BPM 2010 Update / Task 9: Toll Coding Guide / Revised 3/26/13

Introduction

Section 1 below provides a general discussion of how tolls are represented in the BPM, with additional details as to how tolls were created for the *Base Year 2005 BPM.* **Section 2** presents how tolls are calculated for updated base and future year scenarios, while **Section 3** presents a specific revision to the blended toll methodology which is needed to take into account the widening price gap depending on traffic composition, especially for trucks.

This document is accompanied by the DRAFT worksheet BPM Coding_Tolls_130322.xls that provides the detailed methods, assumptions and data used to develop toll value inputs for use with the both Central and the 2G versions of the BPM 2005, as well as the BPM 2010 Update (Stage 1) under development as the TH-TDFM, and which is to be integrated into the final BPM 2010 Update (Stage 2).

Table 1 shows the eighteen sheets that comprise this toll coding tool.

Table 1 – Contents of Coding Guide Spreadsheet

1a-Summary 2005	Summary table of toll rates used in BPM 2G, TH-TDFM update and observed
1b-Summary 2010	Summary table of toll rates to be used in BPM 2010 update
1c-Summary 2015	Summary table of toll rates to be used in BPM 2015 update
2a-2005 WorkSheet	Detailed calculations of 2005 weighted tolls
2b-Input (EB Counts)	2005 PA and 2010 Tappan Zee traffic counts by category
2c-Other Input	Observed E-Z pass shares by time of day & Reduction Plan details
3a-MTA Tolls	2010-2013 MTA toll schedule
3b-2010 MTA detail	Detailed Counts at MTA Facilities, Week of October 18-21, 2010
3c-2015 MTA detail	Updated 2015 MTA toll calculations using 2010 EZ-Pass and axle proportions
4a-PA Tolls	2012-2015 PA Toll Schedule
4b-2010 PA detail	Detailed EZ-Pass shares, axle counts, toll rates for 2010
4b-2015 PA detail	Updated 2015 PA toll calculations using 2010 EZ-Pass and axle proportions
5a-2005-BPM-TOLL-LINKS	Detailed tolled link worksheets to be joined to BPM 2G model
5b-2010-BPM-TOLL-SCL	
5c-2015-BPM-TOLL-SCL	
6a-2005-TH-TDFM-TOLL-LINKS	Detailed tolled link worksheets to be joined to TH-TDFM model
6b-2010-TH-TDFM-TOLL-SCL	
6c-2015-TH-TDFM-TOLL-SCL	
7a-2010-BPM-TOLL-REV	Detailed tolled link worksheets for revenue calculation only
7b-2015-BPM-TOLL-REV	
7d-2015-TH-TDFM-TOLL-REV	
7c-2010-TH-TDFM-TOLL-REV	

1 – General Toll Coding Issues

1.1 - Representation of Tolls in BPM Highway Network

The BPM was originally developed for Base Year 1996, using survey data and other inputs developed for that point in time, including tariffs or the toll facilities in the region. The behavioral relationship estimated for the travel choice models between travelers' perception of the relative disutility of travel time and monetary cost reflects conditions at that point in time. In other words, the value of time implied by the BPM choice models are appropriately expressed in 1996 dollars.

Before the 2002 Update, tolls were coded in the BPM highway network data based on the cash auto toll value, or the cash heavy truck estimated average toll coded on links where tolls are charged, with tariff values being those in place in 1996/97. This basic representation of tolls ignored various forms of discounts available to different travel segments, but was a reasonable way to incorporate the toll component of travel into the BPM choice models as part of their statistical estimation, and for the calibration of the assignment procedures.

With the introduction of E-Z Pass, and various time-of-day toll policies in the region, starting with the Port Authority of NY/NJ's March 2001 toll change, this method represents even more of a simplification of reality than it did when originally implemented in the BPM. As part of the BPM 2002 Update, consideration was given to the modifications to the BPM data structures and enhancements to the choice models that would be needed to better address the new tolling polices, and also to account for generally higher average toll costs (at least in nominal dollars). It was determined that a meaningful improvement in how the BPM could model tolls will require time and resources beyond the available timeline for the 2002 Update.

For the 2005 Update, it was decided that the 1996/97 dollar tolls be converted to 2005 dollars. The auto tolls on Port Authority and MTA facilities were calculated based on weighted Cash (30%) and E-Z Pass (70%) tolls, where a general average percentage E-Z Pass (70%) users on bridges/tunnels was obtained from the recent MTA 2006 OD surveys. For PA bridges and tunnels, tolls were further averaged (1/3rd for peak and 2/3rd for off-peak) across time-of-day to compute an average toll. Average truck tolls were computed by Urbitran based on truck size distribution (number of axles) on different facilities. This change required implementing a procedure within the BPM MDSC model to "re-index" (e.g. by CPI) the estimated value of time related coefficients on cost components in the choice model utility expressions.

As in prior versions of the BPM, tolls are implemented as link attributes, coded in the highway networks database. As explained above, auto tolls represent average daily costs per vehicle. Average daily truck (6 or more tires) tolls are coded in a separate field in the highway network. Estimated truck tolls were updated to reflect real truck tolls in 2005, weight-averaged by both the volume and tolls applied in each truck toll class (typically number of axles).

1.2 Additional Details: 2005 Auto Tolls

In the two category toll model, Port Authority facilities (GWB, Lincoln, Holland, Bayonne, Goethals and Outerbridge) auto tolls are set at a blended rate of $4.83 for cars, which is the combination of 30% cash toll of $6 for all periods of the day, one third of the 70% remaining peak E-Z Pass toll of $5 and two-thirds of the 70% remaining E-Z Pass off-peak toll of 4$. For the 4

detailed time periods tolls (by 4 vehicle classes), this value was updated by facility in the summary sheet with the data available for 2005, including the Staten Island Bridges (SIB) plan observed shares. The latter reduces the toll value by an average of $1.

For MTA facilities, major bridges have a car toll of $4.15 (70% of the E-Z Pass rate of $4 and 30% of the cash rate of $4.50), Verrazano Narrows has double that in the EB direction and while the same proportions apply to Henry Hudson at $1.90 (.7*$1.15+.3*$2.25) and the minor crossings at $1.73 (.7*$1.50+.3*$2.25).

The other tolled infrastructures that are collected on a barrier based system are the Tappan Zee Bridge @ $3.72 (.7*$3.60+.3*$4), the New Rochelle Barrier on I-95 @ $1.29 (.7*$1.20+.3*$1.50), the Yonkers and Harriman Barriers on I-87 @ 82¢ (.7*75¢+.3*$1) and all of the NY State Bridge Authority bridges at $1 each for cars (no E-Z Pass rebate). The lone distance based NY Thruway link in the model, north of Harriman, has the same cost as the Harriman Barrier. Garden State Parkway tolls are also collected at barriers, either mainline toll plazas (at 35¢ or 70¢) or exits (@ 25¢).

The remaining tolled links on the NJ Turnpike are distance based (save for the Lincoln Secaucus Barrier). Entrance to exit toll matrices were not calculated for these facilities due to software limitations. The method uses an initial 1996 calculation of toll increments between each entrance and exit point along these facilities (which takes into account the uneven distance costs). This cost was assigned to a single link in between collection points, with the occasional ramp being added if segregation of movements would lead to different rates. The 1996 tolls were then increased by 33% to account for 2005 prices, all along keeping the same structure. No provision for E-Z pass discounts was taken into account.

1.3 Additional Details: 2005 Truck Tolls

The detail of how truck rates were obtained in 2005 was not traced back to the original report and methodology, which was developed by Urbitran, now Aecom. A reverse engineering methodology was thus arrived at that takes into account the E-Z Pass, axle count mix and time of day proportions for PA facilities, the latter variable being omitted for the rest of the network, save the Tappan Zee Bridge. E-Z pass penetration is over 90% for larger trucks, as most fleets are equipped with these transponders, meaning only the smaller operators will pay cash and that proportion tends to diminish over time. Specific E-Z Pass rates are available for all PA bridges and an overall E-Z Pass rate of 85% was used for the other facilities. Table 1 below shows the structure of the accompanying spreadsheet, where the specifics of these calculations may be found in “2-2005 Worksheet”.

Thus, an average axle ratio was calculated for all bridges, as well as average daily toll rates for 2, 3 and 4 axle trucks, based on E-Z Pass shares as well as time of day for PA facilities. All average axle ratios fall between 2 and 4 axles, so the average daily toll rate can be calculated by interpolating between the two concerned rates. For example if the axle ratio is 2.40, the average rate would be the 2 axle rate plus 40% of the difference between the 3 and the 2 axle rates. This way, future rate can be obtained by using this method and hypotheses on the evolution of axle ratios, E-Z Pass and time of day shares. For PA facilities, an increase should be applied to the new rates, as this method falls consistently 7% short in 2005. For other facilities, the error is negligible on MTA bridges, save for the BBT, where a 20% correction factor is needed. A few coding errors

were also noticed during this reverse engineering process; the tolls at the Holland Tunnel, Tappan Zee and Verrazano Bridges are all too high, and should be corrected to the following for their respective original values: HT $19.05 -> $10.28, TZB $26.04 -> $12.15, VNB $24.56 -> $19.51. Holland truck rates don't really matter given no trucks are allowed in the model, whereas only small trucks are able to use the facility in reality, as also observed for the GWB lower deck.

The method for distance based tolled links (such as the NJ Turnpike or the Garden State Parkway) is not known and a proportion based approach is the only sound method which may be recommended at this time, taking into account that the numbers in the 2005 2G update are 2005 toll rates.

2 – Development of Toll Inputs for Base and Future Year Scenarios

2.1 – General Representation for 2010

Toll coding for 2010 is presented in this section and takes into account the three different network representations. The actual 2005 based 2G model uses 2 daily toll categories for autos and trucks, the TH-TDFM version of the BPM has additional detail on the New Jersey side and uses 16 toll categories divided in four time periods by four vehicles (AM. MD, PM, NT and SOV, HOV2, HOV3, Truck). The 2010 BPM update will integrate the additional New Jersey detail and additional toll categories, as well as update the value of time to a 2010 base, for which dollar values will be actualized. In the current version of the 2010 Update calibration runs, the 2005 dollar values are still used and will be updated once the internal Value of Time (VoT) adjustments have been programmed. An example of a 2015 future horizon is also provided in the tolling guide, which can be used as a template for any desired future horizon. The summary of all barrier type toll rates is presented in the worksheet "1b-Summary 2010", where 2005 dollar values are shown on the left side and 2010 values on the right side (which will be eventually used in the 2010 Updated version). The HOV3 category is also differentiated starting in 2010.

2.1.1-MTA Facilities

With the increasing share of E-Z Pass users, 2010 tolls were updated by facility in function of the E-Z Pass market penetration and by trucking profile, the details of which can be found in "3b-2010 MTA detail". Of the MTA bridges, both BWB and TNB have higher large truck shares, with average truck tolls exceeding $15 per truck at both places, with Throgs Neck as high as $17.50. The other major bridges all have averages tolls below $13. On the car side, the Bronx bridges have the lowest E-Z Pass shares (BWB and RKB) at around 70%, while the other bridges hover around 80%. This gives average tolls ranging from $5.06 at the BBT (85% share) to $5.38 at the Bronx RFK bridge (66% share). The difference is much less pronounced than for the trucks.

2.1.2-PANYNJ Facilities

The 2008 toll rate increases in effect in 2010 were used to calculate new tolls, along with the update hourly vehicle class shares. E-Z Pass shares were only available for three time periods, AM and PM peaks and 24h Weekday, which was applied to the MD and NT periods. The SIB Plan is taken into account using 2005 reported user shares.

2.1.3-Other NY State Facilities

The 2008 toll increase at the New York Thruway (NYTA) is reflected in summary calculations. Commuter discounts were also added to the NYTA, with Harriman being the only location with significant enough commuters (10%) to affect the daily toll. Trucks tolls were increased in proportion to the auto toll increase. New York State Bridge Authority (NYSBA) tolls have not changed since 2005. Tappan Zee Bridge is the only facility with peak pricing, that being only in the AM given the eastbound only direction of tolling. Truck tolls based on average axle counts were adjusted for the three Hudson River crossings (Newburgh, Bear Mountain and Tappan Zee) according to detailed 2010 counts, available in tab "2c-Input (EB Counts)". Tolls for the northernmost NYTA segment and for the Mid-Hudson and Kingston Bridges were removed, as these are all external station links for which increased generalized cost has no influence on path, given external station origins and destinations are fixed at the external model level.

2.1.4-New Jersey Turn Pike (NJTPK) and Garden State Parkway (GSP)

As stated in section 1.3, the link based methodology for NJTPK was conserved, with a growth factor applied to the car toll. NJTPK tolls increased by 40% in 2008, and applying the CPI discounting rate of 89.45% to that increase, this yields a factor of 1.27 to be applied to 2005 NJTPK values in the model. Peak pricing was also introduced in 2008. The method to calculate peak multiplying factor was to divide the price of the longest peak hour trip at the 2010 rate ($7.71), calculated in 2005$ ($6.90) by the max 2005 trip cost ($4.55): 6.90/4.55= 1.52.

For the GSP, the increase in 2008 was a rounded step function: 25¢, 35¢ and 70¢ tolls were increased to 35¢, 50¢ and $1.00 respectively for cars. This overall 43.9% increase was then applied to the 2005 truck rate ($1.74) to give a $2.23 value. Once adjusted to 2010 dollars ($2.49), this gives average axle ratio of 2.68 axles with off-peak truck rates. Applying this axle ratio to peak truck rates, the 2010 value would thus be $2.68. For both facilities, a 1/3 peak and 2/3 off-peak ratio was used to calculate daily toll inputs.

2.2 – General Representation for 2015

Toll calculation for the 2015 horizon uses the same axle and E-Z Pass ratios calculated in 2010. Only three organizations had (or plan to have) toll increases between 2010 and 2015:

2.2.1-MTA Facilities

The recent March 1st 2013 MTA toll increase (11% E-Z Pass-15% cash) applies evenly to both cars and truck (unlike the PANYNJ which heavily penalizes trucks), see worksheet "3a-MTA Tolls". Given this increase is almost aligned with inflation, there are no big differences in 2005 dollar values between 2010 and 2015 MTA tolls.

2.2.2-PANYNJ Facilities

As hinted above, Port Authority tolls increase dramatically from 2010 to 2015, and even more for trucks. Increases were applied or are planned every year from 2011 to 2015, yielding a total average increase of 75% for cars and 150% increase for trucks. December 2015 tolls are used for 2015, even if the norm would be to use mid-year tolls, because it is the last planned toll increase.

All the 2015 toll values could be used as is for any subsequent year and would thus account for inflation to these horizons. The 2005 dollar values on PA facilities more than doubles for cars and is tripled for trucks between 2005 and 2015.

2.2.3-New Jersey Turn Pike (NJTPK) and Garden State Parkway (GSP)

The overall increase on the turnpike was 53% in 2012 and 50% at GSP, where 35¢, 50¢ and $1.00 tolls increased to 50¢, 75¢ and $1.50. The increase factors for NJTPK, when applied to 2005 rates, are thus 1.77 and 2.11 for off-peak and peak respectively. The 2015 truck values at **GSP** when applying the 2.68 average axle ratio are $3.82 and $4.02 respectively.

3 – Toll Blending by Screen Line

Upon implementing the updated tolls per category, the methodology of blending tolls based on axle and E-Z Pass ratios at different facilities seemed to induce contrary effects. For example, Lincoln Tunnel truck traffic has noticeably less large trucks than the other PANYNJ bridges (no trucks allowed in Holland Tunnel), which means that the blended truck rate across all axle categories is lower than at GWB or any of the SIB. In the future, this difference may go up to over 25$, almost half of the other bridges' toll values. In effect, this creates a much more desirable path through LT than at any of the other bridges, in particular GWB which is the closest competition. After assignment, the reverse of the existing situation would be observed, meaning a majority of trucks would be using LT and maybe only half as many at GWB. The only way to correct this situation is to charge the same toll across a screen line, where prices are equivalent, and only use the individual blended tolls for revenue calculations at each individual bridge or tunnel.

In the BPM network, there are only two such screen lines where similarly tolled facilities are in direct competition: the 6 PANYNJ crossings (with a subset of SIB for auto tolls) and the three MTA Bronx-Queens crossings. Verrazano-Narrows has its own tolling scheme, and both MTA tunnels are sufficiently distant from the tolled BQ bridges, as well as being in direct competition with four other free bridges, that they don't need to be lumped with the BQ MTA bridges tolling scheme.

The coding worksheet was set up to carry both the individual blended rates at each facility for 2010 and 2015, to be eventually used for revenue calculations (worksheets 7a-7c, ending in REV), while the worksheets to be used for modeling the uniform screen line rates are identified with an ending SCL in 5b, 5c, 6b and 6c.

The very high trucking tolls exacerbates the differences in the truck mix, and this could really only be solved by expanding the truck classes to match the tolling schemes. However, this is an impractical solution, as both the data for 6 different axle classes is lacking in the Freight Analysis Framework (FAF) used to model trucks and this would further complicate an already very complex modeling structure. It is common practice though to have at least two classes of trucks for models of this magnitude, usually single-unit and tractor-trailer. These two categories could then be assigned to the 2-3 axle and 4+ toll classes and would lead to better toll management, for example banning heavy trucks at Lincoln Tunnel and allowing light trucks at Holland tunnel to reflect the existing truck mix at these two facilities.