INFORMAL STAFF REPORT

MEMORANDUM

To: Keith Selman, Interim City Manager

Thru: Mark Van Vleck, P.E., Assistant City Manager
Valerie H. Gray, P.E., Executive Director Public Works

From: Jeff Edmonds, P.E., Director of Engineering Services

Date: April 22, 2019

Subject: CITY COUNCIL ACTION REQUEST (CCAR) – HOT MIX ASPHALT CONCRETE (HMAC) & PORTLAND CEMENT CONCRETE (PCC) Pavements

ISSUE:

During the September 11, 2018 Council meeting, Councilmember Garza requested a review of the policy regarding bidding street reconstruction projects in both Hot Mix Asphalt Concrete (HMAC) pavement and Portland Cement Concrete (PCC) pavement.

BACKGROUND & FINDINGS:

Up to Bond 2008, the City would typically design arterial road reconstruction projects with HMAC pavement. This was assumed to be the more affordable pavement alternative. There were a small number of roads with PCC pavements at the time, but these were mostly built by others such as the US Navy. With Bond 2008, the City began to bid some of the arterial streets with both HMAC and PCC pavement designs. This resulted in multiple bid awards for the PCC pavement alternative.

In 2013, the City upgraded the pavement design standards to a 30-year design life using the Association of State Highway Transportation Officials (AASHTO) Guide for Design of Pavement Structures. The change in design criteria, combined with market forces, created an environment where PCC became much more competitive with HMAC. In 2016, the City began designing and bidding all arterial Bond projects with both HMAC and PCC pavement alternatives.

In 2016, the practice was to design both HMAC and PCC using a 30-year design life and award the bid to the lower cost pavement alternative. Bidding projects utilizing both PCC and HMAC designs enhanced competition among contractors and reduced costs. Several projects received lower bids for the PCC pavement alternative.

In early 2017, council and staff began discussions about whether a premium was warranted for PCC pavement. There was a shared belief that PCC pavements offered maintenance savings and that the City should therefore be willing to pay a higher price for PCC pavement. At council request, Engineering Services' staff performed life cycle cost analysis (LCCA) comparing a proposed PCC maintenance plan with the City's existing HMAC maintenance plan.

The results of that LCCA validated the belief that PCC offered reduced maintenance costs over HMAC. The analysis indicated that the City should be willing to pay an additional $100,000 per lane mile

($14.20/square yard) for PCC pavement based on maintenance savings. Staff adopted a policy of recommending award of the PCC alternative if it was within $100,000 per lane mile of the HMAC alternative. That policy was communicated to City Council in a CCAR dated June 2, 2017 **(Attachment 1)** and has been applied to all bids on road bond projects since that date.

This CCAR addresses the question raised at the September 11, 2018 City Council meeting, during discussion about the Rodd Field Road Improvement Project award. That project was bid with both HMAC and PCC pavement alternatives. The HMAC alternative was awarded; however, council had a question as to whether the $100,000 per lane mile adequately reflected the value of maintenance savings from PCC pavement.

Freese and Nichols, Inc. (FNI) was tasked with re-evaluating the LCCA between HMAC and PCC pavements and providing a letter report with recommendations **(Attachment 2)**. FNI conducted LCCA based on the recommended pavement preventative maintenance practices for both HMAC and PCC. Only 2% of the City's street network inventory is PCC pavement and the PCC preventative maintenance program is not fully developed. As a result, FNI was also tasked with developing a recommended PCC maintenance program for use in their analysis.

FNI recommended applying three cost range options for bid award recommendations.

- If the PCC alternative is within $96,000 per lane mile of the HMAC alternative,
  - FNI recommended accepting the PCC alternate.
- If the PCC alternative is greater than $156,000 per lane mile more than HMAC,
  - FNI recommended accepting the HMAC alternate.
- If the cost differential falls between $96,000 and $156,000 per lane mile,
  - FNI recommended using a decision matrix that would consider project-specific factors such as traffic volumes, truck percentage, number of driveways and other engineering factors.

Although Engineering Services agrees with using the FNI decision matrix to decide which projects are appropriate to bid with both PCC and HMAC, staff also believes adopting a bid award recommendation policy that is known **in advance by bidders** is a more fair and transparent process.

FNI's decision criteria are good to use in the Design Phase (not Bid Phase) when deciding whether it is appropriate to design and bid a project with both HMAC and PCC pavements.

RECOMMENDATIONS:

Engineering Services believes that FNI's analysis warrants raising the $100,000 per lane mile used in the current staff bid award recommendation policy. Staff is proposing to raise the amount to $125,000 per lane mile ($17.75/square yard), which is approximately the midpoint of the range ($96,000 and $156,000) where FNI recommends applying the decision matrix. Staff will be recommending the PCC alternate if the PCC bid is within $125,000 per lane mile of the HMAC alternative.

Based on FNI's recommendations and staff's experience, Engineering Services feels that most arterials are good candidates to design and bid with both PCC and HMAC pavement. Residential collectors and residential streets are not as good candidates for PCC due to factors listed in the FNI decision matrix as well as other factors.

Provided for your information, and in accordance with these recommendations, attached you will find proposed pavement designs for the Bond 2018 program **(Attachment 3)**.

ATTACHMENT 1

INFORMAL STAFF REPORT

MEMORANDUM

To: Margie C. Rose, City Manager

Thru: Mark Van Vleck, P.E., Assistant City Manager
Valerie H. Gray, P.E., Executive Director Public Works

From: Jeff Edmonds, P.E., Director of Engineering Services

Date: June 2, 2017

Subject: CITY COUNCIL ACTION REQUEST (CCAR) – April 25, 2017
BIDDING STREET BOND PROJECTS WITH BOTH PORTLAND CEMENT CONCRETE (PCC) AND HOT-MIX-ASPHALT-CONCRETE (HMAC)

ISSUE:

During the April 25, 2017 Councilmember Guajardo requested analysis on how to evaluate bids when projects are designed with both PCC and HMAC.

BACKGROUND & FINDINGS:

As per the attached memorandum, several of the Bond 2012 and Bond 2014 projects are being designed with both HMAC and PCC pavements. When projects are designed both ways, a 30-year design life is assumed, and the required pavement section is determined based on the Association of State Highway Transportation Officials (AASHTO) Guide for Design of Pavement Structures. Recommendations to City Council have historically been based on the lowest priced construction bid. The one exception is the Kostorytz Road project (2012 Prop 1). In the case of Kostoryz, the cost differential to award the concrete alternative was bid price for concrete was $35,489.85 or less than 0.5% of total project cost. That was an easy recommendation but does raise the question of how award recommendations will be made when the decision is a closer call.

Life-Cycle Cost Analysis (LCCA):
There is abundant literature on how to conduct LCCA relative to infrastructure investment alternatives. LCCA is a tool to help agencies make economically sound decisions when project alternatives have varying cost patterns over the asset's service life. LCCA seeks to incorporate a total cost approach that considers all relevant costs, rather than just up front cost, when evaluating alternatives. These analyses can become quite complex and involve hundreds of inputs.

LCCA for HMAC versus PCC pavements:
The Federal Highway Administration (FHWA) began promoting pavement LCCA in the 1990's. A great deal of research has been published on the application of LCCA to the question of HMAC versus PCC pavements. Various Departments of Transportation have developed LCCA policies and some have developed software to help with LCCA. Typically a large number of assumptions are required such as timing of future activities, costs of future maintenance, a discount rate for future cash flows, user impacts from future construction, etc. These analyses can become burdensome and may increase confusion.

Potential Budget Impacts:
While LCCA is useful to help agencies select alternatives with an overall lower cost, it does not address the budget impacts of doing so. It is assumed that PCC offers maintenance savings over HMAC pavements and that those savings support a decision to pay a certain premium for PCC pavement. The question still exists, though, of how to budget for that additional up front cost. The savings result from future maintenance cost reductions. Those savings are not currently available to fund a higher cost bid award. Current Bond programs do not have an allowance set aside for additional construction costs even if they are justified by LCCA. This issue will need to be addressed for future Bond programs. It may require increasing project budgets to allow for a certain percentage of projects to be awarded to the higher bid price alternative.

RECOMMENDATION:

Engineering Services has performed some preliminary LCCA comparing the maintenance cost differential between PCC and HMAC. The LCCA confirms that PCC provides maintenance cost savings over HMAC. The maintenance cost savings justify paying a higher construction cost for a PCC roadway. The maintenance cost savings with PCC are estimated at $100,000 per lane-mile ($14.20/square yard).

Where projects are designed and bid with HMAC and PCC, Engineering Services will consider those maintenance cost savings when making the bid award recommendation. If the PCC pavement bid alternate is within $100,000 per lane-mile of the HMAC bids, Engineering will recommend the PCC alternative.

For illustration purposes, the recent Yorktown Boulevard project included approximately 6 lane-miles of total pavement surface when turn lanes, intersections and bike lanes are included. In that case, Engineering Services would have recommended paying up to an additional $600,000 for the PCC bid alternate. Since the bid price difference between PCC and HMAC was $1.7 million, Engineering recommended the HMAC alternate.

ATTACHMENT 2

MEMORANDUM

FREESE AND NICHOLS

Innovative approaches
Practical results
Outstanding service

800 N. Shoreline Blvd., Suite 1600N • Corpus Christi, Texas 78401 • 361-561-6500 • FAX 817-735-7491 www.freese.com

TO: Jeff Edmonds, P.E.
Director of Engineering Services
City of Corpus Christi

CC: Jerry Shoemaker, P.E., Marisa Alaniz, E.I.T.

FROM: Nick Cecava, P.E., CFM

SUBJECT: Pavement Selection Criteria

DATE: April 22, 2019

PROJECT: Yorktown Boulevard – Everhart Road to Staples Street (Bond 2014)
Project No. E13096
Amendment No. 5

Introduction

Updated pavement selection criteria have been developed to assist the City of Corpus Christi (City) in recommending pavement alternatives when bidding street projects using both hot mix asphalt concrete (HMAC) and Portland Cement Concrete (PCC). The criteria have been developed by evaluating both reconstruction and maintenance cost data for both pavement alternatives. These cost evaluations included historical bid pricing for full street reconstruction for each pavement type and data from the City's Street Preventative Maintenance Program (SPMP) within the last three years. The purpose of this study is to refine the City's current approach to pavement selection and assist the City in recommending pavement alternatives on future projects.

Background

The City started designing and bidding street projects using both HMAC and PCC as part of the 2008 Bond Program. The inclusion of a PCC pavement alternative to HMAC was economically driven by the temporary rise in oil prices making PCC pavement more cost competitive with HMAC pavement. Three projects in the 2008 Bond Program were awarded with PCC pavement. These projects include: Staples Street from Williams to Saratoga (JRCP), Staples Street from Barracuda to Brawner Parkway (CRCP), and Kostoryz Road from SPID to Brawner Parkway (JRCP). The City performed an independent Life Cycle Cost Analysis (LCCA) on each roadway project bid and provided pavement recommendations to City Council. The City Council ultimately decided on the pavement alternatives considering the recommendations from City staff.

In March 2013, the City Council amended the Unified Development Code (UDC) with street design requirements for both HMAC and PCC alternatives. The 30-year pavement design for both HMAC and PCC pavement became the City's standard for all bond funded projects.

In June 2017, Engineering Services provided a response to a City Council Action Request that included information on LCCA and evaluating project bids when street projects are designed with both HMAC and PCC.

This response included recommendations for overall maintenance cost savings by selecting PCC over HMAC and when these savings justify paying a higher construction cost for a PCC roadway. The preliminary LCCA and assumptions provided by the City showed that the maintenance cost savings of using PCC were estimated at $100,000 per lane-mile of roadway or approximately $14.20/square yard. Currently, this cost difference is being used to help City staff recommend pavement alternatives for street projects designed and bid with both HMAC and PCC.

Life Cycle Cost Analysis (LCCA)

The purpose of this study is to perform additional LCCA using recent cost data from the SPMP to refine the City's current approach on pavement selection and to assist the City in recommended pavement alternatives on future projects. LCCA was performed using the Federal Highway Administration's *"Real Cost"* program to compare HMAC and PCC design alternatives for various sizes of City street projects. LCCA is an engineering economic analysis tool that helps to quantify and compare the overall costs of HMAC and PCC over a specified service life. LCCA considers all expenditures throughout the life of the roadway, not just the initial construction cost, and allows for cost comparison on an equivalent basis. The *"Real Cost"* program considers the initial costs of construction as well as costs incurred for future anticipated maintenance activities and then converts total life cycle costs into present day value for cost comparison purposes. The program uses a "discount rate" which is an estimated rate of inflation the City expects over the project service life. For the purpose of this study, the discount rate was established at 4% annual average. Modification of the discount rate has a considerable impact on the results obtained.

LCCA is only one of many processes for selecting a pavement type. Both engineering and economic factors should be considered. The reliability of data from LCCA is directly correlated to the reliability and accuracy of the maintenance cost data specified. The LCCA performed as part of this study only considers the City's costs including the initial construction cost and maintenance activities. It does not consider the user costs a pavement selection has on the public or adjacent property owners.

Summary of Cost Data

The data shown in the following tables has been derived from SPMP data provided by the City and engineering assumptions based on recent prices from similar projects. It should be noted that the SPMP focuses primarily on HMAC pavement rehabilitation activities. The City is currently in the process of including PCC rehabilitation activities in the SPMP. Most of the PCC maintenance costs have been estimated from other projects in the City. The maintenance costs presented in these tables focuses on the major maintenance activities associated with life cycle of HMAC and PCC pavements. Minor activities, such as periodic pothole patching, were not included in the LCCA as these costs are negligible to the overall life cycle costs of pavements.

HMAC Life Cycle Activities	Year	Min. ($/SY)	Max. ($/SY)
Full Reconstruction - HMAC	0	*	*
Seal Coat #1	7	$8	$12
Mill and Overlay #1 (Thin)	14	$30	$45
Seal Coat #2	21	$8	$12
Mill and Overlay #2 (Thick)	28	$35	$50
Seal Coat #3	35	$8	$12

*Use Total Project Bid for HMAC including all Utilities

PCC Life Cycle Activities	Year	Min. ($/SY)	Max. ($/SY)
Full Reconstruction - PCC	0	*	*
Reseal Joints and Cracks #1	7	$3	$5
Panel Replacement #1 (2% of Pavement)	12	$5	$7
Reseal Joints and Cracks #2	15	$3	$5
Panel Replacement #2 (3% of Pavement)	24	$7.5	$10
Diamond Grinding with Joint Replacement	25	$15	$18
Panel Replacement #3 (4% of Pavement)	36	$10	$13

*Use Total Project Bid for PCC including all Utilities

Results

For this study, LCCA was performed over a period of 40 years. This timeframe allows for the inclusion of a "major" rehabilitation activity for each type of pavement near the end of its 30-year service life. The inclusion of a major activity for both HMAC and PCC alternatives provides the City with a more accurate estimation of the total future costs of a roadway. PCC pavement offers maintenance cost savings over HMAC, but typically comes at a higher initial construction cost which must be considered in the City's budget. In addition, the results of the LCCA are dependent on the assigned maintenance cost values and average inflation (discount rate) used in the calculations. Periodic evaluation of the unit costs and expected savings should be conducted as the price of materials are subject to change over time.

Decision Matrix

Due to the variability of LCCA costs and assumptions, it is recommended that the City consider other parameters when selecting the best pavement type for a project. A weighted decision matrix is a simple tool that can be useful when evaluating HMAC vs. PCC pavements instead of relying on present and future costs alone. When the difference between total project bid pricing for HMAC and PCC pavement alternatives falls between a specified range of costs, it is recommended that the City consider project specific factors to assist in making the pavement recommendation. Listed below are key factors that can be used in a weighted decision matrix:

1. **Average Daily Traffic (ADT)** (30 points)
    - Traffic counts should serve a primary role in helping the City select HMAC vs. PCC. Generally, PCC maintenance activities are fewer and less substantial than HMAC rehabilitation activities. Long term disruptions of heavily traveled arterials for future maintenance should be considered in the pavement selection process.
    - Objective: ADT less than 10,000 vpd
    - Objective: ADT 10,000 to 20,000 vpd
    - Objective: ADT greater than 20,000 vpd

2. **Percentage of Trucks and Buses** (30 points)
    - Percentage of Trucks and Buses – Heavy vehicles such as 18-wheelers and buses do the most damage to City streets especially in areas of heavy turning movements and start/stopping.

Consideration should be given to reinforcing these areas to help protect the City's investment.

- Existing and future bus routes
- Future development (Growth and Traffic Impacts)

3. **Adjacent Development / # of Driveways** (20 points)
    - Adjacent development (Commercial, Industrial, Residential, etc.)
    - Number of Driveways – Generally fewer driveways (especially on arterials) provide the City a good opportunity to utilize CRCP pavement which is ideal when constructing long stretches of roadway

4. **Other Engineering Factors** (20 points)
    - Existing utilities under pavement - Future utility upgrades and maintenance by both City and franchise utility companies are more difficult, costly, and disruptive with PCC pavement than with HMAC pavement.
    - Adjacent pavement surfaces (HMAC or PCC) and transition lengths for each type of pavement
    - Project schedule and phasing
    - Contractor and resource availability for either HMAC or PCC

In addition to these factors, there are many other unique factors that can be considered when comparing HMAC vs. PCC pavements. The City should look at the attributes of each individual project when evaluating the pavement selection. An example decision matrix is shown in the table below.

Table 1. Example Decision Matrix

Evaluation Criteria (HMAC or PCC)	Criteria Maximum	Score
Average Daily Traffic	30	
Percentage of Trucks and Buses	30	
Adjacent Development / # of Driveways	20	
Other Engineering Factors	20	
	TOTAL SCORE	

Recommendations

It is important that the City provide an appropriate balance of HMAC and PCC street projects to match the City's demand with the supply of experienced and available contractors and resources to keep overall prices competitive. When projects are designed and bid with HMAC and PCC, the City should consider the initial construction costs and future maintenance costs when making a bid recommendation. An equivalent PCC pavement typically has a higher initial construction cost than HMAC pavement but offers maintenance savings over HMAC pavements. Higher engineering design costs and initial construction cost of PCC will also need to be budgeted by the City in the planning process for future bond programs.

Based on the LCCA performed as part of this study using current data, the recommendations for pavement selection should be based on the following criteria:

1. When the cost difference of PCC is **below $13.57/SY**, the City should recommend **PCC**

2. When the cost difference of PCC is **within the range of $13.57/SY to $22.55/SY**, the City should review the decision matrix to assist with the pavement recommendation (subject to availability of funds)

3. When the cost difference of PCC is **above $22.55/SY**, the City should recommend **HMAC**

Pavement Selection Criteria	Cost Difference (Cost/SY) Total PCC Bid minus Total HMAC Bid		
	Less than $13.57	$13.57 to $22.55	Greater than $22.55
Recommend PCC Pavement	Recommend PCC		
Review Decision Matrix		Decision Matrix	
Recommend HMAC Pavement			Recommend HMAC

ATTACHMENT 3

Bond 2018 & Type B Street Projects
Pavement Design Recommendations

PROJECT	PAVEMENT DESIGN/BID RECOMMENDATION
Airline Road - SPID to McArdle Rd.	HMAC and PCC
Alameda Street - Louisiana St. to Chamberlain St.	HMAC and PCC
Beach Avenue - E. Causeway Blvd. to Dead End at Gulfbreeze Blvd.	HMAC and PCC
Brawner Parkway - Carroll Ln. to Kostoryz Rd.	HMAC and PCC
Calallen Drive - Red Bird Ln. to Burning Tree Ln.	HMAC and PCC
Callicoatte Road - IH 37 to Up River Rd.	HMAC and PCC
Castenon Street - Trojan Dr. to Delgado St.	HMAC and PCC
Everhart Road - SPID to McArdle Rd.	HMAC and PCC
Frio St/Hacala St/Dorado St. Corridor - Greenwood Dr. to Martin St.	HMAC and PCC
Gollihar Road - Greenwood Dr. to Crosstown Expressway	HMAC and PCC
Gulfspray Ave. - Pedestrian / Bike Access	HMAC and PCC
JFK Causeway Access Road Improvements	HMAC and PCC
Junior Beck Drive - Dead End to Bear Ln.	HMAC and PCC
Laguna Shores Rd - Caribbean Dr. to Hustlin' Hornet Dr.	HMAC and PCC
Laguna Shores Road - Graham Rd. to SPID	HMAC and PCC
Laguna Shores Road - Mediterranean Dr. to Wyndale St.	HMAC and PCC
Leopard Street - Nueces Bay Blvd. to Palm Dr.	HMAC and PCC
Lipes Boulevard - Yorktown Blvd. to Sun Wood Dr.	HMAC only
Long Meadow Drive - Hunt Dr. to St. Andrews Dr.	HMAC and PCC
McArdle Road - Carroll Ln. to Kostoryz Rd.	HMAC and PCC
N. Beach Area Primary Access - Beach & Timon / Surfside	HMAC and PCC
North Lexington Boulevard - Hopkins Rd. to Leopard St.	HMAC and PCC
Residential Street Rebuild Program (RSRP)	HMAC only
S. Staples Street - Baldwin Blvd. to Kostoryz Rd.	HMAC and PCC
Slough Road	HMAC
South Oso Parkway - S. Staples St. to S. Oso Pkwy.	HMAC only
Strasbourg Drive - Riom St. to Grenoble Dr.	HMAC only
Swantner Drive - Indiana Ave. to Texan Trl.	HMAC and PCC
Wooldridge Road - Everhart Rd. to Cascade Dr.	HMAC only