To: Joseph E. Crowe       Attn: District Four
From: Scott E. Stitt
Subject: Pavement Design
Date: November 16, 2011

FAP Route 1380 (US Route 24)
Section 16w-1, RS-3
Fulton County
Through Astoria

We have reviewed the pavement selection for the above captioned section, which was submitted by email dated October 13, 2011. Life cycle costs favor the rigid option over the HMA design.

The approved pavement design is as follows:

**US Route 24 through Astoria**

8.75 inches of rigid pavement with tied shoulders
6 inches of subbase granular material, type A
Geotextile fabric

If you have any questions, please contact Paul Niedernhofer at (217) 524-1651.
GENERAL LOCATION MAP

FAP 317 (US 24)
Sections: 16W-1, RS-3
Fulton County
Contract No. 88795

Begin Project
STA 871+50.00

End Construction
STA 24+30.00
RECOMMENDATIONS

The proposed improvement consists of the reconstruction of 21,350 square yards of pavement on US 24 through Astoria. The pavement will be selected based on the percent difference from the Life Cycle Cost Analysis. The results of the Life Cycle Cost Analysis show the present cost per mile per year as $52,632 for the Jointed Plain Concrete Pavement and $60,042 for the Full-Depth HMA Pavement. The percent difference between the two is greater than ten percent. Therefore, the recommendation is for 8 ¾" Jointed PCC pavement tied to type B-6.24 curb and gutter with 6" of subbase granular material, type A on top of geotechnical fabric. It should also be noted that due to the stage construction that will be required, the use of HMA pavement would not be a viable option.
Pavement Design

Route: FAP317 (US Rte. 24)
Section: 16w-1, RS-3
County: Fulton
Catalog No. 0300101-06D
Job No. D-94-085-96

DESIGN DATA:
- Class II Truck Route
- Design Period = 20 years
- Design Year = 2023
- Traffic Growth factor is 1% Annually
- Other Principal Arterial
- 6,405 Feet of New Pavement – 21,350 sf

\[
(1.01)^{14} = 1.1495
\]

<table>
<thead>
<tr>
<th>2009 TRAFFIC</th>
<th>2013 TRAFFIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADT = 4,400</td>
<td>ADT = 5,058 ✓</td>
</tr>
<tr>
<td>PV = 3,999</td>
<td>PV = 4,597 ✓</td>
</tr>
<tr>
<td>SU = 251</td>
<td>SU = 288 ✓</td>
</tr>
<tr>
<td>MU = 150</td>
<td>MU = 172 ✓</td>
</tr>
</tbody>
</table>

The project involves the construction of new pavement on 6,405 Feet, the following analyses are required.
• Mechanistic Design:
• Rigid
• Full-Depth HMA

MECHANISTIC DESIGN: (Rigid)

A. Given:

• 6,405 Feet of New Pavement
• Sub-grade Support Rating (SSR) = poor
• Edge Support Tied

From figure 54-2.B (DESIGN LANE DISTRIBUTION FACTOR FOR STRUCTURAL DESIGN TRAFFIC) of Chapter 54 of the BDE manual the following information is obtain:

<table>
<thead>
<tr>
<th>Number of Facility Lanes</th>
<th>Percent of Total Vehicular Class Volume (ADT) in Design Lane</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rural</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PV</td>
<td>SU</td>
<td>MU</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 or 3*</td>
<td>50%</td>
<td>50%</td>
<td>50%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>30%</td>
<td>45%</td>
<td>45%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥ 6</td>
<td>20%</td>
<td>40%</td>
<td>40%</td>
<td>8%</td>
<td>37%</td>
</tr>
</tbody>
</table>

* One-way roads and streets.

DESIGN LANE DISTRIBUTION FACTORS FOR STRUCTURAL DESIGN TRAFFIC

Figure 54-2.B

B. Solutions:
1. Traffic Factor

<table>
<thead>
<tr>
<th>Class</th>
<th>TF = DP [ \frac{(0.15 \times P \times PV) + (143.81 \times S \times SU) + (696.42 \times M \times MU)}{1 \times 10^6} ]</th>
<th>Equation 54-4.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class II</td>
<td>TF = DP [ \frac{(0.15 \times P \times PV) + (135.78 \times S \times SU) + (587.21 \times M \times MU)}{1 \times 10^6} ]</td>
<td>Equation 54-4.2</td>
</tr>
</tbody>
</table>
### Mechanistic Design

<table>
<thead>
<tr>
<th>Design Period</th>
<th>%PV</th>
<th>%SU</th>
<th>%MU</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>90.30%</td>
<td>47.04%</td>
<td>34.69%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Data Year/ADT</th>
<th>2009-2013</th>
<th>4,410</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Year</td>
<td>2013</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4,597</td>
<td>288</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Facility Type</th>
<th>PV</th>
<th>SU</th>
<th>MU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interstate or Supl Freeway</td>
<td>0</td>
<td>500</td>
<td>1,500</td>
</tr>
<tr>
<td>Other Marked State Route</td>
<td>0</td>
<td>250</td>
<td>750</td>
</tr>
<tr>
<td>Unmarked State Route</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Flexible Design

<table>
<thead>
<tr>
<th>Class I (4 Lanes or More)</th>
<th>CPV</th>
<th>CSU</th>
<th>CMU</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.15</td>
<td>143.81</td>
<td>696.42</td>
</tr>
<tr>
<td>Class II (2 or 3 Lanes with)</td>
<td>0.15</td>
<td>132.50</td>
<td>482.53</td>
</tr>
<tr>
<td>Class III (2 or 3 Lanes with)</td>
<td>0.15</td>
<td>109.14</td>
<td>384.35</td>
</tr>
<tr>
<td>Class VI (2 or 3 Lanes with)</td>
<td>0.15</td>
<td>9.86</td>
<td>78.84</td>
</tr>
</tbody>
</table>

### Number of Lanes

<table>
<thead>
<tr>
<th>P</th>
<th>S</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>0.32</td>
<td>0.45</td>
<td>0.45</td>
</tr>
<tr>
<td>0.20</td>
<td>0.40</td>
<td>0.40</td>
</tr>
</tbody>
</table>

### TABELE

**TF (actual) =**

\[
10,000,000 \times (0.15 \times 0.50 \times 4.597) + (135.78 \times 0.50 \times 288) + (567.21 \times 0.50 \times 172) = 1.37
\]

**TF (Min) =**

\[
10,000,000 \times (0.15 \times 0.50 \times 0) + (135.78 \times 0.50 \times 250) + (567.21 \times 0.50 \times 750) = 4.59
\]

**TF (actual) =**

\[
10,000,000 \times (0.15 \times 0.50 \times 4.597) + (112.06 \times 0.50 \times 288) + (385.44 \times 0.50 \times 172) = 0.99
\]

**TF (Min) =**

\[
10,000,000 \times (0.15 \times 0.50 \times 0) + (112.06 \times 0.50 \times 250) + (385.44 \times 0.50 \times 750) = 3.17
\]
- Using equation 54-4.2 of the BDE manual for a Class II facility

\[ TF_{R(\text{actual})} = 1.37 \]
\[ TF_{F(\text{min})} = 4.59 \text{ (Controls)} \]

From figure 54-4 E PCC Thickness

- Using a poor SSR grade and a traffic factor of 4.59 The PCC pavement thickness is 8.75 "

\[ \text{Thickness (inches)} \]
\[ \text{Rigid Pavement Traffic Factor} \]

\[ 0 \quad 1 \quad 2 \quad 3 \quad 4 \quad 5 \quad 6 \quad 7 \quad 8 \quad 9 \quad 10 \]
MECHANISTIC DESIGN: (Full Depth HMA)

A. Given:
   - 6,405 Feet of New Pavement
   - Sub grade Support Rating (SSR) = poor
   - Asphalt Binder Type = PG 64-22

B. Solutions:
   1. Traffic Factor

\[
TF = DP \left[ \frac{(0.15 \cdot P \cdot PV) \cdot (112.06 \cdot S \cdot SU) + (385.44 \cdot M \cdot MU)}{1 \times 10^6} \right] \]

   - Using equation 54-5.2 of the BDE manual for a Class II facility
     \(TF_{(actual)} = 0.99\)
     \(TF_{(min)} = 3.17\) (Controls)
2. AC Mix Temperature
   - From figure 54-5.C of the BDE manual, use temperature = 76.8°F

Note: The minimum design HMA mixture temperature will be 73°F.
3. Design $E_{HMA}$
   - From figure 54-5.D of the BDE manual, $E_{HMA} = 640$ ksi
4. Design HMA strain:
   - From figure 54-5.E of the BDE manual, HMA Strain = 86
5. Thickness
   a. For Flexible design:
      - From figure 54-5.F of the BDE Manual
        - Thickness = 10.25 inches
RESULTS:

A) Mechanistic Design (Rigid)
- 8.75" PCC Pavement (21,350 SQ YDS)
- 6" Sub-base granular material Type A (7,295 Tons) with geotechnical fabric

B) Méchanistic Design Full Depth HMA
- 10.25" Full Depth Bituminous using PG 64-22 (17,080 SQ YDS)
- HMA Shoulders 10.25" (2,451 Tons)
- 6" Sub-base granular material Type A (7,295 Tons) with geotechnical fabric
## Maintenance and Rehabilitation Activity Schedule

### Jointed Plain Concrete Pavement

### And Unbonded Jointed Plain Concrete Overlays

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Price Const.</th>
<th>Free Const.</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Stabilized Sub-Base 4&quot;</td>
<td>0</td>
<td>SQ YD</td>
<td>$30,002</td>
<td>$946,648</td>
</tr>
<tr>
<td>* Concrete Shoulders 8.75&quot;</td>
<td>0</td>
<td>SQ YD</td>
<td>$30,002</td>
<td>$0</td>
</tr>
<tr>
<td>* Sub-Base Gravel Material A (6&quot;)</td>
<td>7,886</td>
<td>TON</td>
<td>$146,628</td>
<td></td>
</tr>
<tr>
<td>Longitudinal Joint Routing and Sealing</td>
<td>20,800</td>
<td>LIN FT</td>
<td>$2,560</td>
<td>$93,240</td>
</tr>
<tr>
<td>Geosynthetic Fabric</td>
<td>21,380</td>
<td>SQ YD</td>
<td>$172,218</td>
<td>$32,023</td>
</tr>
<tr>
<td>Lime 4% (120 LB/1000 FT OF SOIL)</td>
<td>800,481</td>
<td>TON</td>
<td>$30,002</td>
<td>$0</td>
</tr>
</tbody>
</table>

**Present Construction Costs Over the Period of 40 Years**

$1,178,281 $571,975

### Activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Year</th>
<th>PWPx</th>
<th>Unit</th>
<th>Unit Price</th>
<th>Price Const.</th>
<th>Free Const.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class B Pavement Patching</td>
<td>0.10%</td>
<td>PWP10</td>
<td>21</td>
<td>SQ YD</td>
<td>$373</td>
<td>$5,736</td>
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<tr>
<td>Class B Pavement Patching</td>
<td>0.20%</td>
<td>PWP15</td>
<td>43</td>
<td>SQ YD</td>
<td>$175</td>
<td>$7,473</td>
</tr>
<tr>
<td>Class B Pavement Patching</td>
<td>2.00%</td>
<td>PWP20</td>
<td>477</td>
<td>SQ YD</td>
<td>$175</td>
<td>$24,725</td>
</tr>
<tr>
<td>Class C Shoulders Patching</td>
<td>0.50%</td>
<td>PWP25</td>
<td>0</td>
<td>SQ YD</td>
<td>$100</td>
<td>$0</td>
</tr>
<tr>
<td>Longitudinal ECP Joint Routing and Sealing</td>
<td>100%</td>
<td>PWP30</td>
<td>12,810</td>
<td>LIN FT</td>
<td>$2</td>
<td>$25,620</td>
</tr>
<tr>
<td>Class C Shoulders Patching</td>
<td>1.00%</td>
<td>PWP35</td>
<td>0</td>
<td>SQ YD</td>
<td>$100</td>
<td>$0</td>
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<tr>
<td>Class C Pavement Patching</td>
<td>4.00%</td>
<td>PWP40</td>
<td>854</td>
<td>SQ YD</td>
<td>$175</td>
<td>$149,459</td>
</tr>
<tr>
<td>Class C Pavement Patching</td>
<td>1.50%</td>
<td>PWP45</td>
<td>0</td>
<td>SQ YD</td>
<td>$100</td>
<td>$0</td>
</tr>
<tr>
<td>HMA Overlay of Pavement</td>
<td>2.25%</td>
<td>PWP50</td>
<td>2,690</td>
<td>TON</td>
<td>$85</td>
<td>$228,659</td>
</tr>
<tr>
<td>HMA Overlay of Shoulders</td>
<td>1.50%</td>
<td>PWP55</td>
<td>0</td>
<td>TON</td>
<td>$85</td>
<td>$0</td>
</tr>
<tr>
<td>Longitudinal ECP Joint Routing and Sealing</td>
<td>100%</td>
<td>PWP60</td>
<td>12,810</td>
<td>LIN FT</td>
<td>$2</td>
<td>$25,620</td>
</tr>
<tr>
<td>Random Crack Route &amp; Seal</td>
<td>5%</td>
<td>PWP65</td>
<td>6,405</td>
<td>LIN FT</td>
<td>$2</td>
<td>$12,810</td>
</tr>
<tr>
<td>Reflect Transverse Crack Route &amp; Seal</td>
<td>40%</td>
<td>PWP70</td>
<td>5,124</td>
<td>LIN FT</td>
<td>$2</td>
<td>$10,248</td>
</tr>
<tr>
<td>Partial Depth Pavement Patching</td>
<td>0.10%</td>
<td>PWP75</td>
<td>21</td>
<td>SQ YD</td>
<td>$35</td>
<td>$740</td>
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<tr>
<td>Class B Pavement Patching</td>
<td>0.50%</td>
<td>PWP80</td>
<td>107</td>
<td>SQ YD</td>
<td>$175</td>
<td>$18,681</td>
</tr>
<tr>
<td>Longitudinal ECP Joint Routing and Sealing</td>
<td>100%</td>
<td>PWP85</td>
<td>12,810</td>
<td>LIN FT</td>
<td>$2</td>
<td>$25,620</td>
</tr>
<tr>
<td>Random Crack Route &amp; Seal</td>
<td>50%</td>
<td>PWP90</td>
<td>7,886</td>
<td>LIN FT</td>
<td>$2</td>
<td>$15,372</td>
</tr>
<tr>
<td>Random Crack Route &amp; Seal</td>
<td>50%</td>
<td>PWP95</td>
<td>6,405</td>
<td>LIN FT</td>
<td>$2</td>
<td>$12,810</td>
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<tr>
<td>Partial Depth Pavement Patching</td>
<td>0.50%</td>
<td>PWP100</td>
<td>107</td>
<td>SQ YD</td>
<td>$15</td>
<td>$1,841</td>
</tr>
</tbody>
</table>

**Present Rehab Cost Per Mile For the Period of 40 Years**

$243,635

**Total Present Cost Per Mile For the Period of 40 Years**

$1,215,510

**Present Cost Per Mile Per Year**

$62,832
### Full-Depth HMA Pavement

- **Polymerized HMA Surface Course Mix "D" N50**: 1,913 TON, $171,841
- **Polymerized H M A Binder Course IL-12.5, N50**: 1,192 TON, $90,605
- **H M A Binder Course IL-19.0, N50 0"**: 5,798 TON, $405,709
- **HMA SHOULDERS 10.25"**: 2,451 TON, $190,624
- **SLD-BASE GRAN MANTEL TYPE A 6"**: 7,265 TON, $405,709
- **Geotechnical Fabrics**: 22,650 SQ YD, $2,020
- **Geotechnical Fabrics**: 884,577 TON, $1,000

**Present Construction Costs Over the Period of 40 Years**

- Total Cost: $1,971,400
- Annual Cost: $98,800

### Flexible

**Present Construction Costs Over the Period of 40 Years**

- Total Cost: $1,971,400
- Annual Cost: $98,800

### Activities

**Activity 1 — Year 8**

- **Total Cost**: $52,777

**Activity 2 — Year 10**

- **Total Cost**: $27,529

**Activity 3 — Year 15**

- **Total Cost**: $53,502

**Activity 4 — Year 20**

- **Total Cost**: $25,632

**Activity 5 — Year 25**

- **Total Cost**: $21,183

**Activity 6 — Year 30**

- **Total Cost**: $15,462

**Activity 7 — Year 35**

- **Total Cost**: $15,462

**Activity 8 — Year 40**

- **Total Cost**: $15,462

**Present Rehab Cost per Mile for the Period of 40 Years**

- Total Cost: $404,503

**Present Cost per Mile for the Period of 40 Years**

- Total Cost: $1,386,648

**Present Cost per Mile per Year**

- Total Cost: $60,042