Bicycle Detractor Submodel and Composite Bicycle Priority Model

Task E of the Multimodal Planning Research Project

REPORT

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1.0 Background

This report documents the development of a bicycle detractor submodel, to be combined with the City of San Diego's Bicycle Demand Model (BDM)[1]. The addition of a detractor component to the previous BDM work enables the BDM to operate more like a priority or 'need' model rather than strictly a demand model. With the inclusion of a detractor submodel, this modified BDM will be referred to from this point forward as the City's Bicycle Priority Model (BPM). This report documents the bicycle detractor submodel data inputs and GIS analysis steps in detail, including the GIS process of integrating the newly created bicycle detractors dataset with the BDM into the BPM. This report will help build capacity among other San Diego consultants and City staff to work fluently with the BPM on a variety of planning efforts.

This report is organized into the following chapters:

- ***Chapter 2.0 Bicycle Detractor Submodel:*** This chapter summarizes the bicycle detractor submodel inputs, weights and points.

- ***Chapter 3.0 Creating the Bicycle Priority Model:*** This chapter summarizes the inputs by filename and source to aid in replicating the components of the previously created Bicycle Demand Model (BDM). The BDM is combined with the Bicycle Detractor Submodel documented in Chapter 2.0 to create the Bicycle Priority Model (BPM).

- ***Chapter 4.0 GIS Steps:*** This chapter provides step-by-step guidance for creating the BPM in ArcGIS 10.1.

2.0 Bicycle Detractor Submodel

This chapter summarizes steps taken to create the bicycle detractor submodel.

2.1 Data Inputs

Table 2-1 displays the filename, field headers, file source, and date of all data used for developing the bicycle detractor submodel. The majority of the data was obtained from the SANDAG Series 12 model hwycov shapefile. Collision data was provided by the City of San Diego.

[1] The City of San Diego BDM was updated in 2015 in the report *Bike Demand Model Update – Task D of the Multimodal Planning Research Project.*

Table 2-1: Detractor Submodel Inputs

Input #	Model Input	Filenames	Field	Source	Year of Data	File Folder
1	Collisions per Year (Last 5 Years)	COLLISIONS_Oct2008_Oct2013 database (which includes Collision location/type, Party, Cause sub-databases)	BODY_TYPE_DESC: any record with the keyword 'BIKE'	City of San Diego	2013	Detractors
2	Average Daily Trips	Hwycov.shp	UVOL or ADTVL*100, whichever is greater	SANDAG (Series 12 model)	2013	Detractors
3	Posted Speed Limits	Hwycov.shp	ISPD	SANDAG (Series 12 model)	2013	Detractors
4	Number of Travel Lanes	Hwycov.shp	Number of Lanes: ABLNO + BALNO Presence of Median: IMED = 2	SANDAG (Series 12 model)	2013	Detractors
5	Slope	Elev10grd.e00	Generate elevation raster, then generate slope raster	SanGIS/SANDAG	Mid 1970s	Detractors
6	Roads Adjacent to Freeway Ramps	Roads_all.shp	Roads_all features intersecting at-grade with freeway ramps are manually selected and exported	SanGIS/SANDAG	2016	Detractors

Source: Chen Ryan Associates, November 2016

2.2 Points and Weights

Bicycle detractors are defined as features likely to discourage people from bicycling along a specific roadway. Bicycle detractors represent features that limit bicycling or may present safety or comfort issues. Chen Ryan Associates worked with City staff to develop a list of bicycle detractors and their score within the submodel. **Table 2-2** displays the detractors used in the BPM.

The Bicycle Detractors submodel borrows from the structure of the Detractors submodel used in the City of San Diego's Pedestrian Priority Model (PPM). Compared to the PPM Detractors file:

- The collision and average daily traffic volume inputs in the Bicycle Detractors have identical category breaks, points and weights as the PPM Detractors.
- Posted speed limit was utilized as a PPM Detractor, however the category breaks for the bicycle Detractors submodel are reduced by 5 mph from the PPM to be consistent with the Bicycle Level of Traffic Stress (LTS) speed criteria for bike lanes[2]**.**
- Slope was utilized as a PPM Detractor, however the category breaks have been adjusted to less steep intervals**.**
- **The** number of travel lanes and the presence of raised median is included as a Bicycle Detractor and was not previously used in the PPM Detractors, due to its consideration as an LTS criteria.
- The category breaks in the Detractors submodel matches the street width hierarchy found in the table called "Criteria for Bike Lanes Not Alongside a Parking Lane" (Mekuria et al, 2012; Table 3, documented in **Appendix A**) in the original report published by the Mineta Transportation Institute on LTS.
- The presence of at-grade freeway ramp intersections is included as a Bicycle Detractor and was not previously used in the PPM Detractors. This Detractor is widely identified as a stressful situation and safety risk for bicyclists due to the mixing that occurs with motorists traveling at high speeds.

Figure 2-1 displays the resulting bicycle detractor submodel.

The bicycle detractors submodel will be combined with the Bicycle Demand Model documented in the City of San Diego's 2015 *Bicycle Demand Model Update – Task D of the Multimodal Planning Research Project* in order to create a composite 'Priority' or 'Need' model for bicycling in the City of San Diego. The Bicycle Priority Model will identify areas with the potential for higher levels of bicycling, based on inter- and intra-community demand, particularly along high demand corridors, but that take into consideration physical and perceived barriers to bicycling. Those areas should receive a higher priority for funding and treatments.

[2] Bicycle LTS metric developed for Mineta Transportation Institute *MTI Report 11-19: Low-Stress Bicycling and Network Connectivity* (2012).

Table 2-2: Bicycle Detractors Factors and Scoring

Bicycle Detractors	Points	Weighted Multiplier	Final Score
Collisions Per Year (1/16 mile buffer applied to each collision)			
1 +	3	3	9
0.5 – 0.9	2		6
0 – 0.5	1		3
0	0		0
Average Daily Traffic Volumes			
> 45,000	3	2	6
35,000 – 45,000	2.5		5
25,000 – 35,000	2		4
15,000 – 25,000	1.5		3
10,000 – 15,000	1		2
5,000 – 10,000	0.5		1
< 5,000	0		0
Speed Limit (affects the ability to cross safely)			
> = 40 mph	3	2	6
35 mph	2		4
30 mph	1		2
< = 25 mph	0		0
Number of Travel Lanes, Presence of Raised Median			
> = 3 Lanes per Direction	3	1	3
2 Lanes per Direction (no raised median)	2		2
2 Lanes per Direction (raised median)	1		1
1 Lane per Direction	0		0
Slope			
>10%	2	1	2
5%-10%	1		1
<5%	0		0
Conflict with Freeway Ramps			
Road Segment Intersects At-Grade with Freeway Ramp Entrance/Exit	2	1	2

Source: Chen Ryan Associates, November 2016

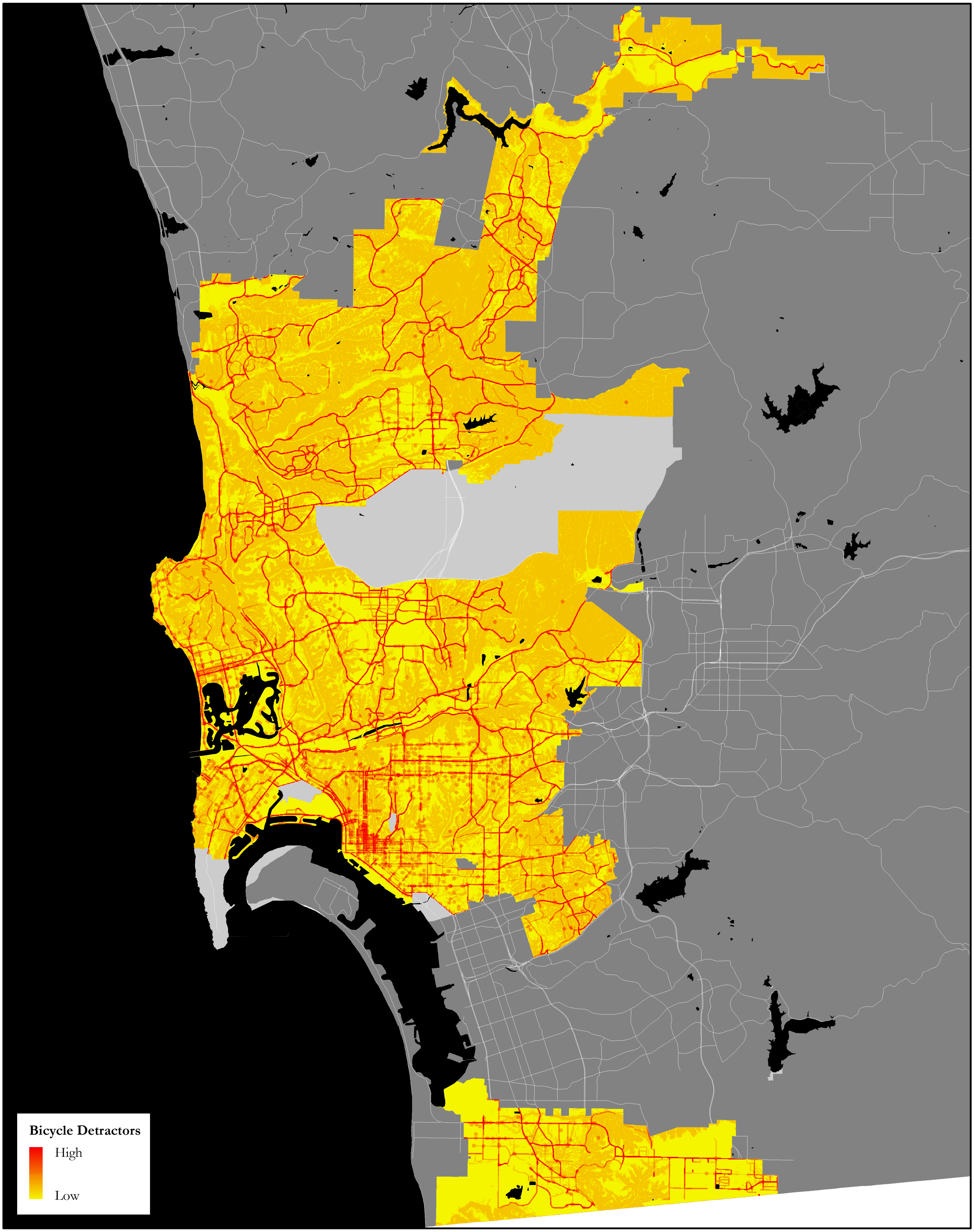

Figure 2-1

Bicycle Detractor Submodel

3.0 Creating the Composite Bicycle Priority Model

This chapter documents the synthesis of the Bicycle Detractor submodel with the Bicycle Demand Model (BDM), documented in the 2015 *Bicycle Demand Model Update – Task D of the Multimodal Planning Research Project,* to create a composite Bicycle Priority Model (BPM). The BDM utilizes two submodels of demand, the intra-community (shorter trip lengths) and inter-community (longer trip lengths) bicycle demand. The final citywide BPM composite model combines the indicators of bicycle demand described in detail in the Task D Report with the detractors described in the previous chapter to identify areas that have the highest BPM composite scores.

Table 3-1 shows the BPM point values of each submodel component. As shown, each Bicycle Demand submodel component contributes a maximum of 12 possible points to the BPM. The sum of all possible detractor points as presented in Table 2-2 amount to a maximum of 28, however the points are adjusted to fit the same 0 to 12 point scale as the Demand submodel components when combined into the BPM. Adjusting the scale of the Detractor Model to be consistent with the point requires multiplying the detractor points by 0.428. The Priority Model is structured to place greater weight on demand than on detractors since the demand or desire to reach a destination should supersede the perceived risk and discomfort that can be improved, and since the number of potential users may affect the prioritization placed on a facility to receive treatments or improvements.

Table 3-1: Bicycle Priority Model Point Values

Submodel Name	Component	Points Possible
Bicycle Demand Model	Intra-Community Demand	0 – 12
	Inter-Community Demand	0 – 12
Bicycle Detractors Model	Detractors	0 – 12

Source: Chen Ryan Associates, August 2016

For the BPM, each road segment's detractor point value is derived from weighted average Detractor points along its extent, as is the case with the BDM. This means that spatial variations in points found in the Detractor submodel will not split road segments into fragmented features, but will instead be used to assemble a weighted average score over the whole road segment. A road segment is defined as a stretch of road from intersection to intersection. The technical process of applying weighted average point value is described in Section 4.2, Step 1.0 of this report.

Figure 3-1 displays the resulting final citywide BPM composite model for the City of San Diego.

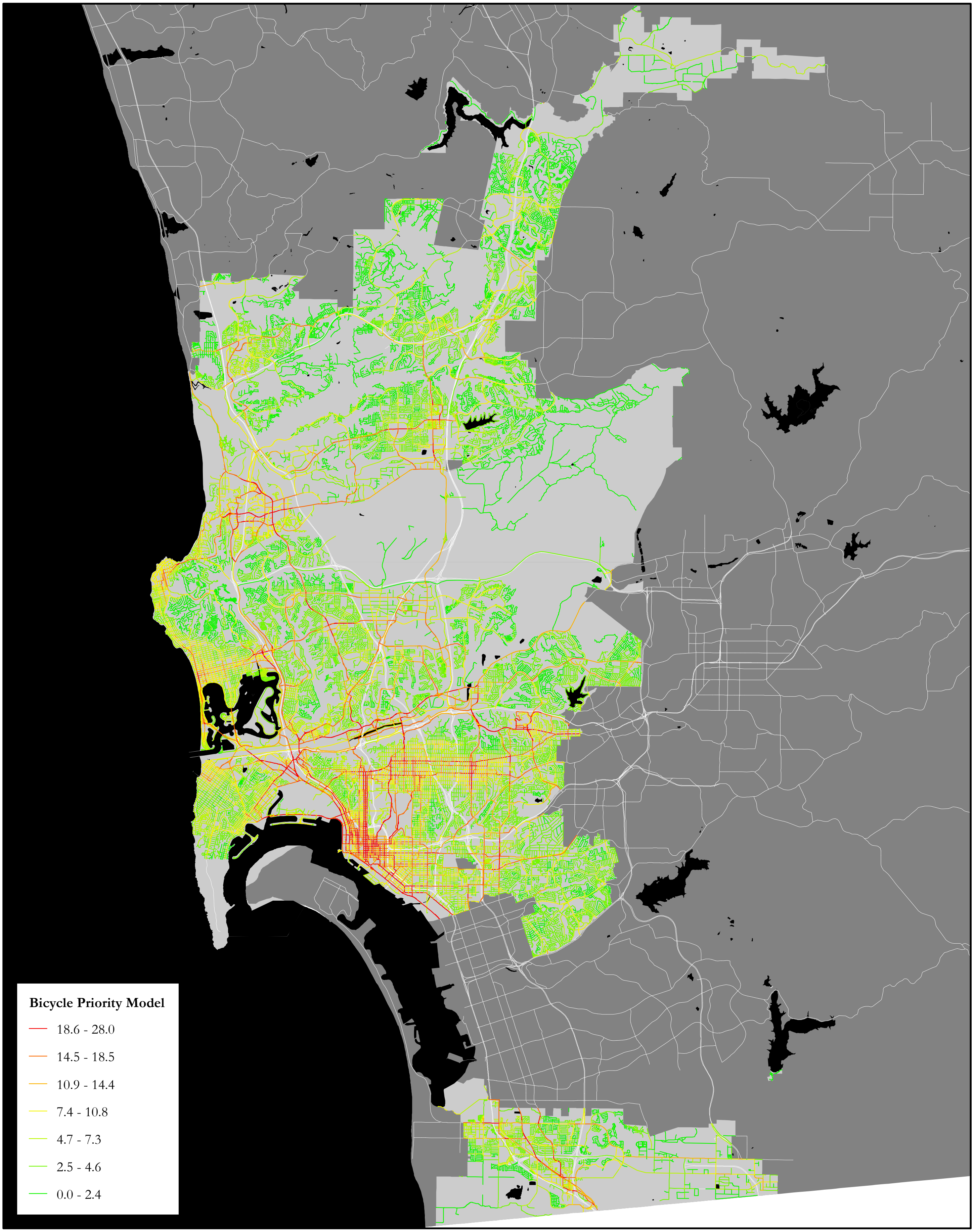

Figure 3-1

Final Citywide BPM Composite Model

4.0 GIS Steps

This section of the report presents detailed analysis steps for developing the BPM in ArcGIS 10.1. It is intended to facilitate other consultant's and City staff's ability to replicate or modify the inputs and model development process. Section 4.1 presents GIS steps for creating the Bicycle Detractor submodel, Section 4.2 describes the steps required to combine the Bicycle Detractor submodel with the Bicycle Demand Model.

To facilitate ease of reading, the following formatting rules were applied:

- Single quotes are used (' ') to denote text input in ArcGIS 10.1.
- ArcGIS tools and tool suites are noted in blue, bold text.
- All fieldnames are capitalized.
- All data inputs are referred to by the "Model Input" and "Input #" fields from Tables 2-1 and 2-2.

4.1 Bicycle Detractor Submodel GIS Steps

There is a total of six inputs used to create the bicycle detractor submodel. Three of the inputs - volumes, posted speeds and number of travel lanes – are obtained from the SANDAG regional transportation model shapefile (Inputs #2 - #4 in Table 2-2). Bicycle collision locations (Input #1) is a point shapefile obtained from the City of San Diego's traffic collision database. Slope (Input #5) is calculated from an elevation raster dataset obtained from SanGIS. Locations of roadways with freeway ramp conflicts (Input #6) utilize the Roads_all shapefile from SanGIS, and require interpreting aerial imagery to determine locations. Development of the bicycle detractor surface requires four key steps as summarized in the list below:

- **Step 1.0** explains how Input #1 (bicycle collisions) was processed.
- **Step 2.0** explains how Inputs #2 and #3 (average daily trips and speed limits) are processed.
- **Step 3.0** explains how Input #4 (number of travel lanes) is processed.
- **Step 4.0** explains how Input #5 (slope) is processed.
- **Step 5.0** explains how Input #6 (roadways with freeway ramp conflicts) is processed.
- **Step 6.0** describes the map algebra employed to sum the points associated with each of the inputs and create a single raster surface.

Step 1.0 Generate Bicycle Collisions Raster Input #1

1.1 Generate collisions shapefile within ArcGIS from City's traffic collision database.

Add Collision.dbf from the City's traffic collision database and extract 5 years of data to a map document in ArcGIS. Use **Add XY Data** under **File/Add Data** to generate Point events. Specify COLLISION_X_COORD_NUM under X Field and COLLISION_Y_COORD_NUM under Y Field. Specify

NAD_1983_StatePlane_California_VI_FIPS_0406_Feet under the Coordinate System of Input Coordinates. Click OK. Export the Collision Events output to shapefile.

1.2 *Determine which collisions in the City's traffic collision database involved bicyclists.*

Import Party.dbf from the City's traffic collision database into ArcGIS. Use **Select by Attributes** on the fieldname BODY_TYPE_DESC on the Party database and select all categories which include the word "BIKE". Export selected features into separate dbf file.

1.3 *Join exported bicycle party database to the Collisions shapefile created in Step 1.1 using the common fieldname SYSTEM_NUM.*

Select all features which involved a party on a bicycle. When executing the join, any features not involving a bicycle will have null values in the attributes from the joined dbf. Export selection into separate Bicycle Collisions shapefile.

1.4 *Use the **Collect Events** Tool on the Bicycle Collisions shapefile exported in previous step to summarize the number of collisions occurring at the same location.*

The **Collect Events** tool is located in the **ArcToolbox** under **Spatial Statistics Tools/Utilities**. Under Input Incident Features, load the bicycle collisions shapefile. Specify a location for saving the bicycle collision events output shapefile. Click OK.

1.5 *Calculate collisions per year using the bicycle collision events shapefile.*

In the bicycle collision events shapefile, create a new field (using the Double field type) called Collision Rate. Right-click on the new Collision Rate fieldname and use the **Field Calculator** to divide the collision events by '5' years, which is the timespan of the data. Add another field (using the Short Integer field type) called Points. Right-click on the new Point fieldname and use the **Field Calculator** to assign the Final Score values associated with the collision rates, as presented in Table 2.2.

1.6 *Create a 1/16 mile as-the-crow-flies buffer of the collision events shapefile.*

Open the **Buffer** tool located in the **ArcToolbox** under **Analysis/Proximity**. Under the Input Features, add the collision events shapefile. Specify a filename and location for saving the collision buffer output file under Output Feature Class. Enter '330' feet in the Linear Unit box. Change the *Dissolve Type setting* from NONE to LIST, and check the box next to the Points field. Click OK.

1.7 *Generate a raster file from the collision events buffer shapefile created in the previous Step 1.6.*

Use the **Polygon to Raster** tool located in the **ArcToolbox** under **Conversion Tools/To Raster**. When the polygon to raster tool window opens, add the collision events buffer shapefile to *Input Features*. Select the Points field under *Value*. Specify a location for saving the output file. Change the *Priority Field* from NONE to Points. Change Cellsize to '75'. Click OK.

1.8 *Process the collision event buffer raster from the previous Step 1.6 using the **Reclassify** tool.*

The **Reclassify** tool is located in the **ArcToolbox** under **Spatial Analyst Tools/Reclass**. When the reclassify tool window opens, add the events buffer raster under Input Raster. Under *Old Values*, select the Points field. Keep the point values the same under *New Values* but assign '0' points to NoData. Specify a location for saving the file under Output Raster. Click the *Environments button*, expand Processing Extent, choose the City of San Diego boundary shapefile. Click OK to exit Environments. Click OK to run the tool.

Step 2.0: Generate Traffic Volume Input #2 and Speed Input #3 Rasters

2.1 *Add the hwycov shapefile to the map document and create a 75 foot buffer around the shapefile.*

Open the **Buffer** tool located in the **ArcToolbox** under **Analysis/Proximity**. Under the Input Features, add the hwycov shapefile. Specify a filename and location for saving the hwycov buffer output file under Output Feature Class. Enter '75' feet in the Linear Unit box. Leave the Dissolve Type setting from NONE. Click OK.

2.2 *Create a new attribute field within hwycov buffer shapefile called DET_VOLS to populate with traffic volume data.*

a) Within attribute table window, click Table Options located in the upper left corner of the attribute table and select Add Field. Specify the new field as a double and assign it the fieldname DET_VOLS.

b) Use **Select by Attributes** from Selection on the Main Menu to select all features with a higher UVOL than ADTVL (x100). Enter the following command into the formula box: "UVOL" > ("ADTVL" * 100). Populate DET_VOLS field with the values from UVOL for the selected features.

c) Reverse the selection and populate the DET_VOLS field with the values from ADTVL * 100.

2.3 Generate a raster file from the hwycov buffer shapefile for both the Speed and Average Daily Trips.

Generate a speed raster file using the **Polygon to Raster** tool located in the **ArcToolbox** under **Conversion Tools/To Raster***.* When the **Polygon to Raster** tool window opens, add the hwycov shapefile under Input Features. Under Value, select the ISPD fieldname (posted speed).

Specify a location for saving the speed raster output file. Change Cellsize to '75'. Hit OK. Repeat this process for traffic volumes by selecting DET_VOLS under Value.

2.4 Process the speed and volume rasters from the previous step using the ***Reclassify*** *tool.*

The **Reclassify** tool is located in the **ArcToolbox** under **Spatial Analyst Tools/Reclass**. When the reclassify tool window opens, add one of the rasters under Input Raster. Click the *Classify* button to set the category breaks specified in Table 2-2. Click OK. In the reclassify tool window, the Old Values will now show the class breaks. Under New Values, specify the Final Score values, also listed in Table 2-2, for the respective detractor inputs being processed. Assign '0' points under NoData. Specify a location for saving the raster file under Output Raster. Click the Environments button, expand Processing Extent, choose the City of San Diego boundary shapefile. Click OK to exit Environments. Click OK to run the tool.

2.5 Repeat Step 2.4 until a reclassified raster file has been created for both inputs (speed and traffic volume).

Step 3.0: Generate Number of Travel Lanes Raster Input #4

3.1 Create a new attribute field within hwycov buffer shapefile called MAX_LANES and populate with values.

a) Within attribute table window, click Table Options located in the upper left corner of the attribute table and select Add Field. Specify the new field as a short integer and assign it the fieldname MAX_LANES.

b) Use **Select by Attributes** from Selection on the Main Menu and enter "ABLNO" > "BALNO" into formula box. Populate MAX_LANES field for selected features with values from ABLNO.

c) Reverse the selection and populate the MAX_LANES field for the selected features with the values from BALNO.

3.2 Add another field into hwycov buffer shapefile called DET_LANES and populate with values.

a) Within attribute table window, click Table Options located in the upper left corner of the attribute table and select Add Field. Specify the new field as a short integer and assign it the fieldname DET_LANES.

b) Use **Select by Attributes** from Selection on the Main Menu and enter MAX_LANES > 2 into formula box. Populate DET_LANES field for selected features with 3. Clear selection when completed.

c) Use **Select by Attributes** to select features where MAX_LANES = 2 AND IMED = 2 and populate DET_LANES field for those selected features with 1. Clear selection when completed.

d) Use **Select by Attributes** to select features where MAX_LANES = 2 AND DET_LANES = 0 and populate DET_LANES field for those selected features with 2.

3.3 Generate a raster file from the hwycov buffer shapefile for Number of Travel Lanes.

Generate a number of travel lanes raster file using the **Polygon to Raster** tool located in the **ArcToolbox** under **Conversion Tools/To Raster**. When the **Polygon to Raster** tool window opens, add the hwycov shapefile under Input Features. Under Value, select the DET_LANES fieldname (number of travel lanes). Specify a location for saving the travel lane raster output file. Change Cellsize to '75'. Hit OK.

*3.4 Process the number of travel lane raster from the previous step using the **Reclassify** tool.*

The **Reclassify** tool is located in the **ArcToolbox** under **Spatial Analyst Tools/Reclass**. When the reclassify tool window opens, add number of travel lane raster under Input Raster. Under New Values, specify the Final Score values, also listed in Table 2.2, for the respective detractor inputs being processed. Assign '0' points under NoData. Specify a location for saving the raster file under Output Raster. Click the Environments button, expand Processing Extent, choose the City of San Diego boundary shapefile. Click OK to exit Environments. Click OK to run the tool.

Step 4.0: Generate Slope Raster Input #5

4.1 Generate elevation by importing elevation interchange (.e00) file using the ***Import from E00*** *tool.*

The **Import from E00** tool is located in the **ArcToolbox** under **Conversion Tools/To Coverage** to generate the elevation raster dataset from the elevation interchange file. Add the elevation E00 file to *Input Interchange file* and specify the output folder and output file name. Click OK.

4.2 Generate slope from elevation raster using the ***Slope*** *tool.*

The **Slope** tool is located in the **ArcToolbox** under **Spatial Analyst Tools/Surface**. Add the elevation raster to *Input raster*. Specify the output raster file name and save location in the *Output raster* field. Specify PERCENT_RISE under *Output measurement*.

Note: there is one raster cell within the slope data with a massive outlier value (10,300.2). This outlier value throws off the symbology which will always assume a regular distribution of values. Therefore, when the slope data gets added to the map, the default display will be a single color – which makes it appear like the tool did not work properly. The export worked, but in order to view the data the category breaks need to be adjusted "normal" slope values under (e.g. values under 100). This adjustment will enable the display of slope variation.

4.3 Process the slope raster using the ***Reclassify*** *tool.*

The **Reclassify** tool is located in the **ArcToolbox** under **Spatial Analyst Tools/Reclass**. When the reclassify tool window opens, add the slope raster under Input Raster. Click the Classify button and when the Classification dialog box opens change the number of classes to 3. Change the first two break values to 5 and 10 (leaving the max value alone). Click OK to exit the Classification dialog box. Change the *New values* to '0', '1', and '2' for the three category breaks. Change NoData to '0'. Specify a location for saving the file under Output Raster. Click OK to run the tool.

Step 5.0: Generate Roadways with Freeway Ramp Conflict Input #6

5.1 Add the Roads_all shapefile and add aerial image background to map.

The aerial image background can be added to the map document by expanding the Add Data button to show Add Basemap. Choose Imagery from the options which appear in the dialog box.

5.2 Manually select and export into a separate shapefile all Roads_all features which intersect with an at-grade intersection (entry or exit) with a freeway ramp. If an intersecting Roads_all feature terminates mid-block, expand selection of features under location to nearest end of block segment (intersecting roadway).

5.3 Create a 75 foot buffer around the exported roads containing a freeway ramp intersection shapefile.

Open the **Buffer** tool located in the **ArcToolbox** under **Analysis/Proximity**. Under the Input Features, add the hwycov shapefile. Specify a filename and location for saving the hwycov buffer output file under Output Feature Class. Enter '75' feet in the Linear Unit box. Change the Dissolve Type setting to ALL. Click OK.

5.4 Generate a raster file from the roads containing a freeway ramp intersection buffer shapefile.

Generate a roads layer containing a freeway ramp intersection buffer raster file using the **Polygon to Raster** tool located in the **ArcToolbox** under **Conversion Tools/To Raster***.* When the **Polygon to Raster** tool window opens, add the roads containing a freeway ramp intersection buffer shapefile under Input Features. The Value can remain under the default category. Specify a location for saving the output file. Change Cellsize to '75'. Hit OK.

*5.5 Process the roads containing a freeway ramp intersection buffer raster using the **Reclassify** tool.*

The **Reclassify** tool is located in the **ArcToolbox** under **Spatial Analyst Tools/Reclass**. When the reclassify tool window opens, add the roads containing freeway ramp intersection raster under Input Raster. Change the *New values* to '2'. Change NoData to '0'. Specify a location for saving the file under Output Raster. Click the Environments button, expand Processing Extent, choose the City of San Diego boundary shapefile. Click OK to exit Environments. Click OK to run the tool.

Step 6.0: Combine Input Rasters to Create the Detractor Submodel

6.1 Create a composite detractors raster from the reclassified rasters generated in Steps 1.8, 2.4, 2.5 and 3.4, 4.3 and 5.5.

Open the **Raster Calculator** tool located in the **ArcToolbox** under **Spatial Analyst Tools/Map Algebra**. Add each reclassified raster into a summation equation. Specify a location for saving the detractors raster output file and hit OK. This last step generates the final detractor submodel raster surface.

4.2 Combining Bicycle Detractors with Combined Inter- and Intra-Community Demand

This section explains how to incorporate the Bicycle Detractors submodel point values into the previously created Bicycle Demand Model. Instructions for the creation of the Bicycle Demand Model within GIS are provided in Section 5 of the Task D Report. The following steps provided assume the Bicycle Demand Model is already created.

- **Step 1.0** explains how the Detractor Submodel is converted to a shapefile.
- **Step 2.0** explains how the Detractor Submodel shapefile is combined with the Bicycle Demand Submodel shapefile.

Step 1.0 Convert Bicycle Detractors Submodel to a Polygon Shapefile

1.1 Convert the bicycle detractor raster into a polygon shapefile.

Open the **Raster to Polygon** located in the **ArcToolbox** under **Conversion Tools/From Raster**. Add the detractor raster file created in the final step of Section 4.1 of this Report, and specify GRIDCODE under the fieldname called Value Field. Specify a location for saving the output file. Uncheck the Simplify Polygons button. Click OK.

Step 2.0 Combine the Bicycle Demand Shapefile (final product created in Task D) with the Bicycle Detractors Polygon Shapefile

2.1 Add the Bicycle Demand shapefile created in Task D to a map document and intersect with the Bicycle Detractors polygon shapefile.

Use the **Intersect** tool in the **ArcToolbox** under **Analysis/Overlay** to intersect the Bicycle Demand Model shapefile with the Bicycle Detractors polygon shapefile.

2.2 Add New Length and Length Points fields to the Intersected Demand shapefile.

a) Add New Length and Length Points fields (using the Double field type) to the intersected demand shapefile.

b) Right-click the header of the New Length field and choose **Calculate Geometry**. Select Length in the calculate geometry window under Properties. Select Feet US [ft] under Units in the calculate geometry window.

c) Right-click the Length Points fieldname and open **Field Calculator**. Multiply New Length by GRIDCODE Points (this is the fieldname containing the final point values from the Detractor submodel).

2.3 Summarize detractor points from Intersected shapefile.

Open the attribute of the Intersected Roadways shapefile and right-click the field header containing the Identification field generated in Step 2.4 of Task D and choose **Summarize**. In the **Summarize** dialog box, expand New Length and Length Points and check the box next to Sum. Specify an output location, name the summary table as Sum_Detractors and click OK. Allow the table to be added to the map document.

2.4 Add new two fields in Bicycle Demand shapefile added in Step 2.1 to store Detractor Points and Need Points.

Open the Bicycle Demand shapefile attribute table and add new fields (using the Double field type) called Detractor Points and Need Points. There are character limits on field headers, so choose abbreviated title.

2.5 Join the Sum_Detractors summary table created in previous step to the Bicycle Demand shapefile and calculate point totals for new fields created in Step 2.4.

a) **Join** the Sum_Detractor summary table to the Bicycle Demand shapefile. Choose the common join fields in boxes 1 and 3 (that fieldname should be Identification). Click OK.

b) Use the **Field Calculator** to copy the summary information from the Detractors summary table field into the unpopulated Detractor Points. In the Field Calculator command box, divide Length Points by New Length (from the summary fields which were generated in Step 2.3) by 2. The expression should look like this: ([Length Points] / [New Length]) * 0.428

   Note: 0.428 is the multiplication value needed to bring the 28 point maximum detractor scale to a 12 point scale, as discussed in Section 3.0.

c) Use the **Field Calculator** to add combined inter- and intra-community demand points with detractors points into Need Points.

List of References

City of San Diego. *Bicycle Demand Model Update – Task D of the Multimodal Planning Research Project*. 2015.

City of San Diego. *City of San Diego Bicycle Master Plan Update.* 2013.

City of San Diego. *City of San Diego Bicycle Master Plan.* 2002.

Appendix A

MTI Report 11-19:

Low-Stress Bicycling and Network Connectivity, Table 3

Table 3. Criteria for Bike Lanes Not Alongside a Parking Lane

	LTS ≥ 1	LTS ≥ 2	LTS ≥ 3	LTS ≥ 4
Street width (through lanes per direction)	1	2, if directions are separated by a raised median	more than 2, or 2 without a separating median	(no effect)
Bike lane width (includes marked buffer and paved gutter)	6 ft. or more	5.5 ft. or less	(no effect)	(no effect)
Speed limit or prevailing speed	30 mph or less	(no effect)	35 mph	40 mph or more
Bike lane blockage (may apply in commercial areas)	rare	(no effect)	frequent	(no effect)

Note: (no effect) = factor does not trigger an increase to this level of traffic stress.