



# MILLER COMPANIES

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**JULY 19, 2016**

## **PRELIMINARY ENGINEERING REPORT**

**FOR:**

**LOST CANYON LAKES TREATMENT FACILITIES  
AKA WILDWOOD**

**PRELIMINARY**

### **LOCATION**

**7233 WILDWOOD ESTATES DR  
STEEDMAN, MO 65077**



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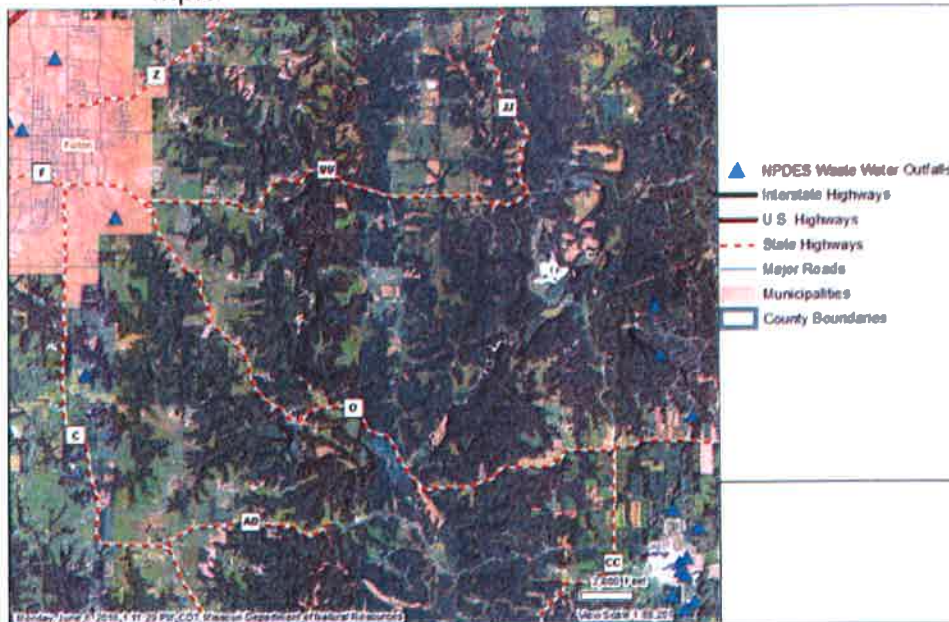
## Introduction

The purpose of this preliminary engineering report is to evaluate the existing wastewater treatment facilities ability to comply with requirements of Missouri State Operating permit. A separate report contains information regarding the collection system evaluation.



Fig. 1 Callaway County Missouri

### MoDNR Simple Viewer



This imagery indicates the date and time the map was generated. Data layers on the map are updated at a variety of intervals and may not reflect current conditions. Disclaimer: Although this map has been compiled by the Missouri Department of Natural Resources, no warranty, expressed or implied, is made by the department as to the accuracy of the data and related materials. The act of distribution shall not constitute any such warranty, and no responsibility is assumed by the department in the use of those data or related materials.

Fig 2 Wildwood location SE of Fulton, MO

## ***Definitions***

The following terms are defined for clarity in this report:

**Comfort Station:** Community showers and toilets. No additional average daily flow volumes added for this waste source since, total average daily flows determined for per lot flow calculations which include flows generated at this source.

**Community Building:** Assembly area for community. No additional average daily flow volumes added for this waste source since, total average daily flows determined for per lot flow calculations include flows generated at this point.

**Owned Lots:** Lots owned by community members without permanent structures. Occupancy varies from tent camping to mobile campers or nonpermanent structures.

**Permanent Residence:** Lots with permanent structures constructed.

**RV sites:** Pads for tents and recreational vehicles in campground open to the public.

### *Treatment facilities*

Outfall #001 is discharge from a three-cell lagoon with a design flow of 25,000 gallons per day located in SE ¼, Section 26, T47N, R08W, Callaway County, Missouri. Outfall #001 serves community building, 2 comfort stations, 51 permanent residence, 805 owned lots and up to 899 additional lots on the property for a total of 1,755 lots. Existing collection system includes gravity main (estimated 4,230 feet), pressure main (estimated 5,223 feet) and two grinder pump stations. Majority of influent received is from hauling of holding tank by pump truck. Pump truck is owned and operated by facility owner. Existing lagoon cell sizes estimated from aerial photography are primary cell 88,000 square feet, second cell 24,700 square feet, and third cell 6,000 square feet.



Fig. 3 Lagoon Cell 1 outlet



Fig. 4 Lagoon Cell 2



Fig. 5 Lagoon Cell 2 outlet



Fig 6 Lagoon Cell 3 with wet area above



Fig 7 Lagoon Cell 3 Outlet



Fig. 8 Outfall



Outfall #002 is discharge from an extended aeration package plant with a design flow of 3,060 gallons per day located in NW ¼, Section 1, T47N, R08W, Callaway County, Missouri. Outfall #002 serves one office/store, comfort station and 26 RV sites. Existing collection system includes gravity service lines, pressure main and a pump station.



Fig 9 Package Plant



Fig 10 Clarifier



Fig 11 Chlorinator



Fig 12 Outfall 002

## Soils Survey Review

Soils Survey of Callaway County, Missouri was reviewed to determine general site limitations for various waste treatment methods that are currently in use or may become part of a future solution. Excerpts from the soil survey are provided in the appendix include: Soils map of area, tables 12, 14 and 17. Soil units found in the service area include: 15B, 18F, 19C2, 20D, 21C, 21C2, 22C2, 24D, 24F and 29. All units have severe limitations for absorption fields. With the current size of the lots is not likely that a comprehensive plan to install on-site sewage treatment systems would be practical. Soil features affecting irrigation include wetness, percs slowly and slope.



Fig 13 Soils Map Sheet 33 of Soil Survey of Callaway County, Missouri

## Records Review

Discharge Monitoring Reports (DMR's) from January 2014 through November 2015 were supplied by the owner for review for both outfalls. It should be noted no DMR information was provided for the months of August through December 2014. Outfall #001 had a single exceedance for fecal coliform. Outfall #002 had a single exceedance for TSS and two exceedances for fecal coliform. The table below, with DMR analysis results provided by the owner for review, is also included in the appendix.

Date	outfall 1: Lagoon Influent		outfall 1 Lagoon Effluent					
	BOD mon	TSS mon	BOD	TSS	pH	Ammonia	FC	TCR
1/14	x	x	ND	ND	ND	ND	ND	ND
2/14	x	x	ND	ND	ND	ND	ND	ND
3/14	ND	ND	ND	ND	ND	ND	ND	ND
4/14	x	x	ND	ND	ND	ND	ND	ND
5/14	x	x	ND	ND	ND	ND	ND	ND
6/14	18.66	29.6	10.56	43.5	7.91	x	x	
7/14	x	x	ND	ND	ND	ND	ND	ND
8/14	x	x	x	x	x	x	x	x
9/14	x	x	x	x	x	x	x	x
10/14	x	x	x	x	x	x	x	x
11/14	x	x	x	x	x	x	x	x
12/14	x	x	x	x	x	x	x	x
1/15	ND	ND	ND	ND	ND	ND	ND	ND
2/15	ND	ND	ND	ND	ND	ND	ND	ND
3/15	ND	ND	ND	ND	ND	ND	ND	ND
4/15	ND	ND	ND	ND	ND	ND	ND	ND
5/15	ND	ND	ND	ND	ND	ND	ND	ND
6/15	ND	ND	ND	ND	ND	ND	ND	ND
7/15	63	70	27	48	9.2	0.8	1750	
8/15	ND	ND	ND	ND	ND	ND	ND	ND
9/15	34	32	8	4	7.7	31.9	10	0.05
10/15	ND	ND	ND	ND	ND	ND	ND	ND
11/15	ND	ND	ND	ND	ND	ND	ND	ND
12/15	x	x	x	x	x	x	x	x
Date	BOD	TSS	BOD	TSS	pH	Ammonia	FC	TRC
GeoMean	34.2	40.5	13.2	20.4	8.2	5.1	132.3	0.05
Max	63	70	27	48	9.2	31.9	1750	0.05
Min	18.66	29.6	8	4	7.7	0.8	10	0.05

Date	outfall 2: Extended Aeration Influent		outfall 2: Extended Aeration Effluent					
	BOD mon	TSS mon	BOD	TSS	pH	Ammonia mon	FC	TCR
1/14	x	x	ND	ND	ND	ND	ND	ND
2/14	x	x	ND	ND	ND	ND	ND	ND
3/14	ND	ND	ND	ND	ND	ND	ND	ND
4/14	x	x	ND	ND	ND	ND	ND	ND
5/14	x	x	ND	ND	ND	ND	ND	ND
6/14	23.17	193.3	9.36	10.3	8.1	13	135.5	0.13
7/14	x	x	10.42	1.5	7.81	31	1	0.13
8/14	x	x	x	x	x	x	x	x
9/14	x	x	x	x	x	x	x	x
10/14	x	x	x	x	x	x	x	x
11/14	x	x	x	x	x	x	x	x
12/14	x	x	x	x	x	x	x	x
1/15								
2/15	11	12	6	7	8	16.8		
3/15	84	120	6	7	7.9	9.5		
4/15	17	40	6	55	7.7	12.9	10	4.44
5/15	12	16	16	12	7.7	16.5	10	0.01
6/15	6	12	7	12	7.6	14.6	10	0.017
7/15	12	3	10	6	7.8	23.5	10	0.07
8/15	23	17	10	6	8	32.5	156000	0.001
9/15								
10/15	32	16	22	1	8.2	84	3000	0.04
11/15			42	3	8.1	51.5		
12/15								
Date	BOD	TSS	BOD	TSS	pH	Ammonia	FC	TRC
GeoMean	18.3	22.9	10.7	6.3	7.9	22.2	70.8	0.05
Max	84	193.3	42	55	8.2	84	156000	4.44
Min	6	3	6	1	7.6	9.5	1	0.001

Table 1 DMR Data

Abatement order on consent (AOC) No. 2015-WPCB-1262 has been issued and signed by owners.

In the Finding of the Facts section of the AOC the following items are a portion of the total entries listed as paragraphs A through P.:

- 1) On March 29, 2012 the MSOP expired by its own terms. Samples were to be taken, analyzed and results provided to the department every month for both outfalls. A schedule of compliance in the MSOP also required outfall No. 001 to comply with final limitations for Fecal Coliform by March 28, 2012.
- 2) Citation of 19 CSR 20-3.060(6)(F) with an explanation that holding tanks are limited to temporary use for situation where a public sewer will be available, or where an approved onsite system will be installed within a year.
- 3) Turkey Park, Robin Park, Deer Park, Crow Park 1 and Pheasant Park 1 were recorded prior to June 30, 1974. The Missouri Clean Water Commission Regulations for Disposal of Wastewater in Subdivision became effective on June 30, 1974. Beaver Park 1, Beaver Park 2, Canyon View, Pheasant Park 2 and Crow Park 2 were recorded after June 30, 1974. The department has not received any records or approved a report as required by the June 30, 1974, regulations.
- 4) Numerous exceedances for TSS, BOD, TRC and Fecal Coliform were included in an NOV on June 22, 2012.
- 5) On February 20, 2013, department staff conducted an investigation at the campground in response to a concern that wastewater was leaking through the lagoon berm. Several deficiencies were found at both wastewater treatment facilities. A standard records review also revealed numerous violations which included exceeding effluent limitations, submission of flow data, maintaining flow within adjusted design flow, applying for MSOP renewal and submitting domestic sludge report.
- 6) DMRs submitted by the association to the department between January 2013 and February 2014 report no discharge at Outfall No. 001 in 13 of 14 months and at Outfall No. 002 in 7 of 14 months. Exceedances for BOD, TSS during three of the months discharge was reported.
- 7) Department issued a letter on February 20, 2014 to notify the association the renewal application was denied.

*Site visit observations*

Expected odors and trash were absent from lagoon facility.

Lagoon transfer piping from cell each cell was at the surface level of the water. Possible performance issues could be experienced during extended periods of cold weather when surface of lagoon freezes over.

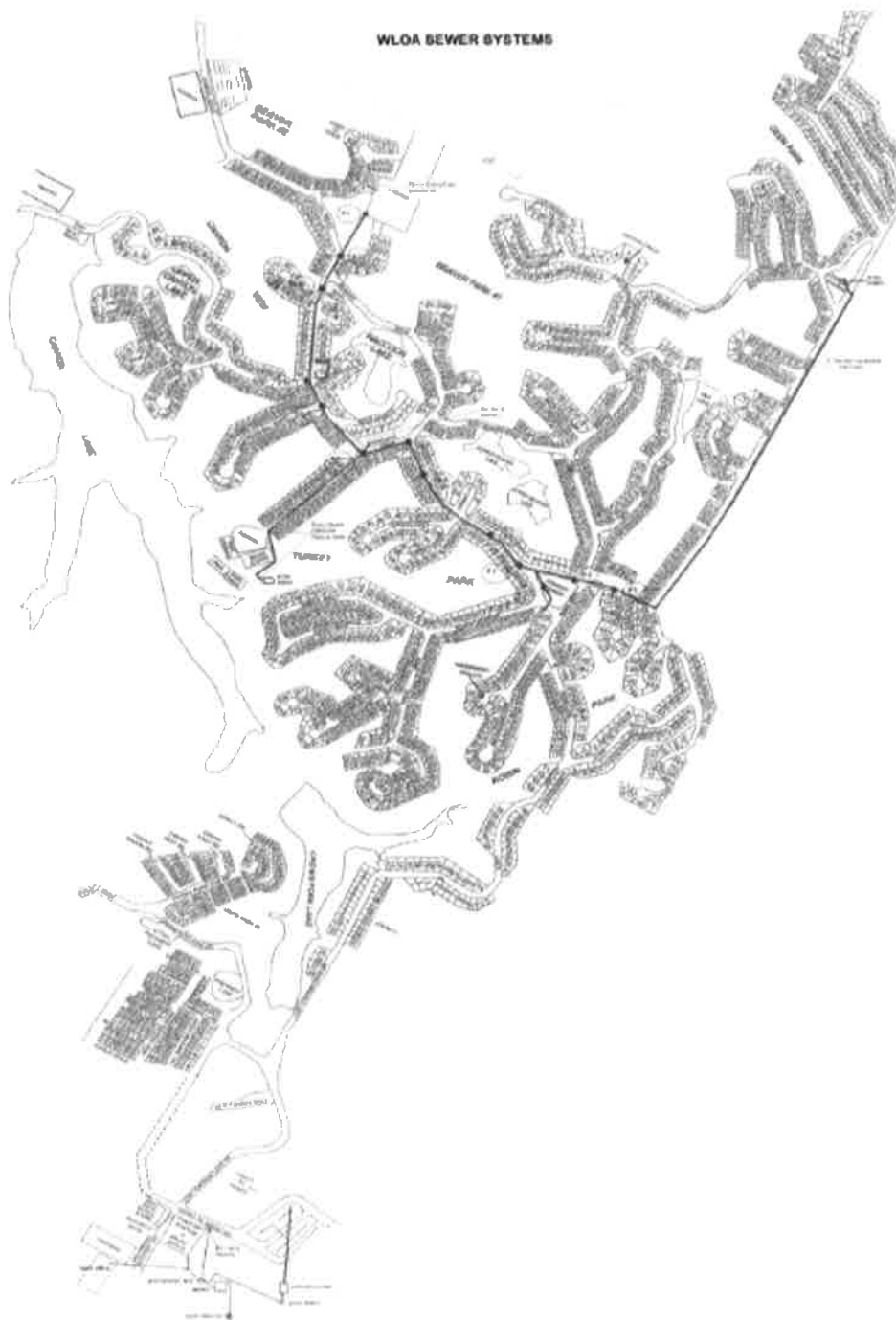
A wet area on the down slope berm of cell two has developed just above cell three.

Third cell was at a level significantly below the discharge. The AOC indicated that MDNR personnel have been to the lagoon to investigate a concern of leaking. No information in the AOC or documents provided by the owner indicated the findings of the previous investigation.

It was noted during the site visit that contact tank baffles were not present.

## Planning and Service Area

The Wildwood Lot Owners Association is the Continuing authority which includes various subdivisions recorded on 10 plats. A total of 1,755 lots comprised of 51 lots with permanent residence, 805 owned lots and 899 additional lots owned by the developing entity. . A map of the overall area with existing collection system is shown below.



## **Population Projection and Planning Period**

Ninety-six percent of the existing property owners are transient to the community utilizing lots for camping activities with tents or travel trailers. Persons per lot and waste strength will be applied at accepted values for camper trailers. The six percent of owners listed in this report as permanent are owners who have actual permanent structures constructed. The term permanent is not intended to convey that this a sole or primary residence for the owners although some may fit that category. Persons per lot and waste strength will be applied at accepted values for single family dwellings. Actual population or occupancy numbers were not provided by owner at the time this report was completed.

Currently forty-nine percent of the lots are owned by individuals. Taking the earliest plat recording date listed in the AOC as the starting date for the development which was 1973 it has taken forty-three years to reach the current population density. Since this is a not a typical community or service area, an assumed growth rate of five percent will be applied over the next twenty years. Ratios of permanent to camping lots will be assumed to project into the future at the same rate which is six percent. A twenty year planning period has been chosen due to the typical design life of wastewater treatment systems for the design flow volumes. As discussed in later section for average daily flow the current water use has been conservatively determined to be at eighty percent of the current lagoon operating permit.

Calculations below for existing and future population served are based on accepted design values in 10 CSR 20.8 as follows:

Outfall 001 (Lagoon) currently serves 189 persons occupying permanent lots, 2,415 persons on camper lots for a total of 2,604 persons. Future population served 2,734

Outfall 002 (Package Plant) currently serves 78 persons on RV pads and an office/store with 6 employees for a total of 84 persons. No future expansion projected for RV Park therefore no design population increase for planning period.

Spreadsheets for design flow and unit sizing are provided in the appendix.

## Hydraulic Capacity Determination

### *Design Average Flow*

Using per person flow rates from 10 CSR 20.8 results in Outfall 001 having a design flow of over ninety-one thousand gallons per day. This design flow rate is almost four times the facility permitted average daily flow which is 25,000 gallons per day. Public water supply records indicate the well produced 16,521 gallons per day in the year 2015. A water use chart for water produced at the well for the entire community, in the appendix, shows the average daily flows for each month and for each three month cycle. The highest average daily flow for a three month period, which is the design flow through time of a lagoon, was seventy-eight percent of the lagoon permitted average daily flow or 19,464 gallon per day.

The owners have indicated several uses for water, which would reduce the flow to the treatment facilities, including: unknown water distribution system leakage, main flushing, pool, irrigation and dust control on the gravel drives. No information was provided as to the extent of the water usage diverted from the sewer system but it was believed to be significant. For the purposes of this report no reduction of water produced by the well have been applied to the amount of water received at the treatment facility. Using the total gallons produced at the well is a conservative approach to determine real world loading rates for this community.

Using per person flow rates from 10 CSR 20.8 results in Outfall 002 having a design flow of 2,430 gallons per day. This is roughly eighty percent of the current package plant permitted average daily flow.



## **Organic Capacity Determination**

In the absence of influent testing data on either facility, the design organic loading rates have been set to 0.17 pounds per person for permanent lots and 0.08 pounds per person for camping lots and RV pads. Total organic loading rate, for the lagoon, will be determined by reducing the design loading rate by the same percentage as the real world hydraulic flow rate. This will allow the waste strength to remain the same as concentrations proposed in 10 CSR 20.8.

### ***Biochemical Oxygen Demand***

Using pounds per person from 10 CSR 20.8 results in Outfall 001 having a design loading of 218 pounds BOD<sub>5</sub>. The flow reduction of water received was seventy eight percent. Therefore, the loading has been determined to be 48 pounds BOD<sub>5</sub>

Using pounds per person from 10 CSR 20.8 results in Outfall 002 having a design loading of 6.7 pounds BOD<sub>5</sub>. Since the design loading for Outfall is less than the permitted loading no reductions have been applied.

## **Findings**

Four violations of the operating permit occurred between January 2014 and November 2015. Three of the four exceedances were for fecal coliform.

No disinfection system installed on Outfall 001 (lagoon) as per required SOC.

Water level well below discharge elevation in third lagoon cell at time of site visit.

Water conditions, observed in the first cell, did not reflect those typically found at a lagoon treating domestic waste. Water was clear, odorless and void of miscellaneous trash typically observed at wastewater treatment facilities.

Lagoon, Outfall 001, large enough to meet design requirements for permitted flow.

Preliminary sizing evaluated for changing lagoon over to no discharge irrigation requires 11 acres.

Package plant, Outfall 002, large enough to meet design requirements for permitted flow.

No pumping and hauling records available to review and utilize to assist in actual flow numbers for lagoon.

Alternatives for ammonia treatment alternatives will not be investigated until Missouri Department of Natural Resources meets criteria of Missouri Revised Statutes Section 644.058.1, specifically presents owners with a complete assessment including findings that there is an environmental need for revision to the operating permit.

## **Recommendations**

Hire or contract with certified operator who has direct control over both collection and treatment components of the entire wastewater system.

Complete all work required by SOC to meet effluent limits for Fecal Coliform. The proposed permit contain E. coli instead of Fecal Coliform. Installation of chlorination disinfection and dechlorination equipment will meet the requirements of the proposed MSOP.

Owner must understand and instruct operation personnel to collect and maintain all applicable records regarding the collection system and treatment facility. AOC agreement section, paragraph E, requires a log showing day, lot number, gallons pumped and facility accepting the load. Additional records to those required by AOC should include but not be limited to: Park Occupancy numbers on a daily basis and water use on a daily basis.

Lagoon cells need to be field tested, with a water balance study, for leakage to verify the existing facility integrity.

Perform comprehensive evaluation and mapping of existing collection system.

Develop a capital improvement financial plan that will allow for both collection system expansion and treatment system upgrades.

Halt transfer of additional properties to new users until absolute treatment capacities are known and acceptable collection system methods are approved by regulating authorities.

Install water meters at comfort stations that will provide waste generation loadings for each facility.

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## APPENDIX

### A. Soils Survey Callaway County Missouri

Map

Table 12 Sanitary Facilities

Table 14 Water Management

Table 17 Soil and Water Features

### B. DMR Data

### C. Calculation Sheets

Lagoon (adjusted to match well readings)

Package Plant

Water Use (based on PWS well readings)





(Joins sheet 28)

R. 8 W. | R. 7 W.



(Joins sheet 34)

1:630 000 FEET

(Joins sheet 38)

1:710 000 FEET

2 MILES







TABLE 12.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
9C2----- Armster	Severe: wetness, percs slowly.	Severe: slope, wetness.	Severe: too clayey.	Slight-----	Poor: too clayey, hard to pack.
9D2----- Armster	Severe: wetness, percs slowly.	Severe: slope, wetness.	Severe: too clayey.	Moderate: slope.	Poor: too clayey, hard to pack.
10C2, 10D2----- Armstrong	Severe: percs slowly, wetness.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
13A----- Auxvasse	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
15B, 15B2----- Calwoods	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
16C2----- Crider	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight-----	Poor: thin layer.
16D2----- Crider	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Poor: thin layer.
18F*: Goss-----	Severe: slope.	Severe: seepage, slope.	Severe: slope, too clayey, large stones.	Severe: slope.	Poor: too clayey, small stones, slope.
Gasconade-----  Rock outcrop.	Severe: thin layer, seepage, slope.	Severe: depth to rock, seepage, slope.	Severe: depth to rock, seepage, slope.	Severe: seepage, slope.	Poor: area reclaim, too clayey, large stones.
19C, 19C2----- Gorin	Severe: wetness, percs slowly.	Moderate: slope.	Moderate: wetness, too clayey.	Moderate: wetness.	Poor: thin layer.
20D----- Goss	Moderate: percs slowly, slope, large stones.	Severe: seepage, slope.	Severe: too clayey, large stones.	Moderate: slope.	Poor: too clayey, small stones.
21C, 21C2----- Hatton	Severe: wetness, percs slowly.	Moderate: slope.	Moderate: wetness, too clayey.	Moderate: wetness.	Fair: too clayey, wetness.

See footnote at end of table.



TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
22C2, 22D2----- Keswick	Severe: wetness, percs slowly.	Severe: slope.	Severe: wetness.	Severe: wetness.	Poor: wetness.
24D, 24D2----- Lindley	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
24F----- Lindley	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
25----- Marion	Severe: wetness, percs slowly.	Slight-----	Severe: wetness.	Severe: wetness.	Poor: wetness.
27B, 27B2----- Mexico	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
28A----- Moniteau	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
29----- Landes	Severe: flooding, poor filter.	Severe: seepage, flooding.	Severe: flooding, seepage, too sandy.	Severe: flooding, seepage.	Poor: seepage, too sandy.
31----- Haymond	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Good.
32----- Cedargap	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Poor: small stones.
33----- Belknap	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
34----- Putnam	Severe: wetness, percs slowly.	Slight-----	Severe: wetness, too clayey.	Severe: wetness.	Poor: wetness, hard to pack, too clayey.
35C2----- Winfield	Severe: wetness.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness.	Fair: too clayey, wetness.
35D2----- Winfield	Severe: wetness.	Severe: slope, wetness.	Moderate: slope, wetness.	Moderate: slope, wetness.	Fair: too clayey, slope, wetness.
35E2, 35F2----- Winfield	Severe: wetness, slope.	Severe: slope, wetness.	Severe: slope.	Severe: slope.	Poor: slope.

See footnote at end of table.



TABLE 14.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
9C2----- Armster	Moderate: slope.	Moderate: hard to pack.	Deep to water	Slope, erodes easily.	Erodes easily	Erodes easily.
9D2----- Armster	Severe: slope.	Moderate: hard to pack.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
10C2----- Armstrong	Moderate: slope.	Moderate: wetness, hard to pack.	Slope, percs slowly, frost action.	Slope, wetness, percs slowly.	Percs slowly, wetness.	Percs slowly, wetness.
10D2----- Armstrong	Severe: slope.	Moderate: wetness, hard to pack.	Slope, percs slowly, frost action.	Slope, wetness, percs slowly.	Slope, percs slowly, wetness.	Percs slowly, slope, wetness.
13A----- Auxvasse	Slight-----	Moderate: wetness.	Percs slowly---	Wetness, percs slowly, erodes easily.	Erodes easily, wetness.	Wetness, erodes easily, percs slowly.
15B, 15B2----- Calwoods	Moderate: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly..
16C2----- Crider	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope-----	Favorable-----	Favorable.
16D2----- Crider	Severe: slope.	Severe: piping.	Deep to water	Slope-----	Slope-----	Slope.
18F*: Goss-----	Severe: slope.	Severe: large stones.	Deep to water	Large stones, droughty, slope.	Slope, large stones.	Large stones, slope, droughty.
Gasconade----- Rock outcrop.	Severe: depth to rock, seepage, slope.	Severe: large stones, thin layer.	Deep to water	Slope, large stones, droughty.	Slope, large stones, depth to rock.	Large stones, slope, droughty.
19C, 19C2----- Gorin	Moderate: slope.	Moderate: thin layer, piping, wetness.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Erodes easily, wetness.	Erodes easily, percs slowly.
20D----- Goss	Severe: slope.	Severe: large stones.	Deep to water	Large stones, droughty, slope.	Slope, large stones.	Large stones, slope, droughty.
21C, 21C2----- Hatton	Moderate: slope.	Moderate: wetness.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Erodes easily, wetness.	Erodes easily, percs slowly.

See footnote at end of table.



TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
22C2----- Keswick	Moderate: slope.	Moderate: wetness.	Percs slowly, frost action, slope.	Slope, wetness, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily.
22D2----- Keswick	Severe: slope.	Moderate: wetness.	Percs slowly, frost action, slope.	Slope, wetness, percs slowly.	Slope, erodes easily, wetness.	Wetness, slope, erodes easily.
24D, 24D2, 24F---- Lindley	Severe: slope.	Moderate: piping.	Deep to water	Slope-----	Slope-----	Slope.
25----- Marion	Slight-----	Moderate: wetness.	Percs slowly---	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
27B, 27B2----- Mexico	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, slope.	Slope, wetness, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily, percs slowly.
28A----- Moniteau	Slight-----	Severe: wetness.	Flooding, frost action.	Wetness, erodes easily.	Erodes easily, wetness.	Wetness, erodes easily.
29----- Landes	Severe: seepage.	Severe: seepage, piping.	Deep to water	Favorable-----	Too sandy-----	Favorable.
31----- Haymond	Moderate: seepage.	Severe: piping.	Deep to water	Flooding, erodes easily.	Erodes easily	Erodes easily.
32----- Cedargap	Moderate: seepage.	Severe: piping.	Deep to water	Flooding-----	Favorable-----	Favorable.
33----- Belknap	Moderate: seepage.	Severe: piping, wetness.	Flooding, frost action.	Wetness, erodes easily.	Erodes easily, wetness.	Wetness, erodes easily.
34----- Putnam	Slight-----	Severe: wetness.	Percs slowly---	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
35C2----- Winfield	Moderate: seepage, slope.	Moderate: thin layer, wetness.	Frost action, slope.	Slope, erodes easily.	Erodes easily, wetness.	Erodes easily.
35D2, 35E2, 35F2-- Winfield	Severe: slope.	Moderate: thin layer, wetness.	Frost action, slope.	Slope, erodes easily.	Slope, erodes easily, wetness.	Slope, erodes easily.
37C2----- Menfro	Moderate: slope, seepage.	Slight-----	Deep to water	Slope, erodes easily.	Erodes easily	Erodes easily.
37D2, 37E2, 37F2-- Menfro	Severe: slope.	Slight-----	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
39----- Hodge	Severe: seepage.	Severe: piping.	Deep to water	Droughty, fast intake.	Too sandy, soil blowing.	Droughty.
40----- Grable	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing---	Erodes easily, soil blowing.	Erodes easily.

See footnote at end of table.





TABLE 17.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydro-logic group	Flooding				High water table			Bedrock			Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness	Potential frost action	Uncoated steel	Concrete	
9C2, 9D2 Armster	C	None	---	---	3.0-5.0	Perched	Nov-May	>60	---	Moderate	High	Moderate.	
10C2, 10D2 Armstrong	C	None	---	---	1.0-3.0	Perched	Nov-May	>60	---	High	High	Moderate.	
13A Auxvasse	D	Rare	---	---	1.0-2.0	Perched	Nov-May	>60	---	Moderate	High	High.	
15B, 15B2 Calwoods	D	None	---	---	1.0-2.5	Perched	Nov-Apr	>60	---	High	High	High.	
16C2, 16D2 Crider	B	None	---	---	>6.0	---	---	>60	---	High	Moderate	Moderate.	
18F* Goss	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.	
Gasconade	D	None	---	---	>6.0	---	---	4-20	Hard	Moderate	High	Low.	
Rock outcrop.													
19C, 19C2 Gorin	C	None	---	---	2.0-4.0	Perched	Nov-Apr	>60	---	High	High	Moderate.	
20D Goss	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.	
21C, 21C2 Hatton	C	None	---	---	2.0-3.0	Perched	Nov-May	>60	---	High	High	Moderate.	
22C2, 22D2 Keswick	C	None	---	---	1.0-3.0	Perched	Nov-May	>60	---	High	High	Moderate.	
24D, 24D2, 24F Lindley	C	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.	
25 Marion	D	None	---	---	1.0-2.0	Perched	Nov-May	>60	---	Moderate	High	High.	
27B, 27B2 Mexico	D	None	---	---	1.0-2.5	Perched	Nov-May	>60	---	Moderate	High	Moderate.	

See footnote at end of table.



TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Risk of corrosion		
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness	Potential frost action	Uncoated steel	Concrete
28A Moniteau	C/D	Occasional	Brief-----	Nov-May	0-1.0	Apparent	Nov-May	>60	---	High-----	High-----	High.
29 Landes	B	Frequent-----	Brief-----	Nov-May	>6.0	---	---	>60	---	Moderate	Low-----	Low.
31 Haymond	B	Occasional	Brief-----	Nov-May	>6.0	---	---	>60	---	High-----	Low-----	Low.
32 Cedargap	B	Frequent-----	Very brief	Nov-May	>6.0	---	---	>60	---	Moderate	Low-----	Low.
33 Belknap	C	Occasional	Brief to long.	Nov-May	1.0-3.0	Apparent	Nov-May	>60	---	High-----	High-----	High.
34 Putnam	D	None-----	---	---	0.5-1.5	Perched	Nov-May	>60	---	Moderate	High-----	High.
35C2, 35D2, 35E2, 35F2 Winfield	B	None-----	---	---	2.5-4.0	Perched	Nov-May	>60	---	High-----	Moderate	Moderate.
37C2, 37D2, 37E2, 37F2 Menfro	B	None-----	---	---	>6.0	---	---	>60	---	High-----	Low-----	Moderate.
39 Hodge	A	Frequent-----	Brief-----	Nov-May	>6.0	---	---	>60	---	Low-----	Low-----	Low.
40 Grable	B	Rare-----	---	---	>6.0	---	---	>60	---	Low-----	Low-----	Low.
41 Leta	C	Rare-----	---	---	1.0-3.0	Apparent	Nov-May	>60	---	High-----	High-----	Low.
42 Waldron	D	Rare-----	---	---	1.0-3.0	Apparent	Nov-May	>60	---	High-----	High-----	Low.
43 Booker	D	Rare-----	---	---	+5-1.0	Apparent	Nov-May	>60	---	Moderate	High-----	Moderate.
44 Dupo	C	Rare-----	---	---	1.5-3.5	Apparent	Nov-May	>60	---	High-----	High-----	Moderate.
45C Freeburg	C	Rare-----	---	---	1.5-3.0	Perched	Nov-May	>60	---	High-----	High-----	High.

See footnote at end of table.



Date	outfall 1: Lagoon Influent				outfall 1 Lagoon Effluent					
	BOD mon	TSS mon			BOD 45	TSS 80	pH 6.5+	Ammonia mon	FC 400	TCR
1/14	x	x			ND	ND	ND	ND	ND	
2/14	x	x			ND	ND	ND	ND	ND	
3/14	ND	ND			ND	ND	ND	ND	ND	
4/14	x	x			ND	ND	ND	ND	ND	
5/14	x	x			ND	ND	ND	ND	ND	
6/14	18.66	29.6			10.56	43.9	7.91	x	x	
7/14	x	x			ND	ND	ND	ND	ND	
8/14	x	x			x	x	x	x	x	
9/14	x	x			x	x	x	x	x	
10/14	x	x			x	x	x	x	x	
11/14	x	x			x	x	x	x	x	
12/14	x	x			x	x	x	x	x	
1/15	ND	ND			ND	ND	ND	ND	ND	
2/15	ND	ND			ND	ND	ND	ND	ND	
3/15	ND	ND			ND	ND	ND	ND	ND	
4/15	ND	ND			ND	ND	ND	ND	ND	
5/15	ND	ND			ND	ND	ND	ND	ND	
6/15	ND	ND			ND	ND	ND	ND	ND	
7/15	63	70			27	48	9.2	0.8	1750	
8/15	ND	ND			ND	ND	ND	ND	ND	
9/15	34	32			8	4	7.7	31.9	10	0.05
10/15	ND	ND			ND	ND	ND	ND	ND	
11/15	ND	ND			ND	ND	ND	ND	ND	
12/15	x	x			x	x	x	x	x	
Date	BOD	TSS			BOD	TSS	pH	Ammonia	FC	TRC
GeoMean	34.2	40.5			13.2	20.4	8.2	5.1	132.3	0.05
Max	63	70			27	48	9.2	31.9	1750	0.05
Min	18.66	29.6			8	4	7.7	0.8	10	0.05

Date	outfall 2: Extended Aeration Influent				outfall 2: Extended Aeration Effluent					
	BOD mon	TSS mon			BOD 30	TSS 30	pH 6-9	Ammonia mon	FC 400	TCR 0.13
1/14	x	x			ND	ND	ND	ND	ND	ND
2/14	x	x			ND	ND	ND	ND	ND	ND
3/14	ND	ND			ND	ND	ND	ND	ND	ND
4/14	x	x			ND	ND	ND	ND	ND	ND
5/14	x	x			ND	ND	ND	ND	ND	ND
6/14	23.17	193.3			9.36	10.3	8.1	13	135.5	0.13
7/14	x	x			10.42	1.5	7.81	31	1	0.13
8/14	x	x			x	x	x	x	x	x
9/14	x	x			x	x	x	x	x	x
10/14	x	x			x	x	x	x	x	x
11/14	x	x			x	x	x	x	x	x
12/14	x	x			x	x	x	x	x	x
1/15										
2/15	11	12			6	7	8	16.8		
3/15	84	120			6	7	7.9	9.5		
4/15	17	40			6	55	7.7	12.9	10	4.44
5/15	12	16			16	12	7.7	16.5	10	0.01
6/15	6	12			7	12	7.6	14.6	10	0.017
7/15	12	3			10	6	7.8	23.5	10	0.07
8/15	23	17			10	6	8	32.5	156000	0.001
9/15										
10/15	32	16			22	1	8.2	84	3000	0.04
11/15					42	3	8.1	51.5		
12/15										
Date	BOD	TSS			BOD	TSS	pH	Ammonia	FC	TRC
GeoMean	18.3	22.9			10.7	6.3	7.9	22.2	70.8	0.05
Max	84	193.3			42	55	8.2	84	156000	4.44
Min	6	3			6	1	7.6	9.5	1	0.001



Project:	Lost Canyon
Owner:	Wildwood Lot Owners
Date:	2/10/2016
Designer:	BNS

Loading (001 - Lagoon) adjusted to match well readings

Permanent Residence	51
Persons per House	3.7
Gallons per Person per Day	100
Owners - Campers	805
Persons per Unit	3
Gallons per Person per Day	30
Open Lots	899
Persons per Unit	0
Gallons per Person per Day	30
Total persons	2603.7

Flow Rate

Q	18,870 gal
Q	72,450 gal
Q	- gal
Q <sub>total</sub>	91,320 gal
Percent of "design flow" to actual water use	21.31%
Gallons per day	19,464

B.O.D Loading

Pounds of B.O.D. per Day	48.016
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Lagoon Sizing

Minimum Surface Area	
Primary Cell	1.41 Acre
	61,517 sft.
Second Cell	18,455 sft.
Third Cell	6,152 sft.

P.O. Box 282, Lake Rd 54-24  
Osage Beach, MO 65065  
(573) 348-9799

Minimum Detention (120 days)

2,335,680 gallons  
312,257 cft

Volume

---

Primary Cell (Square Sides)	249 ft
Operating Depth	3.5 ft
Total Volume	235,305 cft
Second Cell (Square Sides)	136 ft
Operating Depth	3 ft
Total Volume	62,832 cft
Third Cell (Square Sides)	79 ft
Operating Depth	3 ft
Total Volume	22,989 cft
Volume Check	321,126 cft
	<u>312,257 cft</u>
	8,869 cft



**MILLER/LINDSAY**  
P.O. Box 282, LKRD 54-24  
Osage Beach, MO 65065  
Phone: (573) 348-9799  
Fax : (573) 348-2894

Project: Lost Canyon  
Owner: Wildwood Lot Owners  
Date: 2/10/2016  
Designer: BNS

**Loading (002-Package Plant)**

RV sites	26.00	
Persons RV site	3.00	
Gallons per Person per Day	30.00	
Office /Store	1.00	
Employees per day	6.00	
Gallons per day per employee	15.00	
Persons	84.00	
Flow Rate	2,430.00	gpd
BOD Loading	6.72	ppd
Recirculating rate 20%	8.06	ppd
Suspended Solids Loading	16.80	ppd
Aeration Tank Sizing		
time	324.87	cft
BOD	537.60	cft
Clairfier Sizing		
Time (4 hr detension)	405.00	gal
Min surface size	16.20	sft
Sludge Holding	252.00	cft
Air Requirements		
Aeration Tank	17,472.00	cft
Holding Tank	10,857.37	cft
Chlorination Contact Chamber		
15 min @ peak flow	101.25	gal



Water used

Month	gal/mon	days	gal/day		Lagoon Permit	25,000 gpd
1/15						
2/15						
3/15	298,670	18	16,593			
4/15	479,130	30	15,971			
5/15	759,850	31	24,511	High	Percent of High	98%
6/15	456,020	30	15,201			
7/15	559,150	31	18,037			
8/15	547,270	31	17,654			
9/15	608,510	30	20,284			
10/15	486,500	31	15,694			
11/15	302,400	30	10,080			
12/15	225,500	31	7,274	Low	Percent Low	29%
	4,723,000	293	16,119	Average	Percent Ave	64%

3month flows

Mar-May	1,537,650	79	19,464	High	Percent High	78%
April-June	1,695,000	91	18,626			
May-July	1,775,020	92	19,294			
June-Aug	1,562,440	92	16,983			
July-Sept	1,714,930	92	18,641			
Aug-Oct	1,642,280	92	17,851			
Sept-Nov	1,397,410	91	15,356			
Oct-Dec	1,014,400	92	11,026	Low	Percent Low	44%

