

## **NETWORK ANALYSIS AND TRANSPORTATION PLANNING ASSIGNMENT**

### **Understanding the Census Transportation Planning Package**

Due before the end of Sunday, March 30th

This assignment provides an introduction to integrating “Journey to Work” data from the Census Transportation Planning Package (CTPP) into ArcGIS. This assignment focuses on analyzing the transportation mode choice for commuters.

The assignment guides you through the following steps:

- Downloading data from the Bureau of Transportation Statistics website
- Adding the data to ArcGIS
- Extracting a subset of data and creating maps displaying CTPP information

Although this assignment uses data from New York City, the same techniques can be applied to other parts of the country.

#### **SOFTWARE**

This assignment uses both ArcGIS and Microsoft Access.

#### **DATASETS**

This assignment uses two datasets for the New York City region:

- Census Tract shapefile for New York City metropolitan region, containing all census tracts within 100 miles of Central Park
- State boundary for all states with part of the state within 100 miles of Central Park

#### **ABOUT THE CENSUS TRANSPORTATION PLANNING PACKAGE**

The CTPP is a set of tabulations from the long-form of the decennial census, designed to gather information useful for transportation planning. It contains three data products:

- Tabulations at Residency (121 tables): By place of residency. Provides summary tables that describe persons, household and workers characteristics by place of residence.
- Tabulations at Work (88 tables): By place of work. Summarizes information about workers such as industry, sex, age, occupational class and time of arrival at work by place of work.
- Journeys to Work (14 tables): Provides detailed information about the commute trip from home to work, allowing the user to obtain such information as the origin and destination of each commuting trip, the travel time of the trip, when the trip began or ended, including people per vehicle and travel mode.

#### **ASSIGNMENT**

##### 1. Selecting the appropriate data from the CTPP

The Bureau of Transportation Statistics (BTS) provides a portal for downloading tables from the 2000 CTPP. This site functions as a simplified version of the Census' American Factfinder.

On a browser go to the following link:

[http://www.transtats.bts.gov/DL\\_SelectFields.asp?Table\\_ID=1348&DB\\_Short\\_Name=CTPP%202000](http://www.transtats.bts.gov/DL_SelectFields.asp?Table_ID=1348&DB_Short_Name=CTPP%202000)

The download page for the CTPP 2000 Part 3 is shown here.

At the top of the list is the IDs table, containing geographic identifying information. Each record in this table consists of a pair of Home and Work locations. The remainder of the list is the data tables, P3-001 through P3-014. Each of these tables is listed along with a brief description of the contents.

This assignment focuses on mode choice (how many workers use each type of transportation to get to work). The logical table for this is P3-006, which lists each mode of transportation and the number of workers who used it to get from home to work.

Unfortunately, there are severe limitations with table P3-006 that are not readily apparent. This table is subject to a data privacy threshold imposed by the Census Bureau for the CTPP. Specifically, records with fewer than three un-weighted home to work pairs for a given field are set to zero. At the census tract level this occurs often in this table because the data is split into 17 transportation modes and further disaggregated into a very large number of home to work location pairs. This was ostensibly applied by the Census Bureau to protect the privacy of individuals and was applied to tables p3-003 through P3-007.

However, there's a workaround for the threshold problem. Two other tables in the CTPP Part 3 can be used to estimate the number of workers using each mode of transportation to get to work. Table P3-008 contains the "mean travel time by means of transportation to work" and table P3-014 contains the "aggregate travel time by means of transportation to work". Dividing the aggregate travel time by mean travel time can be used to estimate the number of workers for each home to work location pairs.

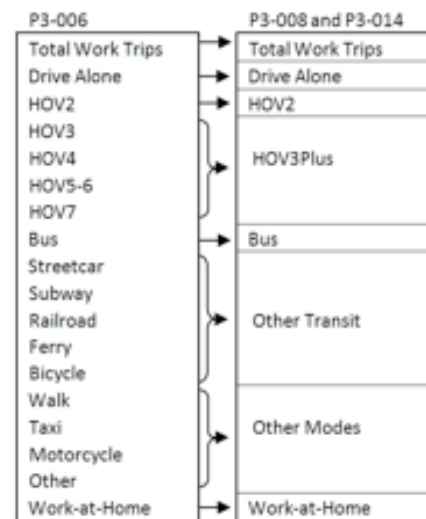
Number of workers = Aggregate travel time / Average travel time

This method is not a perfect replacement for table P3-006. The P3-008/P3-014 combination has only 8 transportation mode variables instead of the 18 variables modes in table P3-006. This is accomplished by combining multiple modes into single variables. The figure on the right shows how these variables are combined.

Another limitation of this method is that it doesn't work well for calculating the number of workers working at home. This method divides aggregate travel time by the average travel time; however it takes workers zero minutes to travel to work if they work at home.

A final note of caution: the CTPP data is rounded. All of its tables (except mean, median and standard deviation tables) are subject

The screenshot shows the RITA website interface for downloading CTPP 2000 Part 3 data. It features a top navigation bar with links like 'About BTS', 'BTS Press Room', 'Data and Statistics', 'Publications', 'Subject Areas', and 'External Links'. A search bar is located in the top right. Below the navigation bar, there's a 'Data Tools' section on the left with links like 'Database Directory', 'Glossary', 'Upcoming Releases', and 'Data Release History'. The main content area displays a list of data tables (P3-001 through P3-014) with their descriptions. The 'Data Tools' section is visible on the left.



to the following rounding rules:

- 0 is kept as 0
- 1 - 7 is rounded to 4
- Anything above 7 is rounded to the nearest multiple of 5

This can lead to discrepancies amongst the total values within tables. The rounding of CTPP tables is not a fatal flaw, but should be kept in mind when analyzing tables.

## 2. Download data from CTPP:

At the top of the BTS website, select the GEography and State. In this assignment we will be downloading census tract level data for New York State.

In the first pull-down menu, select “St-Cnty-CTract”. In the second one, select “New York”.

In the next section, check the boxes for “Merge groups into one table” and “select documentation”.

The screenshot shows the RITA (Research and Innovative Technology Administration) Bureau of Transportation Statistics website. The header includes the RITA logo and navigation links. The main navigation bar has tabs for About BTS, BTS Press Room, Data and Statistics, Publications, Subject Areas, and External Links. The TranStats section is active, showing a search bar and a list of resources. The CTPP 2000 : CTPP 2000 Part 3 section is displayed, with filters for Download Instructions, Filter SummaryLevel (St-Cnty-CTract), and Filter Tab\_Area (New York). The 'Merge groups into one table' and 'Documentation' checkboxes are checked. A table lists various CTPP tables with their descriptions and checkboxes for selection.

Group Name	Description
<input checked="" type="checkbox"/> IDs (Identifiers)	Tabulations of Place of Residence by Place of Work: Provides geographic identification number for each standardized geographic area identified by CTPP
<input type="checkbox"/> P3-001 (Part3 Table 001)	Total workers (1). The various fields under this table are a cross tabulation of one or more variables. The universe is All Workers for this table.
<input type="checkbox"/> P3-002 (Part3 Table 002)	Vehicles available (4) by Means of transportation to work (8). The various fields under this table are a cross tabulation of one or more variables. The universe is Workers residing in households for this table.
<input type="checkbox"/> P3-003 (Part3 Table 003)	Poverty status in 1999 (4). The various fields under this table are a cross tabulation of one or more variables. The universe is Workers for whom poverty status has been determined for this table.
<input type="checkbox"/> P3-004 (Part3 Table 004)	Minority status (3). The various fields under this table are a cross tabulation of one or more variables. The universe is All Workers for this table.
<input type="checkbox"/> P3-005 (Part3 Table 005)	Household income in 1999 (9). The various fields under this table are a cross tabulation of one or more variables. The universe is Workers residing in households for this table.
<input type="checkbox"/> P3-006 (Part3 Table 006)	Means of transportation (18). The various fields under this table are a cross tabulation of one or more variables. The universe is All Workers for this table.

Next, to select the tables we are using, do not check the box for the tables. Instead, click on the name of the tables (P3-008 and P3-014) to open up a list of the variables.

Table P3-008 breaks each of the 8 mode variables further into different time periods, but for our purposes we only want the totals. Because of this, for each of the 8 variables, only select the first instance. Thus for table P3-008, select the following variables to download:

1. T308C1\_1
2. T308C2\_1
3. T308C3\_1
4. T308C4\_1
5. T308C5\_1

6. T308C6\_1
7. T308C7\_1
8. T308C8\_1

is Workers residing in households for this table.	
<input type="checkbox"/> P3-008 (Part3 Table 008)	Mean travel time by Means of transportation to work (8) and Time leaving home to go to work (4). The various fields under this table are a cross tabulation of one or more variables. The universe is All Workers for this table.
<input checked="" type="checkbox"/> T308C1_1	All Workers; For All 8 Categories Of Means Of Transportation To Work; For All 4 Categories Of Time Leaving Home To Go To Work
<input type="checkbox"/> T308C1_2	All Workers; For All 8 Categories Of Means Of Transportation To Work; Time Leaving Home To Go To Work Is From 5:00 A.M. To 8:59 A.M.
<input type="checkbox"/> T308C1_3	All Workers; For All 8 Categories Of Means Of Transportation To Work; Time Leaving Home To Go To Work Is From 9:00 A.M. To 4:59 A.M.
<input type="checkbox"/> T308C1_4	All Workers; For All 8 Categories Of Means Of Transportation To Work; Who Worked At Home
<input type="checkbox"/> T308C2_1	All Workers; Who Drove Alone; For All 4 Categories Of Time Leaving Home To Go To Work
<input type="checkbox"/> T308C2_2	All Workers; Who Drove Alone; Time Leaving Home To Go To Work Is From 5:00 A.M. To 8:59 A.M.
<input type="checkbox"/> T308C2_3	All Workers; Who Drove Alone; Time Leaving Home To Go To Work Is From 9:00 A.M. To 4:59 A.M.
<input type="checkbox"/> T308C2_4	All Workers; Who Drove Alone; Who Worked At Home
<input checked="" type="checkbox"/> T308C3_1	All Workers; Who Travel To Work By 2-Person Carpool; For All 4 Categories Of Time Leaving Home To Go To Work
<input type="checkbox"/> T308C3_2	All Workers; Who Travel To Work By 2-Person Carpool; Time Leaving Home To Go To Work Is From 5:00 A.M. To 8:59 A.M.
<input type="checkbox"/> T308C3_3	All Workers; Who Travel To Work By 2-Person Carpool; Time Leaving Home To Go To Work Is From 9:00 A.M. To 4:59 A.M.
<input type="checkbox"/> T308C3_4	All Workers; Who Travel To Work By 2-Person Carpool; Who Worked At Home
<input checked="" type="checkbox"/> T308C4_1	All Workers; Who Travel To Work By 3-Or-More-Person Carpool; For All 4 Categories Of Time Leaving Home To Go To Work
<input type="checkbox"/> T308C4_2	All Workers; Who Travel To Work By 3-Or-More-Person Carpool; Time Leaving Home To Go To Work Is From 5:00 A.M. To 8:59 A.M.
<input type="checkbox"/> T308C4_3	All Workers; Who Travel To Work By 3-Or-More-Person Carpool; Time Leaving Home To Go To Work Is From 9:00 A.M. To 4:59 A.M.
<input type="checkbox"/> T308C4_4	All Workers; Who Travel To Work By 3-Or-More-Person Carpool; Who Worked At Home

Table P3-014 also further divides the 8 transportation modes by time of day, so again select a subset of the variables:

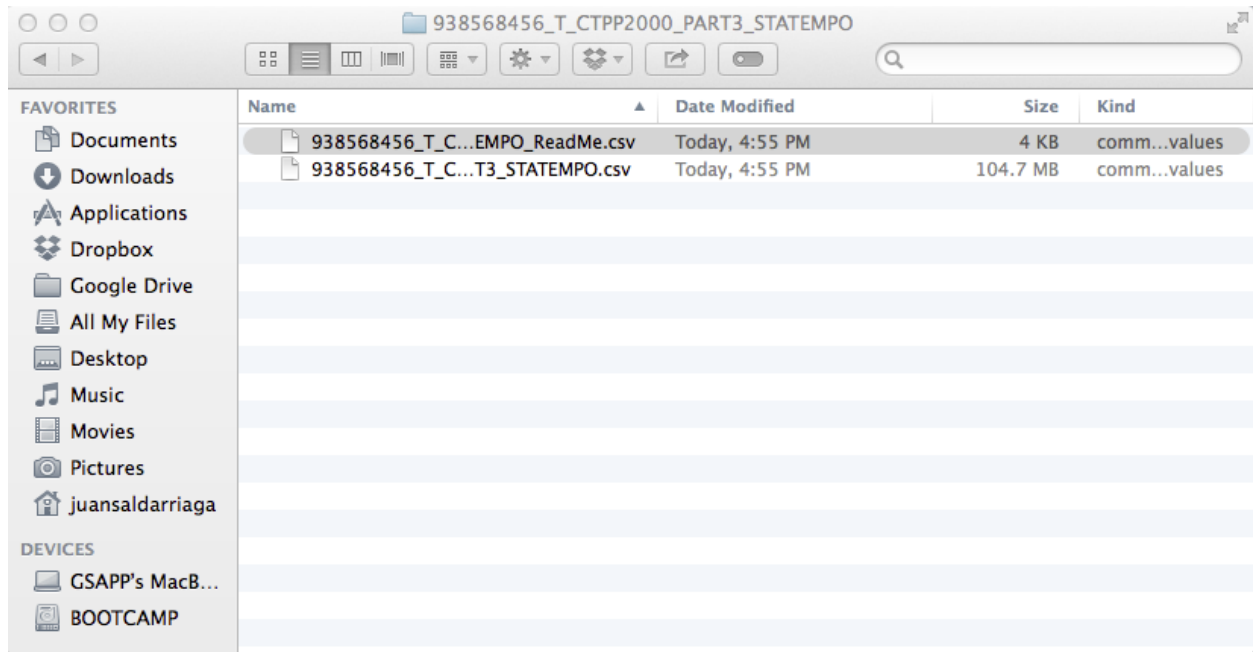
1. T314C1\_1
2. T314C2\_1
3. T314C3\_1
4. T314C4\_1
5. T314C5\_1
6. T314C6\_1
7. T314C7\_1
8. T314C8\_1

Note that these 8 variables correspond to the 8 transportation modes described above.

Now that we have selected the geographic unit of analysis, state, the merge tables and documentation options, and chosen the appropriate tables, we can finally download the data. Click the download button and save the file in a project folder where you will keep all the data for this tutorial.

### 3. Unzip the data:

After the data has completed downloading, unzip the data to your project folder. The zip file contains two files, a database and a data dictionary.

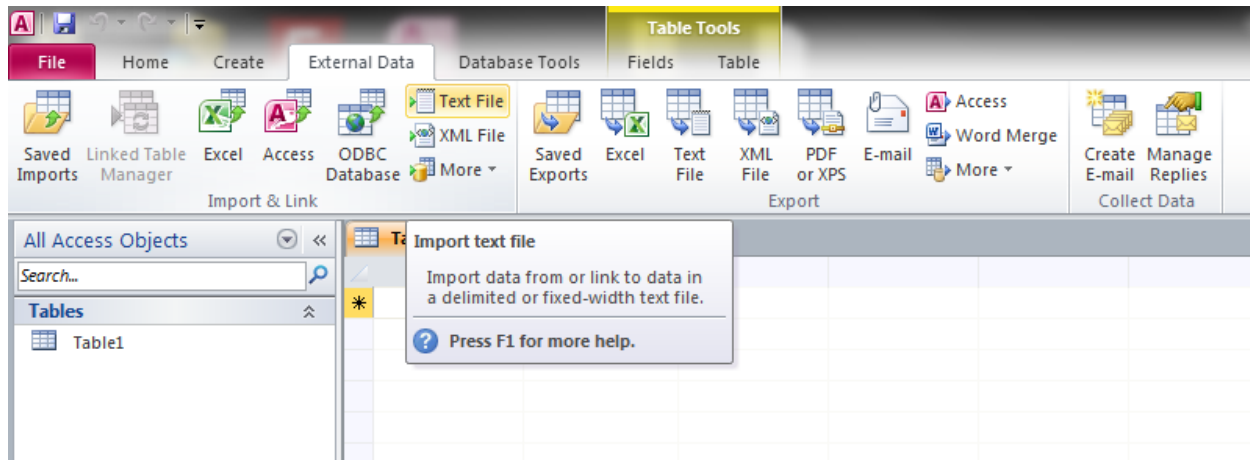


### 4. Format the data:

Because the dataset is quite large, we will do some pre-processing of the data in Microsoft Access to make the file easier to use in ArcGIS.

Open Microsoft Access and start a new Blank Database. Name the database CTPP\_NY.accdb and save it in the same directory where the data you just downloaded is.

Microsoft Access will automatically open a blank table. Click on the External Data tab and select the button for "Text File".



This will open the import dialog box. Select the CSV database file and click ok.

In the importing options that appear next select “Delimited” and press next.

Then, select “Comma” as the file was a CSV (“Comma Separated Values”). In addition, check the option that says “First Row Contains Field Names”. If you don’t do this the data will not import your field name and the first row of your new table will have the field names. This will cause problems during the importing procedure. Click next.

The next dialog box allows you to define the data types and to exclude certain data fields. Because our table includes several fields with no data we will exclude several of these fields. The table below lists all the fields and whether to exclude them or not, and what type of data the field should be in. Use the table as a guide for each variable.

1	SYS_FIELD_NAME	TEXT	23	QPOWTRACT	TEXT
2	SOURCE	TEXT	24	SUBSUMLEVWRK	---DO NOT IMPORT
3	FILEID	TEXT	25	DEWORKGEO	---DO NOT IMPORT
4	TAB_AREA	TEXT	26	FLOW_FLAG	---DO NOT IMPORT
5	TR_TAB_AREA_NM	TEXT	27	FILLER	---DO NOT IMPORT
6	SUMLEV	TEXT	28	T308C1_1	DOUBLE
7	SUMLEV_NM	TEXT	29	T308C2_1	DOUBLE
8	STATE3	TEXT	30	T308C3_1	DOUBLE
9	COUNTY	TEXT	31	T308C4_1	DOUBLE
10	COUSUB	---DO NOT IMPORT	32	T308C5_1	DOUBLE
11	COUSUBCE	---DO NOT IMPORT	33	T308C6_1	DOUBLE
12	PLACE2	---DO NOT IMPORT	34	T308C7_1	DOUBLE
13	PLACECE2	---DO NOT IMPORT	35	T308C8_1	DOUBLE
14	TRACT	TEXT	36	T314C1_1	LONG INTEGER
15	SUBSUMLEVRES	---DO NOT IMPORT	37	T314C2_1	LONG INTEGER
16	DETRESGEO	---DO NOT IMPORT	38	T314C3_1	LONG INTEGER
17	QPOWST	TEXT	39	T314C4_1	LONG INTEGER
18	QPOWCO	TEXT	40	T314C5_1	LONG INTEGER
19	QPOWMCDFIPS	---DO NOT IMPORT	41	T314C6_1	LONG INTEGER
20	QPOWMCD	---DO NOT IMPORT	42	T314C7_1	LONG INTEGER
21	QPOWPLFIPS2	---DO NOT IMPORT	43	T314C8_1	LONG INTEGER
22	QPOWPL2	---DO NOT IMPORT			

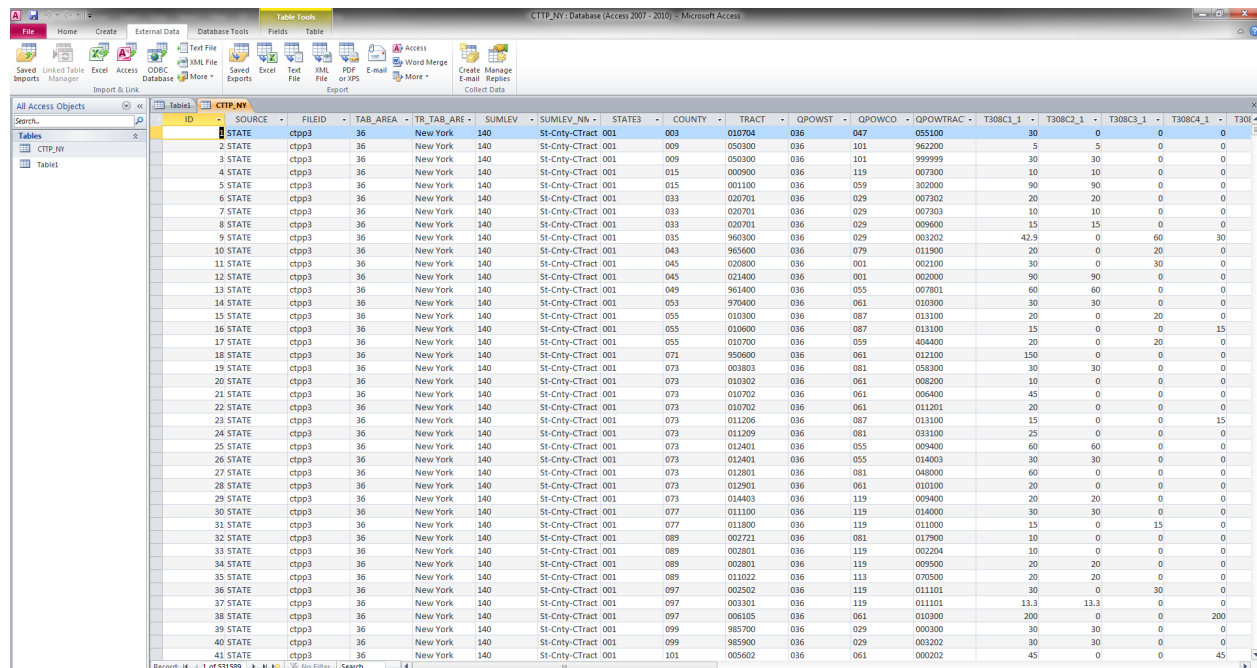
The next dialog box selects the primary key. In this case, leave the default “Let Access add primary key” and click next.



Name the table CTPP\_NY and click “Finish”.

If you want, you can save these importing rules to save you time next time you download CTPP data. Click next.

The new table, CTPP\_NY should appear in the Access workplace. If it doesn’t open automatically, double-click on the table CTPP\_NY in the table of contents sidebar on the left.



The screenshot shows the Microsoft Access application window titled "CTPP\_NY - Database (Access 2007 - 2010) - Microsoft Access". The ribbon includes "File", "Home", "Create", "External Data", "Database Tools", "Table Tools" (with "Fields" and "Table" tabs), and "Access". The "Table Tools" ribbon has "Import & Link", "Export", "Create", "Manage", and "Collect Data" groups. The "All Access Objects" pane on the left shows "Tables" and "CTPP\_NY". The main window displays a data grid for the "CTPP\_NY" table. The grid has columns: ID, SOURCE, FILEID, TAB\_AREA, TR\_TAB\_AREA, SUMLEV, SUMLEV\_NW, STATE3, COUNTY, TRACT, QPOWST, QPOWCO, QPOWTRACT, T308C1\_1, T308C2\_1, T308C3\_1, T308C4\_1, and T308C5\_1. The data rows show various combinations of these values, representing census tracts and their relationships.

ID	SOURCE	FILEID	TAB_AREA	TR_TAB_AREA	SUMLEV	SUMLEV_NW	STATE3	COUNTY	TRACT	QPOWST	QPOWCO	QPOWTRACT	T308C1_1	T308C2_1	T308C3_1	T308C4_1	T308C5_1
1	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	003	010704	036	047	055100	30	0	0	0	0
2	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	009	050300	036	101	962200	5	5	0	0	0
3	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	009	050300	036	101	999999	30	30	0	0	0
4	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	015	000900	036	119	067300	10	10	0	0	0
5	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	015	001100	036	059	302000	90	90	0	0	0
6	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	033	020701	036	029	007302	20	20	0	0	0
7	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	033	020701	036	029	007303	10	10	0	0	0
8	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	033	020701	036	029	009600	15	15	0	0	0
9	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	035	960300	036	029	003202	42.9	0	60	30	0
10	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	043	965600	036	079	011900	20	0	20	0	0
11	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	045	020800	036	001	002100	30	0	30	0	0
12	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	045	021400	036	001	002000	90	90	0	0	0
13	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	049	961400	036	055	007801	60	60	0	0	0
14	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	053	979400	036	061	010300	30	30	0	0	0
15	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	055	010300	036	087	013100	20	0	20	0	0
16	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	055	010600	036	087	013100	15	0	0	0	15
17	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	055	010700	036	059	404400	20	0	20	0	0
18	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	071	959600	036	061	012100	150	0	0	0	0
19	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	073	003803	036	081	006300	30	30	0	0	0
20	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	073	010302	036	061	008200	10	0	0	0	0
21	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	073	010702	036	061	006400	45	0	0	0	0
22	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	073	010702	036	061	011201	20	0	0	0	0
23	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	073	011206	036	087	013100	15	0	0	0	15
24	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	073	011209	036	081	013100	25	0	0	0	0
25	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	073	012401	036	055	009400	60	60	0	0	0
26	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	073	012401	036	055	014003	30	30	0	0	0
27	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	073	012801	036	081	048000	60	0	0	0	0
28	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	073	012901	036	061	010100	20	0	0	0	0
29	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	073	014403	036	119	009400	20	20	0	0	0
30	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	077	011100	036	119	014000	30	30	0	0	0
31	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	077	011800	036	119	011000	15	0	15	0	0
32	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	089	002721	036	081	017900	10	0	0	0	0
33	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	089	002801	036	119	002204	10	0	0	0	0
34	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	089	002801	036	119	009900	20	20	0	0	0
35	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	089	011802	036	113	070500	20	20	0	0	0
36	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	097	002502	036	119	011101	30	0	30	0	0
37	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	097	003301	036	119	011101	13.3	13.3	0	0	0
38	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	097	006105	036	061	010300	200	0	0	0	200
39	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	099	985700	036	029	000300	30	30	0	0	0
40	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	099	985900	036	029	003202	30	30	0	0	0
41	STATE	ctpp3	36	New York	140	St-Cnty-Contract	001	101	005602	036	061	000202	45	0	0	0	45

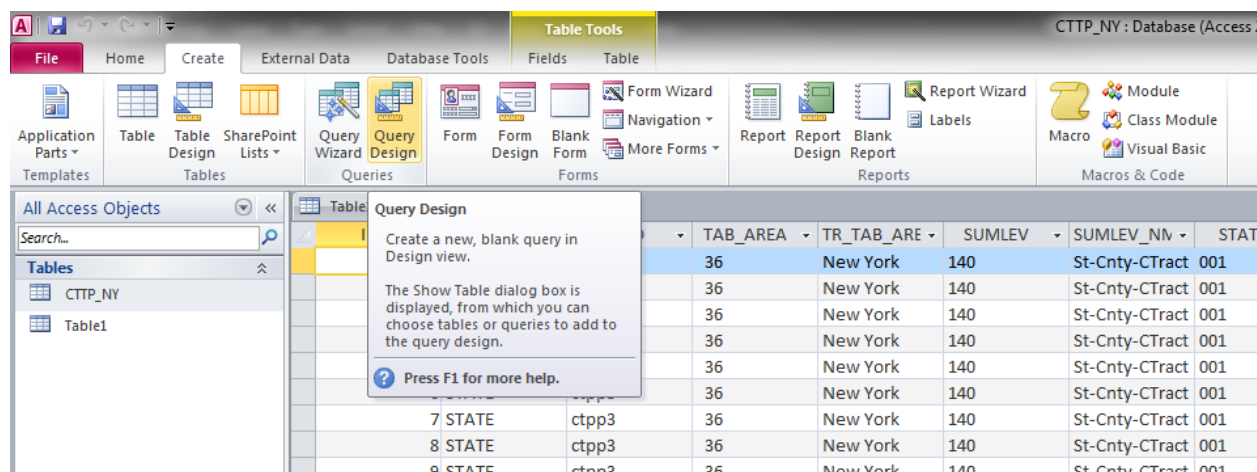
Review the database. Make sure that the procedure imported the data properly. There should be over 530,000 records. The database lists every combination of home census tract and work census tract for New York State. The home locations are designated by the QPOWST, QPOWCO and QPOWTRACT fields.

## 5. Querying to a table:

Because the database is so large, we are going to filter the data to keep only the data with work locations in Manhattan. This will allow us to analyze the mode of travel from workers in Manhattan.

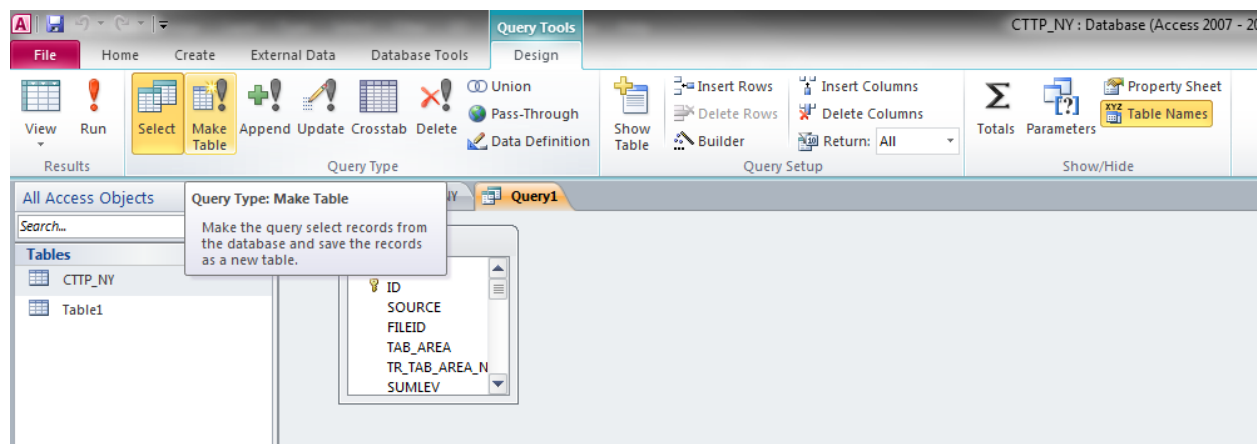
To do this we will create a query for work locations in New York State (QPOWST = 036) and New York County (QPOWCO = 061).

Click on the “Create” tab in Access and then the “Query Design” button.



This adds a tab to the workspace called “Query1”. In addition, a window at the bottom allows you to add a table to the query. Add a table CTPP\_NY and close the “Show Table” window.

Table CTPP\_NY now appears in our query and lists all the fields in our table. At the top of the window, click on the “Make Table Button”.



This opens a dialog box. Enter “ManhattanWorkers” as the name of the table. This will be the name of the table that will be created when this query is run.

## 6. Querying ManhattanWorkers:

To make the BTS data useful, we need to create a table from the query containing the following fields.

- H\_Tract The home location (state ID, county ID, and census tract number)
- W\_Tract The work location (state ID, county ID, and census tract number)
- Workers The number of workers traveling from H\_Tract to W\_tract, calculated by dividing the following variables in Table 14 by Table 8:  

$$\text{Workers} = \text{T308C1\_1} / \text{T314C1\_1}.$$
- SOV The number of workers driving to work in a single occupancy vehicle (SOV).  

$$\text{SOV} = \text{T308C1\_2} / \text{T314C1\_2}.$$



HOV2	The number of workers traveling in a 2-person carpool (HOV2). HOV2 = T308C1_3 / T314C1_3
HOV3Plus	The number of workers traveling in a 3-or-more-person carpool. HOV3Plus = T308C1_4 / T314C1_4
BUS	The number of workers traveling by bus or trolley bus. Bus = T308C1_5 / T314C1_5
Transit	The number of workers traveling by streetcar, subway, railroad or ferryboat. Transit = T308C1_6 / T314C1_6
Other	The number of workers traveling by bicycle, walked, motorcycle or taxi. Other = T308C1_7 / T314C1_7

The work-at-home variables are omitted from these calculations as discussed previously.

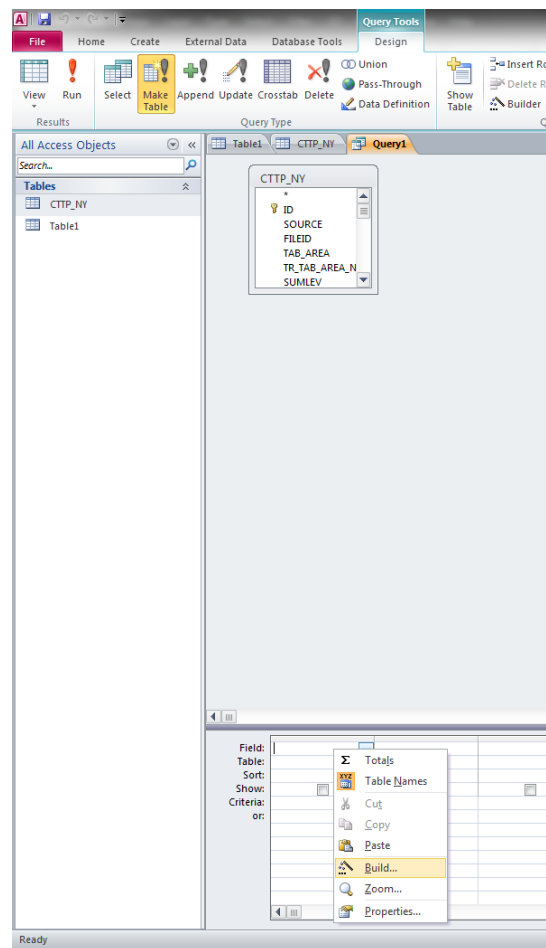
To calculate the H\_Tract and W\_Tracts variables, right-click on the “Field” value in the first element in the query definition and select “Build” from the pull-down menu.

This will open the “Expression Builder” window, which enables the user to define new variables for the output table.

In the “Expression Builder” window we will write the expression for calculating H\_Tract. As the table currently exists, there is no unique identifier taht we can use to join this data to a census tract shapefile. The sate, county and tract fields must be combined so that we can link this table to the Census Tracts shapefile. In particular, we will link our identifying variable to the FIPS code (an 11 character standard geographic identifying field).

Thus, we have to add new fields to the CTPP\_NY in which we will include all information.

For the H\_Tract field the following expression will be used:  
*H\_Tract:*



*Right([CTPP\_NY]![STATE3],2)+[CTPP\_NY]![COUNTY]+[CTPP\_NY]![TRACT]*

The first line of the command, “H\_Tract” defines the name of the output field in our new table. In Access’ SQL commands, fields are denoted first by the table name in brackets followed by the “!”, then the variable name also in brackets. Thus, the variable State3 in the CTPP\_NY table is listed as [CTPP\_NY]![STATE3].

The reason that the “Right” command is used with the State3 field is because the State ID from the BTS data uses a 3-character text field, but the FIPS code uses only two characters to identify each state. The

“Right” command truncates the field after taking the first X number of characters. In our case, we have set X as the number 2.

The following describes how to use the Expression Builder to construct the above command.

First, define the name of the new variable as “H\_Tract” followed by a colon and press return.

To call the “Right” command, select “Functions” below and then “Built-In Functions” from the left-side list. Finally, double-click on the “Right” command from the list of operations in the column on the right.

Next, replace the <<string>> in the command window with variable STATE3. To do this select “Tables” and then CTPP\_NY from the left-side list. Then double click on the STATE3 variable from the list in the middle column.

Then replace the <<length>> with the number 2.

To concatenate the State, County and Tract identifiers, use a “+” sign in between the State3 and COUNTY variable and another “+” sign between the COUNTY and TRACT variables. As an alternative to constructing this manually you can also write this expression or paste it into the command window.

After the command is entered click OK.

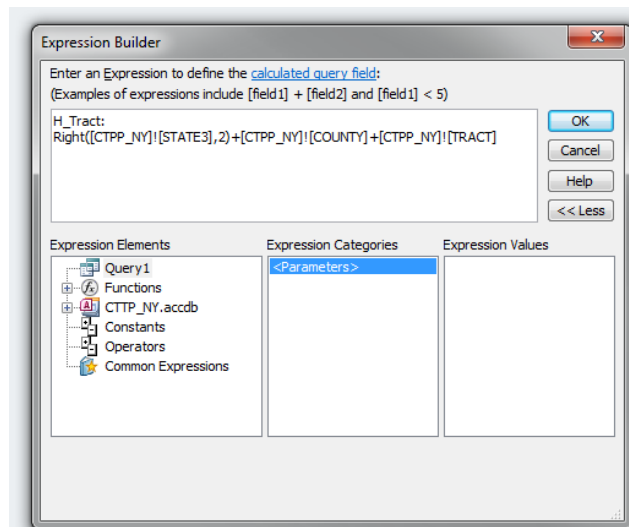
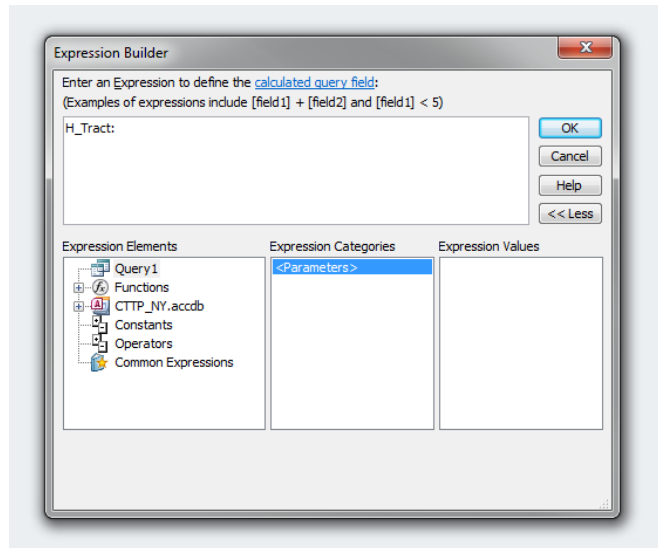
This adds the expression to the query design (at the bottom). Note that the visible portion of the Field lists the following: “H\_Tract: Right([CTP

Click on the check-box to “Show” so that the variable we just created will be included in the output table.

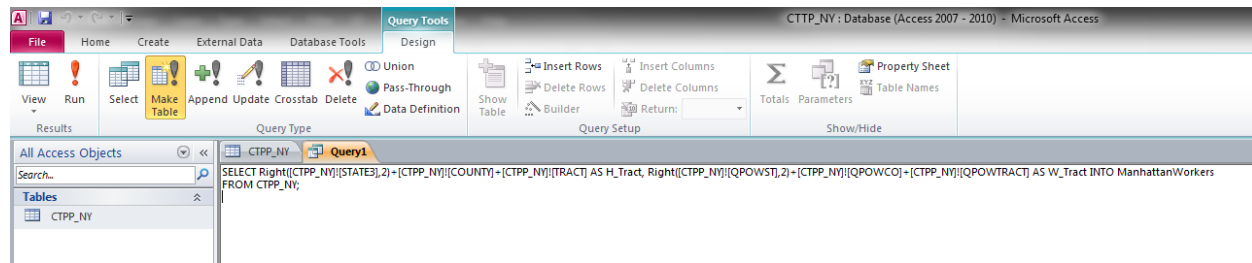
Next, construct the command for the W\_Tract field. This time, try copying the following two lines of code directly to the expression builder instead of building the command manually:

```
W_Tract:  
Right([CTPP_NY].[QPOWST],2)+[CTPP_NY].[QPOWCO]+[CTPP_NY].[QPOWTRACT]
```

While the Expression Builder is useful at first, it can be tedious to enter many variables. Entering commands in SQL code is much faster and easier.



To convert existing query to SQL View, click on the “View” button at the top left of the window and select SQL View. This will change the view so that it appears like the image below.



Next, copy the following SQL code into the window above and **replace** the existing code:

```
SELECT
Right([CTPP_NY]![STATE3],2)+[CTPP_NY]![COUNTY]+[CTPP_NY]![TRACT] AS H_Tract,
Right([CTPP_NY]![QPOWST],2)+[CTPP_NY]![QPOWCO]+[CTPP_NY]![QPOWTRACT] AS W_Tract,
IIf([CTPP_NY]![T308C1_1]>0,[CTPP_NY]![T314C1_1]/[CTPP_NY]![T308C1_1],0) AS Workers,
IIf([CTPP_NY]![T308C2_1]>0,[CTPP_NY]![T314C2_1]/[CTPP_NY]![T308C2_1],0) AS SOV,
IIf([CTPP_NY]![T308C3_1]>0,[CTPP_NY]![T314C3_1]/[CTPP_NY]![T308C3_1],0) AS HOV2,
IIf([CTPP_NY]![T308C4_1]>0,[CTPP_NY]![T314C4_1]/[CTPP_NY]![T308C4_1],0) AS HOV3Plus,
IIf([CTPP_NY]![T308C5_1]>0,[CTPP_NY]![T314C5_1]/[CTPP_NY]![T308C5_1],0) AS Bus,
IIf([CTPP_NY]![T308C6_1]>0,[CTPP_NY]![T314C6_1]/[CTPP_NY]![T308C6_1],0) AS Transit,
IIf([CTPP_NY]![T308C7_1]>0,[CTPP_NY]![T314C7_1]/[CTPP_NY]![T308C7_1],0) AS Other
INTO ManhattanWorkers
FROM CTPP_NY
WHERE ((([CTPP_NY].QPOWST)="036") AND (([CTPP_NY].QPOWCO)="061"));
```

The first three lines of the SQL code begin the selection (SELECT) and then define the H\_Tract and W\_Tract fields.

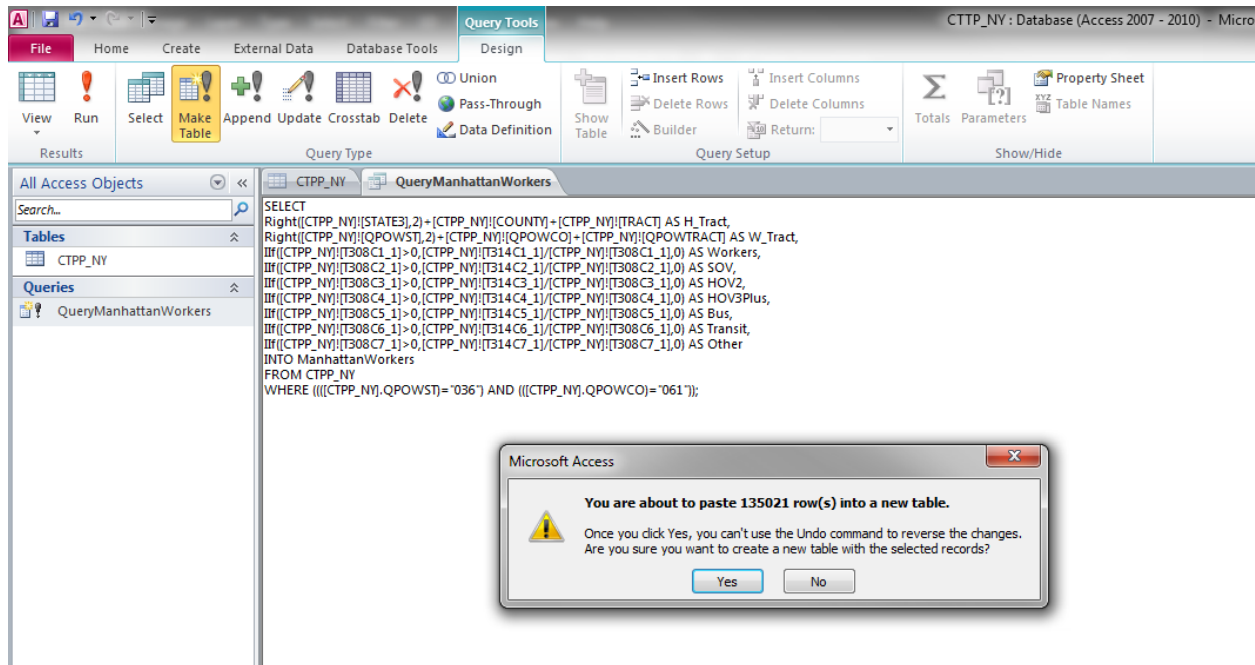
The following seven lines define each of the Journey to Work fields, one for Workers, SOV, HOV2, etc. These lines of code each include an “IF” statement (the command is “iif”) which calculates the number of workers (Table 14 divided by Table 18) only when there are more than zero workers for this particular mode.

The syntax for an “IF” statement in Access is the command “iif (expression, true, false)”. Without the “IF” statement, this process would return “Null” values for any home and work location pair with zero for that particular mode.

The final three lines of code define where to send the output data (ManhattanWorkers) followed by a conditional statement to only select work-locations from table CTPP\_NY that are in New York State (QPOWST = “036”) and Manhattan (QPOWCO = “061”).

Now to save and run the query, right-click on the Query1 tab just above the SQL code and save the query as QueryManhattanWorkers.

To run the query, select the query we just saved from the left panel and click on the red exclamation mark at the top right of the window.



Click “Yes” when you get the warning message asking if you want to paste 135,021 rows into a new table. This new table “ManhattanWorkers” will be created in the table of contents.

Double click on this new table to open it.

H_Tract	W_Tract	Workers	SOV	HOV2	HOV3Plus	Bus	Transit	Other
01053970400	36061010300	5	5	0	0	0	0	0
01071950600	36061012100	1	0	0	0	1	0	0
01073010302	36061008200	8	0	0	0	0	0	8
01073010702	36061006400	6	0	0	0	0	6	0
01073010702	36061011201	17	0	0	0	0	0	17
01073012901	36061010100	9	0	0	0	0	0	9
01097006105	36061010300	14	0	0	14	0	0	0
01101005602	36061000202	8	0	0	8	0	0	0
01115040202	36061007400	7	0	0	0	0	0	7
01115040501	36061000900	5	0	0	0	0	0	5

## 7. Aggregating the data:

The data in the ManhattanWorkers table lists the number of workers traveling from each home location (H\_Tract) to each work location (W\_Tract) by each mode of transportation. Because a specific home location will likely send workers to multiple locations, most H\_Tract are listed multiple times.

To analyze a given work location, each of the different home tracts sending workers to that location need to be aggregated together. The tables below demonstrate this concept. The table on the left lists each combination of home and work tracts, much like the CTPP\_NY table. To calculate the number of workers from each H\_Tract, the table needs to be simplified. This simplification is shown on the table on the right,

which lists each H\_Tract and the total number of commuters traveling there, regardless of the W\_Tract.

H_Tract	W_Tract	WORKERS
1001	2002	100
1001	2003	200
1002	2004	100
1002	2002	0
1003	2003	200
1003	2004	100
1004	2005	400



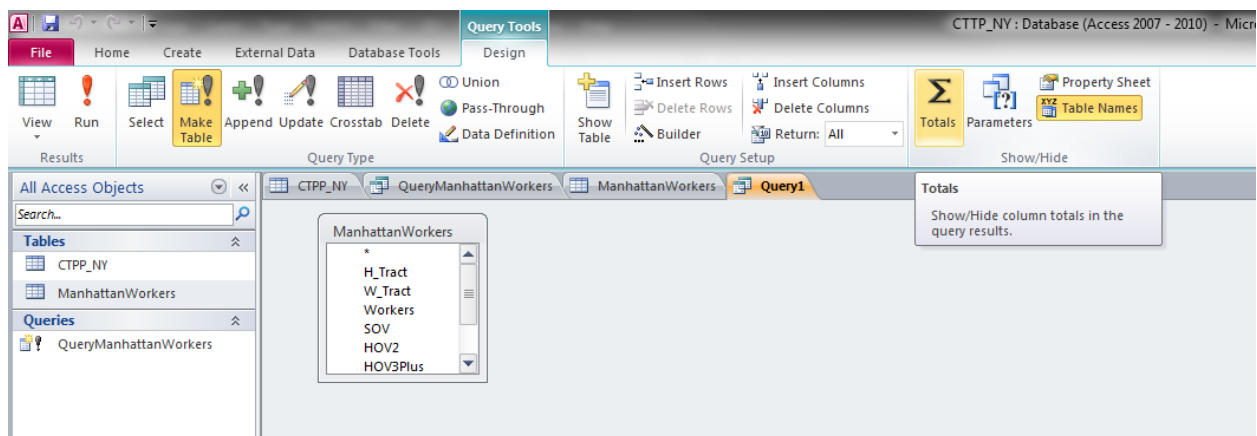
H_Tract	WORKERS
1001	300
1002	100
1003	300
1004	400

In Access, this procedure can be accomplished by writing another query that aggregate data from the ManhattanWorkers table and outputs into a new table.

To do this start a New Query. Add the ManhattanWorkers table to the query design page.

Click on the “Make Table” button and name the output table “AggregateManhattanWorkers”.

Next, click on the “Totals” button in the Query Design window.



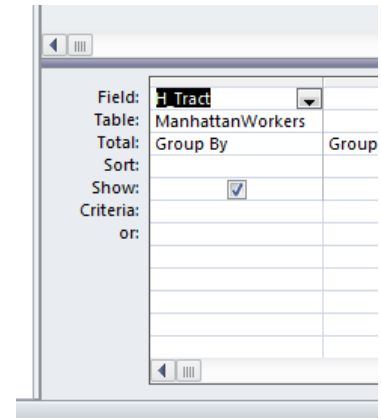
This adds a new element (“Totals”) to the query definition table at the bottom. Clicking on the new “Totals” element at the bottom opens the pull-down menu. To aggregate the data, choose to “Group By” and for the other fields we will select a function.

In our case, the function we will select will be “Sum” because we want to aggregate each of the grouped

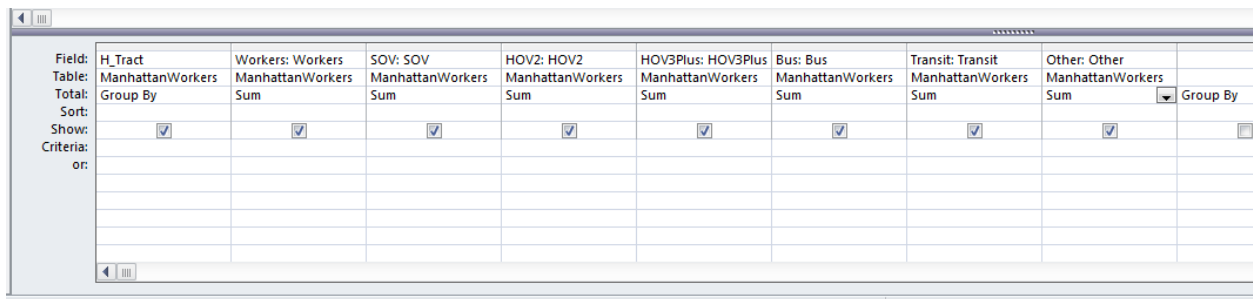
locations together.

In the query window, select H\_Tract from the ManhattanWorkers fields and drag the field into the query definition at the bottom. Make sure that “Totals” is set to “Group By”.

Skip the W\_Tract variable in this query. Next, drag the Workers and each of the six “Journey to Work” transportation mode variables to the query definition setting at the bottom. For each field add a prefix with the name followed by a colon and then the name again. This will ensure that the name in the output table is the same as the name in the ManhattanWorkers table.



Also, for each of the variables, except the first one (H\_Tract), click on the “Totals” drop-down menu and change the option to “Sum”. The query definition should look like the image below:



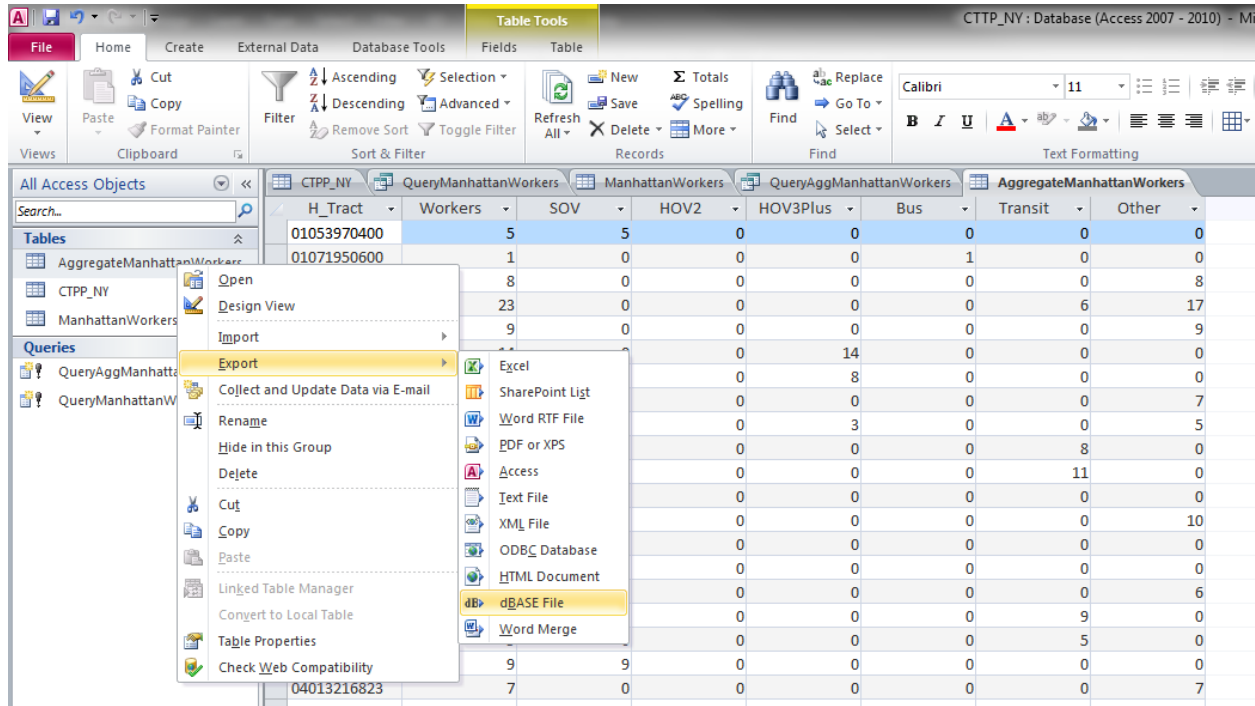
Save the query as “QueryAggManhattanWorkers” and run the query.

As before, instead of designing the query in Access, the following SQL code could have been used to achieve the same results:

```
SELECT ManhattanWorkers.H_Tract,
Sum(ManhattanWorkers.Workers) AS Workers,
Sum(ManhattanWorkers.SOV) AS SOV,
Sum(ManhattanWorkers.HOV2) AS HOV2,
Sum(ManhattanWorkers.HOV3Plus) AS HOV3Plus,
Sum(ManhattanWorkers.Bus) AS Bus,
Sum(ManhattanWorkers.Transit) AS Transit,
Sum(ManhattanWorkers.Other) AS Other
INTO AggregateManhattanWorkers
FROM ManhattanWorkers
GROUP BY ManhattanWorkers.H_Tract;
```

To export the newly created AggregateManhattanWorkers table and review the data double-click on the new table on the table of contents to your left. Right-click on the AggregateManhattanWorkers table and select Export and then dBase file.





In the export window, name the file CTPP\_NY.dbf. Make sure to select the file type dBase IV (\*.dbf). Note, this is not the default, the default is dBase III.

#### 8. Importing the data into ArcGIS and joining it:

Add the following three files to a new map document:

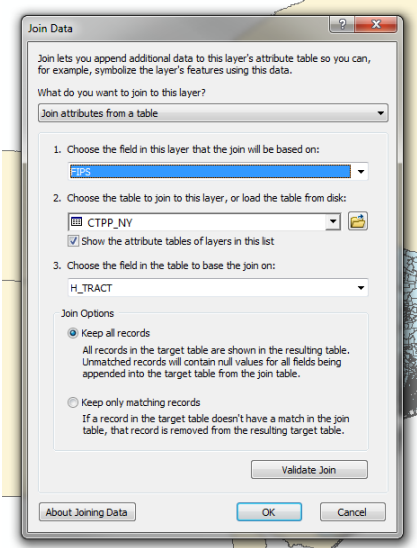
1. the CTPP\_NY.dbf file we just created.
2. The Census Tract shapefile for the New York Region (CensusTracts\_NewYorkRegion.shp).
3. The State Boundary shapefile for the New York Region (States\_NewYorkRegion.shp).

Recall that in the earlier steps, we added the H\_Tract and W\_Tract variables to the CTPP\_NY table by combining the State, County and Tract data fields. The 11 character ID is the same format as the ID used by the census category FIPS.

Join the H\_Tract and the FIPS by right-clicking on the CensusTracts\_NewYorkRegion shapefile and selecting “Joins and Relates” and “Join”.

In the Join Data window, select FIPS as the field the join will be based on. Select CTPP\_NY as the table to join to this layer and the H\_Tract as the field in the table to base the join on. Click ok.

The image below shows the results of the join. Note that several of the census tracts have null values from the join. This makes sense because not all the census tracts in the region have commuters traveling to Manhattan.



CensusTracts_NewYorkRegion												
VACANT	OWNER_OCC	RENTER_OCC	SQMI	OID	H_TRACT	WORKERS	SOV	HOV2	HOV3PLUS	BUS	TRANSIT	OTHER
306	2123	435	75.4	6640	42025020200	6	0	2	0	2	2	0
350	1305	573	1.56	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>
52	1228	222	9.67	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>
268	794	167	37.56	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>
184	877	412	6.6	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>
168	1547	275	76.69	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>
254	2329	454	94.17	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>
146	2314	679	42.45	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>
1083	954	191	172.14	3410	36025990700	30.97546	9.97546	5	0	0	14	2
3070	1411	527	243.95	3498	36039080400	80.9991	32.00095	2	0	13	21.99816	12
1341	1290	382	97.35	3414	36025991200	44	11	2	0	8	14	9
816	435	143	210.19	6152	36111950900	27	6	13	0	0	8	0
205	255	89	10.75	6150	36111950700	11	0	6	0	0	5	0
750	673	164	142.16	3415	36025991300	8	3	0	0	0	5	0
664	610	241	85.65	6151	36111950800	26	3	0	6	10	7	0
590	1144	289	55.88	6149	36111950600	134.90188	15.99707	40.00597	0	18	48	12.89655
311	1091	422	12.03	6148	36111950500	78.01928	11	9	0	18.00174	7	33.01754
135	900	154	7.17	6154	36111951100	6	0	6	0	0	0	0
437	1497	372	65.22	6153	36111951000	65	24	0	0	16	25	0
915	1096	464	95.3	6120	36105950200	34	18	10	0	0	6	0
117	1428	212	28.97	6155	36111951200	7	7	0	0	0	0	0
614	1088	258	86.28	6119	36105950100	13	0	0	13	0	0	0
460	1885	501	55.05	6168	36111952900	92	41	0	0	0	26	25
800	1547	468	61.89	6187	36111955000	183.08084	57.08846	23.99684	7	34.00277	43.99278	17
575	971	251	48.93	6122	36105950400	15	8	5	2	0	0	0
161	844	423	10.68	6166	36111952700	45	7	15	0	16	7	0

Export the joined data as a new shapefile and add it to the map document.

Now you are ready to create the maps.

## DELIVERABLES

One 11x17 PDF document with the following maps and graphs:

1. A map showing the number of workers in those census tracts who commute to Manhattan.
2. A “matrix” (series) of maps showing the proportion of those workers who use each transportation mode to commute to Manhattan.
3. Graphs and charts that answer the following questions:
  - How many workers in total work in Manhattan
  - How many come from outside the city
  - How many come from each borough
  - What is the proportion for each one of these (total, outside the city, each borough) that use each transportation method.

Again, think about layout, colors, fonts, labels, legends, etc.