From:	Jonathan Lovekin <jlovekin@mines.edu>
Sent:	Thursday, December 1, 2022 5:25 PM
To:	Karl Stout; kariparsons@elpasoco.com; Amy Crandall; JustinKilgore@elpasoco.com; Mitchell, Timothy
Cc:	Andrew White
Subject:	RE: [External] Sample Settlement Calculations

Kari,

CTL has provided calculations and the methodology used to determine the settlement potential of the undocumented fill. CGS appreciates the additional information, as this satisfies the request from our review of this application. CGS has no further objection to the approval of the development plan and final plat.

In our opinion, Friday's meeting is no longer needed.

Thank you,

Jonathan R. Lovekin, P.G.
Senior Engineering Geologist
Colorado Geological Survey at the Colorado School of Mines
1801 Moly Road, Golden, CO 80401
303.384.2654

From: Karl Stout <Karl@TheGarrettCo.com>
Sent: Thursday, December 1, 2022 1:33 PM
To: kariparsons@elpasoco.com; Jonathan Lovekin <jlovekin@mines.edu>; Amy Crandall <acrandall@mines.edu>; JustinKilgore@elpasoco.com; Mitchell, Timothy <TMitchell@CTLThompson.com>
Cc: Andrew White <awhite@thegarrettco.com>
Subject: [External] Sample Settlement Calculations

Hello,

In preparation for tomorrow's discussion regarding the Citizen on Constitution Multifamily project, please see CTL-Thompson's summary of their methods utilized to calculate differential settlement, along with supplementary calculations. We are hoping you have a chance to review these items before tomorrow's meeting so we can have a productive discussion. We can upload these responses to the County EDARP portal whenever requested.

Thank you.

Andrew White
Civil Engineering Manager, The Garrett Companies
o: 317.497.8275

RELENTLESSLY PURSUING EXCELLENCE

From: Mitchell, Timothy <TMitchell@CTLThompson.com>
Sent: Wednesday, November 30, 2022 4:57 PM
To: Andrew White <awhite@thegarrettco.com>; Karl Stout <Karl@TheGarrettCo.com>; Eberhart, Gwendolyn <geberhart@ctlthompson.com>
Subject: Sample Settlement Calculations

Please see the attached sample calculations. The method shown, was chosen for the simplicity in showing the calculations. Other methods were also used, as previously noted, to provide context for our judgement in determining appropriate recommendations; however, these are not as simple to show, and I judge this method to be suitable to provide a reasonable assessment of settlements for this project site. Other methods will give different settlement amounts.

These calculations show the "worst case" N value of 8 blows per foot and a high N value of 50 blows per foot. Blow counts are on the logs and the sampler type has been taken into account for the calculations. In practice, the method shown is generally taken as N/4 = Allowable Bearing Capacity (ksf) for up to 1 inch of settlement. I have also shown the second calculation for footing widths greater than 4 feet, although this does not start to show much significance until the footings are larger. Typically, due to simplicity, we do this calculation in our head for sand sites as we count blows in the field, look at the field logs, and as we evaluate the site during the design process. If N/4 is higher than the allowable pressure, then the settlement is calculated as less than 1-inch. I did not show each of the calculations, Gwen and I, have run in our heads.

We apply engineering judgment to the blow counts, because one single blow count does not necessarily reflect the soils through the depth of influence both vertically or horizontally. Additionally, the variations shown in the calculations, from the two scenarios run, reflect differentials over a wide spacing on the site. They also do not indicate how much of the settlement occurs during construction, as loads are applied. The calculations also show a much higher degree of accuracy than is applied to recommendations. **These reasons are why the settlement calculations are used as a basis for judgement and are not typically provided outright. It is highly likely someone will take the values out of context and not consider the overall site, subsurface conditions, and the proposed construction type, because they do not apply the same judgement as the engineer evaluating the site weighing the responsibility of providing the sealed design recommendations.**

As previously stated, the PT Slab design also helps to mitigate differential soil movements. The design adjusts the stiffness based on expected differential movements (which are more than expected due to settlement). This is different methodology than design of separate shallow foundation elements.

As stated, the existing fill does not need to be mitigated due to the calculated settlements. The requested additional investigation is to verify conditions in our boring logs are consistent within the building footprint. This is best done during the construction process when the area is more open and can be better assessed. This same process would be done whether existing fills were identified early in the site evaluation or during construction.

Lastly, in full disclosure, I recalled one time I have been asked for my settlement calculations. It was from another geotechnical consultant, working for us (previous employer) on a related portion of the Virginia State Capital Renovation, back in 2004. This involved a 35-40 foot cut for a below-grade structure with heavy loads, adjacent to the historic capital building. They had tight tolerances due to the building type and age. An interesting, in-depth project for an engineer with only 8 years of experience.

Tim

Timothy A. Mitchell, P.E.
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Licensed States: CO, UT, VA

CTL|THOMPSON
Founded in 1971

SUBJECT: CITIZEN ON CONSTITUTION
SAMPLE SETTLEMENT
CALCULATIONS
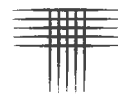
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BY: TAM   PAGE 1 OF 1

MEYERHOF (1965)

S = SETTLEMENT IN INCHES
q = SOIL STRESS IN KIPS/SQUARE FOOT
B = FOOTING WIDTH IN FEET
N = UNCORRECTED BLOW COUNTS

$$S = 4q/N \quad (B \leq 4)$$

$$S = \frac{6q}{N}\left[\frac{B}{(B+1)}\right]^2 \quad (B > 4)$$

q = 2000 PSF ≈ 2 KSF

GENERALLY $q = \frac{N}{4}$ FOR S = 1"

N VARIES FROM ABOUT 8 TO 50 IN THE FILL, PER BORING LOGS IN REPORT.

B = RIB WIDTH + 6 · SLAB THICKNESS   (EDGE)

= 12" + 6 · 4" = 36" = 3'

∴ $S = \frac{4q}{N}$ N = 8 ⟹ $S = \frac{4 \cdot 2}{8} = \frac{8}{8} = \boxed{1''}$

N = 50 ⟹ $S = \frac{4 \cdot 2}{50} = \frac{8}{50} = \boxed{0.16''}$

B = RIB WIDTH + 16 · SLAB THICKNESS (INTERIOR)

= 12" + 16 · 4" = 76" = 6.33' ⟹ USE 6.5'

∴ $S = \frac{6q}{N}\left[\frac{B}{(B+1)}\right]^2$ N = 8 ⟹ $\frac{6 \cdot 2}{8}\left[\frac{6.5}{6.5+1}\right]^2 = \frac{12}{8} \cdot [0.87]^2 = 1.5 \cdot 0.76 = \boxed{1.14''}$

N = 50 ⟹ $\frac{6 \cdot 2}{50}\left[\frac{6.5}{6.5+1}\right]^2 = \frac{12}{50}[0.76] = 0.24 \cdot 0.76 = \boxed{0.18''}$

N=8 REPRESENTS WORST, SINGLE BLOW COUNT.
INCREASING TO 9.12 RESULTS IN ALL SETTLEMENTS ≤ 1".
BASED ON JUDGEMENT OF OVERALL BLOW COUNTS,
SETTLEMENTS ARE LESS THAN 1" TOTAL
AND LESS THAN 0.5" DIFFERENTIAL FOR BUILDING
PURPOSES. ∴ NO MITIGATION IS REQUIRED
DUE TO CALCULATED SETTLEMENTS.
EXPANSIVE SOILS ARE ADDRESSED VIA THE
PT SLAB DESIGN PARAMETERS THAT ACCOUNT
FOR DIFFERENTIAL MOVEMENTS OF
1.44" OVER 4.7' (EDGE LIFT) AND
-0.98" OVER 9.0' (CENTER LIFT), WHICH MEET
OR EXCEED TOTAL, CALCULATED DIFFERENTIAL SETTLEMEN.

SAMPLE CALCULATIONS
ONLY. SEE REPORT
FOR RECOMMENDED DESIGN
VALUES AND RECOMMENDATIONS

COLORADO REGISTERED
TIMOTHY A. MITCHELL
39019
11-30-22
PROFESSIONAL ENGINEER