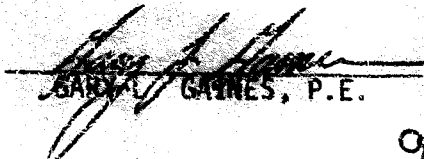


ENGINEER'S REPORT  
ON  
PROPOSED SANITARY SEWER FACILITIES  
TO SERVE  
**ECOLOGY ACRES SUBDIVISION**  
IN  
STODDARD COUNTY, MISSOURI

PREPARED FOR:  
BIEN AND GIBBS, INC.  
HIGHWAY 114 WEST  
DEXTER, MISSOURI 63841

PREPARED BY:  
TROTTER AND ASSOCIATES  
CONSULTING ENGINEERS  
100 RIDGETOP DRIVE  
DEXTER, MISSOURI 63841

  
GARY L. GAINES, P.E.



Applicant Exhibit No. 3  
Date 10/19/78 Case No. SA-77-11  
Reporter Shelley



G.L. GAINES, P.E.  
LOYD GARNER, L.E.  
V. DARRY, OOR, P.E.  
C.R. TROTTER, CONSULTANT

## TROTTER ASSOCIATES

CONSULTING ENGINEERS

101 RIDGETOP DRIVE - BOX 208  
DEXTER, MISSOURI 63841  
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DESIGNERS  
PLANNERS  
SUPERVISORS  
LABORATORY

May 5, 1976

Mr. Carl Bien  
Bien and Gibbs, Inc.  
Highway 114 West  
Dexter, Missouri 63841

RE: Sanitary Sewer Facilities  
Ecology Acres

Dear Mr. Bien:

The following is an Engineer's Report prepared by our firm on the proposed sanitary sewer facilities to serve Ecology Acres Subdivision in Stoddard County, Missouri. The report contains the basic information which was used in designing the proposed facilities. Since all of the proposed facilities will be privately financed, the report does not contain cost estimates or financing recommendations.

As you know, various alternates were considered in selecting the collection and treatment systems described herein. A gravity collection system was compared with the pressure system, and a lagoon was compared with the mechanical treatment process. The proposed facilities outlined herein reflect your preferences, and we feel these facilities will meet the needs of the subdivision and protect the waters of the state.

Very truly yours,

TROTTER AND ASSOCIATES

Gary L. Gaines, P.E.

GLG/nef

**ENGINEER'S REPORT  
PROPOSED SANITARY SEWER FACILITIES  
ECOLOGY ACRES SUBDIVISION**

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ENGINEER'S REPORT  
PROPOSED SANITARY SEWER FACILITIES  
ECOLOGY ACRES SUBDIVISION

I. SUMMARY

Ecology Acres Subdivision is a recorded, seventy-eight acre residential development in Stoddard County, Missouri. The site has been subdivided into 144 lots. Approximately fifteen homes now exist in the subdivision; however, when it is completely developed, it could contain over 100 homes. (In outlying residential developments, many home-owners occupy more than one lot.) Ultimately, the subdivision could house over 400 people; however, in order to provide a workable biological wastewater treatment process, a design population of 250 will be used.

The entire subdivision, except for roads, alleys, parks, and a site for the wastewater treatment facility, will be used for residential development. Therefore, the entire wastewater flow will be domestic, and contributions of 100 gallons per capita per day (GPCD) and 0.17 pounds of BOD per capita per day will be used for design purposes.

The wastewater collection system will be made up of both gravity and pressure lines. A single eight-inch gravity line will run down the approximate center of the subdivision, and pressure lines from the various lot clusters will discharge into the gravity line. By utilizing a combination of pressure and gravity lines, dependable service can be provided at a reasonable initial cost. Individual grinder pumps will be used at the homes to pump the sewage into the pressure lines.

Sewage treatment will be provided with an extended aeration plant. The plant will be a duplex facility, sized to handle a hydraulic loading of 25,000 GPD and an organic loading of 42.5 pounds of BOD per day. A larger initial plant would be impractical because initial loadings would not keep the plant operating effectively. When the design loading is reached, the initial plant will be expanded.

The extended aeration plant will be fully capable of producing a suitable effluent. The facilities will include: a bar screen, a flow splitter, two aeration basins, and two settling basins. Duplex blowers and motors will be provided to supply the air needed for aerating the sewage and operating the air-lift sludge return pumps. Pumps will be provided to supply water to foam inhibiting sprayers, and flow measuring facilities will be provided.

The receiving stream is a small tributary of Cane Creek. The stream flows into Cane Creek, which flows into Dudley Main Ditch, which flows into the St. Francis River. The distance from the point of discharge into the receiving stream to the St. Francis River via the waterways is approximately ten miles. The receiving stream is too small to support higher forms of life, it carries only a trickle most of the time. However, Cane Creek, Dudley Main Ditch, and the St. Francis River do support higher life forms. Since the receiving stream has little flow, and since down-

stream conditions are favorable to higher life forms, a very stable effluent must be produced by the treatment facility.

The entire sanitary sewer facilities will be privately financed; therefore, cost estimates and finance recommendations will not be presented. The facilities will be operated and maintained through a privately owned public utility. Such a utility must be formed and operated in compliance with the rules and regulations of the Missouri Public Service Commission.

## II. INTRODUCTION

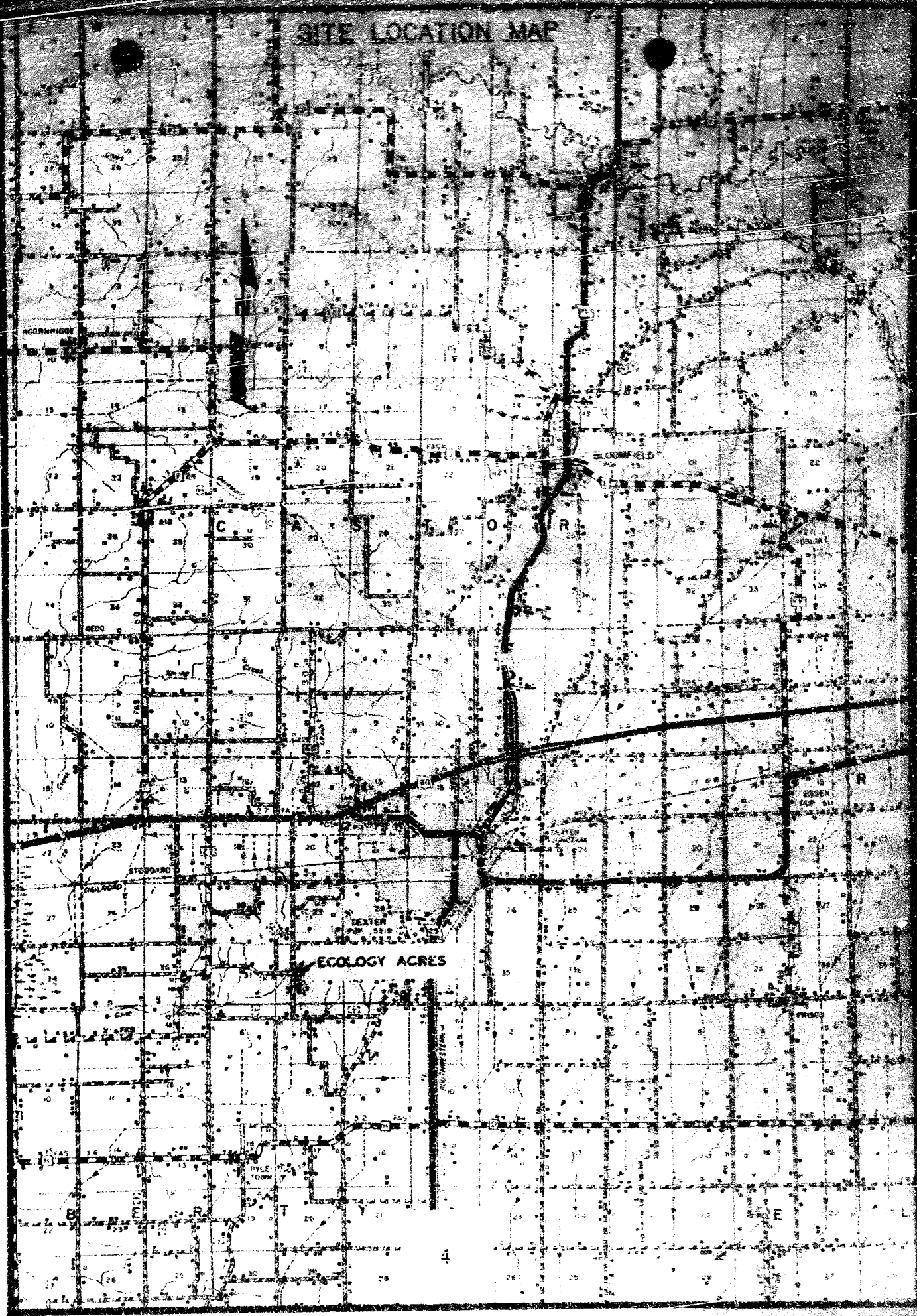
Ecology Acres Subdivision is a seventy-eight acre residential development located in Stoddard County, Missouri. It is located approximately two and one-half miles southwest of Dexter (see site location map on Page 4). A blacktop county road runs along the west side of the subdivision, and State Route "A1" runs within a few feet of it on the south side. The subdivision can be entered from either of these roads.

The subdivision was originally recorded in 1973, but the original owner sold his interests to Bien and Gibbs, Inc. in late 1974. Since that time, much development has taken place. Roads have been constructed, water lines have been installed, telephone and electric services have been provided, and many new homes have been built. Since most of the lots in the subdivision have been sold, home building is expected to continue at a rapid pace.

This report was prepared as part of the overall effort to provide a central sewer system in the subdivision. Bien and Gibbs, Inc., recognizing that a central sewer system is necessary both to protect the environment and to comply with state regulations, has taken the initial steps to cause a public utility to be formed and a central sewer system to be designed. As home building continues, the need for a central system will increase; and Bien and Gibbs, Inc. stands ready to provide for the needed facilities.

Since the site is a relatively new development which does not lie inside any incorporated city, town or village, it is not directly mentioned in any planning studies. However, it is safe to assume that the installation of central sewer systems is consistent with most comprehensive plans.

# SITE LOCATION MAP



### III. BACKGROUND

The area to be served by the proposed facilities is a recorded subdivision in an outlying area. It is a private development with fixed boundaries, so future annexation or expansion is unlikely.

The subdivision is located in the lower St. Francis River drainage basin. A small tributary of Cane Creek runs adjacent to the site on the south side, and this tributary will be the receiving stream. Cane Creek runs through the northwest portion of the site and serves as a waterway for surface drainage. (See the site location map on Page 5.)

Since the development is relatively new, population predictions cannot be based on past trends. Instead, the design population will have to be estimated by using generally accepted average values. The entire site has been subdivided into 144 lots; however, considering that many individual homes will occupy more than one lot, the subdivision could contain from 100 to 140 homes when fully developed. A recent report from the Census Bureau stated that the average number of persons per American household is 2.94, and the average number of persons per American family is 3.42. If most of the homes in Ecology Acres will be occupied by families, an average population density of 3.30 persons per lot could be assumed. With this density the subdivision could ultimately house between 330 and 462 persons.

All of the area within the subdivision, except for that used for roads, alleys, parks, etc., will be used for residential development. No commercial, industrial or institutional land use is anticipated.

The site is moderately hilly (see site location map on Page 6) and partially covered by woods. The soil is mostly clay, possibly containing some small pockets of sand or gravel. No rock or hardpan outcroppings are evident. Generally, the site topography and geology favors residential development, and no problems are anticipated in installing the proposed facilities.

Since the site is moderately hilly and most of it is in a topographically high area, flooding will not be a problem.

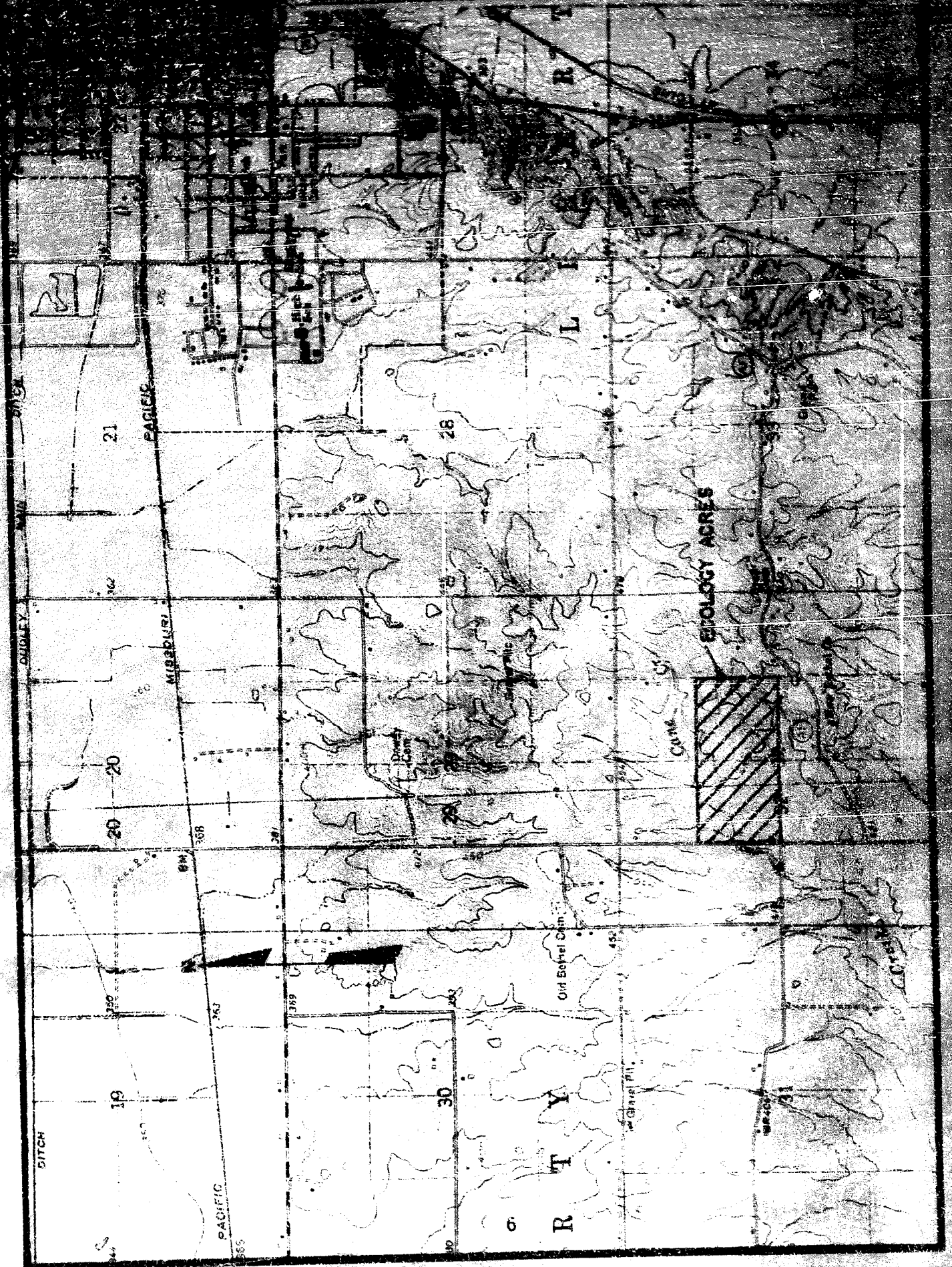
A network of roads has been constructed within the subdivision, and hard-surfaced county and state roads provide access to the site (see subdivision layout on Page 7).

The proposed facilities will be constructed, operated, and maintained through a private sewer company. Since this company will be a public utility company, it will be regulated by the Missouri Public Service Commission. A certificate of convenience and necessity will be obtained.

The private sewer company will be responsible for developing and enforcing rules and regulations to control sewer usage; for establishing and collecting sewer use rates; for operating and maintaining the sewer

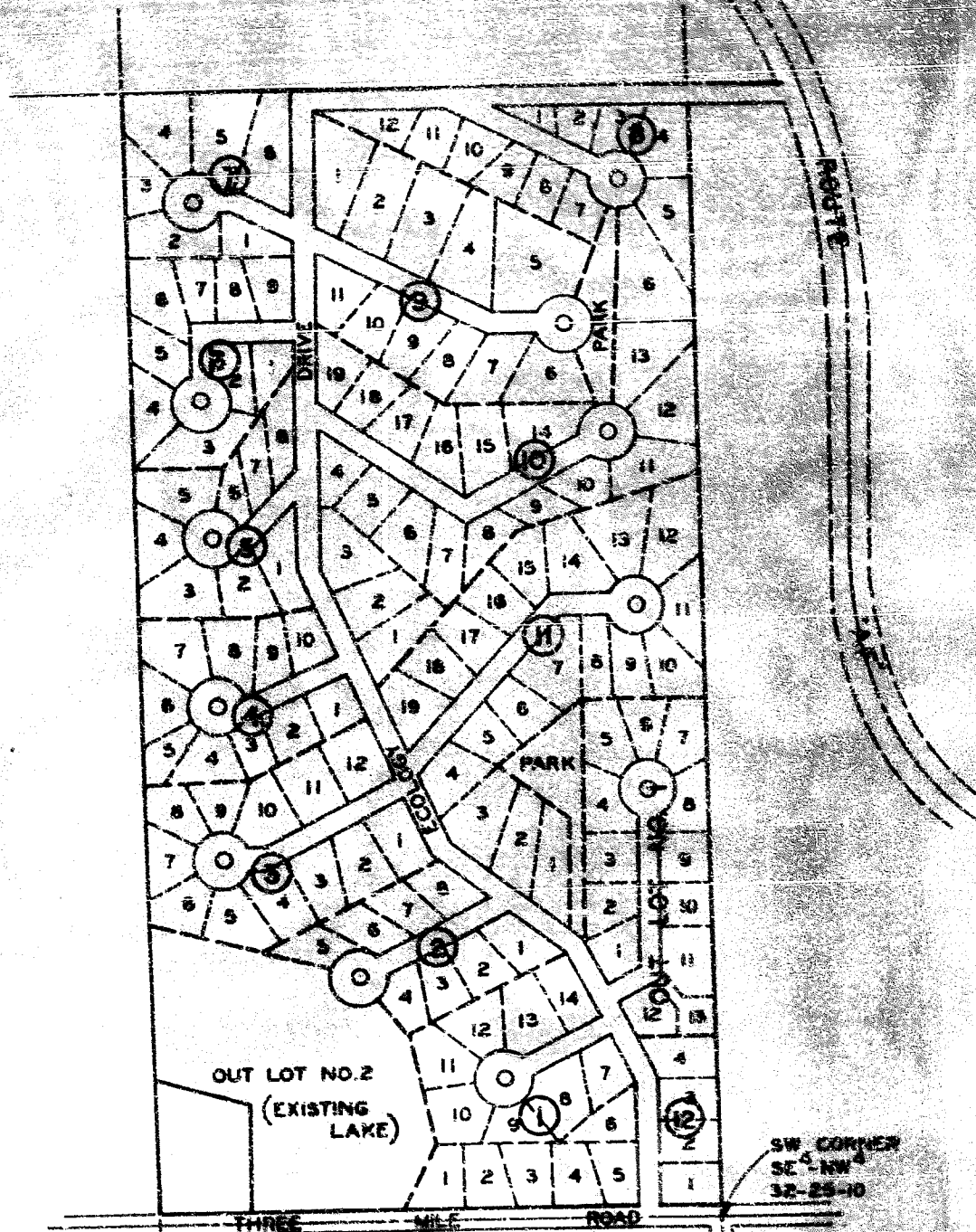


# SITE LOCATION MAP



ECOLOGY ACRE SURVEY  
GENERAL LAYOUT

SCALE: 1"=400'



**LEGEND**

- BLOCK LINES -----
- LOT LINES - - - - -
- BLOCK NUMBER..... (2)
- LOT NUMBER..... 2

facilities, including sampling and testing in compliance with the discharge permit; and for being responsible to the various state agencies for compliance with applicable rules, regulations and laws. Portions of the company's activities will be regulated by the Department of Natural Resources, and portions will come under the jurisdiction of the Public Service Commission.

#### IV. EXISTING FACILITIES

All of the existing homes in the subdivision are served by individual septic tanks. No central sewer facilities exist. The septic tank drain fields work very poorly in the tight clay soil. The clay allows little percolation and becomes quickly saturated with either wastewater or surface water. When the soil becomes saturated, partially treated sewage rises to the surface and causes unpleasant and unhealthy conditions. As the subdivision is developed and more homes are built, the situation will worsen.

The subdivision is fortunate in that it is served by Stoddard County Public Water Supply District No. 1.

## V. PROPOSED FACILITIES

### A. COLLECTION SYSTEM

The collection system will be a combination pressure and gravity system. Due to the hilly terrain, the installation of a complete gravity system would be very expensive; many deep cuts would be required and at least two pumping stations would be needed. (A complete gravity system was designed and evaluated.) However, a complete pressure system, although less expensive than a gravity system, would have certain disadvantages. More maintenance would be required than with a gravity system, and a defective line in a pressure system could interrupt the sewer service over a large area. Therefore, a combination pressure and gravity system will be used in an attempt to provide reliable service at a reasonable cost.

A single eight-inch gravity line will run down the approximate center of the subdivision, and pressure lines from the various lot clusters will discharge into the gravity line (see proposed collection system layout on Page 11). This arrangement will make the pressure lines operate independently of each other. Therefore, one of the biggest drawbacks to an all pressure system is avoided. In the system as proposed, a defective pressure line will affect only a single lot cluster and not the entire system.

The gravity line will be constructed along a natural ridge which runs through the subdivision. The line will be constructed of eight-inch vitrified clay pipe. The pipe will be laid on continuous grades between the manholes, and the grades will be steep enough to produce flow velocities in excess of two feet per second. All gravity lines will be placed at least three feet deep to prevent freezing and to protect them from superimposed loads. The pipe will be laid true to line and grade, and all joints will be made tight to minimize infiltration/exfiltration and prevent the entrance of roots.

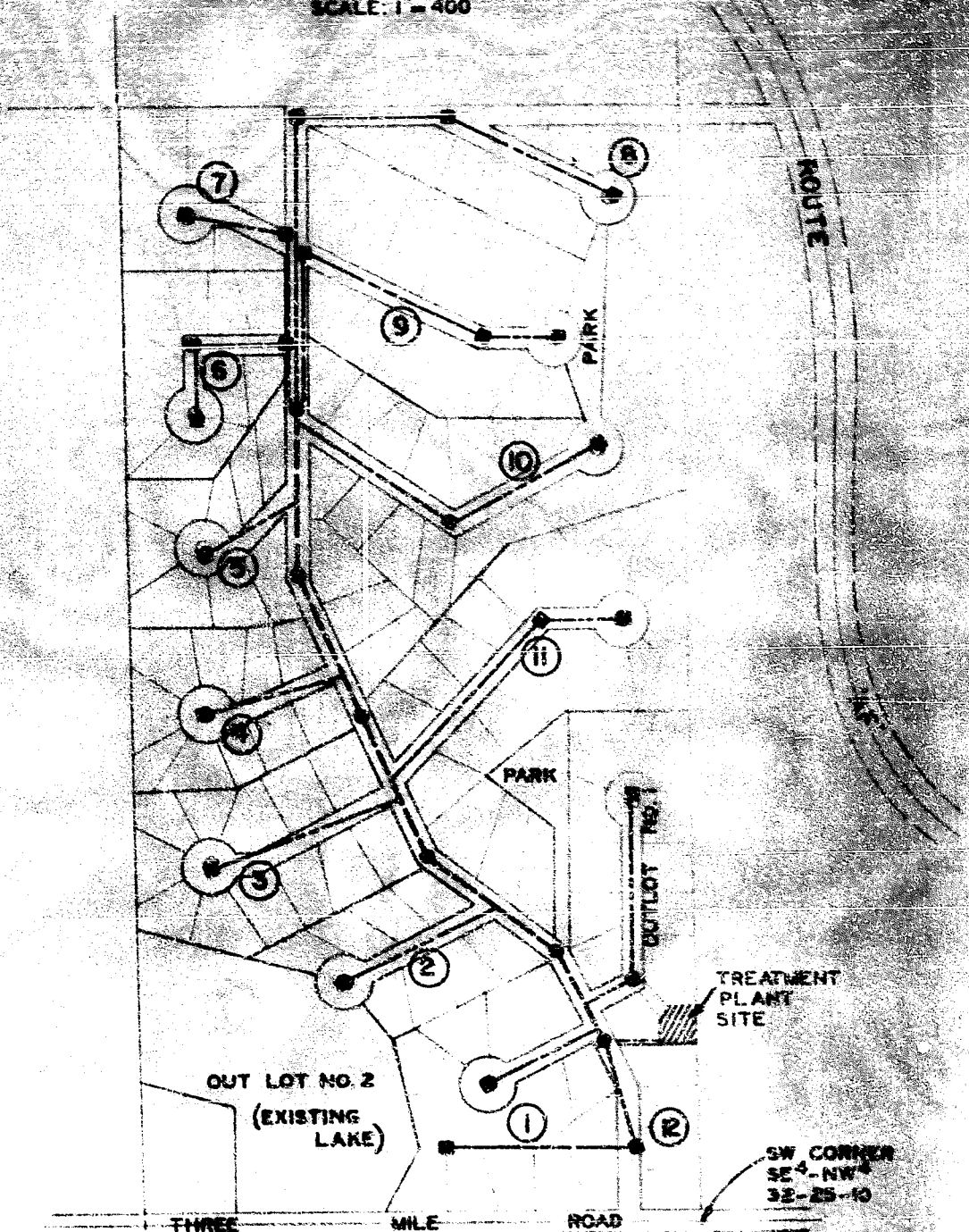
Manholes will be constructed in the gravity line at all changes in grade and alignment and at the ends. The manholes will not be more than 400 feet apart. All manholes will be constructed of either concrete or masonry and they will be at least 42 inches in diameter. The manholes will be constructed watertight, with suitable frames and covers and smooth inverts.

All pressure lines will be constructed of PVC pipe with an SDR rating of 26 (160 PSI) or better. The pressure lines will be designed on the basis of peak sewage flow rates so that flow velocities in the range of two to five feet per second will be achieved in all lines at least once every 24 hours. These scouring velocities should prevent the accumulation of solids and grease on interior pipe surfaces.

The system is laid out so that the pressure lines discharge into the gravity line at relatively high points. Therefore, the pressure lines

ECOLOGY AGENCY SUBDIVISION  
 PROPOSED SEWER  
 COLLECTION SYSTEM

STATE



**LEGEND**

- PROPERTY LINES
- GRAVITY SEWER LINES
- PRESSURE SEWER LINES
- MANHOLE
- CLEANOUT
- BLOCK NUMBERS

will flow full and remain full all the time. This will minimize air intrusion and help prevent drying and plating of solids on internal surfaces.

All pressure lines will be buried deep enough to prevent freezing. As shown on the collection system layout, all lines branch out from the gravity line, and no looping or interconnecting of pressure lines is proposed. This design allows for predictable flow rates in the pipes.

The lines will be sized so that the maximum heads at the branch ends do not exceed 80 feet; however, total dynamic heads approaching 80 feet are desirable and will be obtained wherever possible. This will provide optimum scouring velocities, minimum sewage holding capacities, and the most economical pipe installations.

Various appurtenances will be used in the pressure system to provide for dependable operation and maintenance of the system. Cleanouts will be provided at all major changes in alignment and at the upstream end of all branches. The cleanouts at the ends of the lines will be fitted with the necessary appurtenances to allow for pressure flushing of the lines. Since the flow in all of the lines will be in an uphill direction, air release valves and pressure control valves will not be needed. However, if the detailed design of the lines indicates that there will be a need for these facilities, they will be provided. All grinder pump installations will be equipped with check valves, gate valves, and all the necessary fittings.

## B. TREATMENT SYSTEM

The treatment system will be an extended aeration plant, with all the necessary appurtenances, located at the site shown on Page 11. Either a completely prefabricated plant, or one requiring little field assembly, will be used. The facility will be designed to stabilize domestic wastewater to the following effluent limitations:

1. Biochemical Oxygen Demand (BOD) of not more than 30 mg/L;
2. Suspended Solids (SS) of not more than 30 mg/L;
3. pH between 6.0 and 9.0; and
4. Dissolved Oxygen (DO) of not less than 6.0 mg/L.

The plant will be sized for a hydraulic loading of 25,000 GPD and an organic loading of 42.5 pounds of BOD per day. If daily per-capita contributions of 100 gallons of flow and 0.17 pounds of organic matter are considered, the plant would be sized to handle a population equivalent (PE) of 250. As pointed out elsewhere in this report, the subdivision could ultimately house between 330 and 462 persons. However, since only approximately fifteen homes now exist in the subdivision, and since ultimate development will take several years, it would be inappropriate to build facilities now to handle the ultimate population.

A biological facility sized to handle a population that large would not function properly for several years. Therefore, a facility to handle a PE of 250 will be installed now, and the facility will be designed to provide for future expansion when needed.

The treatment facility will include: a bar screen, a flow splitter, duplex aeration basins, duplex settling basins, flow measuring facilities, and all the necessary pumps, piping and appurtenances needed for a complete, workable system. (The bar screen may not be needed since 85 percent of the homes will discharge through grinder pumps; the need for a bar screen will be evaluated when construction plans are developed.) Duplex blowers and motors will be used to supply the air to the aeration basins and the air-lift sludge return pumps. The aeration basins will be sized to provide at least 24 hours detention at design flow, and the settling basins will be sized for a surface loading of 500 GPD/ft<sup>2</sup> or less.

No on-site sludge disposal facilities will be provided. Sludge production will be minimal in the extended aeration plant, and sludge disposal or conditioning facilities would not be justified. Screenings and waste sludge will be hauled off and disposed of at an approved disposal facility.

#### C. MISCELLANEOUS:

No pumping stations will be required in the system. All wastewater will flow into the gravity line which runs through the subdivision, and this line will flow by gravity to the treatment plant.

Since only residential development will take place in the subdivision, only domestic wastewater will reach the treatment facilities.

The treatment plant effluent will have little impact on the receiving stream. The stream carries little or no flow most of the time; therefore, higher life forms are not abundant. A stable effluent, rich in oxygen, will be produced by the treatment plant, so existing aquatic life will not be harmed. The flow in the receiving stream must travel approximately ten miles before reaching the St. Francis River, a Class A stream. Overland flow of the stable effluent will minimize its impact on the Class A stream.

The collection and treatment facilities will be operated and maintained by a private corporation. The private corporation will be formed as a public utility in accordance with the rules and regulations of the Missouri Public Service Commission. The utility company will provide a capable operator to operate and maintain the facilities. Information and guidance from both the Engineer and the equipment suppliers will be made available to the operator.

All testing needed to comply with the NPDES permit requirements will be performed by a private laboratory. Several laboratories offer this service to facilities in this area.



## VI. TECHNICAL INFORMATION AND DESIGN CRITERIA

### A. COLLECTION SYSTEM:

To effectively show all the design information on the collection system, a copy of the preliminary plan is included herein. This full size sheet is necessary to show details on the topography and the lines. Elevations, grades, flowlines, line size and various other information cannot be shown on the small sheets.

The gravity lines in the collection system were designed in accordance with state guidelines. Since standard procedure was followed, no further design information on the gravity lines will be presented here.

However, the design information on the pressure lines will be presented in detail. The preliminary pressure sewer system pipe schedule and branch analysis sheet, as shown on the following page, lists all the calculations pertaining to the pressure lines. This sheet was developed from the information shown on the preliminary plan and the following guidelines:

1. Each branch was analyzed separately,
2. The pipe sections between cleanouts were considered separately in each branch,
3. One grinder-pump installation was assumed for each lot served by the pressure line (note that some lots are served by the gravity line),
4. Eleven GPM maximum flow was assumed for each pump installation (this is common with positive displacement pumps),
5. Statistical information obtained from a publication by the Environmental One Corporation was used to determine the maximum number of pumps operating simultaneously compared with the total number of pumps connected (this information is presented in Appendix A),
6. The calculations are based on using PVC pipe with an SDR rating of 26 (Appendix B is presented herein to facilitate calculations),
7. Collector lines smaller than two inches were not considered because of the potential cleaning problem with smaller lines.

Although the calculations indicate that pipe sizes smaller than two inches could be used and still maintain total heads below 80 feet, smaller lines would be more difficult to clean and, therefore, were not considered. The larger lines should cause no operational problems because in all but one instance the maximum velocity is over two feet per second. If pressure lines are too large, they will become coated on the inside until adequate scouring velocities are produced.

PHILIPPINE PRESSURE SEWER SYSTEM PIPE SCHEDULE AND BRANCH ANALYSIS SHEET

Br. No.	No. of Pipes	Accum. Total	Max. Flow (gpm)	Stagn. (hrs)	Max. Velocity (fps)	Length (ft)	Friction Loss 100 ft. (ft.)	Accum. Head-Loss (ft.)	Max. Elev. Main (ft.)	Pump Site Elev. (ft.)	Elev. Diff. (ft.)	Max. Tot. Head (ft.)
1	6	6	33	2	2.94	550	1.53	6.83	425.0	412.0	13	23.93
	3	9	33	2	2.94	265	1.53	4.05				
2	6	6	33	2	2.94	250	1.53	3.82	428.0	415.0	10	13.82
3	10	10	44	2	3.92	440	2.61	11.48	429.0	420.0	9	23.67
	0	10	44	2	3.92	130	2.61	3.39				
4	6	6	33	2	2.94	400	1.53	6.12	443.0	424.0	19	25.12
5	10	10	44	2	3.92	450	2.61	11.74	451.0	432.0	19	30.74
6	7	7	33	2	2.94	130	1.53	1.99	454.0	440.0	14	30.08
	7	14	44	2	3.92	540	2.61	14.09				
7	8	8	33	2	2.94	360	1.53	5.51	473.0	432.0	34	39.51
8	7	7	33	2	2.94	300	1.53	4.59	491.0	455.0	26	30.59
9	8	8	33	2	2.94	380	1.53	5.81	491.0	461.0	30	47.29
	7	15	44	2	3.92	440	2.61	11.48				
10	5	5	33	2	2.94	170	1.53	2.60	491.0	480.0	11	20.87
	4	9	33	2	2.94	275	1.53	4.21				
	0	9	33	2	2.94	200	1.53	3.06				
10	6	6	33	2	2.94	270	1.53	4.13	491.0	471.0	20	31.01
	0	6	33	2	2.94	250	1.53	3.82				
	0	6	33	2	2.94	200	1.53	3.06				
11	3	3	22	2	1.96	180	0.72	1.30	491.0	475.0	16	39.48
	8	11	44	2	3.92	450	2.61	11.74				
	0	11	44	2	3.92	400	2.61	10.64				
12	10	10	44	2	3.92	430	2.61	11.22	491.0	465.0	26	62.27
	2	12	44	2	3.92	340	2.61	8.87				
	0	12	44	2	3.92	620	2.61	16.18				

The grinder pumps will be installed outside of the houses. Four inch gravity lines will carry the flow from the houses to the units, and the units will discharge through 1/2 inch lines. The 1/2 inch lines will run to the two inch collector lines.

#### B. TREATMENT SYSTEM:

The extended aeration plant will consist of the following units: bar screen (optional), flow splitter, duplex aeration basins, duplex settling basins, flow measuring facilities, and all pumps, piping, controls, and appurtenances. The specific geometrical arrangement of the plant will not be known until a certain make of plant is selected by the owner; however, the general flow diagram will be as shown on Page 17.

Design criteria for the proposed treatment system is as follows:

Hydraulic Loading = 25,000 GPD

Organic Loading = 42.5#/day

Design Population Equivalent = 250

Average Design Flow = 17.4 GPM

The aeration basins and equipment will be sized to provide at least 24 hours of detention time and an air supply of at least 2000 ft<sup>3</sup> per pound of BOD:

Total Basin Volume = 25,000 gal + 7.48 gal/ft<sup>3</sup> = 3342 ft<sup>3</sup>

Individual Basin Volume = 3342 ft<sup>3</sup> ÷ 2 = 1671 ft<sup>3</sup>

Possible Dimensions = 10' deep x 10' wide x 16'-9" long

Air Requirements = 2000 ft<sup>3</sup> x 42.5#/BOD/day = 85,000 CFD  
= 59 CFM

The settling basins will be sized for a surface loading of not more than 600 GPD/ft<sup>2</sup>, and the effluent weir loading will not exceed 10,000 GPD/ft:

Total Basin Area = 25,000 gal ÷ 600 GPD/ft<sup>2</sup> = 42 ft<sup>2</sup>

Individual Basin Area = 42 ft<sup>2</sup> ÷ 2 = 21 ft<sup>2</sup>

Possible Dimensions = 10' deep 4' wide x 10' long (Although these dimensions provide excess area, they are compatible with aeration basin design.)

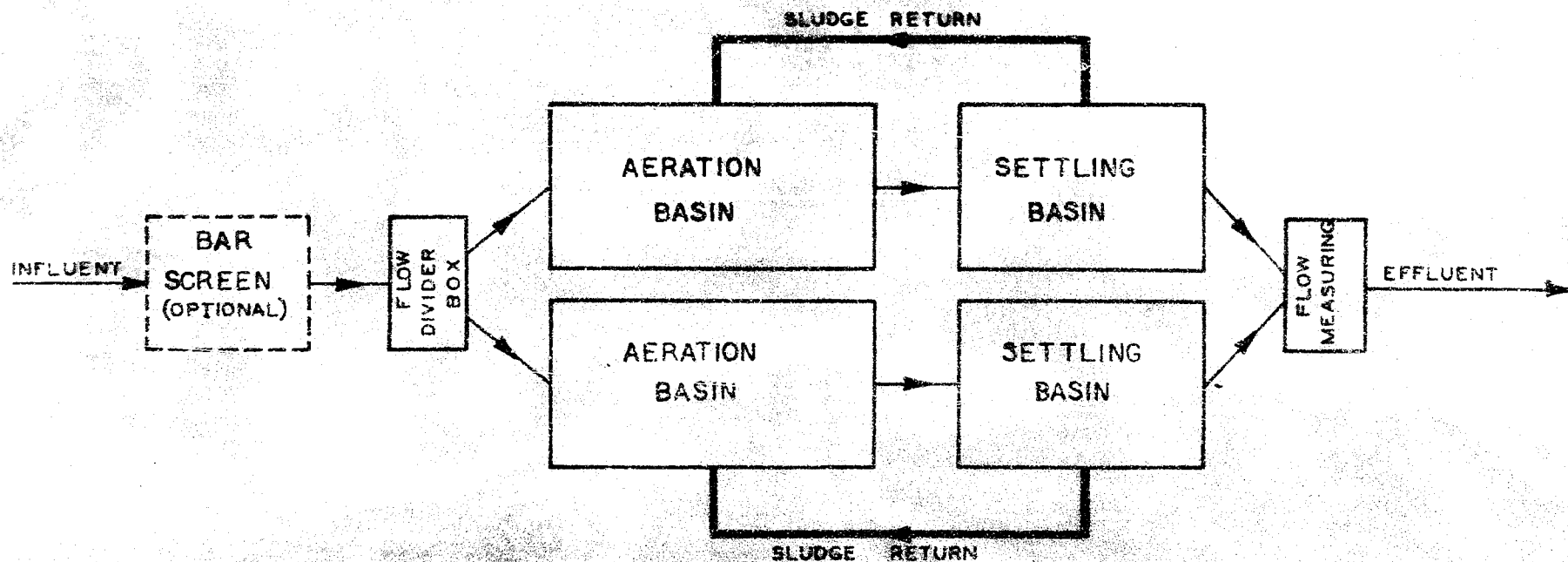
Minimum Weir Length = 25,000 GPD ÷ 10,000 GPD/ft = 2.5 ft

The blowers and motors, flow meter, piping arrangement, controls, and entire plant layout will be detailed in the construction plans.

## FLOW DIAGRAM PROPOSED TREATMENT PLANT

### NOTES :

1. DUPLEX MOTORS AND BLOWERS WILL BE USED.
2. SLUDGE RETURNED BY AIR LIFT PUMPS.
3. EXCESS SLUDGE TO BE PUMPED FROM AERATION BASINS.



APPENDIX A

Maximum Number of Grinder Pump Cores  
Operating Daily

Number of Grinder Pump Cores Connected	Maximum Daily Number of Grinder Pump Cores Operating Simultaneously
1	1
2 - 3	2
4 - 9	3
10 - 18	4
19 - 30	5
31 - 50	6
51 - 80	7
81 - 113	8
114 - 146	9
147 - 179	10
180 - 212	11
213 - 245	12
246 - 278	13
279 - 311	14
312 - 344	15

**NOTE:** *This design approach was considered to be mandatory to insure daily scouring. The capability of the Grinder Pumps to operate at least 40% above the design pressure criteria of 51 feet will handle these short duration approximately bi-monthly conditions when the simultaneous Grinder Pump operations will exceed the tabulated "maximum daily simultaneous operations". The typical "overlap" interval of pumps operating simultaneously is in the order of 60 seconds or less. The "maximum number of daily simultaneous operations" is based on data from the NYS/EPA pressure sewer research project and actual low pressure sewer systems now in operation. The Environmental One Grinder Pump Model Farrell 210 and 212 have one "pump core" each and the 214 has two "pump cores".*

APPENDIX 6

VELOCITY (FT/SEC) AND FRICTION HEAD LOSS (FT/100 FT) IN SDP 26 PVC PIPE (VELOCITY AND HEAD LOSS BASED ON FLOW OF 11 GALLONS PER MINUTE PER PUMP CORE)

NO. PUMPS RUNNING	1"		1 1/2"		2"		3"		4"		6"		8"		NO. PUMPS RUNNING
	VELOCITY FPS	HEAD LOSS FT.	VELOCITY FPS	HEAD LOSS FT.	VELOCITY FPS	HEAD LOSS FT.	VELOCITY FPS	HEAD LOSS FT.	VELOCITY FPS	HEAD LOSS FT.	VELOCITY FPS	HEAD LOSS FT.	VELOCITY FPS	HEAD LOSS FT.	
1			2.01	1.15											1
2			4.02	4.15	3.07	2.18	1.56	.72							2
3			6.02	8.78	4.60	4.87	2.94	1.53							3
4					6.14	7.77	3.92	2.03	1.80	.39					4
5							4.90	3.96	2.25	.69					5
6							5.88	5.52	2.70	.83					6
7							5.26	7.34	3.15	1.11	1.91	.33			7
8									3.60	1.42	2.18	.42			8
9									4.06	1.76	2.46	.52			9
10									4.51	2.14	2.73	.63			10
11									4.96	2.55	3.00	.75			11
12									5.41	3.00	3.28	.89			12
13									5.86	3.48	3.55	1.03			13
14									6.31	3.99	3.82	1.18			14
15									6.76	4.53	4.09	1.34	1.88	.36	15
16									4.37	1.51	2.93	.21			16
17									4.64	1.69	2.13	.25			17
18									4.91	1.87	2.26	.28			18
19									5.19	2.07	2.38	.31			19
20									5.46	2.28	2.51	.34			20
21									5.73	2.49	2.64	.36			21
22									6.00	2.72	2.76	.41			22
23									6.28	2.95	2.89	.46			23
24									6.55	3.19	3.01	.48			24
25									6.82	3.44	3.14	.52	1.85	.14	25
26											3.28	.56	1.93	.16	26
27											3.39	.58	2.05	.17	27
28											3.51	.64	2.08	.18	28
29											3.64	.68	2.15	.19	29
30											3.77	.73	2.22	.20	30
31											3.89	.77	2.30	.22	31
32											4.02	.82	2.37	.23	32
33											4.14	.87	2.45	.24	33
34											4.27	.92	2.52	.25	34
35											4.39	.97	2.60	.27	35
36											4.52	1.02	2.67	.28	36
37											4.64	1.07	2.75	.30	37
38											4.77	1.13	2.82	.31	38
39											4.89	1.17	2.89	.32	39
40											5.02	1.24	2.97	.34	40
41											5.15	1.30	3.04	.35	41
42											5.27	1.36	3.12	.36	42
43											5.40	1.42	3.19	.38	43
44											5.52	1.48	3.26	.41	44
45											5.65	1.54	3.34	.43	45
46											5.77	1.60	3.41	.45	46
47											5.90	1.67	3.48	.46	47
48											6.02	1.74	3.56	.48	48
49											6.15	1.80	3.64	.50	49
50											6.27	1.87	3.71	.52	50

Head Loss Calculations  
From Modified Hazen -  
Williams Formula

$$H = .2083 \left( \frac{100}{C} \right)^{1.85} \times \frac{q^{1.85}}{d^{4.87}}$$


C = 150  
d = I.D. pipe in inches  
q = flow in gallons per minute

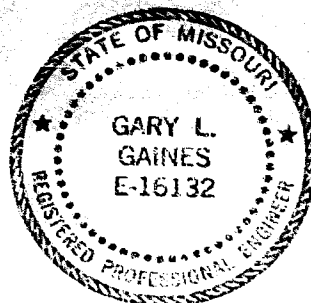
SUPPLEMENT NO. 1  
TO  
ENGINEER'S REPORT  
ON  
PROPOSED SANITARY SEWER FACILITIES  
TO SERVE  
**ECOLOGY ACRES SUBDIVISION**  
IN  
STODDARD COUNTY, MISSOURI

(ORIGINAL REPORT SUBMITTED IN MAY, 1976)

PREPARED FOR:  
BIEN AND GIBBS, INC.  
HIGHWAY 114 WEST  
DEXTER, MISSOURI 63841

PREPARED BY:  
TROTTER ASSOCIATES  
CONSULTING ENGINEERS  
100 RIDGETOP DRIVE  
DEXTER, MISSOURI 63841

  
GARY L. GAINES, P.E.





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REGISTERED PROFESSIONAL ENGINEER  
MISSOURI, P.E.

July 29, 1977

Mr. Carl Bien  
Bien and Gibbs, Inc.  
Highway 114 West  
Dexter, Missouri 63841

RE: Sanitary Sewer Facilities  
Ecology Acres and Western Heights


Dear Mr. Bien:

The following is a supplement to an Engineer's Report prepared by our firm in May, 1976, on proposed sanitary sewer facilities to serve Ecology Acres in Stoddard County, Missouri. This supplement is intended to provide information on expanded facilities which will serve both Ecology Acres and Western Heights. Since all of the proposed facilities will be privately financed, cost estimates are not included herein.

As you know, the original Engineer's Report pertained to Ecology Acres only. However, since the original report was completed, you have obtained and are developing additional land adjacent to Ecology Acres known as Western Heights. Therefore, you requested that the facilities as proposed for Ecology Acres be expanded to serve Western Heights also. The contents of this supplement is in accordance with your request.

Very truly yours,

TROTTER ASSOCIATES

  
Gary L. Gaines, P.E.

GLG/nef



SUPPLEMENT NO. 1  
TO  
ENGINEER'S REPORT  
ON  
PROPOSED SANITARY SEWER FACILITIES  
TO SERVE  
ECOLOGY ACRES SUBDIVISION

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## I. SUMMARY

An Engineer's Report was developed in May, 1976, on proposed sanitary sewer facilities to serve Ecology Acres, a recorded, seventy-eight acre residential subdivision in Stoddard County, Missouri. Since that time, the developers, Bien and Gibbs, Inc., of Dexter, Missouri, have acquired and are developing additional land adjacent to Ecology Acres. Since this additional land, called Western Heights, is contiguous to Ecology Acres, the developers want a central sewer system which will serve both subdivisions. This centralization is in accordance with good planning; therefore, this supplement was prepared to provide information on the expanded facilities necessary to serve the entire development area.

The general design proposed in the original report will remain essentially unchanged; it will simply be expanded to provide facilities which will serve both subdivisions. A combination pressure and gravity collection system will be utilized throughout. An extended aeration plant will be used to treat all of the wastewater from both subdivisions.

The combined area of both subdivisions is approximately 120 acres. The land has been subdivided into a residential development containing a total of 278 lots. An ultimate population of 760 has been estimated for design purposes. There are approximately 25 homes now existing in both subdivisions, and many new ones are being constructed.

The information in the original report pertaining to the receiving stream, topography, geology, and existing facilities remains unchanged. All of the proposed facilities will be privately financed, and they will be operated and maintained by a public sewer district.

## II. INTRODUCTION

An Engineer's Report on proposed sanitary sewer facilities to serve Ecology Acres Subdivision in Stoddard County was completed in May, 1976. Since that time, the developers, Bien and Gibbs, Inc., of Dexter, have obtained 42.7 additional acres of land adjacent to Ecology Acres. This land, called Western Heights, is now being developed along with Ecology Acres. Since the subdivisions are contiguous, the developers want to provide a central sanitary sewer collection and treatment system which will serve both. The purpose of this supplement is to provide information on a single system which will serve both subdivisions.

The facilities proposed in the original Engineer's Report included a collection system made up of both gravity and pressure lines, and an extended aeration treatment plant made up of the individual components necessary to produce a suitable effluent. Nothing new will be proposed in this supplement; the same design concepts will simply be expanded to serve the additional land. The collection system which was proposed to serve Ecology Acres will remain unchanged, and a similar system will be used in Western Heights. All of Western Heights will be served by pressure and gravity lines which drain to a single pump station. This station will pump the wastewater from Western Heights into the main gravity line in Ecology Acres; therefore, all of the wastewater from both subdivisions will flow to a single treatment facility. The treatment facility proposed in the original report will be used, and provisions will be made to expand it so that it can handle the entire flow. This will not be difficult since a prefabricated or module plant to be built in 25,000 gallon increments was proposed.

The original Engineer's Report was submitted to the Missouri Department of Natural Resources for review on May 5, 1976. The report was reviewed, and comment letters were sent to the engineer on July 22 and August 17, 1976. Since then the project has been dormant due to problems encountered by the developers. However, the developers now feel that the problems can be resolved, and they want to proceed with the project. Therefore, this supplement is intended not only to provide information on an expanded sanitary sewer system, but also to address the review comments already made by the Department of Natural Resources.

### III. BACKGROUND

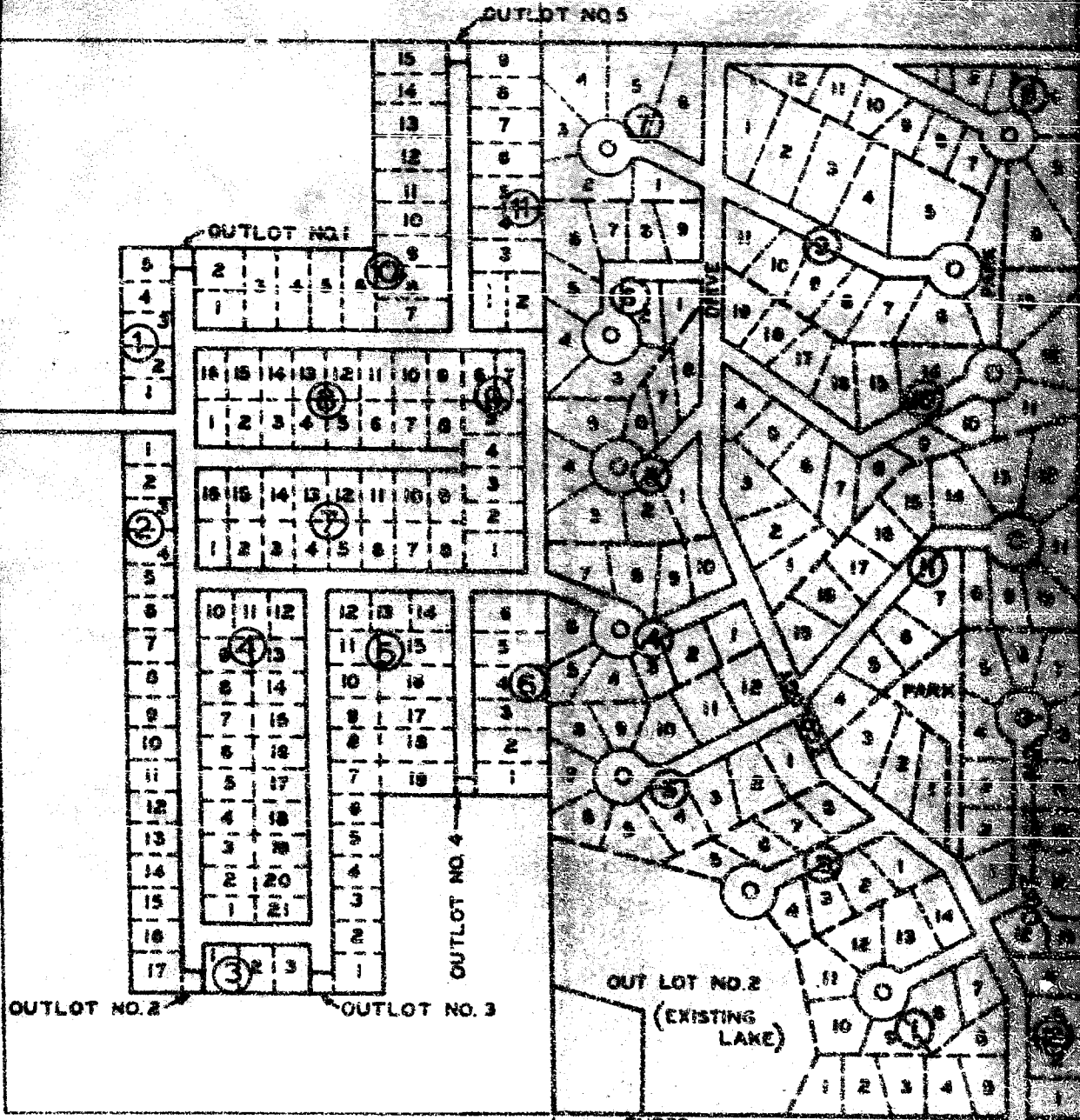
The area to be served by the proposed facilities includes two outlying recorded subdivisions, Ecology Acres and Western Heights, as shown on the general subdivision layout on the following page. The original Engineer's Report dealt only with Ecology Acres, and it contained site location and layout maps of the area. Those maps, combined with the layout on the following page, show the location and layout of both subdivisions. The information in the original report pertaining to the receiving stream, type of development, topography, geology, and existing facilities applies to both subdivisions. New population predictions for the entire area must be developed, and the establishment of a public sewer district as opposed to a private sewer company will be discussed.

The original report stated that 100 to 140 out of a total of 144 lots in Ecology Acres could eventually contain homes. By considering an average population density of 3.30 persons per lot, it was concluded that the subdivision could ultimately house between 330 and 462 persons. There are a total of 134 lots in Western Heights. Therefore, both subdivisions contain a total of 278 lots. If 190 to 270 lots were built upon, the total population would reach 627 to 891. It is very difficult to predict the ultimate population of a new subdivision because past growth data is not available. However, considering the average of the estimated growth span; i.e., the average of 627 and 891, a design population of approximately 760 could be expected.

The original report indicates that the proposed facilities would be constructed, operated, and maintained through a private sewer company, which, being a public utility, would be regulated by the Missouri Public Service Commission. This is no longer planned; instead, a public sewer district will be formed. The public district, which will be formed in accordance with the appropriate Missouri Statutes, will assume all the responsibilities that were proposed for the private company. Clean Water Commission Regulations require that a continuing authority be provided as part of a suitable plan of operation, and the regulations indicate that a public district is an acceptable authority. Therefore, steps are being taken to form such a district. Since it will be a public district, it will not be regulated by the Missouri Public Service Commission, and a certificate of convenience and necessity will not be required. The district will be formed through the Stoddard County Court, and proof of its formation will be submitted when organization is complete.

# WESTERN HEIGHTS AND ECOLOGY ACRES GENERAL SUBDIVISION LAYOUT

SCALE: 1" = 400'



**LEGEND**

BLOCK LINES ————

LOT LINES - - - - -

BLOCK NUMBER ..... ②

LOT NUMBER ..... 2

SW CORNER  
SE 1 - NW 4  
32-25-10

#### IV. PROPOSED FACILITIES

The general design of the proposed facilities as presented in the original report will not be changed. A combination pressure and gravity collection system will be used in both subdivisions, and an extended aeration plant will be used to treat all of the wastewater from both subdivisions. There will be some minor changes from what was proposed in the original report, and the following will describe these changes. Otherwise, all of the information contained in the original report will apply.

##### A. COLLECTION SYSTEM

The collection system will be a combination pressure and gravity system with a general layout as shown on the following page. The portion of the system which will serve Ecology Acres is exactly as originally proposed. The portion which will serve Western Heights will consist of a main gravity line across the south side of the subdivision, with gravity laterals running up the approximate center and west side which terminate at high points on the north side of the subdivision. Pressure lines serving low areas not served by the gravity line will discharge into the gravity line at these high points. Most of the lots in Western Heights will be served by the gravity lines; only five branch pressure lines will be used. All of the collection system in Western Heights will drain to a single pump station located in the southwest corner of the subdivision. This station will pump the wastewater into the gravity line which runs down the approximate center of Ecology Acres.

The preliminary layout of the collection system in Western Heights, as shown on the following page, was developed from topographic information that was taken from large scale maps. Therefore, the elevations used, and, hence, the specific layout of the system, may vary somewhat from what is shown. However, the general layout will be followed, and any changes which prove to be necessary will not affect the integrity of the overall system. Work is now underway to obtain detailed field data so that specific grades, distances, etc. can be established. Of course, this information will be developed and shown in detail in the construction plans and specifications.

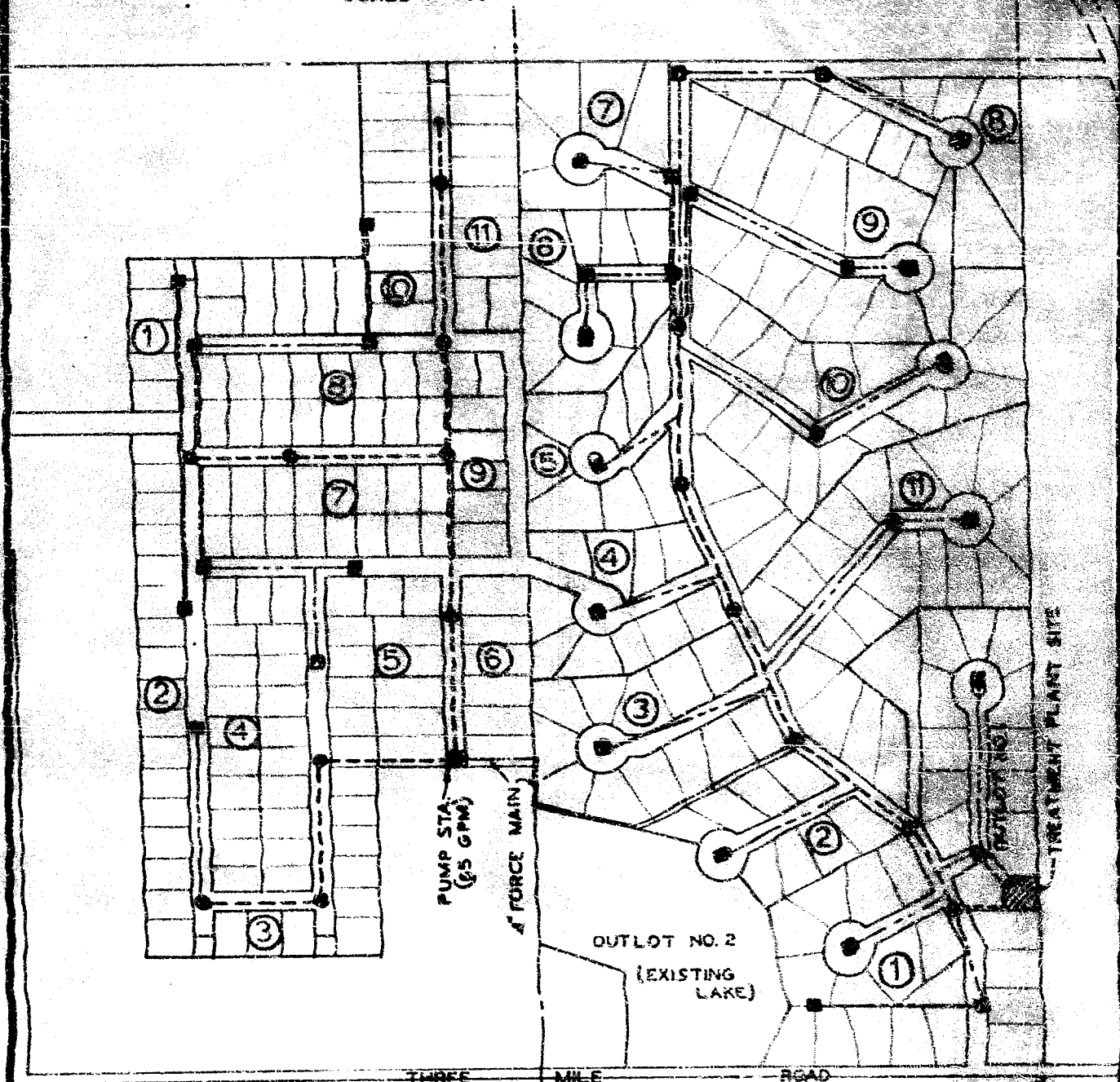
The original report contains information on how the gravity and pressure lines will be constructed, what materials will be used, and what design standards will be followed. All of this information will still apply and will not be repeated here.

One concept will be changed in the collection system: instead of providing individual grinder pump installations for each home, multi-family units will be used wherever possible. This cluster arrangement will allow the grinder pumps to be controlled by the sewer district, as recommended by the Department of Natural Resources.

# GENERAL LAYOUT

## WESTERN HEIGHTS AND ECOLOGY ACRES PROPOSED SEWER COLLECTION SYSTEM

SCALE: 1" = 400'



### LEGEND

- PROPERTY LINES
- FORCE MAIN SEWER LINE
- GRAVITY SEWER LINE
- PRESSURE SEWER LINE
- MANHOLE
- CLEANOUT
- BLOCK NUMBERS

SW CORNER  
SE<sup>4</sup> - NW<sup>4</sup>  
32-25-10

①

6

Grinder pumps are normally available in various sizes, from the small, simplex individual-home unit to the larger, duplex multiple-home unit. The individual-home unit manufactured by the Environment One Corporation which was considered in the original report has a storage capacity of 60 gallons and a pumpage rate of 11 GPM. Units with greater storage capacities and pumpage rates are available for multi-family service. Typical sizes include a unit with a storage capacity of 120 gallons and a pumpage rate of 11 GPM for two-family service, and a unit with a storage capacity of 120 gallons and a pumpage rate of 22 GPM for three-through-six-family service. The exact storage capacities and pumpage rates vary among manufacturers.

The type of service which will be provided at the various locations throughout the subdivisions, whether it be single-family or multi-family, and also the number of families that can be served by a single installation, will be dependent on neighborhood topography and site development techniques. If two or more houses are arranged on a slope such that they have a common low point, a multi-family unit would be used; if not, single-family units will be required. Since it is not possible to regulate specific home locations, orientations, and plumbing details, the type of service will be determined as the areas are developed.

A branch analysis was performed on the pressure lines in Ecology Acres in the original report. Further analyses will not be made because the use of multi-family units will reduce the maximum total heads, and pipe sizes smaller than two inches will not be used for maintenance reasons; therefore, it is apparent that all branch heads will be less than 80 feet in Ecology Acres. Branch heads in Western Heights will also be less than 80 feet because, generally, lower static heads, shorter pressure lines, and fewer pumps exist on the branches.

#### B. TREATMENT SYSTEM

All of the information in the original report on the treatment system still applies. A prefabricated extended aeration plant, sized for a hydraulic loading of 25,000 GPD and an organic loading of 42.5 pounds of BOD per day, will be provided. Since this design is based on serving a population of 250, and since a total design population of 760 was estimated, it is apparent that the treatment facilities will have to be expanded as the subdivisions are developed. In fact, based on the total design population, the capacity of the facilities will ultimately have to be tripled. The facilities will be constructed in 25,000 gallon increments, and effluent monitoring will indicate when expansion is necessary.



### C. MISCELLANEOUS

All of the wastewater flow from Western Heights will drain to a single pump station located in the southwest corner of the subdivision. The station will pump the flow into the gravity line in Ecology Acres through a PVC force main.

As previously stated, there are a total of 276 lots in both subdivisions, and 134 of them, or 48%, are in Western Heights. Therefore, 48% of the design population, or 355 people, can be expected to reside in Western Heights. If a flow rate of 100 gpcd were considered, the pump station would receive an average flow of 36,500 GPD or 25 GPM. In order to handle maximum flows, the station will be designed to pump 2.5 times the average flow, or approximately 65 GPM.

Approximately 1000 feet of four inch PVC force main will carry the 65 GPM from the pump station to a manhole on the gravity line in Ecology Acres (see layout of proposed sewer collection system). The flow will travel at a velocity of 1.66 FPS and will create a dynamic headloss of approximately three feet per 1000 feet (PVC pipe with SDR rating of 26). Since the static head will be approximately 40 feet, and since some minor headlosses will occur, the pump station will operate against a total dynamic head of approximately 50 feet.

The pump station will initially serve only a few homes. There are presently no occupied homes in Western Heights. Several homes are now being constructed, and it is estimated that ten to twenty new homes will be built per year. Therefore, a pump station installation for less than fifty homes, a simplex system with no standby power, will be provided initially. Provisions will be made to install a duplex pump system with standby power when the number of homes the unit serves reaches 50, which will likely occur in two to four years.