Cody Vavra
AQUA Engineering
5352 S Valentia Way
Greenwood Village, CO 80111
cody.vavra@aquaeng.com

MEMORANDUM

TO: Cody Vavra

FROM: Meg Parish, Permit Section Manager, Water Quality Control Division

DATE: 6/6/2022

RE: PEL200642 - Groundwater PELs for Pine Canyon Water Reclamation Facility
and
PEL200644 – Reuse PELs for Pine Canyon Water Reclamation Facility

Permittee/
Facility: Pine Canyon Water and Sanitation District - Pine Canyon Water Reclamation Facility

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The Water Quality Control Division (division) of the Colorado Department of Public Health and Environment has prepared Preliminary Effluent Limits (PELs) for the proposed Pine Canyon Water and Sanitation District - Pine Canyon Water Reclamation Facility. This PEL is based on the following assumptions:

- the facility's maximum month daily average hydraulic design capacity is 0.405 million gallons per day (MGD);
- the facility will reclaim 100% of its treated domestic wastewater under the division's reclaimed water program and will have zero effluent discharge to groundwater;
- the facility is located in the Chatfield Reservoir Watershed where the requirements of Regulation 73 – Chatfield Reservoir Control Regulation apply;
- the facility will meet applicable Regulation 73 phosphorus limitations through the implementation of a land application management plan (LAMP) pursuant to Regulation 73.4(2)(c);
- the point of compliance with permit effluent limitations and Regulation 84 reclaimed water limitations is "end-of-pipe" (prior to the lined storage impoundments and distribution of reclaimed water). Note that in an email dated November 3, 2021 the PEL applicant stated that the point of compliance would be subsequent to treatment and "*inside the WWTP's building before discharging to the storage ponds.*" Groundwater monitoring wells will not be approved as points of compliance.

PELs are used for planning purposes and are required as part of the Site Approval process. PELs are a projection of effluent limits that would be contained within a Colorado Discharge Permit System (CDPS) discharge permit based on the regulatory requirements in place at the time of this analysis and information disclosed by the applicant. As described in Attachment A, these PELs have been developed based on the current available information, including, but not limited to: information provided in the PEL application; current water quality regulations and/or standards; and current division policies and standard practices.

PELs do not constitute permission to discharge pollutants under the Water Quality Control Act (25-8-101, et. seq., C.R.S.). Final permit limits must be calculated after receipt of a discharge permit application and under the terms and conditions of Regulations 41, 61 and 62 (5 CCR 1002-41, 61, and 62). A determination of which effluent limits ultimately apply in a permit will depend on information available at the time of permit application and development, including but not limited to: current regulations and/or standards; permit application information; process knowledge; and monitoring data. The final effluent limits are expected to be similar, but will not necessarily be identical, to the projections in this PEL.

Table 1 summarizes the PELs that the proposed treatment facility will be evaluated against under the Site Approval process. This evaluation will include a determination of whether the proposed treatment facility, as designed, can meet these limitations. A new or modified wastewater treatment facility will be expected to meet the limitations for these parameters upon commencement of discharge or upon starting-up the modified treatment process. **Appendix A** describes the purpose and basis for these PELs.

Table 1
Preliminary Effluent Limitations - Pine Canyon Water Reclamation Facility

Parameter	Limitations
Regulation No. 62 – Technology-Based Limitations	
BOD_5 (mg/l)	45 (7-day average), 30 (30-day average)
BOD_5 (% removal)	85 (30-day average)
Oil and Grease (mg/l)	10 (maximum)
pH (s.u.)	6.0-9.0 (minimum-maximum)
Total Suspended Solids (mg/l)	45 (7-day average), 30 (30-day average)
TSS (% removal)	85 (30-day average)
Total Suspended Solids (mg/l), Non-aerated waste stabilization ponds*	160 (7-day average), 105 (30-day average)
Total Suspended Solids (mg/l), Aerated waste stabilization ponds*	110 (7-day average), 75 (30-day average)
Regulation No. 73 - Chatfield Watershed Control Regulation	
Phosphorus, mg/l	1.0 mg/l (30-day average) and compliance with LAMP
Phosphorus, lbs/year	1,233.0 lbs/year and compliance with LAMP
Regulation No. 84 – Category 3 Reclaimed Water for Centralized Reclaimed Water Treatment System	
Turbidity NTU	3 (monthly avg.) not to exceed 5 in more than 5% of individual samples
E. coli cfu/100mL	None detected in at least 75% of samples per calendar month and 126/100mL single sample max

Regulation No. 84 – Category 3 Reclaimed Water for Localized Reclaimed Water Treatment System

	Enteric Viruses	Parasitic Protozoa	Enteric Bacteria
Log_{10} Reduction Target (10^{-4}) Category 3	8.5	7.0	6.0

*Where adjusted TSS limitations are used, the 85 percent removal requirement for TSS shall be waived, pursuant to Regulation No. 62.

Appendix A
Purpose and Basis for Preliminary Effluent Limitations
Pine Canyon Water Reclamation Facility

Introduction

The Water Quality Control Division (division) has developed Preliminary Effluent Limitations (PELs) for Pine Canyon Water Reclamation Facility, proposed to be located in Douglas County Colorado. This evaluation was conducted to facilitate issuance of PELs for pollutants of concern that may be discharged from a domestic and/or industrial WWTF. PEL were developed based on the following assumptions:

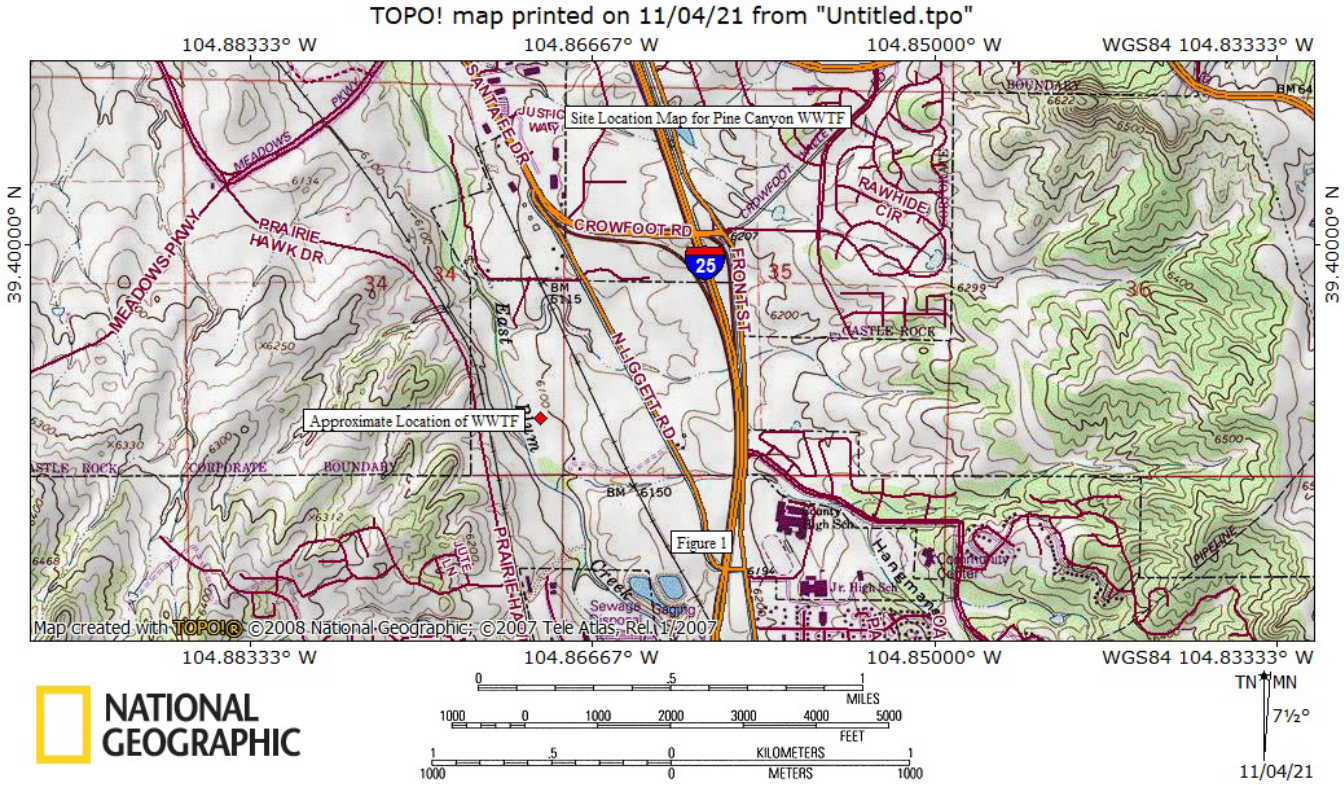
- the facility's maximum month daily average hydraulic design capacity is 0.405 million gallons per day (MGD);
- the facility will reclaim 100% of its treated domestic wastewater under the division's reclaimed water program and will have zero effluent discharge to groundwater;
- the facility is located in the Chatfield Reservoir Watershed where the requirements of Regulation 73 – Chatfield Reservoir Control Regulation apply;
- the facility will meet applicable Regulation 73 phosphorus limitations through the implementation of a land application management plan (LAMP) pursuant to Regulation 73.4(2)(c);
- the point of compliance with permit effluent limitations and Regulation 84 reclaimed water limitations is "end-of-pipe" (prior to the lined storage impoundments and distribution of reclaimed water). Groundwater monitoring wells will not be approved as points of compliance.

Facility Location

The proposed facility location is shown in Figure A-1. The latitude and longitude of the proposed facility location is approximately:

Latitude: 39.39609444 North
Longitude: -104.86533333 West

Figure A-1 - Location Map:



BASIS FOR DEVELOPMENT OF LIMITATIONS

Pollutants of Concern

The following pollutants of concern are applicable to wastewater treatment facilities located in the Chatfield Reservoir Watershed that reclaim 100% of their treated domestic wastewater under the division's reclaimed water program and discharge zero effluent to groundwater:

- Biological Oxygen Demand (BOD)
- Total Suspended Solids (TSS)
- Oil and Grease
- pH
- Phosphorus
- Turbidity
- E. coli

The PEL application did not identify additional pollutants of concern. Minor domestic wastewater treatment facilities (WWTFs) that do not receive industrial waste generally do not have other parameters such as metals, organics and radionuclides, present at concentrations that have reasonable potential to cause or contribute to an exceedance of a water quality standard and, therefore, additional pollutants of concern were not evaluated in this PEL. However, if future information establishes a reasonable potential for other pollutants to be present at such concentrations, discharge permit effluent limitations for these parameters may be added at that time. The applicable water quality standards and technology-based limitations for these pollutants are contained in the following regulations:

- Regulation No. 41: The Basic Standards for Groundwater
- Regulation No. 62: Regulations for Effluent Limitations
- Regulation No. 73: Chatfield Reservoir Control Regulation
- Regulation No. 84: Reclaimed Water Control Regulation

Regulation No. 41 – Water Quality Based Groundwater Standards:

Groundwater standards for a domestic and/or industrial WWTF are provided in Tables 1-4 of Regulation No. 41 - The Basic Standards for Groundwater. The majority of the numeric standards listed in Regulation 41 are the maximum contaminant levels (MCLs) for public drinking water supplies, as established by the National Primary Drinking Water Regulations. The remainder are derived from the Colorado Basic Surface Water Standards.

Given that the proposed Pine Canyon Water Reclamation Facility will reclaim 100% of its treated domestic wastewater under the division's reclaimed water program and will have zero discharge of effluent to groundwater, water quality based groundwater standards are not applicable to the discharge, and thus PELs based on Regulation 41 are not included in Table 1.

Regulation No. 62 – Technology-Based Limitations:

Table 1 includes PELs for technology-based standards applicable to all discharges of wastewater to State waters, with the exception of storm water and agricultural return flows. These standards are provided in Regulation No. 62 - Regulations for Effluent Limitations. The permittee will be required to meet technology-based standards at "end-of-pipe" (prior to the lined storage impoundments and distribution of reclaimed water).

Regulation No. 73 - Chatfield Watershed Control Regulation:

Regulation No. 73 - Chatfield Reservoir Control Regulation manages and regulates the amount of phosphorus that is allowed to be discharged into the Chatfield Watershed and/or Reservoir. Regulation No. 73 regulates the pounds per year of phosphorus and the concentration of phosphorus at the point of discharge or in lysimeters. Point source dischargers are listed in Regulation 73 by their legal name, and the regulation includes the pounds per year of phosphorus each facility is authorized to discharge. Each of these facilities is required to meet a phosphorus effluent limitation of 1.0 mg/l for a 30-day average at the design capacity of the wastewater facility except as provided in section 73.3(2)(f), and the annual wasteload allocation specified in the regulation except as provided in 73.3(2)(e),(g),(h), and (i).

Pine Canyon Water Reclamation Facility has not obtained a wasteload allocation for phosphorus in Regulation 73. Table 1 therefore includes a PEL of zero for phosphorus.

Pine Canyon Water Reclamation Facility is currently developing a land application management plan (LAMP) to ensure zero discharge of phosphorus to groundwater. Where the LAMP identifies a calculated phosphorus effluent concentration that results in a zero discharge of phosphorus to groundwater, this division will modify this PEL to include the calculated phosphorus value as an effluent limitation, along with any other applicable control measures, monitoring requirements, or other requirements necessary to implement and maintain the LAMP.

Note that where a LAMP is used to control discharges of phosphorus to state waters, the permittee will be required to meet a calculated phosphorus value at "end-of-pipe" (prior to the lined storage impoundments and distribution of reclaimed water).

Regulation No. 84 -Reclaimed Water Control Regulation:

The PEL application specified the following proposed uses of reclaimed water which requires Category 3 water:

- Unrestricted-Access Landscape Irrigation

- Agricultural Irrigation
- Non-Discharging Construction and Road Maintenance
- Toilet and Urinal Flushing

Based on these proposed uses, Table 1 includes applicable PELs for the Category 3 use of reclaimed domestic wastewater per Regulation No. 84 - Reclaimed Water Control Regulation.

In a follow-up email to the division dated September 28, 2021, the applicant also indicated that the treatment system will be defined as a Centralized Reclaimed Water Treatment System per Regulation 84 section 84.5(8). At the onset of construction, the population of the community (< 1,000) will deem it necessary for reclaimed water treatment to meet Localized System treatment requirements. However, the division will grant a variance from Localized System requirements as long as the only use of reclaimed water is restricted-access landscape irrigation. The following requirements in Regulation 84 must be complied with for the duration of the variance:

- 43 acres of non-food crops and silviculture that are inaccessible to the public will be irrigated.
- The irrigated area will be blocked by a railroad with no crossing by the general public and by a gated fence.
- The conditions of the LAMP (Reg. 73 compliance) will be met.
- The variance from meeting localized system treatment requirements for Regulation 84 will expire after three years from the issuance of the Treater Authorization with an opportunity to apply for an extension.
- Once the population of 1,000 is reached, the variance will be discontinued and the centralized treatment system will produce Category 3 Plus reclaimed water for the intended authorized applications.

In addition to meeting the water quality standards in Table 1, proper filtration and disinfection must produce reclaimed water that reliably achieves the following requirements (in the event of a conflict between Regulation #22 and these filtration and disinfection requirements, these requirements shall control over any conflicting filtration and disinfection requirements in Regulation No. 22):

1. Disinfection that provides a minimum of 99.999 (5-log) inactivation of enteric viruses through one of the following treatment techniques:

    a. For free chlorine or monochloramines, log inactivation of viruses to be determined as referenced in 5-CCR-1002-11 and defined by the USEPA for disinfection of surface water (Hepatitis A), or

    b. Minimum UV of 40 mJ/cm2 using a validated reactor per the Ultraviolet Disinfection Guidance Manual for the Final Long Term 2 Enhanced Surface Water Treatment Rule (November 2006).

2. Filtration by any one of the following treatment techniques:

    a. Conventional or direct filtration,

    b. Membrane filtration accepted for use by the division in accordance with section 11.8 of 5 CCR 1002-11,

    c. Bag or cartridge filtration accepted for use by the division in accordance with section 11.8 of 5 CCR 1002-11, or

    d. Alternative filtration technologies accepted by the Division in accordance with Wastewater Design Criteria Alternative Technology Acceptance that is third party challenge tested to reliably remove 99.9% of challenge particles that are at most 3 micron diameter.

Additionally, any recycled spent filter backwash water, thickener supernatant or liquids from the dewatering process must be returned to a location within the treatment process that is before the filtration technology or an alternative Department-approved location. For conventional or direct filtration, the location of return must be prior to the coagulant feed location. For all other filtration technologies, the location of return must be prior to the filtration process and approved by the Division.

The effluent quality from Pine Canyon Water Reclamation Facility will be expected to meet the appropriate Category Standards at the reclaimed domestic wastewater point of compliance. The point of compliance with permit effluent limitations and Regulation 84 reclaimed water limitations is "end-of-pipe" (prior to the lined storage impoundments and distribution of reclaimed water) and will be so noted in the Notice of Authorization, which is issued by the Permits Section. The Pine Canyon Water Reclamation Facility will be required to obtain a Notice of Authorization from the Permits Section prior to treating, distributing and using reclaimed water (see details of uses in Regulation 84). To expedite the reclaimed water permitting process, the Pine Canyon Water Reclamation Facility may submit a Letter of Intent to the Division during the site approval process. The Notice of Authorization for approved uses at the facility will not be issued until the site approval process is complete for the facility.

In addition to meeting the appropriate Category Standards, the Pine Canyon Water Reclamation Facility must control the rate of irrigation to ensure the application of effluent is at or below agronomic rates for nutrients and/or evapotranspiration rates. The treatment facility and the end user will also be required to meet additional monitoring, reporting and management practices. These are further described in Regulation No. 84.

References

Monitoring and Reporting Requirements for Reclaimed Water Treatment Facilities, Water Quality Policy (WQP) 25

The Basic Standards and Methodologies for Surface Water, Regulation 31.

The Basic Standards for Groundwater, Regulation 41.

Site-Specific Water Quality Classifications and Standards for Groundwater, Regulation 42.

Colorado Discharge Permit System Regulations, Regulation 61.

Regulations for Effluent Limitations, Regulation 62.

Reclaimed Water Control Regulations, Regulation 84.

Site Location and Design Approval Regulations for Domestic Wastewater Treatment Works 5 CCR 1002-22.

Appendix B
Agricultural Rate Review for the Pine Canyon LAMP
Colorado Water Quality Control Division

1.0 Introduction

This Land Application Management Plan (LAMP) review concerned three (3) agronomic parameters, namely; evapotranspiration (ET), nitrogen (N) and phosphorus (P). Agronomic rate calculations for these parameters, based on the proposed plants/crops, were conducted to determine the most limiting parameter, on which any permitting limitations would be based. In the case of Pine Canyon LAMP, special attention was attributed to the agronomic rate of phosphorus, since the facility is located within a phosphorus control regulation zone.

The proposed facility is designed to generate 0.405 MDG of municipal wastewater with maximum effluent concentrations of 10 mg/l and 1 mg/l for nitrogen and phosphorus, respectively. The LAMP also includes a phosphorus concentration of 0.16 mg/l as an option if/when needed to be used.

Based on a 0.405 MGD design capacity, the facility will be producing 147,825,000 gallons of water per year. This figure is adequately conservative, due to engineering requirements that necessitate reevaluation of maximum daily output should the system ever approach 95% (0.385 MGD) of the current maximum output.

Wastewater will be stored in the interim within a 17.4 acre pond with a 10 foot maximum depth. Based on 10-year pond evaporation information from the Lower South Platte Water Conservancy District, this pond is expected to provide an evaporation loss of 19,035,882 gallons of water per year. Therefore, a treated wastewater amount of 128,789,118 (147,825,000 -19,035,882) gallons per year will be available for irrigation.

In the LAMP, a total of 255.4 acres of land is proposed to be irrigated with the treated wastewater from the proposed facility. Irrigated land included 3 types of plants/crops; turf lawn (28.9 (residential) + 63.5 (commercial) = 94.1 acres), trees and shrubs (11.1 (residential) + 107.9 (commercial) = 119 acres) in residential and commercial lands, and alfalfa crop (42.3 acres) for agricultural production.

2.0 Agronomic Parameter Evaluation Results

2.1 Evapotranspiration

Appropriate land-based application rates and total volumes of wastewater are based on soil properties and water-loss rates from evaporation and transpiration. Reasonable estimates of evapotranspiration (ET) for each of the three proposed vegetation communities were assimilated through literature review, and via communications with various experts. These ET values are considered the maximum amount of water that can be applied to a system without causing deep percolation, and to a runoff. The feasibility of proposed irrigation associated with this LAMP has focused on deep percolation, total irrigation water volumes, and nutrient loading; but runoff can only be prevented through appropriate, site-specific management of irrigation waters considering both application rates, duration, and frequency.

The division reviewed the seasonal distribution of ET estimates proposed in the LAMP calculations in comparison to water use data from nearby CoAgMET stations, and found the data to be reasonable.

Turf Grass Vegetation Community

The estimated ET rates for the turf grass were based on publications and personal communications with Dr. Koski (Koski 2012 and 2021). Weekly ET rates were adjusted upward based on personal communications with Dr Koski, and assimilated to monthly rates, resulting in a total ET rate of 32.3 inches for the irrigation season (Table 2-1, below).

Table 2.1 Estimated ET for Turfgrass Lawns

Month	April	May	June	July	August	September	October	Total

Weekly ET[1] (in.)	0.75	1	1	1.5	1.5	1	0.75	7.5
Weekly ET[2], Adjusted, (in)	0.75	1	1.33	2	2	1	0.75	8.83
Monthly ET (inches)	1.5*	4	5.3	8	8	4	1.5*	32.3

*Two-weeks of water application assumed.
[1]Master Gardner 2012
[2]Recommended upward adjustment from Dr.Koski

Tree and Shrub Vegetation Community

Tree and Shrub ET estimates were derived from standard agricultural formulations utilizing a reference ET (realistic upper maximum) and a crop coefficient (Kc; measured, average proportion of ET relative to Reference ET). Reference ET's are variable across the state, with reasonable 10-year averages ranging from 38.95 inches to 56.16 inches. These Reference ETs, when converted to estimates of ET for trees and shrubs with a Kc of 0.5, yield estimates of 19.5 to 28.2 inches of ET for this vegetation community.

Proposed Irrigation water application depths are approximately 8.7 inches, and when considered along with average annual rainfall of approximately 10 inches, still falls well below the range of anticipated water needs for most shrubs and trees. This suggests that an excess of irrigation water does not exist, and the proposed water balance for this community is sensible, possibly even requiring supplemental water.

Suggested spray head for the lawn and tree and shrubs is HE-VAN, manufactured by Rain Bird. A communication with the manufacturer of the product resulted in a "no water application efficiency" outcome for the product. Therefore, a water application efficiency for HE-VAN type sprinkler head in the LAMP was 80%. This means that the 20% more water than the water needed by the plant would be applied to the LAMP area. This water amount would either going to deep percolation of running off the site or both. This can be a concern about the whole system even though the contractor says that all the runoff will be collected in treatment ponds for removal of phosphorus before it is released. If release to the creek then some other permitting may apply. The facility will have to work with the Permits Section to address it. A special attention will have to be paid to the potential runoff water from the irrigated sites to lead the water to the treatment ponds.

Controlling irrigation duration, application rate and frequency may overcome some of these concerns. Also, installing appropriate soil-moisture equipment(s) may be required to ensure no or limited deep percolation and runoff. Relatively frequent, shorter duration irrigation events should be encouraged. Review of sprinkler system will determine if runoff or being generated, may need to adjust irrigation events to 2 or 3 times daily if runoff is being generated.

Alfalfa Production Area

For alfalfa, annual ET rate was varying depending on the literature. Berrada and Reich (2011) of Colorado State University (CSU) suggested that it was 31.6 inches whereas Schneekloth and Andales (2017), also CSU scientists, provided an ET rate for alfalfa as 37.1 inches. Since the 37.1 inches of ET rate is more recent, it is allowed in this evaluation. For the water efficiency for center pivot system, a proposed method for water application was assumed to be 80% by the contractor. It should be noted that the nature of the irrigation systems again 20% of more water than the needed by the plant has to be applied to satisfy plant needs. The higher the water application efficiency the higher the water retention in the root zone.

Schneekloth and Andales (2017) also provided an ET rate for the tall grass which is 25.7 for Greeley area. This value is also found to be appropriate for the LAMP calculations because it is relatively recent recommendation by the CSU scientists.

Water Balance Calculations

Precipitation data for Denver, CO was taken from https://www.weather-us.com/en/colorado-usa/denver-climate. Average annual precipitation for Denver is 12.95 inches. Months where the District would not be irrigating were removed (November-February: 2.12 inches). Thus, the precipitation during the irrigation months (March-October) is 10.83 inches. Therefore, the precipitation during the irrigation months (March-October) of 10.83 inches subtracted from the ET rates for determining the net irrigation amount to be applied to meet the agronomic rate for water consumption. No watering will be occur on measurable precipitation days.

As a result, 112,984,782 gallons of water is needed by the plants in whole project are to satisfy the recommended crop agronomic rate. This amount does not consider irrigation application efficiency which would result in a larger amount of water rate. Considering a water application efficiency of about 80% for pressurized systems for spray heads and for center pivot system which will be used in the LAMP area, total water needed would be 141,230,977 (Table 1) gallons per year. The maximum treated wastewater produced per year would be 147,825,000 gallon. Since the water will be stored in a 17.4 acre pond with a 10 feet depth, an evaporative loss of 19,035,882 gallons is expected and therefore, a treated wastewater amount of 128,789,118 will be available for irrigation purposes. This amount is 12,441,859 gallons lower than the treated wastewater needed for irrigation purposes. This means that the facility will not be producing sufficient water to satisfy crop water requirements through application of treated wastewater. The difference can be made up either by

a) a supplemental irrigation from tap and/or well water(s) or
b) increasing irrigation efficiency (data can support an irrigation efficiency up to about 87%) or
c) reducing the irrigated land with special attention to the other parameters.

Therefore, this LAMP is satisfactory from the water use/application point of view which is the basis for nitrogen and phosphorus applications.

Table 2-2. Summary of agronomic rates and associated parameters for water use, phosphorus and nitrogen.

Parameter	Recommended Application Rate	Actual Application Rate	Allowance Remaining
Water (gal)	141,230,977	128,789,118	12,441,859
Nitrogen (10 mg/L TN in effluent)	37,153	12,329	24,824
Phosphorus (1 mg/L TP in effluent)	4,862	1,233	3,629
Phosphorus (0.16 mg/L TP in effluent)		197	4,665

2.2 Nitrogen

The facility is to produce treated wastewater with 10 mg/l nitrogen in the effluent. Since the 19,035,882 gallons of water is evaporated, the initial concertation of 10 mg/l would be increased to 11.48 mg/l. Therefore, this concentration is used in the calculation which provides the most stringent agronomic rate for nitrogen application.

Nitrogen rates for the turf lawn are based on Kansas State University recommendations for medium quality Kentucky bluegrass. Application rates are 3 lbs per 1000 sq ft area, comparable to recommendations from CSU extension (3.5 to 5 lb of nitrogen). If grass clipping are returned to the turf then these amounts can be reduced by $^1/_4$ to $^1/_3$.

Considering the most conservative case, the nitrogen application rate for a high maintenance bluegrass would be 3.5 lbs per 1000 square feet of turf area. Based on these recommendations, 3 lb/100 sq ft application rate for the young lawn is considered to be appropriate. The age of turf is a factor for nitrogen application considerations, and as the lawn matures the N requirements typically decline. CSU recommends that turf receive 1 lb N at 30 years (Koski, 2021) (https://cmg.extension.colostate.edu/wp-content/uploads/sites/59/2020/01/GN-550-Turf-Management.pdf) and (https://extension.colostate.edu/topic-areas/yard-garden/lawn-care-7-202/).

Similar application rates were considered for the residential ornamentals and tree and shrubs suggested by the LAMP, based on North Carolina State University (NCSU) recommendations. NCSU recommendations are based on delivering a seasonal total of approximately 4 lbs N/1,000 square feet of bed area for. Considering the suggested rate in the LAMP is 75% of that of the NCSU, the proposed rate is considered appropriate even considering minor regional variations.

Appropriate nitrogen application rates for alfalfa are somewhat complicated considering alfalfa usually fixes nitrogen. CSU recommends a total of 0 to 20 lb/acre nitrogen for seedlings depending on the soil nitrogen content. However, in an email, the consultant indicated that based on Keoning et al. (2009), alfalfa removes 50-70 nitrogen/ton harvested. In fact, Keoning et al. (2009) states that when nitrogen is supplied via wastewater or manure, alfalfa preferentially absorbs nitrogen from the soil rather than fixing it from the atmosphere. A reasonable nitrogen application rate for disposal situations is 80% of the nitrogen removed by the crop. In the LAMP, the yield goal is set to 5.5 tons per acre. Based on Johnson et al. (2000) average alfalfa yield can range from 5.85 tons per acre in Rock Ford, CO to 8.25 tons per acre in Wiggins, CO. Therefore, the 5.5 tons per acre on average used in the LAMP would be appropriate. Finally, considering 50 nitrogen/ton harvested (low end of the range) and using 5.5 ton per acre yield goal (lower end of the yield averages), the alfalfa can use 275 lbs per acre nitrogen, with an 80% removal rate, the crop needed nitrogen would be 220 lbs/acre. This amount is significantly higher than that is recommended by Mortvedt et al. (1996) and will allow alfalfa for luxury nitrogen use which is allowable. The recommendation of 220 lbs per acre, in fact is in line with Dr. Joe Brummer (Personal communication, 2022) of CSU whose suggestion was about 240 lbs/acre as he mentioned that alfalfa will not fix the nitrogen and utilize available nitrogen. Furthermore, nitrogen application will be regulated by the reuse Notice of Authorization and, therefore, it is a secondary parameter for this review.

2.3 Phosphorus

As a reference for appropriate application rates of phosphorus, medium qualify general turf cited from Kansas State University suggests 1 lbs per 1000 square feet of P2O5 (translating into a 19.04 lbs phosphorus/acre/year). This application rate is recommended when the Bray P-1 method soil test available-P levels are between 10 and 20 ppm, appropriate for the majority of the LAMP area.

North Carolina State University suggests 1 to 2 lbs of P2O5 for 1000 ft^2 for soil low in phosphorus. As noted before, the phosphorus content of the LAMP area is generally low in phosphorus and therefore the rate of 1 lbs of P2O5 for 1000 ft^2 for soil was considered conservatively appropriate even though other conditions such as climate, rainfall amounts could be different.

In Colorado, Koski and Skinner (2012) suggest balanced or complete fertilizers contain various amounts of phosphorus, potassium, iron and sulfur since they are a good safeguard against a potential nutrient deficiency for lawn. Furthermore, they state that phosphate fertilizer applied to a lawn or garden soil is bound to the soil and does not leach into ground water. Similar conclusions were also reached following a review of the LAMP and local NRCS soils information by Robert Murphy, a soil scientist with CDPHE. He stated that surface pH was measured as slightly acidic to neutral which could allow for slight mobilization of phosphorus, but a look at the deeper horizons shows that pH increases with depth, as would be expected, so the Phosphorus leaching would not be anticipated. He also cited the

availability of calcium carbonate mentioned in the LAMP by Dr. Ippolito, and agreed that calcium carbonate will immobilize phosphorus by forming stable mineral phases which prevent leaching.

LAMP calculations considered a recommended application rate of 19.04 lb/acre of P_2O_5. This rate is quite conservative when compared to reasonable application rates ranging from 50-200 lb/acre of P_2O_5 for new seedlings in low-phosphorus soils.

To calculate the total amount of Phosphorus applied to the LAMP per year, a conversion factor of 0.437 (Keoning et al. 2009) was used to convert from P_2O_5 to elemental P. Based on the 1 mg/l phosphorus concentration in the effluent, and the applied water amounts, a total of 1,233 lb/year phosphorus would be applied to the LAMP area. This is considerably lower than reasonable recommendations, which total approximately 4,862 lb/year. Therefore, it is not anticipated that overapplication of Phosphorus will occur due to application of treated wastewater water.

3.0 Discussion

As detailed in Tables 2-2 (above) and Table 2-3, the actual applied nutrients are considerably lower than reasonable recommended rates, and therefore should not constitute any issues regarding leaching of nutrients beyond the rootzone, if irrigation waters are managed appropriately. Annual applications of nitrogen and phosphorus are about 33% and 25% lower, respectively, than what can be reasonably expected to be uptaken by vegetation within the LAMP. Therefore, additional nutrient application(s) might be needed to sustain healthy crop/plant development in the area.

Table 2-3. Summary of recommended and actual N and P amounts applied through treated wastewater.

Crop/Plant	Recommended N (lbs/year)	Applied N (lbs/year)	Recommended P (lbs/year)	Applied P (lbs/year)
Lawn	12,303	6,568	1,792	657
Ornamental Beds	15,549	3,343	2,265	334
Agricultural Crop	9,302	2,418	805	242
Total	37,153	12,329	4,862	1,233

Special Conditions for Phosphorus Treatment Levels

The LAMP occurs within a phosphorus zone of concern, with significant lands immediately adjacent to surface waters. The LAMP also proposes continuous use of treated wastewater containing phosphorus levels of approximately 1 mg/l. Given site conditions, this level seems to be appropriate for land application and would provide under fertilization for the selected crops. Although deep percolation is not anticipated to be a concern, any amount of phosphorus discharged to surface waters is not acceptable, and irrigation and land management practices will determine the success of the LAMP wastewater management plan in preventing surface water pollution.

EPA recommends soil phosphorus levels be monitored where sludge applications are used continuously over time, especially in cropped areas where sludge application rates may need to be determined by crop phosphorus needs rather than the nitrogen needs of the crop. Given that organic-bound phosphorus will not be readily available for the plant use and could accumulate overtime, annual soil monitoring will be required to inform:

1. Nutrient application rates; and

2. Soil phosphorus levels over time. If organic phosphorus builds up in soils over time, then the facility will need to treat for phosphorus down to 0.16 mg/l levels until a safe phosphorus level is achieved (a maximum of 50% of initial level). Sampling will be conducted at the same time every three years, prior to irrigation season, or in the fall following the final irrigation events.

Furthermore, if at any point the facility is to exceed (or expected to exceed) any of the agronomic rate(s) at 1 mg/l phosphorus case then the facility will address the situation by either:

1. moving to 0.16 mg/l treatment option case for phosphorus as the LAMP considers it as an option or
2. move the wastewater out of the watershed

The return water collection ponds to treat phosphorus will have to be maintained with annual checks. All necessary maintenance to be conducted to ensure integral full functioning of the ponds.

When crop rotation is needed for the agricultural fields, then the facility will find a crop similar to alfalfa in terms of crop agronomic needs to avoid changing the applications rate(s). This will allow minimum changes to overall conceptual plan and avoid substantial revisions or reviews moving forward. Soil samples collected to inform application rate determinations should exhibit representative coverage of the three vegetation communities and NRCS designated soil types across the LAMP. Results will be averaged and the agronomic rate will be based on the average.

Additional Considerations

Even though it is not a part of this LAMP evaluation, salinity and sodium level(s) of the treated waste water is a significant, relevant parameter. Crop water use would be impacted if the electrical conductivity is not suitable for selected crops/plants, and may also result in burning of leaves if the water is chloride and sodium laden. Alfalfa is particularly sensitive to Salinity. Furthermore, if the sodium concentration of the treated wastewater is even moderately elevated, then it will result in infiltration and permeability concerns in local soils. Bauder et al. (2014) provides detailed information about irrigation water quality criteria for crops. Salinity monitoring could be essential to achieving sustainable water applications and beneficial nutrient disposal in the LAMP area.

Managing the slow accumulation of salts within irrigated soil systems typically requires leaching to remove problematic salinity levels. Due to watershed characteristics and the site location being immediately adjacent to surface waters, the need to leach salts, if it were to arise, would create long-term management issues that could significantly hinder the feasibility of wastewater land applications for this project. This scenario would constitute reengagement and additional review and scrutiny from the Division. If any salinity leaching/flushing is applied, it will need to be scheduled at a time that the phosphorus levels would be the lowest. Any leaching/flushing water (if rainfall is not sufficient) will be a phosphorus-free water.

Layout and installation of irrigation systems should consider minimizing and avoiding the application of nutrient-laden waters to impermeable surfaces. Direct discharge to storm drains is a primary source of Phosphorus and nutrient pollution in surface waters, and is unacceptable due to site and watershed characteristics.

4.0 Summary

Proposed reuse of wastewater for irrigation purposes within this LAMP has been reviewed and approved by the division. The feasibility of proposed irrigation associated with this LAMP has focused on deep percolation, total irrigation water volumes, and nutrient loading; but runoff can only be prevented through appropriate, site-specific management of irrigation waters considering both application rates, duration, and frequency. Additional agronomic parameters not addressed in this LAMP (discussed above) will be critical to developing a sustainable wastewater management system that avoids impacting operations and creating additional management expenses. Continued approval of wastewater application is contingent upon successful nutrient and water management, and is revocable if found in violation of permit stipulations or management commitments.

An annual report detailing land management activities is required, and shall be submitted to the division's permit's unit. The annual report will include a detailed table showing water applications in term of time that the systems were run and the amounts of investigated parameters applied. Below is an example summary table that will be provided in the annual report to show applied water, nitrogen and phosphorus amounts were not exceeded the allowable amounts.

Table X. Applied water, nitrogen and phosphorus amounts in year 20XX as compared to allowable amounts

Parameter	Water (gallon)	Nitrogen (lbs)	Phosphorus (lbs)
Allowance	141,230,977	37,153	4,862
Actually Applied			

Content of this report will also include:

1. Soil sample results from all irrigated areas (bluegrass, tree and shrub, and agricultural fields), along with the calculated agronomic rates for fertilizer applications to each for the three proposed vegetation communities. Soil samples should be collected at the same time each year, in the fall or spring. Soil testing for nutrients will use appropriate methods for the nutrients (nitrogen and phosphorus) if the results would be depend on any specific soil parameter such as pH in case of phosphorus.
2. Soil initial and current phosphorus contents will be identified to address organic phosphorus accumulation.
3. Photographs of each vegetation community during peak vegetative cover (approximately August).
4. Photographs demonstrating the integrity and function of sedimentation ponds, surface water routing features, retention basins, and other water management infrastructure.
5. A brief narrative detailing reviews and maintenance activities concerning surface water management features, such as impoundments and retention basins, or irrigation systems, and any issues managing water volumes.
6. Confirmation that irrigation water is not being discharged onto impermeable surfaces or into storm drains, and that no unpermitted discharges to surface waters have occurred within the calendar year.
7. Confirmation that landlords did not applied full nutrient requirements (especially phosphorus) to their lawn and apply only the difference between agronomic rate and the amount provided by the treated waste water. A mechanism will be put in to achieve this requirements before land application can start.
8. If agricultural crop is changed then its impact on the agronomic rates will be provided.

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