## LAKEVIEW WATER COMPANY
## SURROUNDING SNOW BASIN ROAD
## SOUTH OF PINEVIEW RESERVOIR
## WEBER COUNTY, UTAH
## THRUST BLOCK DESIGN AND CALCULATIONS
Project No. 11N223
8-30-2012

### General Site Information:

The proposed waterline for the Lakeview Water Company will extend from the Chalets at Ski Lake #'s 6 and 7 to the south end of the Summit at Ski Lake # 12 in Weber County, Utah. Construction will consist 6, 8, and 10" waterline with a loop around phases 6 and 7 of the Chalets at Ski Lake when completed.

Thrust blocks will be needed as there are several bends required in the design of the waterline extension. A design has been put together for these thrust blocks and is included in this report. Soil bearing pressures used in the design were found in a geotechnical report prepared by Chen and Associates in 1982. A copy of the pertinent pages is attached.

Data showing pipe diameter, bearing area information, resultant force, and dimensions of the thrust blocks are also provided and can be found in the attached calculations.
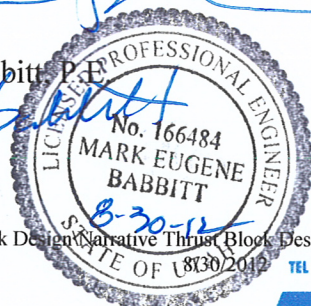
### Calculations:

The unconfined compressive strength of the soil in the area ranges from 2000 psf at the low end to 11000 psf at the high end. To be conservative in the design, the lower value of 2000 psf has been used in the calculations. Calculations are based on a 90° bend. Bearing areas for other bends should be multiplied by the following coefficients: 45° - 0.414, 22.5° - 0.199, 11.25° - 0.098. Calculations are provided for pressure zones near 80 psi, 100 psi, and 120 psi. A safety factor of 1.5 is also accounted for in the resultant force calculations.

Many pipes are 10" in the water system. At a conservative pressure of 120 psi, the thrust block would be required to have an area of approx. 10 square feet. This equates to a height and width of 3.17 feet for the bearing area. See the attached calculations and figures for more details.

Great Basin Engineering, Inc.

Prepared by Ryan Bingham, P.E.

Reviewed by Mark Babbitt, P.E.

No. 166484
MARK EUGENE
BABBITT
8-30-12
8/30/2012

B

A

B/3
MIN.
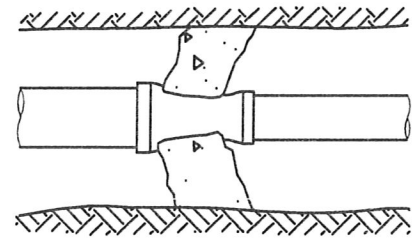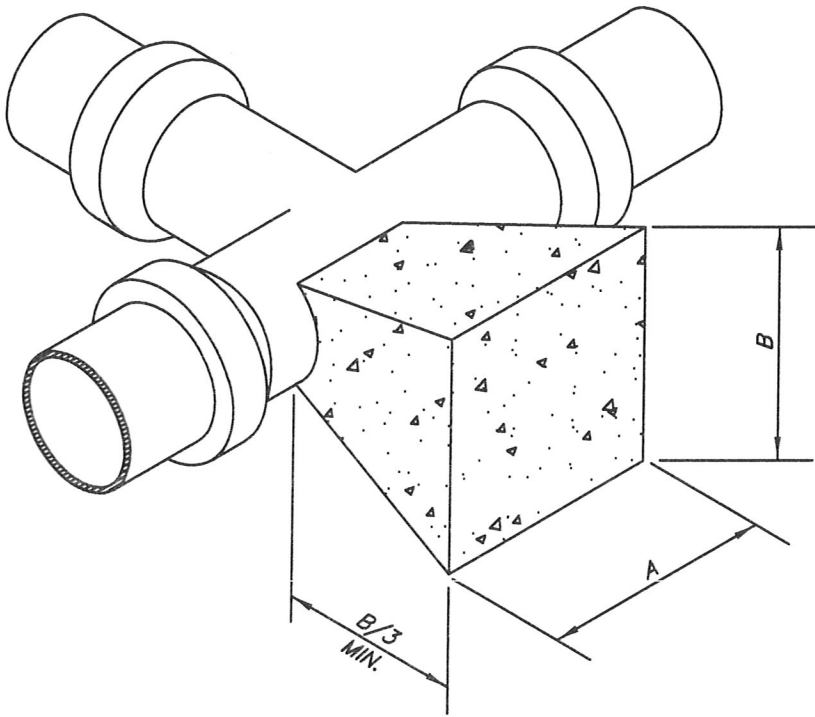
REDUCER

TEE
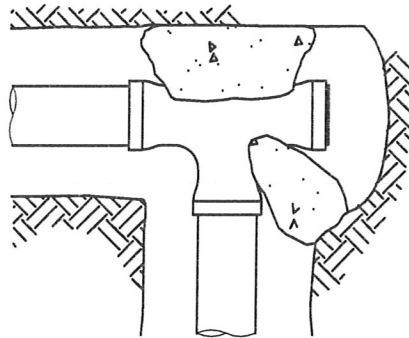
TEE (PLUGGED)
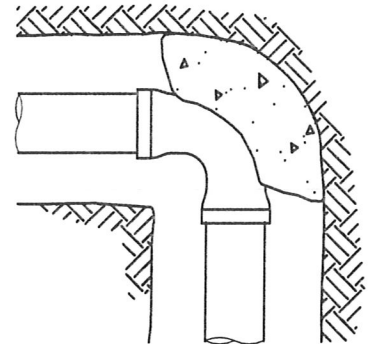
BEND

Thrust Block Calculations

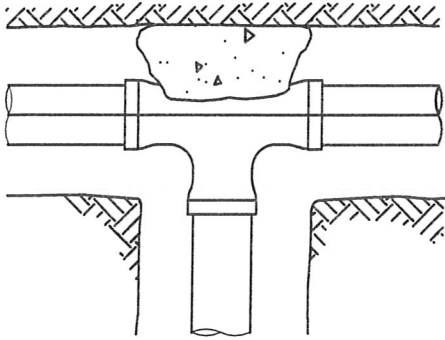Use a soil bearing pressure of 2000 psf as taken from report by Chen and Associates, 1982

Resulting force due to mass flow and flow velocity

$$R_x = \rho\pi\left(\frac{d}{2}\right)^2 v^2 (1 - \cos\beta)$$

$$R_y = \rho\pi\left(\frac{d}{2}\right)^2 v^2 (\sin\beta)$$

Resulting force due to Static Pressure

$$R_{px} = 144 p\pi\left(\frac{d}{2}\right)^2 (1 - \cos\beta)$$

$$R_{py} = 144 p\pi\left(\frac{d}{2}\right)^2 (\sin\beta)$$

Resulting overall force

$$R = \sqrt{\left(R_x + R_{px}\right)^2 + \left(R_y + R_{py}\right)^2}$$

Where...

$\rho =$    1.94    slugs/ft$^3$

p =   pressure   (pdi)

d =   diameter   (ft)

v =    7    (ft/s)   (max speed from water model)

$\beta =$ angle of bend (assume 90°) => Rx=Ry and Rpx=Rpy

$\pi =$ 3.141593

R_ =    force    lbs

## 80 psi pressure zones
p = 80 psi

<div align="right">Dimensions for Thrust Blocking</div>

| Pipe Diam | Pipe Diam | $R_x = R_y$ | $R_{px} = R_{py}$ | R | R (S.F.=1.5) | Bearing block | A | B |
|---|---|---|---|---|---|---|---|---|
| (in) | (ft) | (lb) | (lb) | (lb) | (lb) | Area ($ft^2$) | (ft) | (ft) |
| 6 | 0.5 | 18.7 | 2262 | 3225 | 4838 | 2.42 | 1.56 | 1.56 |
| 8 | 0.67 | 33.2 | 4021 | 5734 | 8601 | 4.30 | 2.07 | 2.07 |
| 10 | 0.83 | 51.8 | 6283 | 8959 | 13439 | 6.72 | 2.59 | 2.59 |

## 100 psi pressure zones
p = 100 psi

<div align="right">Dimensions for Thrust Blocking</div>

| Pipe Diam | Pipe Diam | $R_x = R_y$ | $R_{px} = R_{py}$ | R | R (S.F.=1.5) | Bearing block | A | B |
|---|---|---|---|---|---|---|---|---|
| (in) | (ft) | (lb) | (lb) | (lb) | (lb) | Area ($ft^2$) | (ft) | (ft) |
| 6 | 0.5 | 18.7 | 2827 | 4025 | 6037 | 3.02 | 1.74 | 1.74 |
| 8 | 0.67 | 33.2 | 5027 | 7156 | 10733 | 5.37 | 2.32 | 2.32 |
| 10 | 0.83 | 51.8 | 7854 | 11181 | 16771 | 8.39 | 2.90 | 2.90 |

## 120 psi pressure zones
p = 120 psi

<div align="right">Dimensions for Thrust Blocking</div>

| Pipe Diam | Pipe Diam | $R_x = R_y$ | $R_{px} = R_{py}$ | R | R (S.F.=1.5) | Bearing block | A | B |
|---|---|---|---|---|---|---|---|---|
| (in) | (ft) | (lb) | (lb) | (lb) | (lb) | Area ($ft^2$) | (ft) | (ft) |
| 6 | 0.5 | 18.7 | 3393 | 4825 | 7237 | 3.62 | 1.90 | 1.90 |
| 8 | 0.67 | 33.2 | 6032 | 8577 | 12866 | 6.43 | 2.54 | 2.54 |
| 10 | 0.83 | 51.8 | 9425 | 13402 | 20103 | 10.05 | 3.17 | 3.17 |

# chen and associates, inc.
## CONSULTING ENGINEERS

**SOIL & FOUNDATION ENGINEERING**

401 IRONWOOD DR.   •   SALT LAKE CITY, UTAH 84115   •   801/487-3661

GEOTECHNICAL INVESTIGATION
PROPOSED
TREATMENT CELLS AND STORAGE RESERVOIR
WEBER COUNTY, UTAH

PREPARED FOR:

Horrocks & Corollo Engineers
P.O. Box 377
American Fork, Utah  84003

Job No. 349U

August 19, 1982

5175
5150
5075
5050
5025

5125
5100
5075
5050
5075
5000

Proposal W 10" Waterline W
• T.H.-5
• T.H.-4
• T.H.-3 • T.H.-1
4975
4975
• T.H.-9
• T.H.-8 • T.H.-7 • T.H.-6
• T.H.-2
• T.H.-12
W
• T.H.-13
5100
• T.H.-11
• T.H.-10
5000
5025
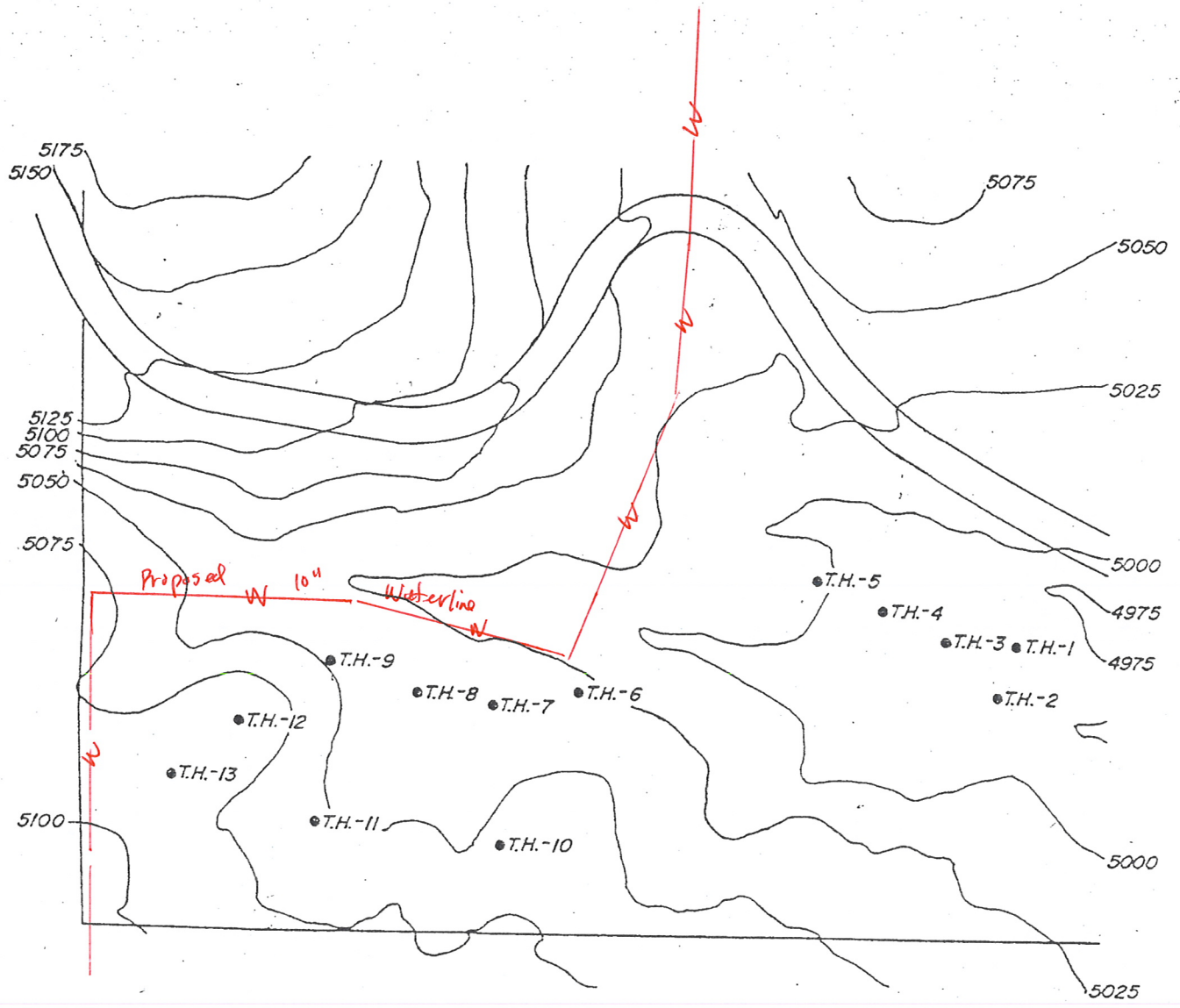
NORTH ▷

Approximate Scale:  1" = 300'

NOTE:    Topography from plans provided
         in June, 1982.

SITE PLAN
AND
LOCATION OF EXPLORATORY TEST HOLES

chen and associates, inc.
CONSULTING   ENGINEERS
401 IRONWOOD DR. · SALT LAKE CITY, UTAH 84115

| Job Number | Date: | |
|---|---|---|
| | | Fig. |

CHEN AND ASSOCIATES

TABLE I

## SUMMARY OF LABORATORY TEST RESULTS

| HOLE | DEPTH (FEET) | NATURAL MOISTURE (%) | NATURAL DRY DENSITY (PCF) | ATTERBERG LIMITS LIQUID LIMIT (%) | ATTERBERG LIMITS PLASTICITY INDEX (%) | UNCONFINED COMPRESSIVE STRENGTH (PSF) | TRIAXIAL SHEAR TESTS DEVIATOR STRESS (PSF) | TRIAXIAL SHEAR TESTS CONFINING PRESSURE (PSF) | PERCENT PASSING NO. 200 SIEVE | SOIL TYPE |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.0 | 25.2 | 96.5 | 53 | 35 | 6400 | | | 88 | Slightly Sandy Clay |
|   | 14.0 | 27.0 | 94.4 | 43 | 26 | | | | 77 | Sandy Clay |
| 2 | 4.0 | 21.5 | 98.0 | 48 | 30 | 11000 | | | 86 | Slightly Sandy Clay |
|   | 9.0 | 23.4 | 95.5 | | | | | | 19 | Silty Sand |
| 3 | 4.0 | 20.9 | 102.4 | 45 | 27 | | | | 80 | Sandy Clay |
| 4 | 4.0 | 11.6 | | 32 | 15 | | | | 18 | Sand and Gravel |
|   | 9.0 | 25.3 | 97.4 | | | | | | 71 | Sandy Clay |
|   | .5-4.0 | | | 46 | 25 | | | | 62 | Very Sandy Clay |
| 5 | 4.0 | 23.1 | 97.3 | 41 | 24 | | | | 76 | Sandy Clay |
|   | 14.0 | 21.6 | 102.4 | 43 | 23 | | | | 81 | Claystone |
| 6 | 4.0 | 10.5 | 98.1 | | | | | | 18 | |
|   | 9.0 | 34.8 | 84.2 | 34 | 12 | | | | 82 | Sandy Clay |
| 7 | 9.0 | 22.3 | 97.3 | 35 | 17 | 6570 | | | 54 | Very Sandy Clay |
|   | 19.0 | 37.1 | 82.6 | 41 | 23 | | | | 73 | Sandy Clay |
| 8 | 4.0 | 21.7 | 97.1 | 42 | 25 | | | | 54 | Very Sandy Clay |
|   | 14.0 | 31.8 | 87.7 | 38 | 19 | 2250 | | | 71 | Sandy Clay |

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SUMMARY OF LABORATORY TEST RESULTS

| HOLE | DEPTH (FEET) | NATURAL MOISTURE (%) | NATURAL DRY DENSITY (PCF) | ATTERBERG LIMITS LIQUID LIMIT (%) | ATTERBERG LIMITS PLASTICITY INDEX (%) | UNCONFINED COMPRESSIVE STRENGTH (PSF) | TRIAXIAL SHEAR TESTS DEVIATOR STRESS (PSF) | TRIAXIAL SHEAR TESTS CONFINING PRESSURE (PSF) | PERCENT PASSING NO. 200 SIEVE | SOIL TYPE |
|---|---|---|---|---|---|---|---|---|---|---|
| 9 | 9.0 | 31.6 | 87.6 | 44 | 26 | 2000 | | | 75 | Sandy Clay |
| 10 | 9.0 | 35.7 | 80.3 | 46 | 24 | | | | 93 | Claystone |
| | 3.0-9.0 | | | 46 | 20 | | | | 94 | Claystone |
| 11 | 4.0 | 25.7 | 93.5 | 53 | 35 | | | | 76 | Sandy Clay |
| | 9.0 | 19.5 | 84.3 | 45 | 24 | | | | 78 | Sandy Clay |
| 12 | 4.0 | 28.4 | 88.3 | 51 | 30 | | | | 89 | Claystone |
| | 9.0 | 9.5 | 88.4 | | NP | | | | 29 | Sandstone |
| 13 | 4.0 | 42.9 | 75.2 | 51 | 23 | | | | 85 | Claystone |
| | 14.0 | 12.0 | 90.1 | | NP | | | | 41 | Sandstone |
| | 4.0-9.0 | | | 39 | 19 | | | | 85 | Claystone |