

##### June 6, 2018

Ms. Laurie Pysock Township Manager

East Marlborough Township 721 Unionville Road Kennett Square, PA 19348

RE: **Douglas C. White – “Northridge” (Pavement Analysis Report)**

Preliminary/Final Subdivision Plan Review

East Marlborough Township, Chester County, PA McMahon Project No. 817235.11

Dear Ms. Pysock:

McM AHON ASSOCI ATES, I N C.

840 Springdale Drive

Exton, PA 19341

p 610-594-9995 | f 610-594-9565

PRI NCI PALS

Joseph W. McMahon, P.E. Joseph J. DeSantis, P.E., PTOE

John S. DePalma William T. Steffens Casey A. Moore, P.E.

Gary R. McNaughton, P.E., PTOE

ASSOCI ATES

John J. Mitchell, P.E. Christopher J. Williams, P.E.

R. Trent Ebersole, P.E. Matthew M. Kozsuch, P.E. Maureen Chlebek, P.E., PTOE

Dean A. Carr, P.E.

##### In response to Comment No. 13 in the review letter from Vandemark & Lynch, Inc. dated April 26, 2018, McMahon Associates, Inc. has prepared this Pavement Analysis Report for the proposed residential development to be located along Gale Lane (T-502) in East Marlborough Township, Chester County, Pennsylvania. The noted comment recommends a “heavier pavement section” be utilized along “Road C” (Hunt Cup Drive) since the road will provide access to the existing industrial park.

In order to ensure an adequate, cost effective and structurally reliable pavement section is proposed in conjunction with the Development, a DARWin Pavement Analysis was completed. The analysis was completed by utilizing soil data collected from a USDA Soil Survey, traffic data identified in the *Traffic Impact Study,* prepared by our office and truck delivery information provided by the current industrial park owner. The soil data collected from the USDA Soil Survey, indicated the soil in the project area was generally gravely-sand and therefore a very conservative California Bearing Ratio (CBR) value of 5.0 was used for the analysis.

The attached DARWin pavement analysis demonstrates that the structural number **(4.20)** for the recommended pavement section, is more than adequate to support the future traffic loads. As a result of the analysis, the previously proposed pavement section, which is consistent with East Marlborough’s Subdivision and Land Development Ordinance, is specified for the proposed development.

***Recommended Pavement Section***

The proposed pavement section for **Hunt Cup Drive** is listed below:

##### ID-2 Bituminous Surface Wearing Course, 1.5” Depth

Engi neeri ng | Planni ng | Desi gn | Tech n ol ogy **mcmah on ass ociat es. com**

Ms. Laurie Pysock June 6, 2018

Page 2 of 2

##### ID-2 Bituminous Surface Binder Course, 2” Depth

* Bituminous Concrete Base Course (BCBC), 5” Depth
* Subbase No. 3A, 6” Depth

If you should have any other questions or require additional information, please feel free to contact me at 610- 594-9995, ext. 5130.

Sincerely,



James J. Kouch, P.E.

Senior Project Manager

JJK/jwj Enclosures

cc: Douglas White

James Hatfield, P.E., Vandemark & Lynch, Inc. James Fritsch, P.E., Regester Associates, Inc.

Nicole R. Kline-Elsier, P.E., PTOE, McMahon Associates, Inc.

I:\eng\817235 - Gale Lane Residential\Design\Pavement\Pavement Design Report\2018-06-06 Pavement Design Letter.docx

ATTACHMENTS

### 1993 AASHTO Pavement Desi gn

DARWin Pavement Design and Analysis System

### A Proprietary AASHTOWare Computer Software Product

Flexible Structural Design Module

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**TRANSPORTATION ENGINEERS & PLANNERS**

Description **Fu\\ De "'**

McMahon Project No. **8\l 23'5**

Designed By **j',J J**

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Checked By --'------ Date

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**INSTRUCTIONS:**

###### PennDOT ESAL Calculator

Gale Lane Residential Development - Pavement Section

Input the required information: Current Traffic Count Year; Design Year; Performance Period; Traffic Growth Rate; Oneway/Twoway; and Number of Lanes in Design Direction. Copy the traffic count data from the RMS Traffic screen and paste into the Traffic Count table.

**INPUT:**

Project Identification Designer

|  |
| --- |
| Gale Lane Residential Development |
| JWJ |
| 06/05/2018 |
|  | 2018 |
| 2018 |
| 10 |
| 0.00% |
| 2 |
| 1 |
| 50.00% |

Date

Current Traffic Count Year

Design Year (When construction will be completed and roadway will be opened to traffic.)

Performance Period (This is used for pavement design only. For Superpave mix design, 20 years is always used.)

Traffic Growth Rate

* 1. Oneway or one direction on a divided highway; (2) Twoway Number of Lanes in Design Direction

Percent Trucks in Design Direction

(This is used for twoway counts only, default is 50%. For oneway counts, 100% is always used)

**Color Coding Legend**

|  |  |  |
| --- | --- | --- |
| **Traffic Count (from RMS)** | Current Count | Design Count |
| TOTAL VEHICLES (ADT) | 880 | 880 |
| TOTAL TRUCKS (ADTT) | 20 | 20 |
| MOTORCYCLE | 0 | 0 |
| CAR | 860 | 860 |
| PICKUP/VAN | 0 | 0 |
| BUS | 0 | 0 |
| 2 AXLE-SIX TIRE | 10 | 10 |
| 3 AXLE-SINGLE UNIT | 0 | 0 |
| 4 AXLE-SINGLE-UNIT | 0 | 0 |
| 3 AXLE W/ TRAILER | 0 | 0 |
| 3 AXLE-MULTI AXLE TRAILER | 0 | 0 |
| 6 AXLE-SINGLE TRAILER | 10 | 10 |
| 5 AXLE-MULTIPLE TRAILER | 0 | 0 |
| 6 AXLE-MULTIPLE TRAILER | 0 | 0 |
| 7 AXLE-MULTIPLE TRAILER | 0 | 0 |
| Percent Trucks in Design Direction | 50.00% |

|  |
| --- |
| Required user input |
| Optional user input |
| Constant from Pub 242 |
| Output |

**Percent Trucks in Design Lane Pub 242 Section 7.1.4**

|  |  |
| --- | --- |
| Lanes in one direction | Percent Trucks |
| 1 | 100% |
| 2 | 90% |
| 3 | 80% |
| Based on user input above | 100% |

**Superpave ESAL ranges**

|  |  |
| --- | --- |
| 0 | < 0.3 million ESALs |
| 300,000 | 0.3 to < 3.0 million ESALs |  |
| 3,000,000 | 3.0 to < 10.0 million ESALs |  |
| 10,000,000 | 10.0 to < 30.0 million ESALs |  |
| 30,000,000 | 30.0 million ESALs and greater |

See Pub 408 Appendix D for Superpave Item Numbers

**OUTPUT:**

|  |  |  |
| --- | --- | --- |
| **Flexible ESALs** | **18,138** |  |
| **Rigid ESALs** | **30,413** |
| **Superpave Mix Design ESALs\*** | **36,275** | **< 0.3 million ESALs** |

**CALCULATIONS:**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Vehicle Classification** | **Count** | **Percent** | **Rigid****Truck Factor** | **Rigid****Daily ESALs** | **Rigid****Design ESALs** | **Flexible****Truck Factor** | **Flexible****Daily ESALs** | **Flexible****Design ESALs** | **Superpave****Mix Design****ESALs** |
| MOTORCYCLE | 0 | 0.00% | 0.00 | 0.00 | 0 | 0.00 | 0.00 | 0 | 0 |
| CAR | 860 | 97.73% | 0.00 | 0.00 | 0 | 0.00 | 0.00 | 0 | 0 |
| PICKUP/VAN | 0 | 0.00% | 0.00 | 0.00 | 0 | 0.00 | 0.00 | 0 | 0 |
| BUS | 0 | 0.00% | 0.24 | 0.00 | 0 | 0.24 | 0.00 | 0 | 0 |
| 2 AXLE-SIX TIRE | 10 | 1.14% | 0.24 | 1.20 | 4,397 | 0.24 | 1.20 | 4,397 | 8,794 |
| 3 AXLE-SINGLE UNIT | 0 | 0.00% | 1.15 | 0.00 | 0 | 0.82 | 0.00 | 0 | 0 |
| 4 AXLE-SINGLE-UNIT | 0 | 0.00% | 7.00 | 0.00 | 0 | 4.50 | 0.00 | 0 | 0 |
| 3 AXLE W/ TRAILER | 0 | 0.00% | 0.60 | 0.00 | 0 | 0.44 | 0.00 | 0 | 0 |
| 3 AXLE-MULTI AXLE TRAILER | 0 | 0.00% | 1.59 | 0.00 | 0 | 1.00 | 0.00 | 0 | 0 |
| 6 AXLE-SINGLE TRAILER | 10 | 1.14% | 1.42 | 7.12 | 26,016 | 0.75 | 3.76 | 13,741 | 27,481 |
| 5 AXLE-MULTIPLE TRAILER | 0 | 0.00% | 2.40 | 0.00 | 0 | 2.33 | 0.00 | 0 | 0 |
| 6 AXLE-MULTIPLE TRAILER | 0 | 0.00% | 1.42 | 0.00 | 0 | 1.28 | 0.00 | 0 | 0 |
| 7 AXLE-MULTIPLE TRAILER | 0 | 0.00% | 1.42 | 0.00 | 0 | 1.28 | 0.00 | 0 | 0 |
|  | **880** | **100.01%** |  | **8.33** | **30,413** |  | **4.97** | **18,138** | **36,275** |

Roadway Management Division Revised December 16, 2008

***Appendix D – Design Freezing Index and Frost Heave Worksheet*** Publication 242 2015 Edition

###### FROST HEAVE WORKSHEET

*To determine the Change in Serviceability Loss Due to Frost Heave, PSIFH, you will need 1993 AASHTO Guide for Design of Pavement Structures.*

The effects of Frost Heave must be accounted for in all **full-depth flexible** pavement designs and bituminous over rubblized concrete designs. To do this, follow the given steps below.

***STEP #1:* Determine the Frost Heave Rate, ** (mm/day)**

* + 1. Obtain the soil classification of the future subgrade at the project site.
		2. Using the soil classification, determine the Average Rate of Heave from Table 9.1 or 9.2.

(Soil Classification: **GM** )

FROST HEAVE RATE: **4** mm/day

###### *STEP #2:* Select the Frost Heave Probability, PF

1. Estimate the percent area of the project that is subject to frost heave. Consider the extent of frost-susceptible subgrade material, moisture availability, drainage quality, number of freeze- thaw cycles per year, depth of frost penetration, and past experience. (Recommended Range: 25% - 75%)

FROST HEAVE PROBABILITY:

**50** %

###### *STEP #3:* Determine the Maximum Potential Serviceability Loss, PSIMAX

1. Use Appendix D to find the Design Freezing Index for the project site.

Design Freezing Index

**592**

1. Use Figure 9.1 to determine the Frost Penetration from the design freezing index.

Frost Penetration

**34.6**

inches =

**2.88**

feet

1. Use Figure G.7 (pg. G-10) of the 1993 AASHTO Guide to determine the Max. Serviceability Loss Due to Frost Heave. Use a Drainage Quality of FAIR.

MAXIMUM POTENTIAL SERVICEABILITY LOSS:

**0.50**

###### *STEP #4:* Determine the Change in Serviceability Loss Due to Frost Heave, PSIFH

* + 1. Use the results obtained in the first three steps to navigate through Figure G.8 (pg. G-11) of the 1993 AASHTO Guide.

###### CHANGE IN SERVICEABILITY LOSS DUE TO FROST HEAVE:

**0.24**

Once the Change in Serviceability Loss due to Frost Heave is determined (Step #4), add it to the

appropriate Terminal Serviceability Index listed in Table 6.4. Use the result as the terminal serviceability input required in DARWin for full-depth flexible pavement designs.

D - 6

***Chapter 9 – Full-Depth Flexible Pavement Design*** Publication 242 2015 Edition

**TABLE 9.1**

**ESTIMATED AVERAGE RATE OF HEAVE (UNIFIED SOILS CLASSIFICATION SYSTEM)**

|  |  |
| --- | --- |
| **CLASSIFICATION OF SUBGRADE SOIL**\* | **ESTIMATED AVERAGE RATE OF HEAVE****(mm/day)** |
| GW | 2 |
| GP | 3 |
|  GM |  4 |
| GC | 4 |
| GW – GM | 4 |
| GW – GC | 3 |
| GP – GM | 4 |
| GP – GC | 4 |
| GM – GC | 5 |
| SW | 3 |
| SP | 1 |
| SM | 7 |
| SC | 5 |
| SW – SM | 7 |
| SW – SC | 4 |
| SP – SM | 7 |
| SP – SC | 3 |
| SM – SC | 5 |
| ML | 15 - 20 |
| CL | 8 |
| OL | \*\* |
| MH | \*\* |
| CH | 1 |
| OH | \*\* |
| ML – OL | \*\* 15 -20 |

\*For MFC A and MFC B pavement designs, this chart is to be used with laboratory classification of subgrade soils. For MFC C, MFC D, and MFC E pavement designs, laboratory classifications are not required (i.e., field classifications are acceptable).

\*\*OL, MH, and OH soils do not meet minimum specifications for subgrade material. ML-OL are marginal and may or may not meet minimum specifications for subgrade.

9 - 3

***Chapter 9 – Full-Depth Flexible Pavement Design*** Publication 242 2015 Edition

## FIGURE 9.1

**DESIGN CHART FOR DETERMINATION OF FROST PENETRATION**

 **34.6" = 2.88'**

###### NUMBER OF CONSTRUCTION STAGES

Staged construction is not to be considered. Therefore, the Number of Construction Stages shall always be set to one.

###### DESIGN STRUCTURAL NUMBER

Once the variables necessary for full-depth flexible design are entered, calculate the design structural number by clicking the "Calculate Button".

The resulting Design Structural Number depicts the required strength the proposed pavement will need to provide. This structural number must be converted to individual layer thicknesses of the pavement through the following equation.

SN = a1d1 + a2d2m2 + a3d3m3 + ...andnmn

|  |  |  |
| --- | --- | --- |
| where: SN | = | Structural Number |
| ai | = | Structural Coefficient for layer I |
| di | = | Thickness of layer I |
| mi | = | Drainage Coefficient for layer I |
|  |  | 9 - 5 |

***Appendix D – Design Freezing Index and Frost Heave Worksheet*** Publication 242 2015 Edition

|  |
| --- |
| **DISTRICT 5** |
| **Location** | **Elevation** | **Index** | **Winter** |
| Berks County |
| Reading WB | 266 | 436 | 62-63 |
| Morgantown | 595 | 664 | 62-63 |
| Carbon County |
| Palmerton | 435 | 749\* | 62-63 |
| Lehigh County |
| Allentown WB | 376 | 752 | 62-63 |
| Allentown Gas | 254 | 621 | 62-63 |
| Monroe County |
| Mt. Pocono 2 mi. N | 1915 | 1194 | 62-63 |
| Stroudsburg | 480 | 987 | 62-63 |
| Tobyhanna | 1950 | 1216 | 62-63 |
| Schuylkill County |
| Port Clinton | 450 | 971\* | 62-63 |
| Northhampton County |
| Bethlehem (Lehigh U) | 411 | 752 | 62-63 |

|  |
| --- |
| **DISTRICT 6** |
| **Location** | **Elevation** | **Index** | **Winter** |
| Bucks County |
| George School | 135 | 685\* | 60-61 |
| Quakertown | 490 | 669\* | 60-61 |
| Chester County |
| Coatesville 1 mi. SW | 342 |  |  592\* | 60-61 |
| Devault 1 mi. W | 360 |  | 629 |  | 60-61 |
| Phoenixville | 105 | 473 | 60-61 |
| Delaware County |
| Marcus Hook | 12 | 228 | 60-61 |
| Montgomery County |
| Graterford 1 mi. E | 240 | 718 | 60-61 |
| Norristown | 75 | 355 | 62-63 |
| Philadelphia County |
| Phila. Airport WB | 7 | 506 | 60-61 |
| Drexel University | 30 | 309 | 62-63 |
| Pt. Breeze | 32 | 184 | 62-63 |

D - 3

*Appendix G*

swelling probability, there is no clear-cut method for approximating frost heave probability

Once values for the three frost heave factors are defined, the equation for serviceability Joss (presented in Figure G 8) should be used to generate a frost heave serviceability Joss curve similar to that presented in Figure 2 2 (Part II) The time, t, used with Figure G 8 should be equal to the analysis period For stage con-

*G-11*

struction and rehabilitation strategies, the perform­ ance period is used The frost heave serviceability loss curve should then be combined with the swelling serv­ iceability loss curve (if applicable) to produce a total **serviceaqility loss versus time curve This curve will** then be used as a component of the design procedure discussed in Chapter 3, Part II

###### Frost Heove Rote, */6* ( mm/day)

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##### Figure G.8. Chart for Estimating Serviceability Loss Due to Frost Heave

*G-10* ***Design of Pavement Structures***

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**Drainage Quality**

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Depth of Frost Penetration (feeti

###### Figure G,7. Graph for Estimating Maximum Serviceability Loss Due to Frost Heave

SERVICEABILITY LOSS DUE TO FROST HEAVE

|  |  |
| --- | --- |
| Project: |  Gale Lane Residential  |
| Designer: |  Jamie Kouch, P.E.  |
| Date: |  06/04/2018  |

|  |  |  |  |
| --- | --- | --- | --- |
| t | 10 | Years | Time |
|  | 4 | mm/day | Frost Heave Rate, Table 9.1 or 9.2 (pg. 9-5 or 9-6) Publication 242 |
| PF | 50 | % | Frost Heave Rate Probability (Recommended Range 25% - 75%) |
| Design Freezing Index | 592 |  | Use Appendix D of Publication 242 to find Design Freezing Index |
| Depth of Frost Penetration | 2.88 | feet | Reference Figure 9.1 (pg. 9-7) of Publication 242. |
| PSIMAX | 0.87 |  | Reference: Figure G.7 (pg G-10 AASHTO 1993 Design of Pavement Structures) |
|  | 34.6 | in | **Note: This is only for Drainage Quality of Fair.** |

Reference: Figure G.8 (pg G-11 AASHTO 1993 Design of Pavement Structures)

|  |  |
| --- | --- |
| PSIFH | 0.24 |