Elgin O'Hare - West Bypass Project
Travel Demand Modeling Strategy and Methodology

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1.0 Introduction

This memorandum documents general considerations and strategies for developing a **sub-area focus travel demand model** to evaluate multimodal traffic movements for the Elgin O'Hare –West Bypass (EO-WB) project. The proposed approach takes full advantage of the existence and capabilities of the Chicago Metropolitan Area Planning (CMAP) travel model (the regional area travel model) to develop a sub-area focus model for the project study area. The intent of the sub-area focus model is to help better understand travel patterns and origin-destination trip exchanges within the EO-WB project study area. The CMAP travel model process, procedures and data will be used to refine the sub-area focus model to develop model outputs to match the requirements of the project.

2.0 Study Area Details

The study area for the Elgin O'Hare – West Bypass project is generally bounded by the Jane Addams Memorial Tollway (I-90) to the north, the Eisenhower Expressway (I-290) to the south and west, and the Tri-State Tollway (I-294) to the east. Even though the geographical extent of the sub-area focus model is limited to the general vicinity of O'Hare Airport, impacts of network and land use assumptions at and around the airport have regional implications. Hence an extended area beyond the study area will be established around the project study area to assess regional impacts of the project.

3.0 Travel Demand Modeling/Forecasting Strategy Overview

The proposed modeling process is designed to take maximum advantage of the CMAP regional travel model and model resources while providing the necessary refinements to effectively address more detailed considerations in the project study area. Two major strategies will be used to achieve this result.

1. Traffic analysis zones and network in the study area will be refined to represent more details to the street network, connections and improved detail in terms of traffic access and egress. To retain sensitivity to changes in regional traffic movement related to the project, the sub-area focus model will be embedded in the larger regional model by adding the network to the regional model network and increasing the number of traffic analysis zones within the project study area.

2. Traffic assignments for both existing (2007) and future forecasts (2030) will be enhanced by establishing a existing baseline set of origin-destination trip tables by adjusting the 2007 base CMAP trip tables (after expansion to the new zone system)

to better match observed traffic volumes using a process known as "Link-OD Estimation". This process will be conducted by specific time period (as defined by the CMAP model) and by specific vehicle modes (autos & three truck classes – light, medium and heavy trucks). Count data will be assembled for most highways and streets in the project study area and for major facilities (freeways and some state highways) in the regional area. The regional level data will increase the probability that the solution set is consistent with actual regional traffic patterns.

The process is designed to provide the necessary focus on more detailed and refined forecasting in the project study area while retaining both sensitivity to potential regional traffic influences and a high degree of compatibility with the data to be imported from the regional model.

4.0 Travel Demand Modeling Implementation

Implementation of the model can be broadly divided into five categories. These are:

- Network Definitions and Traffic Analysis Zone Refinements
- Traffic Count Database Development
- Trip Table Expansion, Factoring and Adjustments
- Traffic Assignments
- Travel Performance Measures, Evaluation and Reporting

The processes that make up each of these categories will continually be refined and updated as the study progresses. However, the basic steps, expected parameters and input/output relationships for each one can be identified and described in broad terms.

All of these processes are being incorporated into an operational framework to facilitate and automate the production use of the model for forecasting. The basic modeling platform for all model operation is the TransCAD software package. TransCAD was chosen over CMAP native EMME/2 environment due to its superior data and database management facilities, its GIS style interface and already available tools (developed for other projects) which could help speed and facilitate development of this model. Travel model data from CMAP will be obtained in the native CMAP EMME/2 format and will be translated into the TransCAD environment. The data transfer from CMAP for the 2007 existing and 2030 forecast RTP scenario has been completed and data exchange for additional supporting information between CMAP and the project team will continue on an ongoing basis.

4.1 Network Definitions and Traffic Analysis Zone Refinements

Since the CMAP highway network is fairly well defined in the project study area, the required refinement is generally to decrease traffic analysis zone sizes by disaggregating the CMAP zones to better represent land use within the study area. In addition to zone refinements, some network adjustment, centroid connector location updates and attribute enhancements will be addressed to improve network connectivity within the project study area.

4.1.1 Network Definitions

The basic network inputs for the model will come from two sources. The first and basic source is the **master highway network** maintained in the Arc/GIS environment by CMAP. This will be used to provide geographic and attribute definition for the majority of the regional network, specifically in the project study area. Specific time period links in the 2007 base year network will be identified and flagged using time period attributes in the master highway network. Changes and additions needed to represent future networks will be derived in a similar fashion and supplemented by updates from the CMAP Transportation Improvement Program database.

The second source of data will be additional new network coding of more detailed streets and zonal access (centroid connectors) in the project study area. Since the majority of streets within the project study area exist as part of the CMAP model, additional coding will be mostly limited to adding centroid connectors. The additional coded network links will be added to the master highway network file along with all necessary link and node attributes flagged to identify presence or absence of specific links in each scenario. Use of the master database concept will eliminate the need to recode the focus model elements in each time period scenario and will facilitate automation of the CMAP eight time period assignment processes. A detailed working paper describing process and methodology of the network development process will be provided as an appendix to the *Travel Demand Modeling and Forecasting Report* after the model development task has been completed.

4.1.2 Traffic Analysis Zone Refinements

The proposed approach will refine the CMAP traffic analysis zones by disaggregating zones to better represent land use patterns within the project study area. The sub-zones will be split within the CMAP zone boundary structure to establish easy data manipulation and transfer between sub-zones and CMAP zones. On the edges of the project study area, zones will be split to provide a buffer around the project area, to ensure reasonable distribution among the roadways entering and exiting the modeled sub-area. The remainder of the CMAP zone system outside the project study area will be utilized "as-is" to maximize compatibility and simplify data import and export between the CMAP model and sub-area focus model. The underlying basis of splitting zones will be existing aerial coverage and roadway connectivity, which will help define land use characteristics and physical barriers to traffic movement within the project study area. Once new sub-zone boundaries are identified, socio-economic data from the parent CMAP zone will be allocated to sub-zones primarily through review of aerial imagery identifying patterns of development within the zone and percentage of area represented by the sub-zone. The sub-zone allocation process will use existing CMAP socio-economic zone boundary definitions and data inputs.

The CMAP regional zone system (1891 zones, including external stations) will be expanded to include an additional 542 zones representing the project study area. The new sub-area focus model will constitute 2433 zones for the EO-WB project. A detailed working paper describing process and methodology along with the correlation table between the sub-area zone system and the CMAP zone system will be provided as an appendix to the *Travel Demand Modeling and Forecasting Report.*

Note that no additional entry and exit stations will be defined for the project. Existing links along the boundary of the CMAP regional model will be retained "as-is" to serve as entry and exit points to the sub-area focus model.

4.2 Traffic Count Database Development

In conjunction with the network development and the zone refinement process a traffic database will be developed to gather/maintain extensive traffic count information. Traffic data will be collected for a typical weekday 24-hour period by direction by vehicle class on an hourly basis. A combination of field data gathering efforts along with existing IDOT count information, Illinois Tollway count data and data from local municipalities will be used for developing the count database system.

The count database will include locations on all major facilities within the study area boundary along with counts on freeways/interstates and tollway facilities beyond the study area boundary.

The traffic count data will be used to support the Link-OD adjustment process and to validate the 2007 existing base year sub-area focus model, thereby optimizing the ability of the travel model to replicate existing traffic conditions. It is important to note that the link-OD adjustment is dependent on the extensiveness and quality of the count data available for the process. Approximately 250 ground count locations have been identified within the project study and regional area.

4.3 Trip Table Expansion, Factoring and Adjustment

The regional trip tables for existing conditions (2007) received from CMAP will require three transformations before they can be used as input to the traffic assignment process which will ultimately generate a 2007 base year existing model for the focus study area.

1. Trip table entries for the CMAP regional model zone system (1891 zones) will need to be expanded to represent the additional 542 zones in the study area.

2. Factors used to allocate daily vehicle mode trips to time periods and specific vehicle classes as part of the CMAP modeling process will be applied to perform the same allocations for the focus study area model. Note that the CMAP four truck classifications (B-plate, light, medium and heavy) will be aggregated to represent three truck classifications based on field data collection efforts for the modeling process. A technical memorandum describing truck classifications and aggregation will be included as an appendix in the *Travel Demand Modeling and Forecasting Report.*

3. This expanded set of trip tables will be input to the Link-OD adjustment process to generate vehicle mode and time period specific traffic volumes which better match the input traffic count data.

Once the expanded and adjusted trip tables are created they will be assigned to the existing network to verify model assumptions, operations and traffic volumes.

4.3.1 Existing Base Year (2007) Trip Table Development

A spreadsheet-based application along with the TransCAD matrix disaggregate process will be used to expand the existing CMAP regional travel model trip tables, to translate socio-economic quantities (population, households and employment), to generate trips, and to allocate parent zone trips to sub-zones. CMAP procedures for auto occupancy factors and time-of-day allocations will be applied to generate separate trip tables by vehicle class. The result is a 2007 base-year sub-area focus trip table by time period and vehicle classes.

The link-OD estimation technique establishes reasonable consistency between observed and model estimated traffic volumes within the project study and regional area. The Link-OD estimation uses an iterative process built around traffic assignment to achieve convergence with the input traffic count data. The process used in this study will replicate the procedures used for CMAP assignments. This process will adjust traffic volumes to match time period and vehicle class specific counts, allowing better correlation between actual and modeled traffic volumes and a more accurate understanding of diurnal traffic patterns. This process will be applied for specific time periods, so operational conditions in the peak period are closely matched. Trip tables resulting from the sub-zone expansion process will be used for the link-OD estimation in conjunction with the traffic assignment procedures to develop the adjusted 2007 existing base year trip tables and loads to evaluate existing conditions.

4.3.2 2030 Existing Plus Committed (Baseline – No Build) Scenario

The 2030 existing plus committed (baseline – no action) network will be developed using input from IDOT, Illinois Tollway, counties, and transit agencies. The master network from CMAP will be updated to reflect the existing plus committed projects to develop a 2030 baseline-no action network. A specific 2030 baseline-no action socioeconomic and land use forecast will be developed to reflect the baseline-no action projects (highway & transit) within the study area. The 2030 baseline-no action forecasts will be developed by adjusting the 2030 CMAP Regional Transportation Plan socio-economic and land use data with extensive input from the *DuPage West O'Hare Economic Development Study* socioeconomic assumptions. The 2030 baseline-no action forecasts will be transmitted to CMAP for their use in generating a regional model run and 2030 baseline-no build trip table for the project study purposes. Note that the 2030 baseline-no action socioeconomic forecasts will reflect accessibility changes based on both 2030 baseline highway and transit projects within the study area.

The 2030 baseline-no action socio-economic forecast will only be adjusted as it relates to the project study area, while the remainder of the CMAP regional area will use the 2030 endorsed Regional Transportation Plan (RTP) forecasts.

4.3.3 Future Year (2030) Trip Table and Alternative Screening Process

The 2030 baseline-no action trip table will be the underlying basis of the alternatives screening and evaluation process. Adjustments to the 2030 baseline-no action trip tables will be made to account for alternative specific trip distribution variations. Development of the future year trip tables will be based on an incremental application process where the difference between the 2007 existing and 2030 baseline–no action trip tables results in an expanded growth trip table. The growth trip table will be added to the 2007 existing sub-area focus trip table to generate 2030 forecast year sub-area focus trip tables used to estimate

future traffic for screening the alternatives. With this method, the 2007 sub-area focus trip tables are used as the starting point to generate traffic forecasts, thus deviating from the standard forecasting process of directly using the 2030 CMAP trip tables. The 2007 existing sub-area focus trip table plus the growth trip table will be the 2030 future sub-area focus trip table. This will serve as input to the future traffic assignment process.

4.3.3.1 Trip Distribution Assessments - Alternative Screening Process

The 2030 baseline-no action trip tables will be adjusted to account for changes in trip distribution characteristics due to accessibility differences in the alternatives considered for the study area. A supplemental model adjustment process will be established that will *pivot* off the 2030 baseline-no action datasets developed by CMAP, allowing an adjustment in trip distribution to account for variations in network accessibility. This adjustment will be integrated into the proposed process for growth factoring model trip tables to represent future travel volumes. The process will be applied for each of the eight time periods defined in the CMAP model to better forecast accessibility impacts related to time-of-day and direction specific facility use. The steps to implement the trip distribution adjustment procedures are as follows:

1. The 2030 baseline-no action trip table for each time period and vehicle class generated by CMAP will serve as the starting point for testing all alternatives in the initial screening stage.

2. The 2030 baseline-no action trip table will be expanded to the EO-WB zone system and subtracted from the corresponding 2007 existing base year trip table as a measure of trip growth.

3. The growth trip table generated will be summed with the 2007 existing base year trip table to estimate total 2030 baseline-no action trip making and summarized as row and column totals for each traffic analysis zone.

4. A trip length/trip cost frequency distribution table for each baseline-no action vehicle type/time period will be generated using the 2030 baseline-no action network to generate zone-to-zone travel impedances and utilized with these tables to generate distance decay (deterrence) functions.

5. The 2030 baseline-no action trip tables row and column totals (zonal productions and attractions), the highway zone-to-zone travel impedances for each initial screening alternative, and the decay functions estimated in step 4 will be input to a standard gravity model distribution to estimate a new trip Origin-Destination pattern distribution based on the 2030 network.

6. The alternative specific highway trip distributions from step 5 will be utilized in a standard CMAP traffic assignment process to generate vehicle class link loadings for each initial screening alternative stage.

This proposed approach will allow an accessibility sensitive distribution to be performed for each alternative specific scenario. Use of the CMAP 2030 baseline-no action trip tables as a starting point will ensure that the resulting distributions reflect the perceptions of the traveling public willingness to make trips of certain lengths/costs. Furthermore, any CMAP

distribution adjustments will reflect expected changes in traveler perception of relative trip lengths, and will be incorporated into all alternative scenarios.

It is important to note that the above described adjustments to the 2030 baseline-no action trip tables due to accessibility changes between alternatives will be performed only if there are appreciable differences in trip distribution characteristics between alternatives as compared to the 2030 baseline-no action scenario.

On an as needed basis, alternative specific socioeconomic and land use forecasts may be developed for the finalist system build alternatives.

4.4 Traffic Assignment

The traffic assignment process relies on a number of assumptions and parameters regarding how different vehicle classes are treated, and how estimated congestion effects route choice. First, different vehicle classes will be assigned using a multi-class equilibrium assignment process which considers different sets of available routes depending on class to represent policies such as truck restrictions. Second, the full compliment of volume-delay functions used in the CMAP model will be coded and used to represent congestion and toll effects. The highway traffic assignments will be performed for each of the eight time periods matching the CMAP time period categories and four vehicle classes (Auto, Light Trucks, Medium Trucks and Heavy Trucks). Table E-1 below lists the CMAP time period stratifications. The link attributes used to drive these assignment functions will be taken directly from the CMAP data and translated to additional new links in the study area, providing maximum compatibility with CMAP travel model outputs.

TABLE E-1 - CMAP TIME PERIOD STRATIFICATIONS

Time Period	Duration
Off-Peak Period	8:00 PM to 6:00 AM
Pre AM Peak Period	6:00 AM to 7:00 AM
AM Peak Period	7:00 AM to 9:00 AM
Post AM Peak Period	9:00 AM to 10:00 AM
Mid-day Period	10:00 AM to 2:00 PM
Pre PM Peak Period	2:00 PM to 4:00 PM
PM Peak Period	4:00 PM to 6:00 PM
Post PM Peak Period	6:00 PM to 8:00 PM

Source: CMAP Transportation Conformity Analysis – Appendix B, October 2006.

5.0 Transit Mode Share Estimations

Transit mode shares for the project study area will be estimated based on a set of matrix adjustments that will be applied to the outputs of the CMAP model. Specific mode choice applications and model runs will not be performed within the sub-area focus model framework for the project during the initial alternatives screening stages. During the initial alternatives screening and evaluation process, the best case transit mode share estimates will be the 2030 baseline-no action condition since it incorporates all the assumptions used in the 2030 CMAP RTP relating to transit improvements. This will allow transit to provide the maximum benefit in terms of minimizing need for expanded road capacity.

Adjustments requiring redistribution of trips to potential destinations, systemic changes in transit services, and other types of changes which could significantly affect regional distributions will require support from the CMAP model runs and will be based on specific transit focused alternatives developed for the project in conjunction with the roadway alternatives. As required, transit focused alternatives will be run using the regional CMAP model to provide a reasonable starting point for executing the sub-area focus model for the project study area.

6.0 Travel Demand Management (TDM)

The sub-area focus model is built on the CMAP model framework and uses outputs from the CMAP modeling process and procedures. The travel demand management strategies developed for the project will be evaluated at the regional level and will require support from CMAP model runs. The CMAP model development process incorporates assumptions as it relates to travel demand modeling strategies and is reflected in the sub-area focus model.

Alternatively, specific travel demand management plans developed by major employment centers in the project study area can provide a framework and starting point to addressed changes in trip making characteristics that will be incorporated in the modeling process.

In addition, the Illinois Tollway has initiated a "*Congestion Pricing Study*" for the Chicago metropolitan area and is currently under development. In conjunction with the alternatives development process for this project, findings and recommendations from the "*Congestion Pricing Study*" will be used to make necessary adjustment to trip making characteristics to address TDM effectiveness in the project study area.

7.0 Travel Performance Measures & Evaluations

A detailed set of performance measures will be calculated for the project study area and regional area using the outputs from the sub-area focus travel demand model. Appropriate performance measures will be used to evaluate transportation system performance. Performance evaluation results and methods from the *DuPage County West O'Hare Economic Development Study* will be used to compare evaluation results of the sub-area focus model.

Traditional performance measure will be calculated within the transportation planning model and added to the link attributes. These measures are readily developed from the data produced in the loaded network, and are generally link based statistics that account for

specific links on the network. Performance measures that will be used to evaluate travel performance by specific time periods include but are not limited to:

*Vehicles Hours of Delay (VHD): Volume * (Congested Travel Time – Free Flow Travel Time)*

*Vehicle Hours of Travel (VHT): Volume * Travel Time*

*Vehicle Miles of Travel (VMT): Volume * Distance Traveled*

Average Speed (Time Period Specific): VMT/VHT

Although these measures are informative, the statistics are limited to link levels (e.g. specific corridors and routes) and thus provide only a limited understanding of the overall transportation network performance. In order to better represent and facilitate evaluation of the roadway network, summary statistics will be developed by aggregating the link data. Variables will be added to the roadway network that can identify specific routes and corridors of interest. Route codes, segment codes, location codes and direction codes will be developed to identify corridors for analysis.

Additional evaluation measures to assess corridor/system level performance will be developed as part of the alternatives development and analysis methodology. As an example, the weighted average speed for each segment will be determined by the ratio of VMT on each link to the total VMT over the route segment, thus accounting for exposure at different speeds along the route segments. In addition to these performance measures, a level-of-service will be computed based on average travel speed, and a weighted percent congestion measure will be calculated using weighting factors to reflect different degrees of congestion based on HCM procedures.

Additional detail regarding travel performance evaluation methods will be documented in the *Transportation System Performance Report* and the *Alternatives Development and Evaluation Memorandum*.