CONSULTING ENGINEERS & GEOLOGISTS, INC.
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Reference: 099251

January 11, 2000

Mr. Tom Herman
T. M. Herman and Associates
493 S. Main Street
Willits, CA 95490-3097

**SUBJECT: PERMEABILITY INVESTIGATION FOR THE PROPOSED WASTEWATER PERCOLATION POND**

Dear Mr. Herman:

This letter presents the results of the limited permeability investigation conducted by SHN Consulting Engineers & Geologists, Inc. (SHN). SHN conducted the investigation at the proposed location of the percolation pond for the City of Willits Wastewater Treatment Facility, on behalf of T. M. Herman and Associates.

Previous geotechnical investigations by SHN in the Little Lake Valley area near Willits have indicated that the native soils are generally comprised of fine grained clays and silts that tend to be relatively impermeable. On December 15, 1999, SHN conducted a limited geotechnical investigation of the proposed percolation pond site, accompanied by a representative of T. M. Herman and Associates. The investigation was limited to a site reconnaissance and two hand auger borings. Attachment 1 is the Percolation Pond Site Plan showing the approximate hand auger boring locations.

The proposed percolation pond site is relatively flat pastureland, which had significant areas of standing water, including ponding and sloughs. A channelized watercourse is located near the western boundary of the site. Hand auger borings were advanced to 7.25 feet near the northwest corner of the site (B-1), and 11.0 feet near the southeast corner of the site (B-2). Hand auger borings indicated that native soils are generally comprised of medium stiff to very stiff clay and silt. The two Boring Logs are included as Attachment 2.

Undisturbed soil samples were collected from each boring using a 2-½ inch hand-driven sampler. One sample from each boring was laboratory tested for hydraulic conductivity (permeability) using a triaxial test with back pressure, in accordance with the American Society for Testing and Materials (ASTM) Method D-5084. The average hydraulic conductivity for the B-1 sample (collected at a depth of 6-¼ feet to 7-¼ feet) was $1 \times 10^{-8}$ cm/sec. The average hydraulic conductivity for the B-2 sample (collected at a depth of 5 feet to 5-½ feet) was $9 \times 10^{-9}$ cm/sec. The laboratory results are included as Attachment 3. These results indicate highly impermeable soil conditions for the purpose of wastewater percolation. Hydraulic conductivity is the rate at

which a porous medium transmits water. To put these hydraulic conductivities into perspective, State and Federal regulations require secondary clay containment for municipal solid waste landfill liners and covers to have permeabilities not exceeding 1 X $10^{-6}$ cm/sec. The low permeability is required to both contain landfill leachate and repel surface and groundwater. The numbers indicate that these clay liners may transmit water 100 times faster than the two samples obtained for this investigation. With tight clay soil, as that encountered during our limited investigation, it is highly unlikely that this site will provide effective percolation of the wastewater.

We trust that this report provides the permeability data and level of investigation you require at this time. If you have any questions, please call either of us at 707/441-8855.

Sincerely,

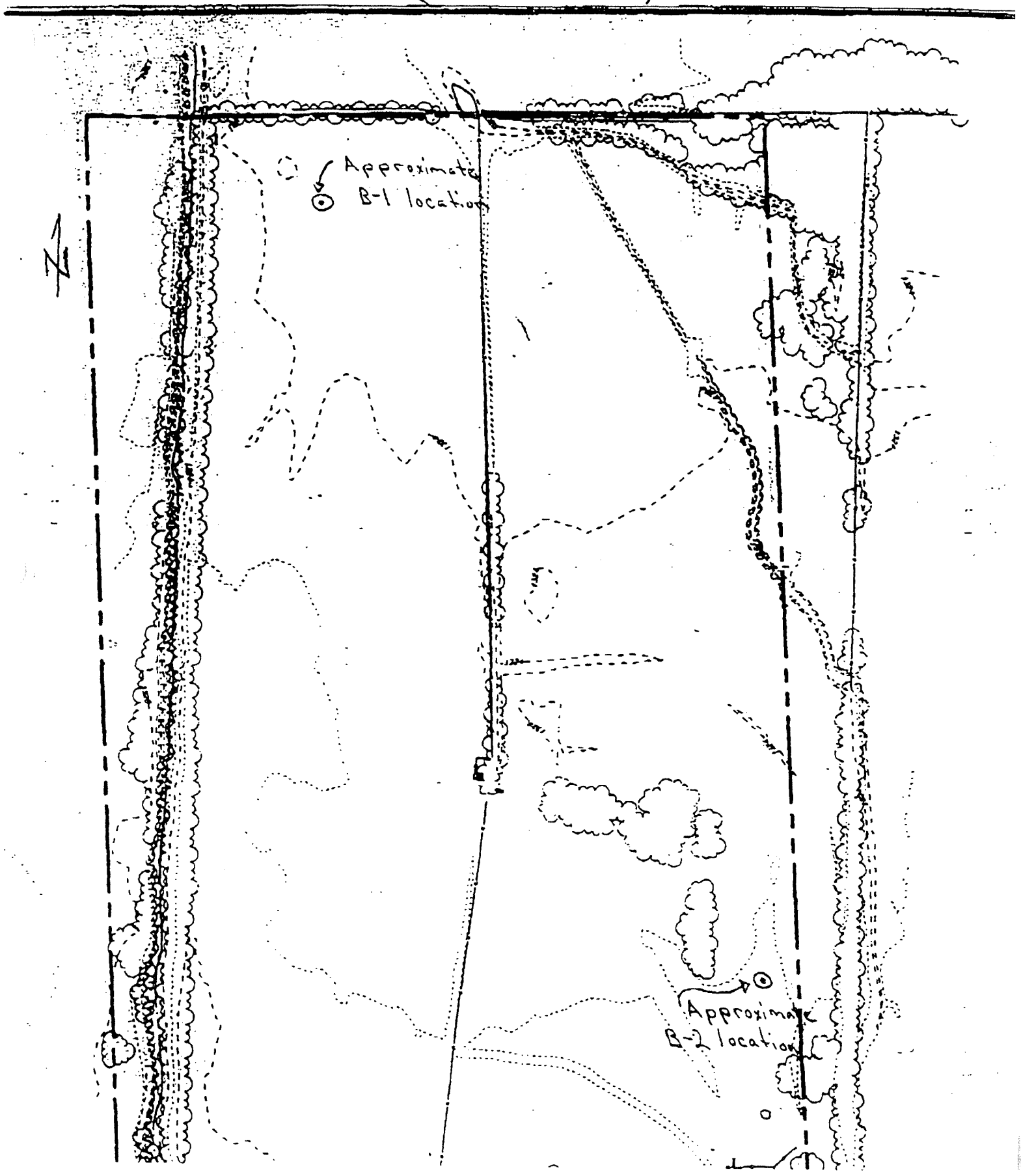
**SHN CONSULTING ENGINEERS & GEOLOGISTS, INC.**

Tom A. Stephens, R.G.
Geosciences Director

Curtis D. Coburn, P.E.
Civil Engineer

TAS/CC:lms
Enclosure
cc w/encl: Robert A. Gearheart, P.E.

# Percolation Pond Site Plan
(1" = 300')



# HOLE NUMBER B-1

PROJECT Willits Wastewater — JOB NUMBER 099251

LOCATION Willits, CA — DATE DRILLED 12/15/99

GROUND SURFACE ELEVATION — SAMPLER TYPE 2.5" I.D. Brass Shelby Tubes, Hand Driven

EXCAVATION METHOD Hand Auger — TOTAL DEPTH OF HOLE 7.25ft.

LOGGED BY CC

| REMARKS | DEPTH (ft.) | SAMPLES | % RECOVERY | GRAPHIC LOG | USCS CLASS | MATERIALS DESCRIPTION | REMARKS |
|---|---|---|---|---|---|---|---|
| | 0 | | | | GM GW | FILL, gravel, sandy, slightly silty, loose, damp to moist, brown, well graded to 1.25" maximum dimension. | Very thin layer of topsoil. |
| | 1 | | | | | | No sample recovery. |
| | | | | | | Becomes wet (saturated). | ▽ 12/15/99 Perched groundwater |
| | 2 | | | | ML MH | SILT, slightly sandy, soft, wet, reddish brown and light brown mottled. | |
| | 3 | | 6 | | | | Sample mostly sluff from upper sand and gravel. |
| | | | | | | Grades to clayey with no fine sand, medium stiff. | |
| | 4 | | 12 | | | | |
| | 5 | | | | CL CH | CLAY, silty, stiff, wet, gray and reddish brown. | |
| | 6 | | 14 | | | | |
| | | | | | | Becomes stiff to very stiff. | |
| | 7 | | 25+ | | | | Hydraulic Conductivity = 1 x 10-8 cm/sec |
| | | | | | | Bottom of boring at 7.25 feet. | |
| | 8 | | | | | | |
| | 9 | | | | | | |
| | 10 | | | | | | |
| | 11 | | | | | | |

# HOLE NUMBER B-2

PROJECT Willits Wastewater
JOB NUMBER 099251
LOCATION Willits, CA
DATE DRILLED 12/15/99
GROUND SURFACE ELEVATION
SAMPLER TYPE 2.5" I.D. Brass Shelby Tubes, Hand Driven
EXCAVATION METHOD Hand Auger
LOGGED BY CC
TOTAL DEPTH OF HOLE 11.0ft.

| REMARKS | DEPTH (ft.) | SAMPLES | % RECOVERY | GRAPHIC LOG | USCS CLASS | MATERIALS DESCRIPTION | REMARKS |
|---|---|---|---|---|---|---|---|
| | 0–2 | | 6 | | SM/ML | SAND, silty, to SILT, sandy, loose/ soft, damp to moist, light brown. Increasing silt content. | |
| | 2–5 | | 8 | | ML/MH | SILT, clayey, medium stiff, damp to moist, light brown and gray. Becomes nearly dry. Becomes stiff, damp. | |
| | 5–9 | | 25+ | | CL/CH | Grades into CLAY, silty to slightly silty, stiff to very stiff, damp to moist, light brown and gray. | Hydraulic Conductivity = 9 x 10-9 cm/sec ▽ 12/15/99 |
| | 9–11 | | 12 | | ML | SILT, sandy, medium dense, moist to wet, gray and light brown with black specks. Occasional well rounded gravel clasts to 1" maximum dimension. | No sample recovery |
| | 11 | | 15 | | | Bottom of boring at 11.0 feet. | |

ATTACHMENT 5



**Hydraulic Conductivity**
**ASTM D 5084**
**Cooper Testing Lab, Inc.**

| | | | | | |
|---|---|---|---|---|---|
| Job No: | 054-109a | Boring: | B-1 | Date: | 01/10/99 |
| Client: | SHN | Sample: | | By: | DC |
| Project: | 099251 | Depth: | 6.75-7.5' | | |
| Soil: | brown sandy CLAY | | | | |

Sample Pressures: Max. Hydraulic
Cell: 42 psi Bot. Cap: 38 psi Top Cap: 36 psi Gradient: 32

| Elapsed Time (min) | Head, (in) | K, cm/sec | *B: = 0.95 |
|---|---|---|---|
| 0 | 79.38 | Start of Test | |
| 734 | 78.83 | 1.3 x 10E-8 | |
| 1064 | 78.58 | 1.3 x 10E-8 | |
| 1471 | 78.28 | 1.2 x 10E-8 | |
| 2179 | 77.73 | 1.4 x 10E-8 | |
| 2537 | 77.48 | 1.3 x 10E-8 | |
| 2904 | 77.18 | 1.3 x 10E-8 | |
| 3617 | 76.78 | 1.4 x 10E-8 | |

Average Permeability: 1 x 10E-8 cm/sec

| Sample Data: | Initial | | Final |
|---|---|---|---|
| Height, in | 2.49 | | 2.48 |
| Diameter, in | 2.38 | | 2.37 |
| Area, in2 | 4.45 | | 4.41 |
| Volume in3 | 11.06 | | 10.96 |
| Total Volume, cc | 181.23 | | 179.57 |
| Volume Solids, cc | 99.75 | | 99.75 |
| Volume Voids, cc | 81.48 | | 79.82 |
| Void Ratio | 0.82 | | 0.80 |
| Porosity, % | 44.96 | | 44.45 |
| Saturation, % | 99.66 | | 99.85 |
| Specific Gravity | 2.80 | Assumed | 2.80 |
| Wet Weight, gm | 360.5 | | 359.0 |
| Dry Weight, gm | 279.3 | | 279.3 |
| Tare, gm | 0.00 | | 0.00 |
| Moisture, % | 29.1 | | 28.5 |
| Dry Density, pcf | 96.2 | | 97.1 |

Remarks: *B=Delta Pore Press/Delta Cell Press (indication of saturation).

## Hydraulic Conductivity
## ASTM D 5084
## Cooper Testing Lab, Inc.

| | | | | | |
|---|---|---|---|---|---|
| Job No: | 054-109 | Boring: | B-2 | Date: | 01/10/99 |
| Client: | SHN | Sample: | | By: | DC |
| Project: | 099251 | Depth: | 5-5.5' | | |
| Soil: | gray CLAY w/sand | | | | |

Sample Pressures: Max. Hydraulic

Cell: 42 psi Bot. Cap: 38 psi Top Cap: 36 psi Gradient: 32

| Elapsed Time (min) | Head, (in) | K, cm/sec | *B: = 0.95 |
|---|---|---|---|
| 0 | 79.38 | Start of Test | |
| 733 | 78.88 | 1.2 x 10E-8 | |
| 1063 | 78.78 | 9.8 x 10E-9 | |
| 1472 | 78.58 | 9.2 x 10E-9 | |
| 2177 | 78.18 | 1.0 x 10E-8 | |
| 2536 | 77.98 | 9.6 x 10E-9 | |
| 0 | 79.38 | | |
| 365 | 79.18 | 9.4 x 10E-9 | |
| 1076 | 78.88 | 8.9 x 10E-9 | |

Average Permeability: 9 x 10E-9 cm/sec

| Sample Data: | Initial | | Final |
|---|---|---|---|
| Height, in | 2.51 | | 2.53 |
| Diameter, in | 2.37 | | 2.37 |
| Area, in2 | 4.41 | | 4.42 |
| Volume in3 | 11.06 | | 11.18 |
| Total Volume, cc | 181.30 | | 183.21 |
| Volume Solids, cc | 107.61 | | 107.61 |
| Volume Voids, cc | 73.69 | | 75.60 |
| Void Ratio | 0.68 | | 0.70 |
| Porosity, % | 40.65 | | 41.26 |
| Saturation, % | 95.53 | | 99.47 |
| Specific Gravity | 2.80 | Assumed | 2.80 |
| Wet Weight, gm | 371.7 | | 376.5 |
| Dry Weight, gm | 301.3 | | 301.3 |
| Tare, gm | 0.00 | | 0.00 |
| Moisture, % | 23.4 | | 25.0 |
| Dry Density, pcf | 103.7 | | 102.6 |

Remarks: *B=Delta Pore Press/Delta Cell Press (indication of saturation).