CALCULATION COVER SHEET

Client: National Grid

Project Name: Hempstead, NY MGP

Project/Calculation Number: 11176098

Title: Frost Depth Estimation

Total Number of Pages (including cover sheet): 5

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Description and Purpose

The following analysis provides an estimate of the frost depth for three scenarios applying to the former MGP site in Hempstead, New York. The estimates were performed using the **ModBerg 99.20** computer program developed by the U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory and based on the Modified Berggren equation of frost penetration. This equation is a well recognized method to estimate frost depths in the region.

Design Basis/References/Assumptions

Input Assumptions

The following assumptions were applied to the model application:

- No snow cover during the winter months (a conservative assumption as snow provides an insulating layer).
- Mineola, New York climatological conditions (provided by program database).
- Asphalt cover is simulated as a 4-inch thick layer with program default properties.
- Grass Cover is simulated as a 4-inch thick, high organic content soil with an assumed 0.3-percent water content (reference "Artic and Subartic Construction Calculation Methods for Determination of Depths of Freezing and Thaw in Soils", TM-5-852-6, Department of the Army and Air Force, page 3-6).
- Site backfill from the 8-foot excavation is simulated as course-grained soil (i.e., moisture, dry density, thermal properties).
- 8-foot excavation depth used to incorporate an as-yet unspecified swell component.
- Default program soil thermal properties are applied.

Description of Scenarios Modeled
The model was run to estimate frost depths for three scenarios applicable to current design issues. They include:

Scenario 1 – Post construction condition including: 4-inch grass cover, 72-inches of course backfill. The N-value, that is the ratio between the air freezing index and surface freezing index, is assumed to be 0.7, indicative of a turf surface (reference TM-5-852-6, Table 2-4).

Scenario 2 – Construction period condition including bare soil (no vegetation), 76-inches of course backfill. The N-value for a bare surface of 0.8 is used (Table 2-4).

Scenario 3 – Paved Parking condition (pre and post construction) including 4 inches of asphalt pavement, 72-inches of course gravel fill. The N-value for an asphalt surface of 0.7 is used (Table 2-4).

Remarks/Conclusions/Results

Scenario 1 – Post construction condition (vegetation). For this scenario the estimated frost depth is 3.6 inches (or 0.3 feet) and is shallower than the depth of the solidified soils.

Scenario 2 – Construction period condition including bare soil (no vegetation). For this scenario the estimated frost depth is 39.2 inches (or 3.3 feet) and is shallower than the solidified soils.

Scenario 3 – Paved parking Areas (pre- and post-construction condition). For this scenario the estimated frost depth is 18.6 inches (or 1.6 feet) and is shallower than the solidified soils.

It is notable that the default thermal properties applied to each of these scenarios, particularly those related to the organic grass layer (K_f and K_u) may not be well matched to site conditions; however, the significance of the potential variability is significantly less than the effects of snow cover on the analysis. The presence of snow would significantly reduce the bare soil and grass cover frost depths.

Calculation Approved By: _____
Project Manager/Date

Revision No.:	Revision Description:	Approved By:
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Project Manager/Date

SCENARIO 1
GRASS WITH ORGANIC SOIL COVER

--- ModBerg Results ---

Project Location: Mineola, New York

Air Design Freezing Index = 367 F-days
N-Factor = 0.70
Surface Design Freezing Index = 257 F-days
Mean Annual Temperature = 53.1 deg F
Design Length of Freezing Season = 71 days

	Layer							
#:Type	t	w%	d	Cf	Cu	Kf	Ku	L
1-Organic	3.6	.3	140.0	24	24	.0	.0	60

t = Layer thickness, in inches.
w% = Moisture content, in percentage of dry density.
d = Dry density, in lbs/cubic ft.
Cf = Heat Capacity of frozen phase, in BTU/(cubic ft degree F).
Cu = Heat Capacity of thawed phase, in BTU/(cubic ft degree F).
Kf = Thermal conductivity in frozen phase, in BTU/(ft hr degree).
Ku = Thermal conductivity in thawed phase, in BTU/(ft hr degree).
L = Latent heat of fusion, in BTU / cubic ft.

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Total Depth of Frost Penetration = .30 ft = 3.6 in.

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SCENARIO 2
COARSE GRAINED SOIL COVER

--- ModBerg Results ---

Project Location: Mineola, New York

Air Design Freezing Index = 367 F-days
N-Factor = 0.80
Surface Design Freezing Index = 294 F-days
Mean Annual Temperature = 53.1 deg F
Design Length of Freezing Season = 71 days

#:Type	Layer t	w%	d	Cf	Cu	Kf	Ku	L
1-Coarse	39.2	20.0	140.0	38	52	6.3	2.7	4,032

t = Layer thickness, in inches.
w% = Moisture content, in percentage of dry density.
d = Dry density, in lbs/cubic ft.
Cf = Heat Capacity of frozen phase, in BTU/(cubic ft degree F).
Cu = Heat Capacity of thawed phase, in BTU/(cubic ft degree F).
Kf = Thermal conductivity in frozen phase, in BTU/(ft hr degree).
Ku = Thermal conductivity in thawed phase, in BTU/(ft hr degree).
L = Latent heat of fusion, in BTU / cubic ft.

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Total Depth of Frost Penetration = 3.27 ft = 39.2 in.
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SCENARIO 3
ASPHALT COVER WITH COARSE GRAINED SOIL UNDERLYING

--- ModBerg Results ---

Project Location: Mineola, New York

Air Design Freezing Index = 367 F-days
N-Factor = 0.70
Surface Design Freezing Index = 257 F-days
Mean Annual Temperature = 53.1 deg F
Design Length of Freezing Season = 71 days

	Layer							
#:Type	t	w%	d	Cf	Cu	Kf	Ku	L
1-Asphalt	4.0	.1	140.0	28	28	.9	.9	0
2-Coarse	14.6	20.0	140.0	38	52	6.3	2.7	4,032

t = Layer thickness, in inches.
w% = Moisture content, in percentage of dry density.
d = Dry density, in lbs/cubic ft.
Cf = Heat Capacity of frozen phase, in BTU/(cubic ft degree F).
Cu = Heat Capacity of thawed phase, in BTU/(cubic ft degree F).
Kf = Thermal conductivity in frozen phase, in BTU/(ft hr degree).
Ku = Thermal conductivity in thawed phase, in BTU/(ft hr degree).
L = Latent heat of fusion, in BTU / cubic ft.

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Total Depth of Frost Penetration = 1.55 ft = 18.6 in.
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