# Coding and Counting

## Joining and summarizing tables to add information

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In the last issue of *ArcUser,* the tutorial "Slopes, Sharp Turns, and Speed—Refining emergency response networks to accommodate steep slopes and turn rules" showed how to model emergency service area coverage for existing and proposed stations using the ArcGIS Network Analyst extension.

In the previous exercise, a network dataset was created, its attributes and turn rules defined, and optimized service areas for fire halls were generated. Travel values, with and without slope adjustments, were calculated, and the optimized area and total street length for each fire hall were calculated. The exercise in this issue's tutorial builds on that project with an additional exercise showing how to map and count the hydrants and incidents in the optimized service areas that were previously generated.

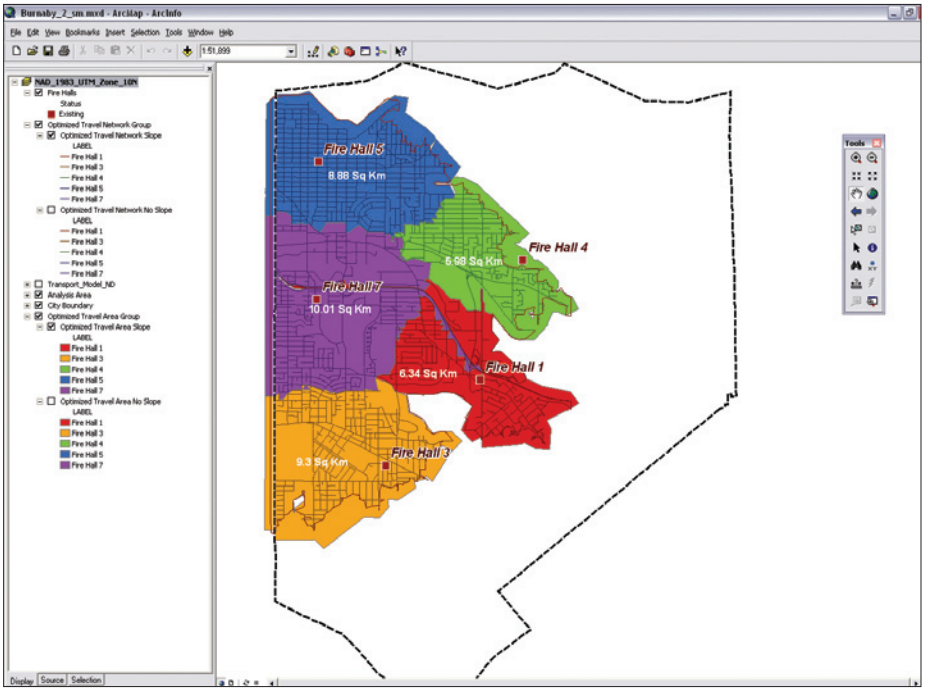
The data for both exercises was supplied by the city of Burnaby, British Columbia, Canada. Burnaby, the third largest urban center in the province, is a major business, residential, and transportation corridor between Vancouver and British Columbia's Lower Mainland. Elevation ranges from mean sea level to 375 meters. Land features have controlled and constrained development throughout this community.

The Burnaby Fire Department serves the entire municipal area and provides aid response into neighboring jurisdictions. The department staffs six fire halls, and a new station will open soon. The agency's staff numbers 286 and, in 2006, responded to 13,400 calls. The Burnaby Fire Department works closely with the city's Engineering Department to plan and optimize service throughout the area. Burnaby's Engineering Department uses ArcGIS Network Analyst to optimize response areas.

### Getting Started

Download the zipped sample dataset for this exercise from *ArcUser Online* (www.esri.com/arcuser) and place it near the root of the drive that will contain the project. Unzip the data and explore it in ArcGIS ArcCatalog.

The archive should generate a directory structure that includes folders for geodatabase files (GDBFiles) and a utility folder containing Microsoft Excel spreadsheets that explain calculations that were incorporated in the previous exercise as well as a VBScript that assigns various penalties for different types of turns.



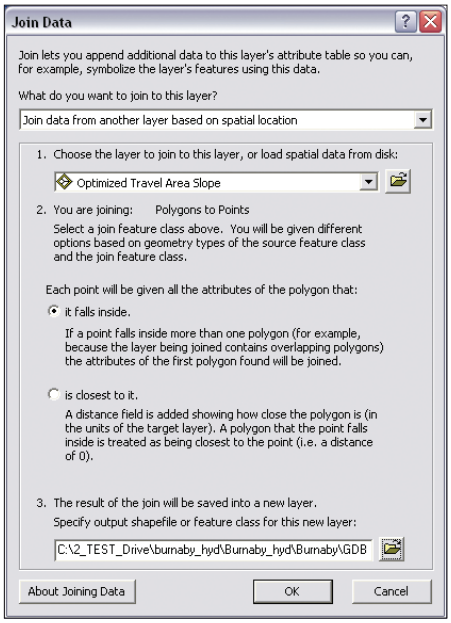

*This tutorial uses a stepped-down version of the map document created in the previous tutorial. The optimized travel areas in this tutorial will be spatially joined with hydrant and incident data and summarized by service area.*

The sample dataset also contains burnaby_2_sm.mxd, the ArcMap document that will be used in the exercise.

### Adding Information Using Spatial Joins

This exercise explains how to map and code Burnaby's fire hydrants to specify the closest optimized fire hall and count the hydrants in the station's optimized response area.

1. Start ArcMap and open burnaby_2_sm.mxd.
2. Load Fire Hydrants Layer file from the Burnaby_Fire.gdb in the GDBFiles > UTM83Z10 folder.
3. In the table of contents (TOC), right-click on Fire Hydrants and choose Joins and Relates > Join. In the Join Data dialog box, select Join data from another layer based on spatial location from the first drop-down. Click the second drop-down and choose Optimized Travel Area Slope.
4. The dialog box should indicate this will join polygons to points. Click the radio button next to It falls inside.




*Use a spatial join to combine hydrant point data with service area polygons.*

**What You Will Need**
- ArcGIS Desktop 9.3 (ArcInfo, ArcEditor, or ArcView license level)
- Sample data from *ArcUser Online*

5. Click the Browse button. In the Save Data dialog box, change the Save as Type to File and Personal Geodatabase feature classes. Navigate to and save this new feature class in Burnaby_Fire.gdb as Fire_Hydrants_Halls. Click Save and click OK.
6. Right-click on the new Fire_Hydrants_Halls feature class and inspect its attribute table to verify that join was performed.
7. Remove Fire_Hydrants_Halls from the TOC. Right-click on Fire Hydrants in the TOC and choose Properties > Source and set the data source to Fire_Hydrants_Halls. Save the map document.

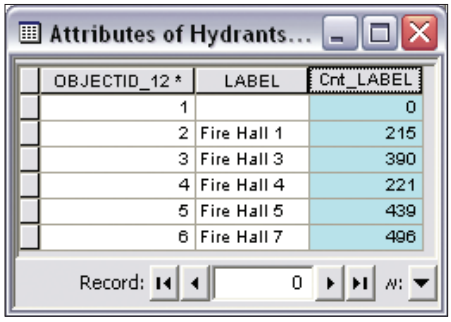
### Counting Hydrants with Summarize

Summarizing on a field in a table can easily generate useful information about data. In this case, Summarize will be used to count the hydrants in each fire hall's travel area.

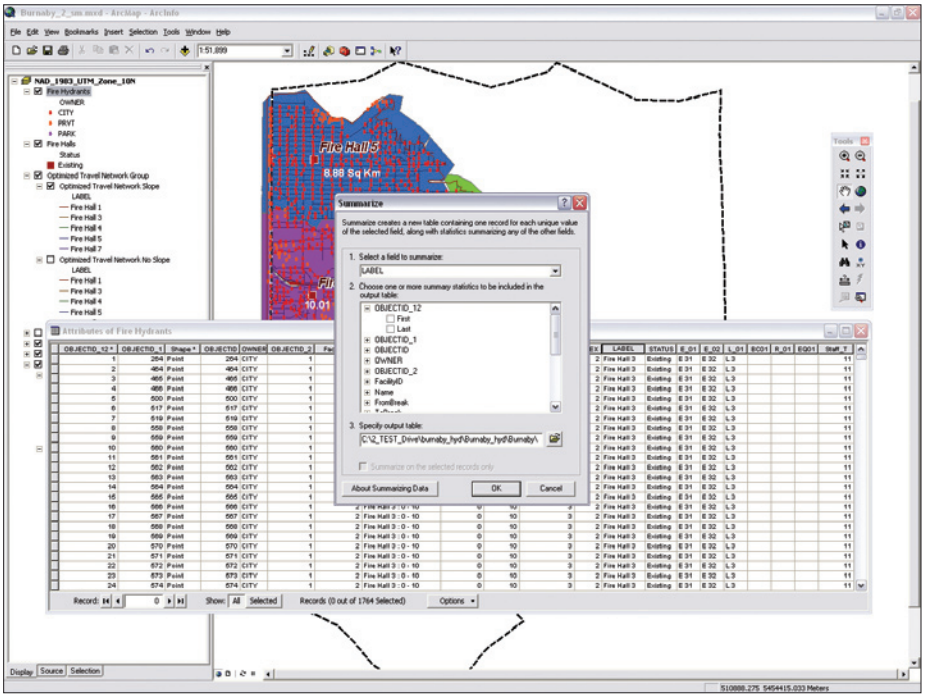
1. Open the Fire Hydrants attribute table and locate the Label field. Right-click on this field and select Summarize. To get only a count, don't specify any summary statistics. Save as a File Geodatabase table called Hydrants_Join_Sum1 and store it in the Burnaby_Fire.gdb.
2. Add the table to the map and check it. Based on the clipped street set, which Fire Hall is responsible for testing the most hydrants? (The answer is the new Fire Hall 7, which has 491 hydrants.)

### Updating Labels

The number of hydrants in each service area can be associated with the rest of the service area record by joining the summary table with the Optimized Travel Area Slope attribute table. Label each service area with the fire hall number and the number of hydrants it contains by joining the hydrant summary table using a simple VBScript.




*The resultant summary table reveals how many hydrants are maintained by each hall.*




*After creating a new feature class from the spatially joined data, summarize hydrants on LABEL file.*

1. In the TOC, right-click on Optimized Travel Area Slope and select Joins and Relates > Joins.
2. In the Join dialog box, choose Join Attributes from a Table. Set LABEL as the field to join. Choose Hydrants_Join_Sum1 as the table to join to and choose LABEL field as the field in Hydrants_Join_Sum1 to base the join on. Choose Keep All Records and click OK. Accept indexing.
3. Open and inspect the Optimized Travel Area Slope table. Does each fire hall record now contain hydrant counts as attributes from Hydrants_Join_Sum1?
4. A label expression has already been applied to label each service area with its area in square kilometers.

```
Round( [sareaopt10_SL.Shape_Area]
/1000000,2)&" Sq Km"
```

Now add some additional script to include the number of hydrants in the label. Double-click on Optimized Travel Area Slope to open the Properties dialog box and select Labels > Expression. Add the following line to the end of the existing expression and click OK.

```
& VBNewLine & [Hydrants_Join_1.
Cnt_LABEL] &" "&"HYDRANTS"
```

5. Save the map document.

### Posting Emergency and Nonemergency Calls

In the United States, the National Fire Incident Reporting System (NFIRS) uses a three-digit numeric code to distinguish between emergency and nonemergency calls. Although the exercise data comes from Canada, NFIRS codes have been added to create a meaningful thematic legend and build summary statistics.

1. Turn off the Fire Hydrants layer. Load Incidents.lyr from GDBFiles > UTM83Z10 and inspect its symbology. These points

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represent responses by the Burnaby Fire Department to incidents that happened in 2007. This layer file applies a Quantities—Graduated Colors legend to display emergency and nonemergency calls by code value range. Table 1 lists the numeric ranges defined by NFIRS 5.0. These ranges will be used to build subsets of the 2007 calls. For a complete list of the NFIRS 5.0 codes and descriptions, download the NFIRS Reference Guide from http://www.nfirs.fema.gov/_download/NFIRS50CRG_011608.pdf. Chapter 3 contains detailed descriptions.

| Inc_Code Range | Description |
|---|---|
| 100–199 | All Fire |
| 200–299 | Rupture or Explosion |
| 300–399 | Rescue, EMS |
| 400–499 | Hazardous Condition |
| 500–599 | Service Call |
| 600–699 | Good Intent Call |
| 700–799 | False Call |
| 800–899 | Weather, Natural Hazard |
| 900–999 | Other or Special Incident |

*Table 1: NFIRS 5.0*

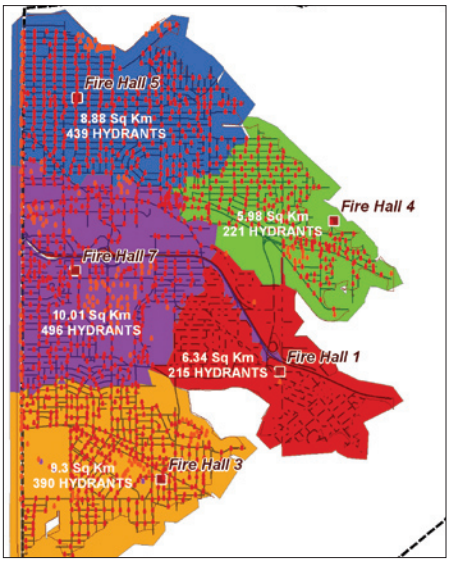
2. To separate the calls by type (fire, rescue and EMS, and other calls), make three copies of the master incident set and use three definition queries to separate the data. In the TOC, right-click on the Incidents Layer file and copy it. Right-click on the Data Frame name and paste three copies of the Incidents.lyr. Rename the top copy to Fire, Explosion, Hazmat. Name the second copy Rescue, EMS. Name the third copy Other Calls. Turn off the Incidents Layer file and the copies.
3. Open the attribute table for Fire, Explosion, Hazmat. Click the Options button on the table frame and choose Select by Attributes. Create a new selection by typing the definition query

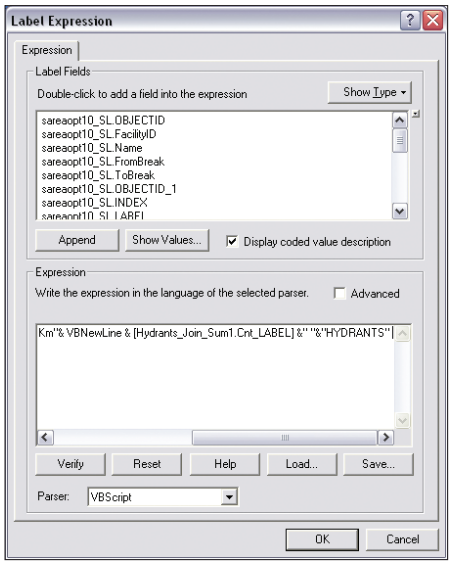
   ("INC_CODE" >=100 AND "INC_CODE"<300) OR ("INC_CODE" >=400 AND "INC_CODE" <500)

   (shown in Table 2) in the text box and click Apply.
4. Open the attribute table and sort on the INC_CODE field to verify that the definition query selected the correct records.
5. Right-click on Fire, Explosion, Hazmat and choose Data > Export. Save the selected features as a feature class called FEH in the Burnaby_Fire.gdb. Do not add this layer to the map.
6. Open the Properties dialog box for Fire, Explosion, Hazmat and change the data source to the FEH feature class.

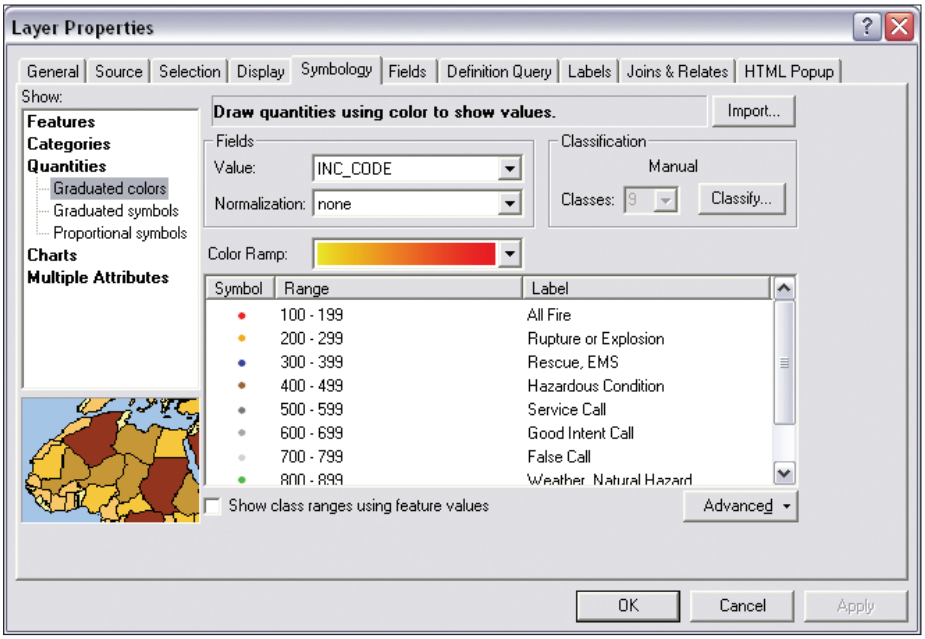
| Layer | Definition Query |
|---|---|
| Fire, Explosion, Hazmat | ("INC_CODE" >=100 AND "INC_CODE"<300) OR ("INC_CODE" >=400 AND "INC_CODE" <500) |
| Rescue, EMS | "INC_CODE" >=300 AND "INC_CODE"<400 |
| Other Calls | "INC_CODE" >=500 |

*Table 2: Definition queries*



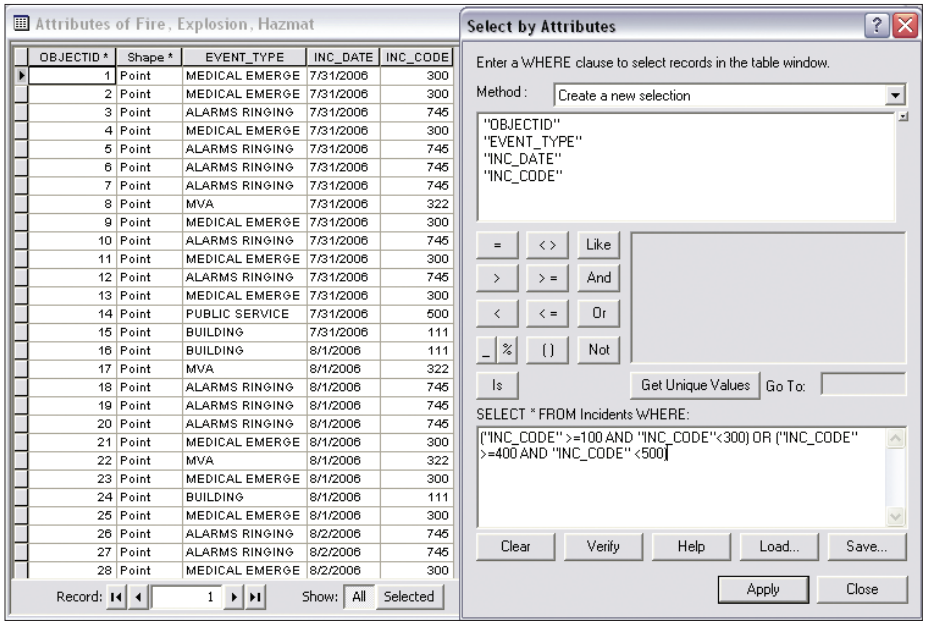




*Add to the existing labeling expression to include the number of hydrants in each label.*

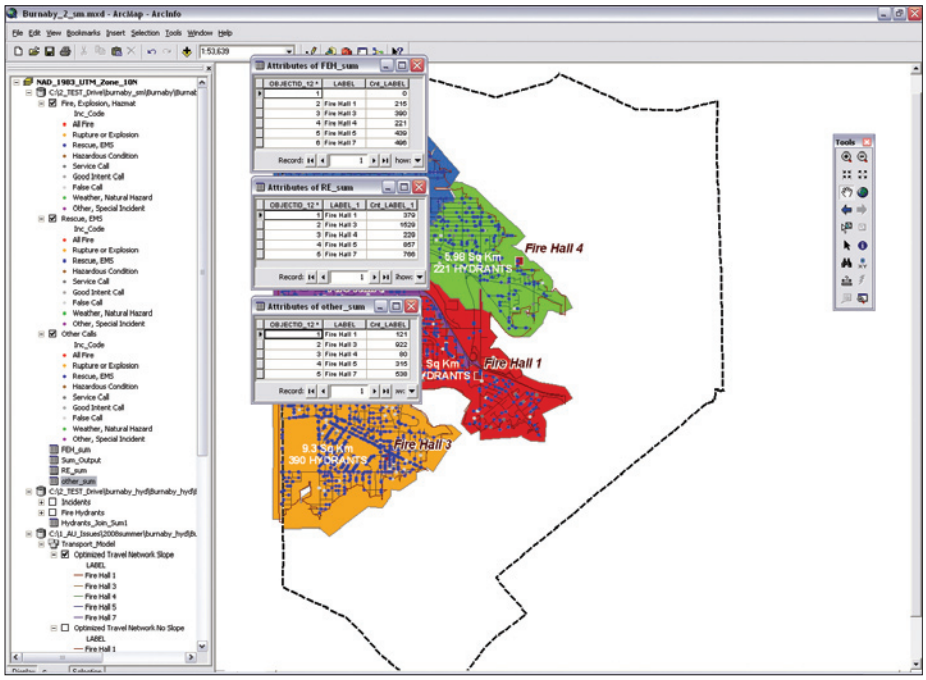



*The Incident Layer file symbolizes the NFIRS codes for Burnaby incidents in 2007. Make three copies of the Incident Layer for the three categories of incidents.*

7. Use the same procedure and the definition queries in Table 2 to select records from the Rescue, EMS and Other Calls layers. Name the output feature classes RE and Other, respectively. Save the map document.




*Use definition queries to select incidents by NFIRS codes for each incident category, save the selected records for each category as a new feature class, and use the new feature classes as the data source for the incident layers.*




*Summarize the incidents for each layer on the LABEL field to learn how many incidents of each type were handled by each fire hall.*

## Joining and Summarizing Service Call Data

Counting the incidents for each fire hall's optimized response area requires spatially joining the service areas to the incidents, then summarizing on the calls.

1. Right-click on Fire, Explosion, Hazmat in the TOC and choose Joins and Relates > Join.
2. In the Join dialog box, select Join data from another layer based on spatial location. Set the layer to join as Optimized Travel Area Slope. Change Save as Type to File and Personal Geodatabase feature classes. Save the new feature class inside Burnaby_Fire.gdb as Fire_Explosion_HazMat_Halls. Click OK. Remove this layer from the map document.
3. Double-click on the Fire, Explosion, Hazmat layer in the TOC and change the data source to Fire_Explosion_Hazmat_Halls, the new geodatabase feature class.
4. Repeat this process two more times. Create the Rescue_EMS_Halls feature class by spatially joining the Rescue, EMS points to Optimized Travel Area Slope polygons. Create the Other_Calls_Halls by spatially joining Other Calls points with Optimized Travel Area Slope polygons. Remove these new layers from the map document and save the map document.
5. Summarize the incident for the selected sets in each layer using the same method employed previously with the hydrants data. Right-click on the Label field and choose Summarize. To get only the count, do not check any boxes in the Summarize dialog box. Save the output tables in the Burnaby_Fire.gdb as File and Personal Geodatabase tables named FEH_sum, RE_sum, and Other_sum, respectively. Add each table to the map and save the map document.
6. Load each summary table into the map document.

Which fire hall had the most rescues and EMS calls? Which fire hall had the fewest? With two engines, a ladder, and 11 personnel, Fire Hall 3 has the most resources but it also performs the most rescues.

## Conclusion

This elaborate analysis assessed and validated public safety response capabilities for a major Canadian provider of fire and EMS services. The processes and workflow taught in this exercise are similar to those used by public safety analysts. ArcGIS 9.3 facilitates and helps standardize this analytical process.

## Acknowledgments

The author thanks the City of Burnaby Fire Department, the Burnaby Engineering Department, and ESRI Canada for the opportunity to define and test this complex time-based solution and use this data as a training set.