Action 2: Correction of Inaccurate Reporting of Acreage on Past Annual Report

Clinton staff have been totalizing the acreage applied to each day for the month and the sum of these values has been errantly used to calculate loading rates for the annual report. The available acreage for land application of effluent is 86 acres. ESC Laboratories has updated the annual reports. The reports are attached in Appendix B of this Corrective Action Plan.

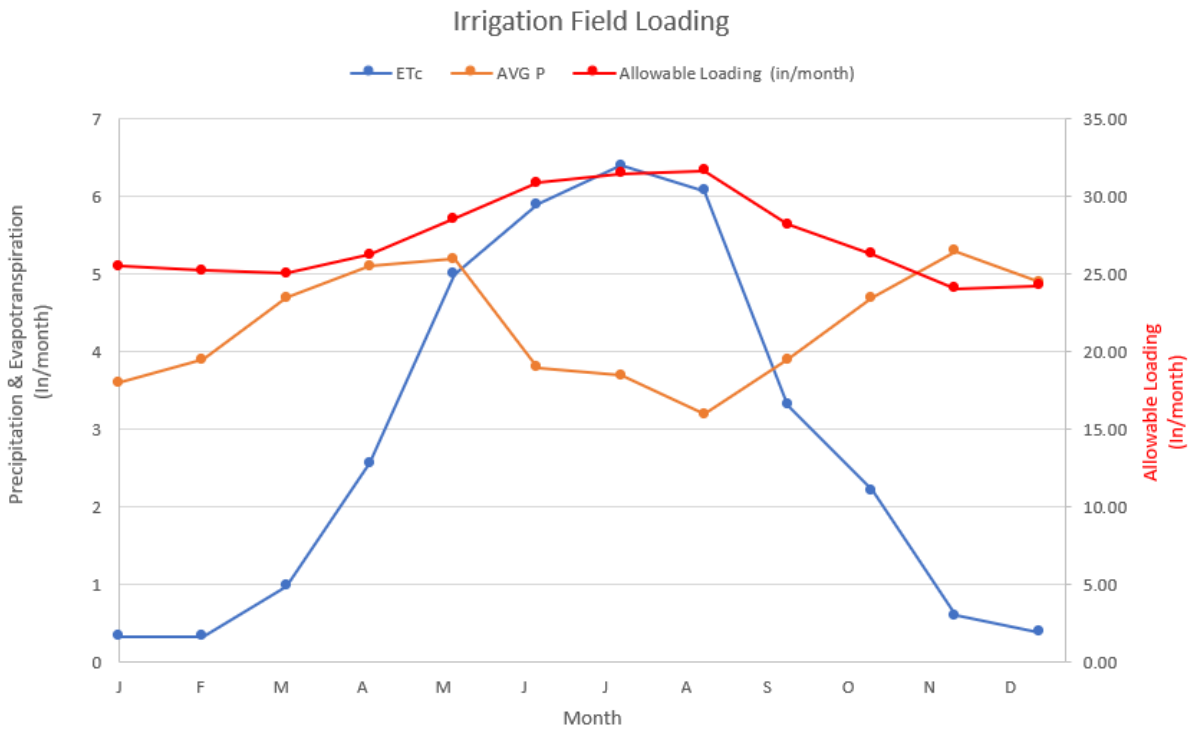
Action 3: Calculation of Allowable Application Rate and Required Acreage

The application of wastewater to vegetated soil surfaces is termed slow rate land treatment. The Clinton land application system uses this type of treatment. Application rates for slow rate land treatment are set by the design percolation rate which depends primarily upon the saturated infiltration rate of the soil (K_{SAT}). Infiltration rates are affected by the ionic composition of the soil and water, the type and stage of vegetation, the rate and duration of water application, and the state of the soil surface. The *EPA Process Design Manual for Land Treatment of Municipal Wastewater Effluents* recommends that a considerable safety factor of 10 to 25 be applied when using published data on soil permeability. This accounts for intermittent applications (time for reaeration), variability of soil at site, and for the reduction in percolation with time (% saturation). The National Cooperative Soil Survey for Van Buren County, AR, published jointly by the U.S. Department of Agriculture (USDA) and the National Resource Conservation Service (NRCS) indicates that both soil types comprising the application fields have a moderately high to high K_{SAT} (capacity of the most limiting layer to transmit water) of 0.57 to 1.98 in/hr. A value of 1 in/hr was utilized for the application rate calculations used in this report. Appendix C contains the referenced soil survey.

Using a 25 safety factor (4% of published value) results in an adjusted K_{SAT} of 28.8 inches per month of allowed water. Subtracting the monthly average precipitation results in the values shown on the next page for allowable application of wastewater. The required acres value was calculated as the amount of land area required to limit the daily application of 456,000 gpd (1,900 gpm application rate x 4 hrs of application x 60 min/hr = 456,000 gpd). Due to more precipitation and less evapotranspiration during the cooler months, more acreage will be required for each application, than during the warmer months. Allowable application is calculated as the adjusted K_{SAT} value, mentioned above plus the monthly evapotranspiration less the monthly average precipitation. The monthly evapotranspiration exceeds the monthly average precipitation for the months of June, July, and August, therefore, the allowable application rate exceeds the adjusted published soil infiltration rate for those months. In all other months the precipitation is expected to exceed the evapotranspiration and reduce the allowable application below the adjusted soil infiltration rate.

Reaeration time is the primary factor in determining the cycle time for applications. However, the large safety factor recommended when using published K_{SAT} values already accounts for this by reducing the assumed infiltration rate considerably below the expected field rate. In addition, the value used from published data is the K_{SAT} of the most restrictive layer of soil, not an average of different soil horizons as would be used for collected in-situ data.

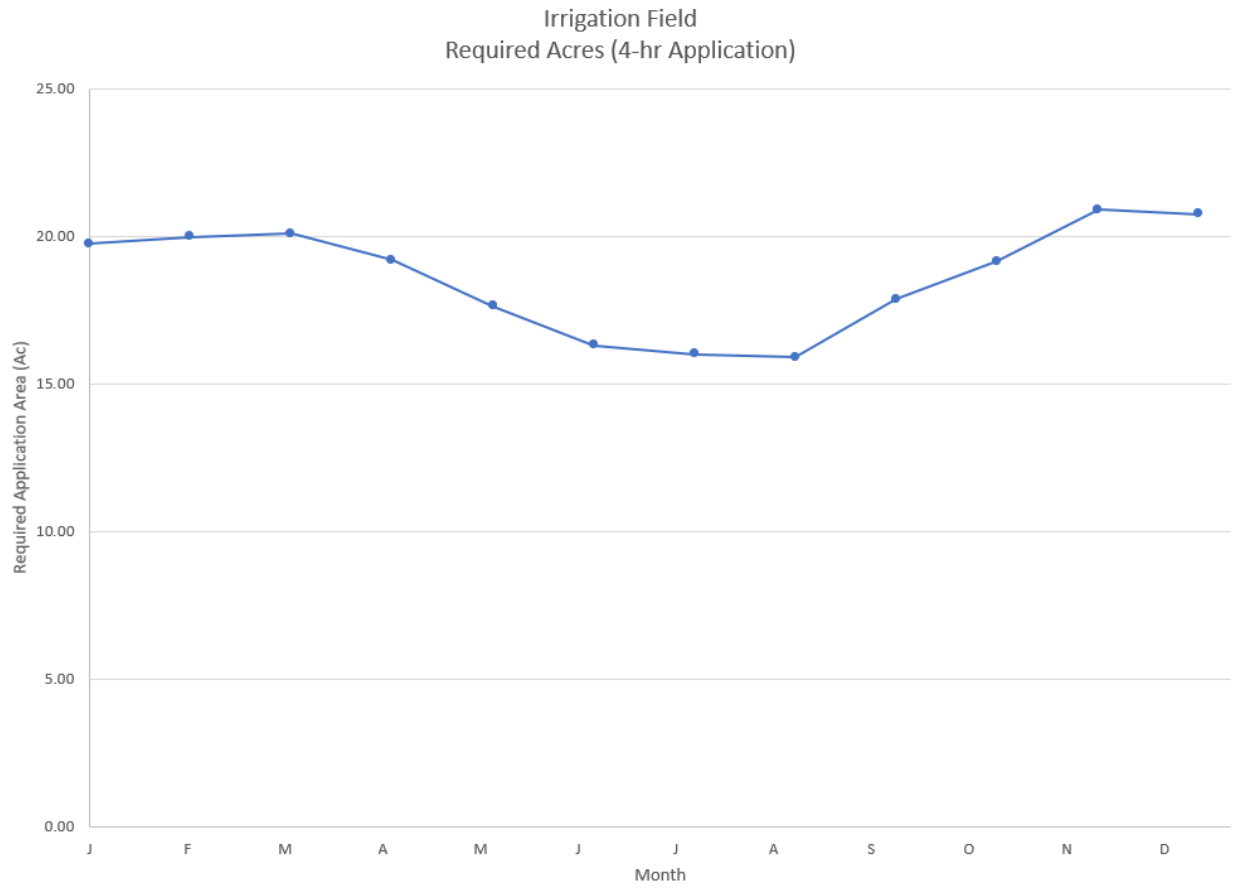
The figure below shows the calculated allowable loading for each month of the year using the rationale explained above.



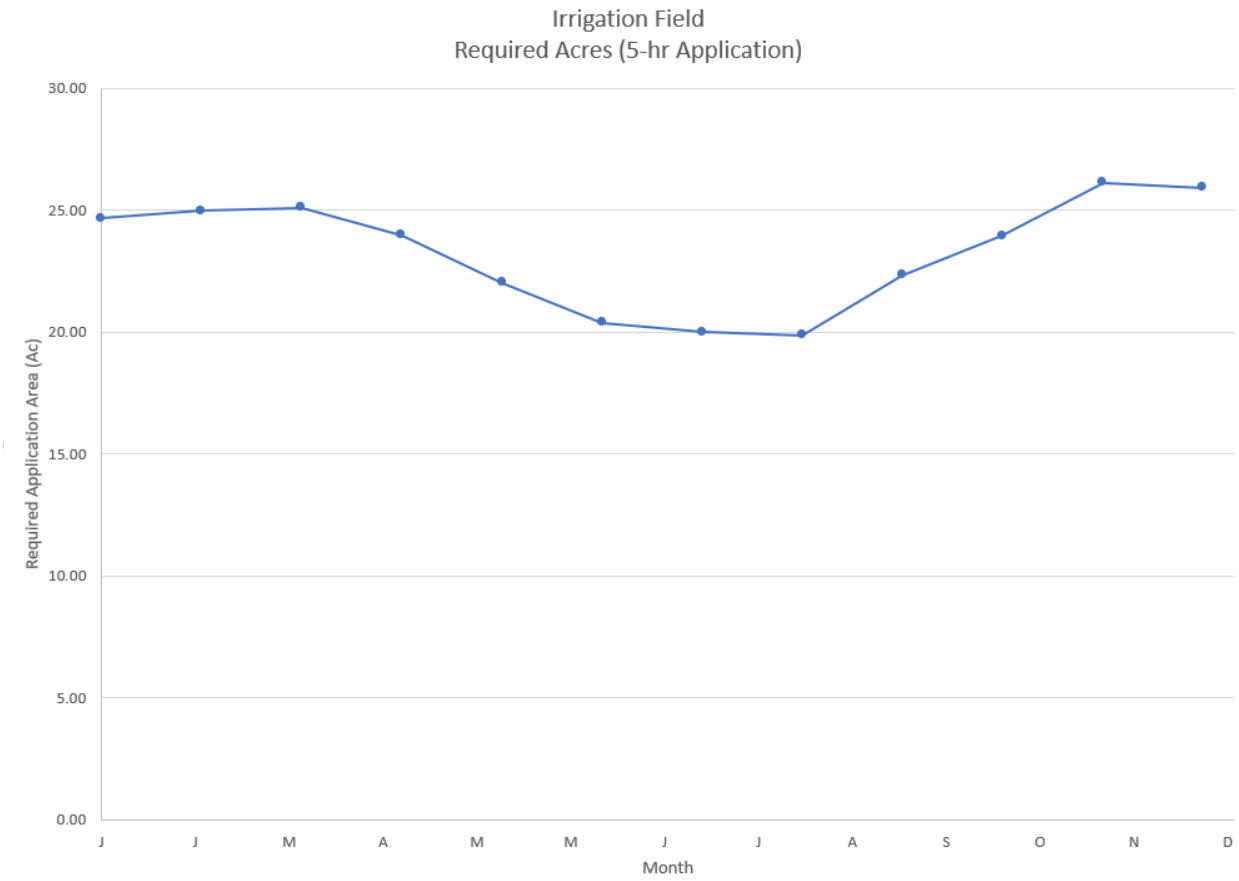
The data is shown in table form below, including the required application area to limit the flow the calculated allowable application rate.

Month	Average Precipitation (in)	Allowable WW Application Rate (in)	Allowable WW Application Rate (in/day)	Req. Acres @ 1,900 gpm Irrigation Rate (Ac for 4-hr)
January	3.6	25.53	0.85	19.73
February	3.9	25.23	0.84	19.97
March	4.7	25.08	0.84	20.09
April	5.1	26.27	0.88	19.18
May	5.2	28.60	0.95	17.62
June	3.8	30.90	1.03	16.30
July	3.7	31.50	1.05	15.99
August	3.2	31.68	1.06	15.90
September	3.9	28.22	0.94	17.86
October	4.7	26.31	0.88	19.15
November	5.3	24.11	0.80	20.90
December	4.9	24.29	0.81	20.75
Yearly	52	87.70	-	-

The intermittent daily application of 4 hours per day requires a small enough acreage to limit the required area to less than 1/3 of the total available acreage of 86 acres, thus allowing a three-day rotation cycle between fields. This is shown in the figure below.



The length of application could be increased to 5 hours per day and still allow a three-day cycle. The figure and table below show the calculated required acres based on 5 hours per day of application.



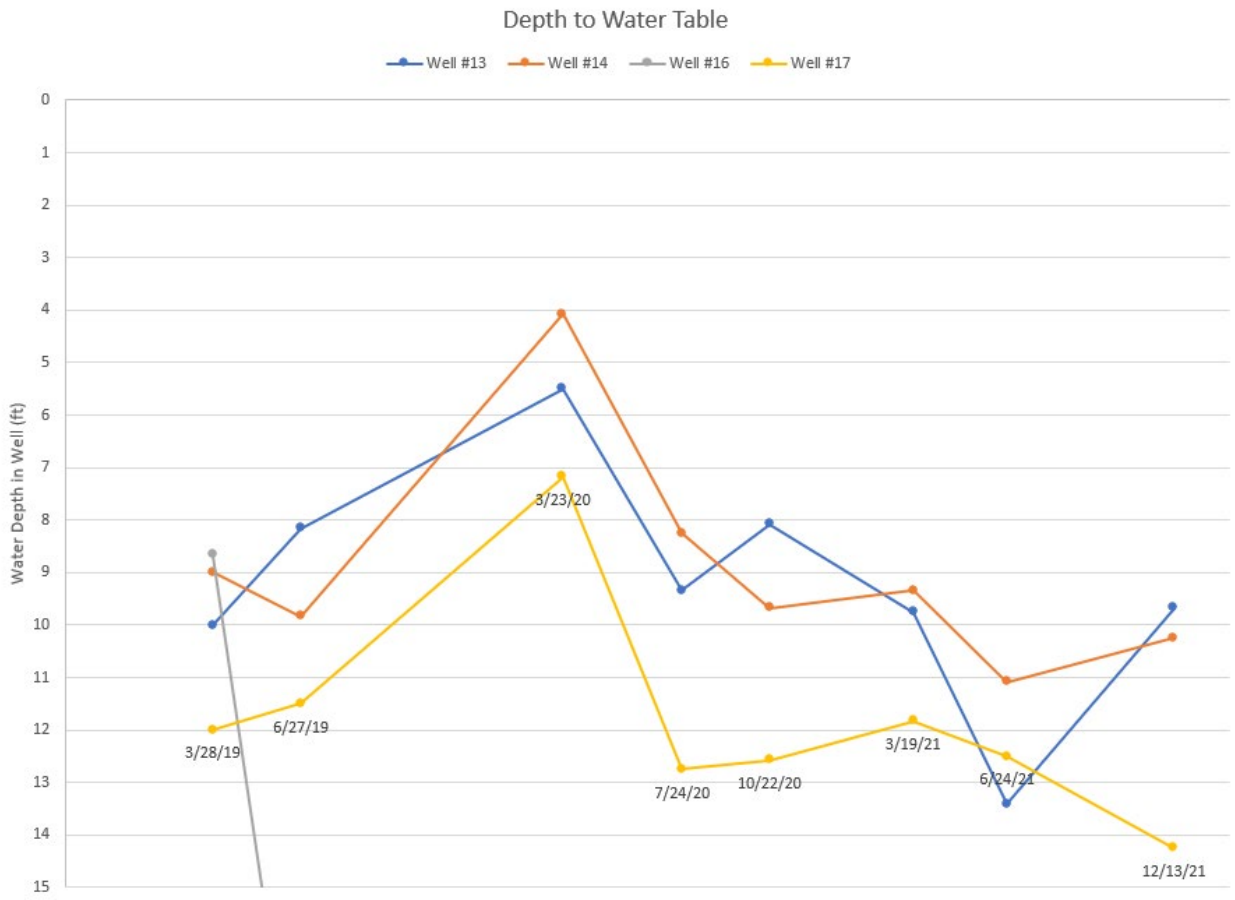
Month	Average Precipitation (in)	Allowable Monthly WW Application Rate (in)	Allowable WW Application Rate (in/application)	Req. Acres @ 1,900 gpm Irrigation Rate (Ac for 5-hr)
January	3.6	25.53	0.85	24.67
February	3.9	25.23	0.84	24.96
March	4.7	25.08	0.84	25.11
April	5.1	26.27	0.88	23.98
May	5.2	28.60	0.95	22.02
June	3.8	30.90	1.03	20.38
July	3.7	31.50	1.05	19.99
August	3.2	31.68	1.06	19.88
September	3.9	28.22	0.94	22.32
October	4.7	26.31	0.88	23.94
November	5.3	24.11	0.80	26.13
December	4.9	24.29	0.81	25.93
Yearly	52	87.70	-	-

Since the design infiltration rate has been reduced to 4% of the published value for the most restrictive soil layer, reaeration time has already been factored in. However, a three-day rotation for the application cycle will add an additional assurance of adequate reaeration of the vadose zone.
In-situ data is scheduled to be collected by a soil science team from the University of Arkansas Division of Agriculture Extension Service, using a Saturo automatic Infiltrometer, pictured below. The data will be submitted according to the dates shown in the Corrective Action Schedule at the end of this report.

Another important consideration for the land application of wastewater effluent is the depth to groundwater. The water depth in the sampling wells is recorded at each well sampling event. The figure below shows the data for 2019 – 2021.

The table below summarizes the data for each well. The well locations are shown on the map on the next page.

Date	Well #13	Well #14	Well #16	Well #17
3/28/19	10	9	8.67	12
6/27/19	8.17	9.83	-	11.5
3/23/20	5.5	4.08	-	7.17
7/24/20	9.33	8.25	-	12.75
10/22/20	8.08	9.67	-	12.58
3/19/21	9.75	9.33	-	11.83
6/24/21	13.42	11.08	-	12.5
12/13/21	9.67	10.25	-	14.25
Average	9.24	8.94	18.58	11.82
Min	5.5	4.08	8.67	7.17
Max	13.42	11.08	20	14.25



The OWQ has requested that soil morphology be utilized to estimate the seasonal high water table. Clinton Water will use a local Designated Representative, as licensed by the Arkansas Department of Health to perform the soil morphology assessment and estimate the depth to the seasonal high water table. The data will be submitted according to the dates shown in the Corrective Action Schedule at the end of this report.