SOUTH OF HIGHLAND
NORTH OF RAIL ROAD

# EVALUATION OF SOIL BORINGS
# for
# RESIDENTIAL FOUNDATIONS

at ✓ TSC

SEDGEBROOK RESIDENTIAL SUBDIVISION
✓ PINGREE GROVE, ILLINOIS

for

SHEAFFER AND ROLAND, INC.
805 WEST LIBERTY DRIVE
WHEATON, ILLINOIS 60187

by

BLANK, WESSELINK, COOK & ASSOCIATES, INC.
2623 EAST PERSHING ROAD
DECATUR, ILLINOIS 62526
217/428-0973

FEBRUARY 15, 1989

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BWC 355-8801

# I N D E X

## INTRODUCTION

Presented in this Report are the results of our evaluation of soil boring data for a shallow residential foundation system.

This evaluation was authorized by Mr. Tom Ennis of Sheaffer and Roland, Inc. The purpose of our study was to design an appropriate foundation for a typical one story residence per soil borings supplied by the owner for the proposed Swedgebrook Residential Subdivision.

## DESIGN CRITERIA

An evaluation of field and laboratory test data of 64 borings made by H. H. Holmes Testing Laboratories, Inc. was done to determine the feasibility of supporting a conventional shallow foundation system at a normal frost depth of about 3.5 feet below existing ground surface at each boring location.

Our evaluation was made based on the following design criteria:

1. Foundation to be a crawl-space with a minimum of 2.0± feet of cover above the bottom of the footing.

2. Footing width to be 16" wide for an 8 inch foundation wall with a wood framed wall and 20" wide for a 10 inch foundation wall with a wood framed wall and brick veneer.

3. Footings to be non-reinforced concrete and foundation walls to be concrete and reinforced top and bottom for beam action and rigidity.

4. Use a net allowable soil pressure of 1,000 PSF for continuous exterior footings and limit foundation and structural movement to about 0.5 inch.

5. Size interior column/pier footings for a net allowable soil pressure the same as exterior footings and place these footings at the same depth below grade as the exterior footings.

## CONCLUSIONS AND RECOMMENDATIONS

Conventional shallow, continuous, wall-bearing footings with a structural foundation wall can be founded on the sand, silt and clay subsoils at a depth of about 3.5 feet ± below existing grade at all but 7 boring locations studied.

## CONCLUSIONS AND RECOMMENDATIONS - cont'd

The factor of safety against a bearing capacity (punching shear) failure will be a minimum of 2$\pm$ for the weakest soil conditions and the most conservative soil and groundwater assumptions. Generally, the safety factor will be about 2.5 or greater. This is considered adequate for the very lightly-loaded residential structures.

Estimated settlements are on the order of 1/4" to 1/2", which is within the tolerable range for the lightly-loaded frame structures.

Organic silts and clays were encountered at borings 23, 27, 39, 42, 48, 58 and 68. At these locations it will be necessary to displace or replace these weak compressible soils with compacted structural fill if conventional shallow foundation systems are to be used at these locations. An alternate foundation system for these weak soil locations would be a deep foundation consisting of drilled piers and a continuous grade beam wall.

The estimated net bearing pressure imposed on the foundation soils at a depth of about 3.5 feet is 907 PSF for a standard 16" wide footing. It is recommended that interior piers/individual footings be sized for this same net (allowable) soil pressure in order to minimize differential settlements.

The 7 boring locations indicating the organic silts and clays are located on a north-to-south line on the east side of the proposed subdivision. It is recommended that the remaining soil borings proposed on the soil boring location diagram be made for the remaining southeast side of the proposed subdivision.

## FOUNDATION DETAIL DESIGN

The recommended shallow foundation for the proposed one story residences of the subdivision is to construct the footings and foundation walls as indicated in the Owner's foundation specifications with the following exceptions (See Enclosure No. 2):

1. Excavate to a depth of 2 feet above the bottom of footings. Trench the remaining 2 foot depth using a bucket width equal to the footing width.

2. Do not allow workers to walk on or disturb the bottom of the footing in any way. Do not use any compaction equipment at the bottom of the footing.

3. Place 2 - No. 5 reinforcing bars continuous at the top and bottom of the foundation wall. At the foundation wall corners and intersecting walls the reinforcing bars should be lapped by 12 inches using bent hooks or corner dowel bars.

The extra work required to construct the footings and foundation walls to meet the requirements of our evaluation should be minimal to the foundation cost, estimate $300.00 to $500.00 per house.

The cost to place a shallow foundation system in the areas of the organic silts and clays based on an average excavation depth of 15 feet would be:

1. Excavate site material and dispose of within the subdivision:

   Area of House* = 38'x52' = 1,976 FT.$^2$

   Area of Garage* = 32'x34' = 1,088 FT.$^2$

   TOTAL AREA = 3,064 FT.$^2$

   3,064 FT.$^2$ X 15' Excavation Depth = 1,701 Cu.Yd.

   Excavation Cost = 2.50/Cu.Yd. x 1,702 Cu.Yd. = $4,255.00

   *Includes 6 ft. over-excavation each side.

2. Buy and load at pit select structural fill, haul and spread with dozer, and compact with vibratory plate in 9" lifts:

   3,064 Cu.Yd. x $12.00/Cu.Yd. = $36,768.00

Total estimated cost to remove and replace 15 feet of weak soils with a structural fill would be about $40,000.00 per house.

Other alternatives would be to place the foundation walls on drilled piers using a truck mounted drilling rig or if the weak soils are within 8 feet or less from grade use a poured concrete basement type of foundation.

The estimated cost for a drilled pier foundation would be $10-12,000 while a concrete basement would add about $6-7,000 per house.

## SUBDIVISION SITE DESIGN

A review of the soil boring location diagram shows that the borings of the seven weak soil conditions are located on one side of the proposed subdivision rather than scattered throughout. This would indicate a large section of the subdivision may need site work done to not only provide a suitable foundation for homes, but also a suitable base for roads, sewers, water mains and utilities.

A method of replacing large areas of weak soils would be to use a displacement method similar to what is used on highway construction projects when peat bogs and such are encountered. Normally this work is done with large construction equipment, so for what you pay to have seven deep individual residential foundations constructed for, estimate $140,000.00, a large portion of the subdivision can be improved for the same cost.

## SUMMARY AND CONCLUSIONS

I. Our evaluation of the soil borings indicate that conventional shallow, continuous, wall-bearing footings with a structural foundation wall can be used on the majority of the proposed subdivision.

II. Our evaluation shows that in an isolated area of the proposed subdivision several borings indicate the need for a revised foundation design for proposed homes in this area.

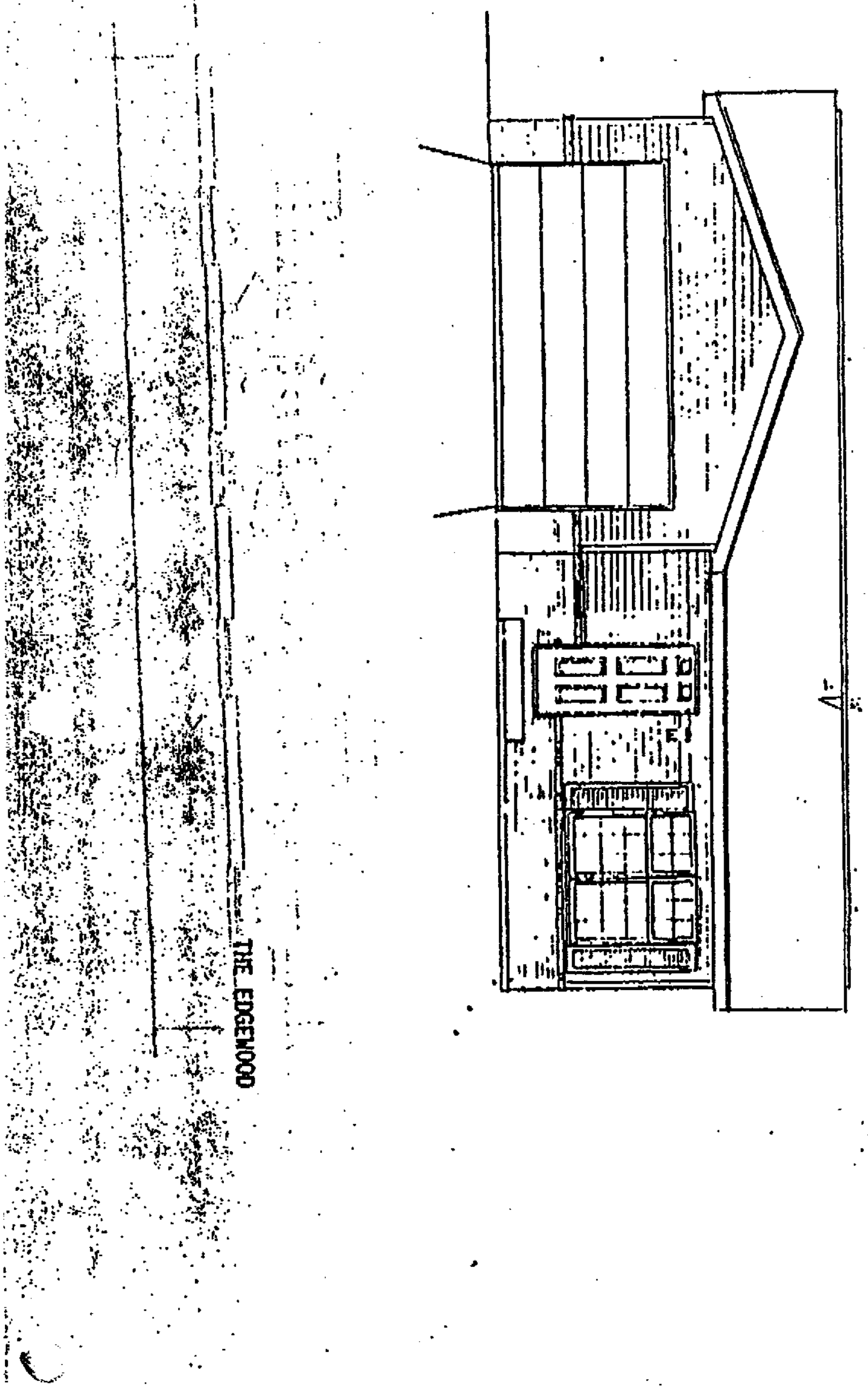
III. We recommend that the remaining proposed soil borings be completed to reveal the subsoil conditions for the entire subdivision.

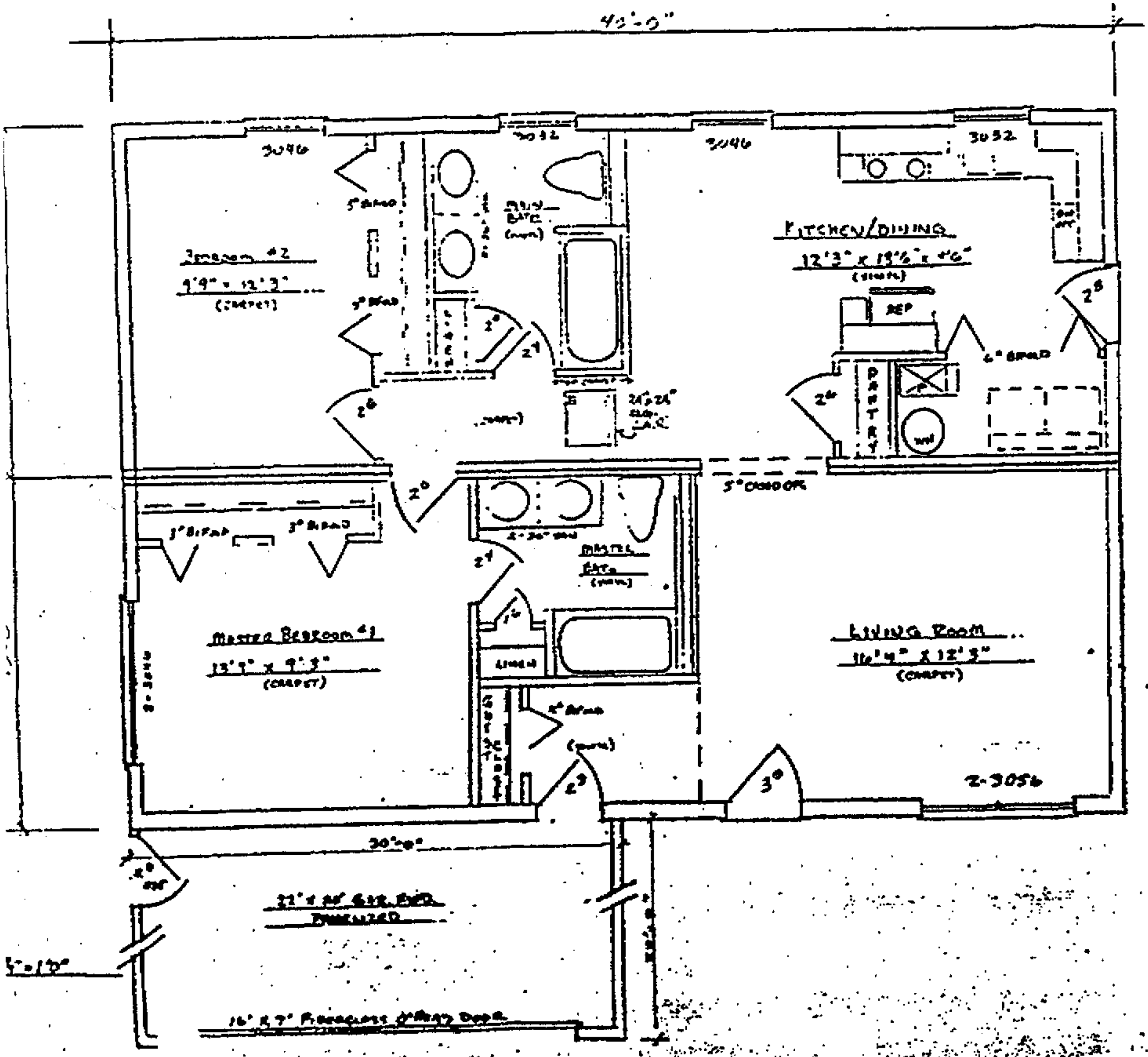
IV. We recommend that a review of all the soil borings be made when finished to investigate the possibility of a method of site work to improve the soil conditions not only for residential foundations, but also for roads and utilities.

V. We recommend that a soils technician be used in close cooperation with the foundation contractor in areas of known or suspected weak soil conditions to correctly identify soil conditions for the foundation engineer.

END.

ENCLOSURE (3)






Revised Edgewood
Two Bedroom/Two Full Baths
1040 SF (HSE Only)

CLIENT NAME AND ADDRES

Sheaffer & Roland, Inc.
805 West Liberty Drive
Wheaton, Illinois 60187

***** FOUNDATION & FLATWORK SPECIFICATIONS *****

EXCAVATING
Includes excavating and rough backfill with dirt on site

CONCRETE
3,000 PSI min

FOOTINGS
8" x 16" for 8" wall, per plan
10" x 20" for 10" wall, per plan (option for brick)

CRAWL SPACE AREA
4" of fill gravel
Vapor barrier
3" +/- concrete floor
Concrete piers or steel columns
Sump pit tank only
Drain tile to sump pit
Vents per plan

FOUNDATION WALL
8" x 40" poured wall, per plan
10" x 38" poured wall, per plan (option for brick)
Anchor bolts

FOUNDATION PLATES
2" x 6" Treated yellow pine for house
2" x 4" Treated yellow pine for garage
1/2" x 6" Fiberglass sill sealer

GARAGE FLOOR
4" of fill gravel
4" of concrete
6 x 6 x 10 WWM

STOOPS
4" of fill gravel
4" of concrete

WALK
4" of fill gravel
4" of concrete
Square feet, per plan

## ***** PANELIZED/MODULAR SPECIFICATIONS *****

**FLOOR AREA**

2" x 8" or 2" x 10" floor joists, 16" o.c.
4 - 2" x 8" or 2" x 10" center beam
5/8" T & G OSP structural subfloor, glued and nailed
No wax resilient floor in kitchen, bath(s), entry, utility or furnace room
Nylon carpet with 1/2" pad in living room/great room, separate dining room, hall and bedrooms

**WALLS**

8'-0" wall height
Double top plate on bearing, 2" x 6" or 2" x 3"
Exterior walls, 2" x 6" @ 24" o.c.
Joining walls, 2" x 3" @ 16" o.c.
Interior non-bearing walls, 2" x 4" @ 24" o.c.
3/8" structural sheathing
1/2" drywall, glued and nailed, house only, garage optional
Vapor barrier on exterior walls

**ROOF**

Engineered trusses, 2" x 6", 24" o.c.
4, 6 or 10/ 12 per plan
1/2" OSP structural roof sheathing
220# Fiberglass seal-down shingles
15# felt paper
Continuous ridge vent
Vented aluminum eaves, per plan
Aluminum gable extensions, per plan
Aluminum fascia

**INSULATION**

Walls, R-19
Ceiling, R-30
Floor, Optional

**EXTERIOR**

Wood windows, double-hung, maintenance free, aluminum clad exterior, w/insulated glass, screens & white grills, per plan
Metal insulated front & rear doors, w/dead lock, per plan
40 year, horizontal double 4" vinyl siding or prefinished siding, per plan
Exterior trim, coordinated w/siding color, per plan

**INTERIOR**

Prefinished doors & trim w/antique brass knobsets, per plan
Vinyl clad [illegible] wire shelving
Finished drywall house ceilings & walls, garage optional

BLANK, WESSELINK, COOK & ASSOCIATES, INC.
ENGINEERS • CONSULTANTS

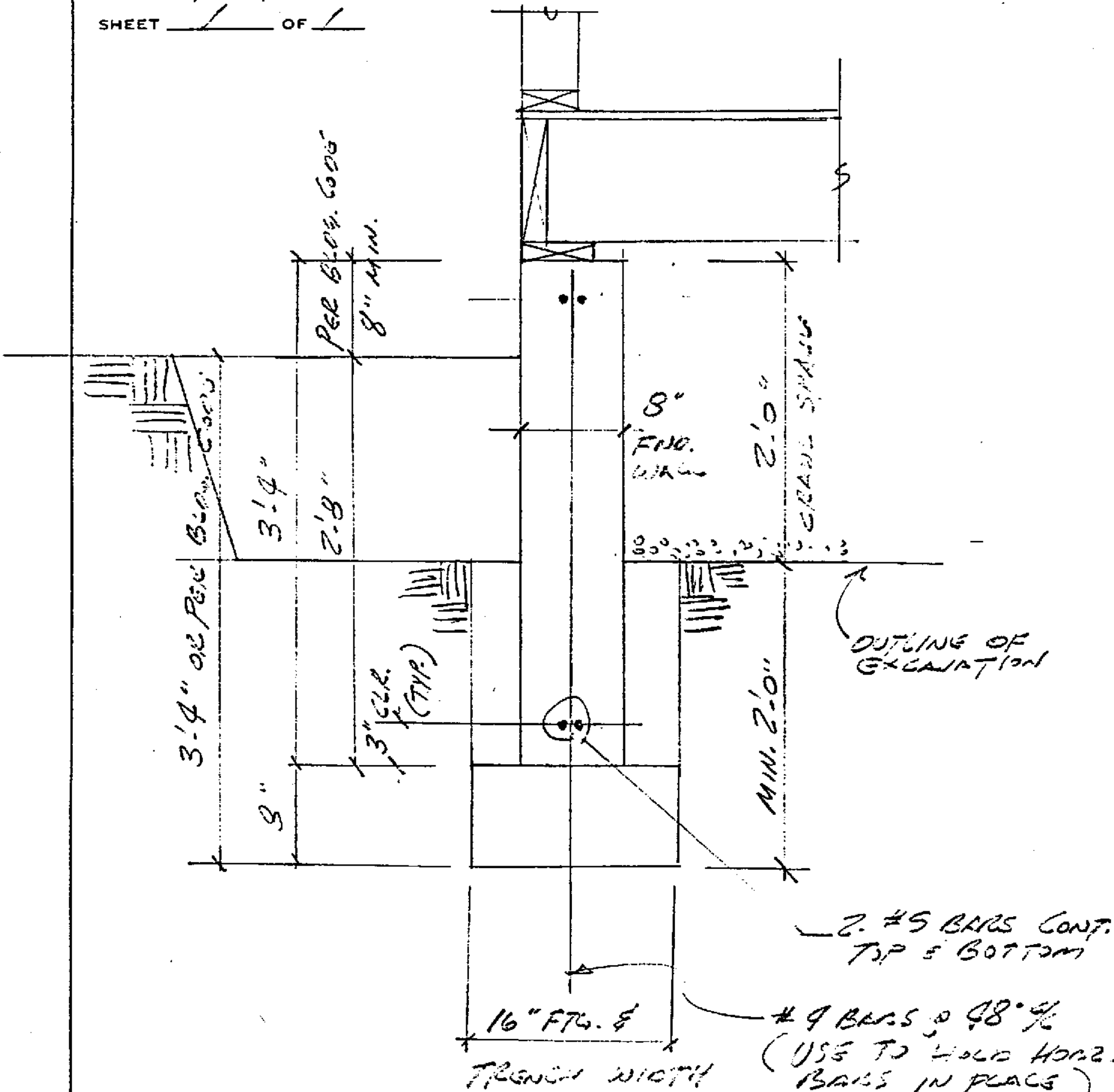
MADE BY JDG DATE 2/89 PROJECT NO. 355-8301
CHECKED BY ______ DATE ______
BACK CHECKED BY ____ DATE ______ PAGE NO. ____ OF ____

CLIENT: SHEAFFER-ROLAND INC.

PROJECT DESCRIPTION: SWEDGEBROOK SUBDIVISION

SUBJECT: PROPOSED SHALLOW FOOTING DESIGN

SHEET 1 OF 1



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construction materials

H. H. HOLMES TESTING LABORATORIES, INC.

• 170 Shepard Avenue • Wheeling, Illinois 60090 • Area Code 312 • 541-4040

January 25, 1989

SHEAFFER & ROLAND, INC.
805 West Liberty Drive
Wheaton, Illinois 60187



Lab No. CH 4105
File No. 7568.0

Attn: Mr. Thomas Ennis
Re. Sedgebrook Soil Borings, Pingree Grove, Illinois

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Gentlemen:

At your request, sixty (60) soil borings were made for the proposed Sedgebrook Residential Subdivision to be constructed at the Southeast corner of the intersection of Reinking Road and Highland Avenue in Pingree Grove, Illinois. . The approximate location of these borings and test results are enclosed in this report.

The purpose of this report is to describe the subsurface conditions encountered at the site, evaluate the physical characteristics of the soil by means of testing of the soils in the laboratory and submit recommendations regarding the design and construction of the foundations of the proposed structures. Also included are the recommendations regarding the streets and driveway facilities.

Conversation with the owner's representative indicated that most of the structures will be one story in height with slab-on-grade floors and without basements, however, basement construction will be considered if site conditions permit.

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Lab No. CH 4105
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Building design loads are not known at the present time, however, it is our understanding that they will be relatively light in magnitude.

These borings were made utilizing a truck mounted rotary type of drill rig which advances the boreholes by continuous flight auger method (ASTM Standard D 1452-80). Representative soil samples were obtained by means of split barrel sampling procedure in accordance with ASTM Standard D 1586-84, "Method for Penetration Test and Split Barrel Sampling of Soils". In this sampling procedure, a 2 inch OD split barrel sampler is driven into the soil a distance of 18 inches by means of a 140 pound hammer falling 30 inches. The value of the Standard Penetration Resistance (SPR N-value) is obtained by counting the number of blows of the hammer over the final 12 inches of driving. All of the soil borings drilled in the proposed building area were extended to a depth of 15 to 20 feet below present grade. Please note that additional soil borings located in the low portion of the site (Southeast corner) were not drilled due to the fact that very soft surficial soil made this area inaccessible to the truck-mounted drill rig. This area will be drilled as soon as the surficial soils freeze enough for the safe access.

A field log of soils encountered in the borings was maintained by the drill crew. All soil samples obtained from the drilling operations were identified, sealed immediately in the field and brought to the laboratory for further examination and testing.

The laboratory testing program consisted of performing natural moisture content test on all samples (ASTM Standard D 2216-80) and unconfined compressive strength tests on representative cohesive samples (ASTM Standard D 2166-85). After completion of the testing program, every soil sample was visually classified in accordance with the Unified Soil Classification System (ASTM Standards D 2487-85 and D 2488-84).

The general soil conditions present at the surface of the project site consist of approximately 2 to 50 inches of topsoil and/or highly organic silt. Underlying the aforementioned organic soils, most of the borings encountered loose to medium dense brown to brown and gray clayey to sandy silt and then a layer of gray clayey silt, which is also loose to medium dense in consistency. However, intermediate layers of medium dense silty sand and silty clay were also encountered in some of the borings. Also, occasional much deeper deposits of organic material were encountered.

The groundwater level measurements were obtained while drilling and after completion of the borings. Short term groundwater level measurements indicate that water was encountered approximately between 3 and 13 feet below present grade in cohesionless deposits in some of the soil borings. Seasonal and yearly fluctuations in the water table can be anticipated due to changes in hydrogeologic regime, such as, but not limited to, variations in precipitation, evaporation and surface runoff.

On the basis of the soil borings and laboratory testing of the soils, it is our opinion that placement of the proposed structures upon the most economical Shallow Foundation System such as spread or trench footings, supported by underlying layers of loose saturated silt and/or organic soil that were encountered in some areas will result in unacceptable settlements that will impair the structural integrity of the proposed buildings. Therefore, since in most cases soils possessing adequate bearing capacity were not encountered at greater depth, these footings shall be supported by a Deep Foundation System as described in latter part of this report. However, construction of the Shallow Foundation System, such as interior and/or exterior wall footings and interior column footings will be possible in certain areas. Before the construction proceeds, we recommend that the existing unsuitable surficial topsoil and/or organic materials should be completely removed from the boundaries of the proposed structure and paved areas, and at least 5 feet beyond the perimeter of the aforesaid areas.

The footings for the buildings should be extended through the upper unsuitable loose soils and founded on underlying original materials possessing maximum net allowable bearing capacity of 1,500 PSF. This lower bearing capacity is recommended in order to limit the differential settlements, that can occur due to the underlying softer/looser materials. Following Table I exhibits the recommended depth of the bottom of the footing from the existing ground surface level to achieve maximum net allowable bearing capacity of 1,500 PSF.

Please be advised that as per the local Building Codes, all footings should be carried to a depth of at least 3'-6" below the

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Lab No. CH 4105
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adjoining ground surface, except that a reinforced concrete slab foundation extending over the entire area below a one-story building shall be permitted at a lesser depth below the adjoining ground surface when so designed as to eliminate structural damage from frost action.

TABLE I

Column A -- Soil Boring Number.
Column B -- Recommended Depth of Bottom of the Footing from the Existing Ground Surface @ the Boring Location for Maximum Net Allow. Bearing Capacity of 1,500 PSF (Ft).
Column C -- Type of Soil at the Proposed Footing Elevation.
Column D -- Depth of Topsoil and Organic Materials (Ft).

| A | B | C | D |
|---|---|---|---|
| B-10 | 6.0 | Brown Clayey/Sandy Silt | 0.5 |
| B-11 | 2.0 | Brown Silty Clay | 0.5 |
| B-12 | 6.0 | Brown Clayey Silt | 0.5 |
| B-13 | 4.0 <a> | Brown Silty Clay | 0.5 |
| B-14 | 6.0 | Brown Clayey Silt | 0.4 |
| B-15 | 2.0 <a> | Brown Silty Clay | 1.0 |
| B-16 | 6.0 | Brown Silty Clay | 0.4 |
| B-17 | 6.0 <a> | Brown Silt, Sand & Gravel | 0.5 |
| B-18 | 6.0 <a> | Brown Clayey Silt | 1.5 |
| B-19 | 6.0 | Brown Clayey Silt | 0.7 |
| B-20 | 2.0 | Brown Clayey/Sandy Silt | 0.5 |
| B-21 | 2.0 <a> | Gray Clayey Silt | 1.2 |
| B-22 | 8.0 | Brown Clayey Silt | 2.0 |
| B-23 | N/A -- Deep Foundation System Proposed | | |
| B-24 | 6.0 | Brown Silt, Sand & Gravel | 0.8 |
| B-25 | 6.0 | Brown Sandy/Clayey Silt | 0.3 |
| B-26 | 10.0 | Gray Clayey/Sandy Silt | 3.0 |
| B-27 | N/A -- Deep Foundation System Proposed | | |
| B-28 | 4.0 <a> | Brown Silty Clay | 0.5 |

TABLE I (continued)

| | | | |
|---|---|---|---|
| B-29 | N/A -- Deep Foundation System Proposed | | |
| B-30 | N/A -- Deep Foundation System Proposed | | |
| B-31 | 4.0 | Brown-Gray Silty Clay | 0.9 |
| B-32 | 2.0 | Brown Silty Clay | 1.2 |
| B-33 | N/A -- Deep Foundation System Proposed | | 0.5 |
| B-34 | 4.0 | Brown-Gray Medium-Coarse Sand | 2.1 |
| B-35 | 4.0 | Brown Fine-Coarse Sand | 0.5 |
| B-36 | 6.0 | Brown Sandy Silt | 0.2 |
| B-37 | 6.0 | Brown Sandy Silt | 1.2 |
| B-38 | 4.0 | Brown Silty Clay | 0.5 |
| B-39 | N/A -- Deep Foundation System Proposed | | |
| B-40 | 2.0 | Brown Clayey Silt | 0.5 |
| B-41 | N/A -- Deep Foundation System Proposed | | |
| B-42 | N/A -- Deep Foundation System Proposed | | |
| B-43 | N/A -- Deep Foundation System Proposed | | |
| B-44 | 2.0 | Brown Silty Clay | 0.7 |
| B-45 | N/A -- Deep Foundation System Proposed | | |
| B-46 | N/A -- Deep Foundation System Proposed. | | |
| B-47 | N/A -- Deep Foundation System Proposed | | |
| B-48 | N/A -- Deep Foundation System Proposed | | |
| B-49 | 6.0 | Brown Silty Clay | 0.4 |
| B-50 | 6.0 | Brown Silty Sand | 0.4 |
| B-51 | 6.0 | Brown Sandy/Clayey Silt | 1.0 |
| B-52 | 6.0 | Brown Sandy/Clayey Silt | 1.3 |
| B-53 | 6.0 | Brown Sandy Silt | 1.5 |
| B-54 | 4.0 | Brown Medium Sand | 0.9 |
| B-55 | 6.0 | Brown Silty Sand | 0.5 |
| B-56 | 10.0 | Gray Clayey/Sandy Silt | 0.5 |
| B-57 | N/A -- Deep Foundation System Proposed | | |
| B-58 | 8.0 | Gray Medium Sand | 1.5 |
| B-59 | 4.0 | Brown-Gray Medium-Coarse Sand | 0.4 |
| B-60 | N/A -- Deep Foundation System Proposed | | |
| B-61 | N/A -- Deep Foundation System Proposed | | |
| B-62 | N/A -- Deep Foundation System Proposed | | |
| B-64 | 10.0 | Gray Silty Clay | 1.0 |
| B-65 | 8.0 | Gray Sandy Silt | 1.1 |
| B-66 | N/A -- Deep Foundation System Proposed | | |
| B-67 | 6.0 | Brown Silty Clay | 1.9 |
| B-68 | 6.0 | Brown Clayey Silt | 2.0 |
| B-71 | N/A -- Deep Foundation System Proposed | | |
| B-74 | N/A -- Deep Foundation System Proposed | | |

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<a> -- maximum net allowable bearing capacity can be increased to 3,000 PSF in this area.

Please be advised that acceptable soils of lesser bearing capacity were encountered at shallower depths in some of the borings, but where portions of the foundation of the same structure rest upon soils which vary substantially in bearing capacity, special provisions should be made during the foundation design phase to prevent serious differential settlement that will impair structural safety of the building.

Where the depth to the suitable soil is greater then the usual frost-protection depth, it is recommended to replace the excavated material with approved backfill (such as 3-inch diameter stone, choked with CA-7, CA-3 coarse aggregate or CA-6 Grade 8 stone, as per the State of Illinois Specifications for Road and Bridge Construction) compacted to a minimum of 95% of ASTM Standard D 1557-78 (Modified Proctor Test) density. Footings, proportioned on the basis of a net allowable soil bearing pressure not to exceed 1,500 PSF may be supported at normal frost-protection design level on the properly compacted fill. The width of excavation should extend at least 1 (one) foot beyond the perimeter of the footing for each 1 (one) foot of undercut below the bottom of the footing in order to provide for adequate lateral distribution of the foundation stresses.

Also, please note that extreme care should be exercised when proportioning the spread footings, so that the un-factored loads transferred through the foundation system do not exceed the load-carrying capabilities of the underlying strata. 60 degree and Modified 60 degree approximations can be used when estimating the stress increments due to uniform footing loading over relatively small area (References #2 and #3). Group action of the footings should also be considered, and final overlot grade for the area should provide adequate frost protection for the footings. Settlement of the foundation as designed above will depend upon the bearing pressure, column loads and the actual footing size and the depth at which the foundation is constructed.

As an alternative to the above proposed foundation scheme, if the site area is more than half covered by individual spread footings, mat footing should be considered. This mat footing will then cover the entire site and act as an integral unit. The trade-offs are reduction in formwork vs. increased concrete and reinforcement. Mat footing flexibility should be considered to obtain more economical foundation.

Also, due to the non-uniform and/or loose soils that were encountered in some of the soil borings, partially or fully compensated foundation should be considered, where the structural load is offset by the weight of the excavated soil. If water table level proves to be stationary, raft foundation can also be considered, where buoyant effect of water is used to offset building's structural loads.

Due to potential variations in the site conditions, we recommend that the adequacy of the subgrade soils be reconfirmed in the field by a qualified soil technician from H.H.Holmes Testing Laboratories.

In order to provide for uniform floor slab support, upon removal of all the topsoil and unsuitable organic soil present within the uppermost 2 to 36 inches from the slab area, based upon Table I, Column D, it is recommended to proof-roll this area with a heavy rubber tired construction equipment. The proof-rolling procedure should help to locate weak zones that may be present below stripped grade. The proof-rolling procedure should be observed by an experienced soil engineer in order to aid in locating any unsuitable materials. The areas of unsuitable soils should be removed to the depth encountered or to a maximum depth of 4.0 feet below design sub-grade, and then bring the site to the desired sub-slab grade with an approved inorganic fill, that is free of debris, placed in loose layers of eight (8) inches and compacted to a minimum of 95% of maximum dry density obtained in accordance with ASTM Standard D 1557-78 (Modified Proctor Method) for cohesive soil, or, if granular material is used, 80% relative density in accordance with ASTM Standard D 2049-69. A typical granular fill consists of CA-6 or Grade 8 stone as per the State of Illinois Specifications for Road and Bridge Construction. Degree of compaction achieved should be checked in the field by a qualified soil technician. The area of soil processing should include building limits plus 5.0 feet. Also, final 6 inches of fill beneath all interior slabs-on-grade should be free-draining crushed stone or gravel. This layer will not only facilitate fine grading of the slab subgrade surface, but would also serve as a capillary cutoff layer which would minimize the migration of moisture through the floor slab. Where standing water develops on the floor slab subgrade, softening of the subgrade or other problems resulting in premature floor slab deterioration can also be expected. All floor slabs-on-grade should be reinforced sufficiently with 6"x6", #6/#6 WWF wire mesh (or Fibermesh, if applicable) to maintain the integrity of the slab. Adequate construction, as well as control, joints should also be provided in order to minimize minor slab cracking.

For the design of basement, if any are to be installed, it is recommended that the perimeter and underdrain systems be provided. These systems should consist of perforated porous wall or joint drain tiles located around and outside of the below grade areas, slightly below the floor slab level. These drain lines should be surrounded by a minimum of 6 inches of well-graded granular filter material having a gradation compatible with the size of openings utilized in the drain lines and surrounding soils which are to be retained. As an alternative, basements located in relatively high water table areas (if any exist), can be designed for the use of prefabricated drainage structures (Geotextiles), such as Exxon's "Tiger Drain" or similar product by another manufacturer. In addition, it is recommended that all basement floor slabs be underlain by a free draining granular layer having a minimum thickness of 6 inches. The perimeter drain lines and the underfloor drainage layer should be connected to a permanent sump and automatic and standby pump arrangement, or to a storm sewer, to remove any water which may accumulate within the backfill and beneath the below grade floor slabs.

With regard to basement wall backfill, the utilization of granular backfill material may be beneficial because of the relative ease of placement and compaction. However, if this arrangement is used, it is recommended that the uppermost 2 feet of backfill be comprised of a lesser permeable silty clay soil to minimize surface water infiltration. In any event, the finished grades around the perimeter of the structure should be sloped to promote surface drainage away from the basement areas.

Unless sheeting is used to brace the sides of the excavation for a basement we recommend sloping the sides of the excavation on a minimum of 2 (horizontal) to 1 (vertical) angle, or flatter in accordance with local ordinances or OSHA regulations.

As previously mentioned in this report, Deep Foundation System is to be used in some areas of the project site. The detailed recommendations on these systems are presented in the