PINE LAKE COUNTRY CLUB  
DRAINAGE PROJECT  
PRELIMINARY DESIGN REPORT

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November 21, 1999

Work Performed

The preliminary design work performed includes 1) using the soils information collected to determine the appropriate spacing of the lateral drain pipes in both the mineral and organic soils; 2) determining the best layout for the proposed subsurface drainage system; and 3) estimating the cost of construction based upon the preliminary design findings.

Results

The soils at the site are of two basic configurations. Approximately 60% of fairway 5 needing drainage consist of topsoil over poorly graded loamy sand varying from fine to coarse texture (USDA series Granby Loamy Sand). The remaining areas have topsoil over a mucky peat soil containing significant quantities of decomposed woody materials (best described by the Adrian Muck series).

The topography of the fairway 5 area indicates the most efficient layout to provide subsurface drainage of those fairways is to install lateral drain pipes, evenly spaced and running parallel to the length axis of the fairway. Those lateral pipes will remove excess water from the soil profile and deliver it to collector pipes intercepting the lateral pipes and carrying the water to a drainage pump station. The drainage pump station will pump the water from the collector pipes to the existing pond that borders the East end of fairway 5. This recommended layout minimizes the length of collector pipe needed and allows all for the discharge of the subsurface drainage water into waters owned by the club.

Exhibit A shows the recommended layout of the lateral drain pipes and the collector main that delivers the water to a pump station to pump the water into an existing pond.

The organic soil was found to have the ability to move water through it at a rate of 2.6 inches per hour. The mineral soil was found to have the ability to move water through it at a rate of 6.9 inches per hour. Examination of the soil data suggests that the lateral drain pipes placed in the organic soil should be spaced at 35 feet. In the mineral soil, a spacing of 70 feet from lateral to lateral will provide an equivalent degree of drainage. The laterals should be installed at approximately four feet depth. These spacings and depth will provide a capability to drain 2 inches of infiltrated rainfall from the soil profile in 24 hours or less. Please refer to Exhibit E for the calculations that support those results.
A typical cross section of an installed lateral pipe follows.

All of the lateral drain pipes will be four inch diameter perforated corrugated plastic tubing with a knitted cloth filter around their perimeter to prevent movement of soil particles into the pipe. The collector drain pipes will also be corrugated plastic tubing, 6 inches in diameter, and will not be perforated. The drainage pump station will consist of a reinforced concrete sump with a pump and electric motor capable of operating with single-phase 220 volt electric service. A profile of a lateral and the collector pipe for the system is provided as Exhibit B. A schematic of the pump station is provided by Exhibit C.

Until the final design work is underway, an accurate estimate of the cost of the drainage work recommended cannot be developed. However, based upon experience with other golf course drainage projects and the extent of drainage needed at the Pine Lake course, it is expected the overall installation cost of the subsurface drainage work for fairway 5 will be $15,440. The work items and quantities used to arrive at that estimate are provided by Exhibit D.
The next phase of the design process is the final design phase. This phase will consist of the preparation of detailed construction drawings, construction specifications and other contract documents suitable for soliciting construction bids and for installing the system as designed.

Exhibits

Exhibit A: Preliminary Design Layout of the Subsurface Drainage System

Exhibit B: Profile of Typical Lateral and Collector Pipes

Exhibit C: Schematic of Proposed Drainage Pump Station

Exhibit D: Preliminary Design Estimate of Quantities

Exhibit E: Preliminary Design Calculations
Exhibit C: Schematic of Proposed Drainage Pump Station
# EXHIBIT D - Preliminary Design Estimate of Quantities

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item</th>
<th>Quantity</th>
<th>Units</th>
<th>Unit Cost</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mobilization</td>
<td>sum</td>
<td>job</td>
<td>$850</td>
<td>$850</td>
</tr>
<tr>
<td>2</td>
<td>4-inch CPT w/ filter through mineral soil</td>
<td>960</td>
<td>lin. Ft.</td>
<td>$3</td>
<td>$2,544</td>
</tr>
<tr>
<td>3</td>
<td>4-inch CPT w/ filter through organic soil</td>
<td>690</td>
<td>lin. Ft.</td>
<td>$4</td>
<td>$2,519</td>
</tr>
<tr>
<td>4</td>
<td>6-inch Collector Pipe</td>
<td>120</td>
<td>lin. Ft.</td>
<td>$6</td>
<td>$778</td>
</tr>
<tr>
<td>5</td>
<td>Pump Station and Appurtenances</td>
<td>sum</td>
<td>job</td>
<td>$7,500</td>
<td>$7,500</td>
</tr>
<tr>
<td>6</td>
<td>Site Cleanup</td>
<td>sum</td>
<td>job</td>
<td>$1,250</td>
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Total $15,440
Exhibit E – Preliminary Design Calculations

(6 pages)
Design subsurface drainage system for Fairway 5 of Golf Course, Pine Lake.

Soil in Fairway:

Mineral - Granby Loamy Sand
Imp. Barrier > 5’ deep
Sat. Hydr. Conductivity:
6.9 inch/hr
8.1 inch/hr

Organic - Adrian Muck
Imp. Barrier > 5’ deep
Sat. Hydr. Conductivity:
2.6 inch/hr

For lateral spacing analysis use:

- Depth to barrier = 5’
- Depth to subdrain = 4’
- Depth to water table = 1.5’
- Ksat = 6.9 inch/hr mineral soil
- Ksat = 2.6 inch/hr organic soil

\[ a = 5’ - 4’ = 1’ \]
\[ m = 4’ - 1.5’ = 2.5’ \]

Use AT11 subroutine to determine lateral spacing, 5 feet for both mineral & organic soil.

<table>
<thead>
<tr>
<th>Drainage Coeff</th>
<th>1.0</th>
<th>15</th>
<th>2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inch/hr</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>86</td>
<td>53</td>
<td>53</td>
</tr>
<tr>
<td>1.5</td>
<td>70</td>
<td>43</td>
<td>43</td>
</tr>
<tr>
<td>2.0</td>
<td>61</td>
<td>37</td>
<td>37</td>
</tr>
</tbody>
</table>
For Collectors, Install of Grade = 0.17% = 0.0017 ft ft
Use ATV solution to calculate cumulative lateral length for S = 85, 70, 60, 50, 40, 35 ft.
and Beamorf diff q = 1.0, 1.5, 2.0, 10, 15, 20 w/hr.

Results

Mineral Soil

<table>
<thead>
<tr>
<th>q (in/hr)</th>
<th>S (ft)</th>
<th>d=6&quot;</th>
<th>d=8&quot;</th>
<th>d=10&quot;</th>
<th>d=12&quot;</th>
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</thead>
<tbody>
<tr>
<td>1.0</td>
<td>85</td>
<td>1881</td>
<td>4051</td>
<td>6480</td>
<td>10537</td>
</tr>
<tr>
<td>1.5</td>
<td>70</td>
<td>1523</td>
<td>3279</td>
<td>5246</td>
<td>8550</td>
</tr>
<tr>
<td>2.0</td>
<td>60</td>
<td>1332</td>
<td>2869</td>
<td>4590</td>
<td>7167</td>
</tr>
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</table>

Organic Soil

<table>
<thead>
<tr>
<th>q (in/hr)</th>
<th>S (ft)</th>
<th>d=6&quot;</th>
<th>d=8&quot;</th>
<th>d=10&quot;</th>
<th>d=12&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>50</td>
<td>3197</td>
<td>6886</td>
<td>11016</td>
<td>17918</td>
</tr>
<tr>
<td>1.5</td>
<td>40</td>
<td>2664</td>
<td>5738</td>
<td>9180</td>
<td>14928</td>
</tr>
<tr>
<td>2.0</td>
<td>35</td>
<td>2284</td>
<td>4916</td>
<td>7869</td>
<td>12795</td>
</tr>
</tbody>
</table>

Length of Fairway = 475' mineral + 215' organic
Width of Fairway = 80'

for 40' spacing, we need \( \frac{40}{80} = 0 \) laterals
\( = 2 \times 690 = 1380 \) ft

for 70' spacing, we need \( \frac{70}{80} = 0 \) laterals
\( = 2 \times 690 = 1380 \) ft

for 35' spacing, we need \( \frac{35}{80} = 0 \) laterals
\( = 3 \times 690 = 2070 \) ft
Try 3 laterals @ 35’ in organic soil and 2 laterals @ 70’ in mineral soil.

\[ 475 \quad 215 \]

This will provide a drainage coeff. = 1.5 inches/day

from AT&T sub-drain if \( \frac{q}{A} = 1.5 \) ”/day \& \( S = 35’ \)

6” collector is good for 3,045 ft

\[ \frac{3045}{475+215} = 4.4 \text{ in} \]

6” is good for

4 laterals @ 35’ each 690’ in length

In our system we have 3 laterals @ 690’ so we can use

6” diam collector @ 0.17% grade delivering water to the pump station.
Pump Station Analysis

Calculate GPM to be pumped

Area Drained =

\[(215\mathrm{ft}^3)(3\times 35\mathrm{ft}) + (475\mathrm{ft}^3)(2\times 70\mathrm{ft}) = 89,075\, \mathrm{ft}^2\]

Volume to pump =

\[
89,075\, \mathrm{ft}^3 \times 1.5 \, \frac{\text{inches}}{\text{day}} \times \frac{1\, \text{ft}^3}{12\, \text{inches} \times 60\times 60 \times 24 \, \text{sec}}
\]

\[
= 0.0859 \, \text{cfs}
\]

\[
= 0.0859 \left(\frac{\text{ft}^3}{\text{s}} \times \frac{7.48\, \text{g}}{\text{ft}^3} \times \frac{60}{\text{min}}\right) = 39\, \text{gpm}
\]

Pond Elev is @ 930.0

Invert elev of collector @ pump station is

\[
\text{Us. inv. elev of collector} = 0.001 \times \text{length of collector}
\]

let us. inv. of collector be 4'

\[
\text{below ground} = 933.1 - 4.0 = 929.1
\]

length = 90' + 30' = 120' (scaled from topo map)

Invert elev @ pump station =

\[
929.1 - (120 \times 0.001) = 928.9 \Rightarrow \text{sl. elev}
\]

try sump that is 8 ft vertical length

bottom of sump elev = 933.3 - 8.0 = 925.3

pull slop elev 1 ft above bottom of sump = 926.3 \Rightarrow \text{sloped elev}

set max elev in outlet pipe @ 2 ft

above pond elev = 930 + 2 = 932.0
Try 4" PVC outlet pipe. Length = 30' (scaled from topo map)

for PVC C value = 150

for sump sizing use n = 10 cycles/hr
DRAINAGE PUMP STATION EVALUATION

INSTRUCTIONS:

This spreadsheet assumes pump is at the outlet of a subsurface drainage system and the pipe outlet is to an open channel. Enter pump efficiency and motor efficiency. Next enter, in table, the remainder of the information required.

<table>
<thead>
<tr>
<th>PUMP EFFICIENCY (%)</th>
<th>motor efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>85</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>design capacity</th>
<th>inside diameter (in)</th>
<th>total length (ft)</th>
<th>pump stop elev (ft)</th>
<th>max. elev. (ft)</th>
<th>Hazen C value</th>
<th>friction loss (ft)</th>
<th>flow velocity (fps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>gpm</td>
<td>(in)</td>
<td>(ft)</td>
<td>(ft)</td>
<td>(ft)</td>
<td>(ft)</td>
<td>(ft)</td>
<td>(fps)</td>
</tr>
<tr>
<td>-----------------</td>
<td>----------------------</td>
<td>-------------------</td>
<td>---------------------</td>
<td>----------------</td>
<td>---------------</td>
<td>-------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>39</td>
<td>4.00</td>
<td>30</td>
<td>528.3</td>
<td>932.0</td>
<td>150</td>
<td>0.030</td>
<td>1.0</td>
</tr>
</tbody>
</table>

| MAX. DISCHARGE (gpm) | 39                 |
| MAX. ELEV. DIFF. (ft) | 5.7                |
| TOTAL FRICTION LOSS (ft) | 0.0              |
| BHP REQ'D (hp) | 0.1                |
| ELECT. REQ'D (kW/hr) | 0.1                |
| DIESEL FUEL REQ'D (gal/hr) | 0.0              |
| GASOLINE REQ'D (gal/hr) | 0.0               |

SUMP DESIGN:

<table>
<thead>
<tr>
<th>Q (gpm)</th>
<th>n (cycles/hr)</th>
<th>start (ft.)</th>
<th>min. stor. elev (ft.)</th>
<th>sump required min. diam. (cu ft)</th>
<th>inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>38</td>
<td>10</td>
<td>926.3</td>
<td>926.9</td>
<td>7.60</td>
<td>22</td>
</tr>
</tbody>
</table>