. For public water supply, soil Type 3, the value is 5.1.

(Lot size) 10,500 sq ft x 5.1 mg N/sq ft/day = 53,550 mg N/day

The 10,500 square foot lot can support 40,909.09 mg of N because:

40,909.09 mg N < 53,550 mg N

Step 4:

Use the value found in *Step 2* and divide by the proposed lot size in square feet to find the maximum allowable TN per square foot on a lot with public water supply and Type 3 soil:

$$40{,}909.09 \text{ mg N/day } \div 10{,}500 \text{ sq ft} = 3.89 \text{ mg N sq ft/day}$$

Check this against the value for Type 3 soil in Table XII:

3.89 mg N sq ft < 5.1 mg N sq ft

This development meets the requirements in Table XII and can be developed using a TLN product.

Example 3

A 6,000 square foot lot with a proposed 2-bedroom SFR using public water with soil Type 3. This lot size does not meet Table XI requirements for Type 3 soils, so a TLN product is required.

Step 1:
Because the OSS must use a TLN product, the N concentration is 30 mg/L:

Convert mg/L to mg/gallon: $\frac{30 \text{ mg}}{1\cancel{\text{L}}} \times \frac{1\cancel{\text{L}}}{0.264 \text{ gal}} = 113.64 \text{ mg/gal}$

Step 2:
Take 113.64 mg/gal and multiply it by the daily design flow:

Convert mg/gal to mg/day: $\frac{240\ gal}{Day} \times \frac{113.64\ mg}{gal} = 27{,}272.73\ mgN/day$

This development is expected to produce 27,272.73 mg N/day using TLN.

Step 3:
Determine maximum allowable mg N/day by multiplying the proposed lot size by the maximum allowable mg N per sq ft per day value given by Table XII. For public water supply and soil Type 3, the value is 5.1.

(Lot size) 6,000 sq ft x 5.1 mg N/sq ft/day = 30,600 mg N/day

The 6,000 square foot lot can support 30,600 mg N because:

27,272.73 mg N < 30,600 mg N

Step 4:
Use the value found in *Step 2* and divide by the proposed lot size in square feet to find the maximum allowable TN per square foot on a lot with public water supply and Type 3 soil:

$$27{,}272.73 \text{ mg N/day } \div 6{,}000 \text{ sq ft} = 4.5 \text{ mg N/sq ft/day}$$

Check this against the value for Type 3 soil in Table XII:

4.5 mg N sq ft < 5.1 mg N sq ft

This development meets the requirements in Table XII and can be developed using a TLN product.

Example 4.1

A 4-bedroom SFR on 14,000 square foot lot with Type 5 soils using public water. This lot size does not meet Table XI requirements for Type 5 soils, so a TLN product is required, but this example serves to demonstrate why it does not meet the requirements in Table XI. Example 4.2 shows how this lot is developable using TLN.

Step 1:

Convert mg/L to mg/gallon: $\frac{60 \text{ mg}}{1\cancel{\text{L}}} \times \frac{1\cancel{\text{L}}}{0.264 \text{ gal}} = 227.27 \text{ mg/gal}$

Step 2:

Take 227.12 mg/gal and multiply it by the daily design flow:

$$\frac{480 \cancel{\text{gal}}}{\text{day}} \times \frac{227.27 \text{ mg}}{\cancel{\text{gal}}} = 109{,}089.6 \text{ mg N/day}$$

This development is expected to produce 109,089.6 mg N/day *without* TLN.

Step 3:

Determine maximum allowable mg N/day by multiplying the proposed lot size by the maximum allowable mg N per square foot per day value given by Table XII. For public water supply, soil Type 5, the value is 3.9.

(Lot size) 14,000 sq ft x 3.9 mg N/day = 54,600 mg N

The 14,000 square foot lot **cannot** support 109,089.6 mg N because:

109,089.6 mg N > 54,600 mg N

Step 4:

Use the value found in *Step 2* and divide by the proposed lot size in square feet to find the maximum allowable TN per square foot on a lot with public water supply and Type 5 soil:

$$109{,}089.6 \, mg \, N \, per \, day \div 14{,}000 \, sq \, ft = 7.79 \, mgN \, sq \, ft \, per \, day$$

Check this against the values in table XII:

7.79 mg N sq ft > 3.9 mg N sq ft

This development does not meet Table XI or Table XII requirements without TLN. Example 4.2 demonstrates the difference when using TLN.

Example 4.2

Same house as 4.1, but with a TLN product.

Step 1:
Because the OSS must use a TLN product, the N concentration is 30 mg/L:

Convert mg/l to mg/gallon: $\frac{30\text{ mg}}{1\ \cancel{\text{L}}} \times \frac{1\cancel{\text{L}}}{0.264\text{ gal}} = 113.64\text{ mg/gal}$

Step 2:
Take the amount of 113.64 mg/gal and multiply it by the daily design flow:

$$\frac{480\ \cancel{gal}}{day} \times \frac{113.64\ mg}{\cancel{gal}} = 54{,}547.2\ mg\ N/day$$

This lot is expected to produce 54,547.2 mg N/day with TLN.

Step 3:
Determine maximum allowable mg N/day by multiplying the proposed lot size by the maximum allowable mg N per square foot per day value given by Table XII. For public water supply, soil Type 5, the value is 3.9:

(Lot size) 14,000 sq ft x 3.9 mg N/day = 54,600 mg N

The 14,000 square foot lot can support 54,600 mg N because:

54,547.2 mg N < 54,600 mg N

Step 4:
Use the value found in *Step 2* and divide by the proposed lot size in square feet to find the maximum allowable TN per square foot on a lot with public water supply and Type 5 soil:

$$54{,}547.2\text{ mg N/day } \div 14{,}000\text{ sq ft} = 3.8\text{ mg N sq ft/day}$$

Check this against the values in Table XII:

3.8 mg N sq ft < 3.9 mg N sq ft

This development now meets table XII using TLN.

Example 5.1

A restaurant on a 12,000 square foot lot with Type 4 soils and public water. Example 5.2 shows how it meets Table XII requirements using TLN.

Step 1:

Convert mg/L to mg/gallon: $\frac{60\text{ mg}}{1\,\cancel{\text{L}}} \times \frac{1\,\cancel{\text{L}}}{0.264\text{ gal}} = 227.27\text{ mg/gal}$

Step 2:

Take 227.27 mg/gal and multiply it by the daily design flow:

$$\frac{450\,\cancel{\text{gal}}}{\text{day}} \times \frac{227.27\text{ mg}}{\cancel{\text{gal}}} = 102{,}271.5\text{ mg N/day}$$

This development is expected to produce 102,271.5 mg N/day.

Step 3:

Determine maximum allowable mg N/day by multiplying the proposed lot size by the maximum allowable mg N per square foot per day value given by Table XII. For public water supply, soil Type 4 lot, the value is 4.3.

(Lot size) 12,000 sq ft x 4.3 mg N/day = 51,600 mg N

The 12,000 square foot lot **cannot** support 51,600 mg N because:

102,271.5 mg N > 51,600 mg N

Step 4:

Use the value found in *Step 2* and divide by the proposed lot size in square feet to find the maximum allowable TN per square foot on a lot with public water supply and Type 4 soil:

$$102{,}271.5\text{ mg N/day } \div 12{,}000\text{ sq ft} = 8.52\text{ mg N/sq ft/day}$$

Check this against the values in Table XII:

8.5 mg N sq ft > 4.3 mg N sq ft

This development does not meet Table XI or Table XII requirements without TLN. Example 5.2 demonstrates the difference when using TLN.

Example 5.2

Same restaurant from example 5.1, but with a TLN product.

Step 1:

Because the OSS must use a TLN product, the N concentration is 30 mg/L:

Convert mg/l to mg/gallon: $\frac{30\text{ mg}}{1\text{L}} \times \frac{1\text{L}}{0.264\text{ gal}} = 113.64\text{ mg/gal}$

Step 2:

Take the amount of 113.64 mg/gal and multiply it by the daily design flow:

$$\frac{450\,\cancel{\text{gal}}}{\text{day}} \times \frac{113.64\ \text{mg}}{\cancel{\text{gal}}} = 51{,}138\text{ mg N/day}$$

This development is expected to produce 51,138 mg N/day.

Step 3:

Determine maximum allowable mg N/day by multiplying the proposed lot size by the maximum allowable mg N per sq ft per day value given by Table XII. For public water supply, soil Type 4, the value is 4.3.

(Lot size) 12,000 sq ft x 4.3 mg N/day = 51,600 mg N

The 12,000 square foot lot can support 51,600 mg N because:

51,138 mg N < 51,600 mg N

Step 4:

Use the value found in *Step 2* and divide by the proposed lot size in square feet to find the maximum allowable TN per square foot on a lot with public water supply and Type 4 soil:

$$51{,}138\text{ mg N/day } \div 12{,}000\text{ sq ft} = 4.2\text{ mg N/sq ft/day}$$

Check this against the values in Table XII:

4.2 mg N sq ft < 4.3 mg N sq ft

This development meets Table XII requirements.

Example 6.1

A 3-bedroom SFR with a 2-bedroom ADU on a 18,000 square foot lot with public water and Type 4 soils.

Step 1:

Convert mg/L to mg/gal: $\frac{60\,mg}{1\,\cancel{L}} \times \frac{1\cancel{L}}{0.264\,gal} = 227.27\,mg/gal$

Step 2:
Take 227.27 mg/gal and multiply it by the daily design flow:

$$\frac{600\ \cancel{gal}}{day} \times \frac{227.27\ mg}{\cancel{gal}} = 136{,}362\ mg\ N/day$$

This development is expected to produce 136,362 mg/N/day.

Step 3:
Determine maximum allowable mg N/day by multiplying the lot size by the maximum allowable mg N per square foot per day value given by Table XII. For public water supply, soil Type 4, the value is 4.3.

(Lot size) 18,000 sq ft x 4.3 mg N/sq ft/day = 77,400 mg N/day

The 18,000 square foot lot **cannot** support 136,362 mg N because:

136,362 mg N > 77,400 mg N

Step 4:
Use the value found in *Step 2* and divide by the proposed lot size in square feet to find the maximum allowable TN per square foot on a lot with public water supply and Type 4 soil:

$$136{,}362\ \text{mg N/day}\ \div 18{,}000\ \text{sq ft} = 7.5\ \text{mg N/sq ft/day}$$

Check this against the values in Table XII:

7.5 mg N sq ft > 4.3 mg N sq ft

This development does not meet Table XII requirements.

Example 6.2

Same scenario as example 6.1 but adding a TLN product.

Step 1:
Because the OSS must use a TLN product, the N concentration is 30 mg/L:

Convert mg/L to mg/gallon: $\frac{30\ \text{mg}}{1\ \cancel{\text{L}}} \times \frac{1\ \cancel{\text{L}}}{0.264\ \text{gal}} = 113.64\ \text{mg/gal}$

Step 2:
Take 113.64 mg/gal and multiply it by the daily design flow:

$$\frac{600\ \cancel{\text{gal}}}{\text{Day}} \times \frac{113.64\ \text{mg}}{\cancel{\text{gal}}} = 68{,}184\ \text{mg N/day}$$

This development is expected to produce 68,184 mg/N/day.

Step 3:
Determine maximum allowable mg N/day by multiplying the proposed lot size by the maximum allowable mg N per sq ft per day value given by Table XII. For public water supply, soil Type 4, the value is 4.3.

(Lot size) 18,000 sq ft x 4.3 mg N/sq ft/day = 77,400 mg N

The 18,000 square foot lot can support 136,362 mg N with TLN because:

68,184 mg N < 77,400 mg N

Step 4:
Use the value found in *Step 2* and divide by the proposed lot size in square feet to find the maximum allowable TN per square foot on a lot with public water supply and Type 4 soil:

$$68{,}184 \text{ mg N/day } \div 18{,}000 \text{ sq ft} = 3.7 \text{ mg N/sq ft/day}$$

Check this against the values in Table XII:

3.7 mg N sq ft < 4.3 mg N sq ft

This development meets table XII requirements using TLN.

Example 6.3

Same scenario as example 6.2 (uses TLN) but reducing the lot size to 15,000 sq ft lot.

Step 1:

Convert mg/l to mg/gallon: $\frac{30 \text{ mg}}{1\ \cancel{\text{L}}} \times \frac{1\ \cancel{\text{L}}}{0.264 \text{ gal}} = 113.64 \text{ mg/gal}$

Step 2:
Take 113.64 mg/gal and multiply it by the daily design flow:

$$\frac{600\ \cancel{\text{gal}}}{\text{Day}} \times \frac{113.64 \text{ mg}}{\cancel{\text{gal}}} = \text{ mg N/day}$$

This development is expected to produce 68,184 mg N/day.

Step 3:
Determine maximum allowable mg N/day by multiplying the proposed lot size by the maximum allowable mg N per square foot per day value given by Table XII. For a public water supply, soil Type 4 lot, the value is 4.3.

(Lot size) 15,000 sq ft x 4.3 mg N/sq ft/day = 64,500 mg N

The 15,000 square foot lot **cannot** support 68,184 mg N with TLN because:

68,184 mg N > 64,500 mg N

Step 4:
Use the value found in *Step 2* and divide by the proposed lot size in square feet to find the maximum allowable TN per square foot on a lot with public water supply and Type 4 soil:

$$68{,}184 \text{ mg N/day } \div 15{,}000 \text{ sq ft} = 4.5 \text{ mgN/sq ft/day}$$

Check this against the values in Table XII:

4.5 mg N sq ft > 4.3 mg N sq ft

This development will not meet Table XII requirements, even with TLN.

<u>Example 7.1</u>

Apartment building (15 bedrooms total), 20,500 square foot lot on Type 5 soils with TLN on public water.

Step 1:
Because the OSS must use a TLN product, the N concentration is 30 mg/L:

Convert mg/L to mg/gallon: $\frac{30 \text{ mg}}{1 \cancel{\text{L}}} \times \frac{1 \cancel{\text{L}}}{0.264 \text{ gal}} = 113.64 \text{ mg/gal}$

Step 2:
Take 113.64 mg/gal and multiply it by the daily design flow:

$$\frac{1800 \cancel{\text{gal}}}{\text{day}} \times \frac{113.64 \text{ mg}}{\cancel{\text{gal}}} = 204{,}552 \text{ mg N/day}$$

This development is expected to produce 204,552 mg N/day.

Step 3:
Determine maximum allowable mg N/day by multiplying the proposed lot size by the maximum allowable mg N per sq ft per day value given by Table XII. For public water supply, soil Type 5, the value is 3.9.

(Lot size) 20,500 sq ft x 3.9 mg N/day = 79,950 mg N

The 20,500 square foot lot **cannot** support 204,552 mg N with TLN because:

204,552 mg N > 79,950 mg N

Step 4:
Use the value found in *Step 2* and divide by the proposed lot size in square feet to find the maximum allowable TN per square foot on a lot with public water supply and Type 5 soil:

$$204{,}552 \text{ mg N/day } \div 20{,}500 \text{ sq ft} = 9.97 \text{ mg N/sq ft/day}$$

Check this against the values in Table XII:

9.97 mg N sq ft > 3.9 mg N sq ft

This development does not meet Table XI or Table XII requirements, even with TLN.

Example 7.2

Apartment building with 8 bedrooms, 20,500 square foot lot, Type 5 soils, public water, with a TLN product.

Step 1:

Convert mg/L to mg/gallon: $\frac{30 \text{ mg}}{1\cancel{\text{L}}} \times \frac{1\cancel{\text{L}}}{0.264 \text{ gal}} = 113.64 \text{ mg/gal}$

Step 2:
Take 113.64 mg/gal and multiply it by the daily design flow:

$$\frac{960\ \cancel{gal}}{Day} \times \frac{113.64\ mg}{\cancel{gal}} = 109{,}094.4\ mg\ N/day$$

This development is expected to produce 109,094.4 mg N/day.

Step 3:
Determine maximum allowable mg N/day by multiplying the lot size by the maximum allowable mg N per sq ft per day value given by Table XII. For public water supply, soil type 5, the value is 3.9.

(Lot size) 20,500 sq ft x 3.9 mg N/day = 79,950 mg N

The 20,500 square foot lot **cannot** support 109,094.4 mg N with TLN because:

109,094.4 mg N > 79,950 mg N

Step 4:
Use the value found in *Step 2* and divide by the proposed lot size in square feet to find the maximum

allowable TN per square foot on a lot with public water supply and Type 5 soil:

$$109{,}094.4\ mg\ N\ /day\ \div 20{,}500\ sq\ ft = 5.3\ mgN/sq\ ft/day$$

Check this against the values in Table XII:

5.3 mg N sq ft > 3.9 mg N sq ft

This development does not meet Table XII requirements, even with TLN.

Appendix B: References

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