

EUE Proposal

Project ID#

Project Title

Project Director	ID Number	Telephone	Email

Department	Campus Box	School College

Course or Program

Project Co-Director	ID	Department	Email

Student Impact:	
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Priority Rating (If Submitting Multiple Proposals):	
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Project Budget

Salary	Wages	Travel	Equip.	Comm	CServ	Auto	Tele	Awards	Total

Cost-Sharing

Salary	Wages	Travel	Equip.	Comm	CServ	Auto	Tele	Awards	Total

Prior EUE Support

Project Director	Project Number	Award Amount	Project Dates

Keeping Cartography Relevant: Retraining Faculty and Redeveloping GEOG320 Labs for ArcGIS Pro

Project Summary

The project investigator (PI) of this project seeks the EUE funding to support his substantial time investment to: 1) learn the new ArcGIS Pro software; and 2) redevelop a total of 12 existing lab exercises in GEOG320 Cartography using the new software. With the technological advancement in cloud computing, mobile mapping and spatial big data, Environmental System Research Institute, Inc. (ESRI) has recently released “the next generation of GIS software,” namely ArcGIS Pro. ArcGIS Pro offers many advantages over the existing GIS software we currently use, namely ArcMap. First, ArcGIS Pro organizes maps, layouts, layers, tables, tasks, tools, and connections to servers, databases, folders, and styles in one central place called “projects.” Second, ArcGIS Pro can connect to ArcGIS Online public content (e.g., base maps, base imagery, etc.). Third, ArcGIS Pro allows maps, layers, geoprocessing tools, or even entire projects to be shared among project team members. Finally, ArcGIS Pro includes essential tools for developers to build apps for dissemination on multiple platforms, such as web, mobile, and desktop, which are very important features for today’s digital world. Clearly, the upgrade is not simply a software update (e.g., from ArcMap 9.0 to ArcMap 10.0), but instead a paradigm shift (i.e., from desktop environment in ArcMap to online/mobile/cloud platforms) in how the software deals with data sets, geoprocessing, and map documents using new graphical user interface. As a result, GIS employers in the United States have already begun to adopt ArcGIS Pro as their standard for GIS practices and operations, and they employ recent graduates from colleges and universities who know ArcGIS Pro. It is significant for those of us who teach GEOG320 Cartography, GEOG418 Introduction to GIS, and other advanced GIS courses to start teaching our current students with the best GIS practices using ArcGIS Pro.

All geography majors and GIS minors are required to take GEOG320. They will all benefit from this redevelopment of the lab exercises as experiential learning opportunity due to the software upgrade. The goal of the project is to prepare our students here at SIUE to be more competitive in the GIS job market. Moreover, the successful completion of the project will have long-lasting impacts on student learning for years to come.

Keeping Cartography Relevant: Retraining Faculty and Redeveloping GEOG320 Labs for ArcGIS Pro

I. Current Situation

GEOG320 Cartography (GEOG320 thereafter) is a core requirement course for all Geography majors and GIS minors. This course serves as a prerequisite for all other advanced GIS technique courses, such as GEOG418 Introduction to GIS, GEOG420 Interactive and Animated Cartography, GEOG421 Digital Elevation Modeling, GEOG424 Vector-based GIS, GEOG425 Raster-based GIS, GEOG431 Web-based Online Mapping, and GEOG432 Python Scripting in ArcGIS. The GEOG320 course offers students the skills in map use and analysis as well as develops their map-making skills by applying cartographic theory to microcomputer cartographic software. Through a series of lectures and lab exercises, students not only develop their cartographic skills, but also become comfortable working in a microcomputer environment. Over the last ten years, the project investigator (PI) developed a total of 12 lab exercises for GEOG320 using ArcMap software from the ESRI (Environmental System Research Institute, Inc.). Those labs represent the best practices within ArcMap environment in the input, manipulation, GIS spatial analysis and visualization of geospatial information. With the technological advancement in cloud computing, mobile mapping and spatial big data, ESRI has recently released “the next generation of GIS software,” namely ArcGIS Pro, which offers many advantages over ArcMap. First, ArcGIS Pro organizes maps, layouts, layers, tables, tasks, tools, and connections to servers, databases, folders, and styles in one central place called “projects.” Second, ArcGIS Pro can connect to ArcGIS Online public content (e.g., base maps, base imagery, etc.). Third, ArcGIS Pro allows maps, layers, geoprocessing tools, or even entire projects to be shared among project team members. Finally, ArcGIS Pro includes essential tools for developers

to build apps for dissemination on multiple platforms, such as web, mobile, and desktop, which are very important features for today's digital world. As a result, GIS employers in the United States have already begun to adopt ArcGIS Pro as their standard for GIS practices and operations, and they employ recent graduates from colleges and universities who know ArcGIS Pro. It is significant for those of us who teach GEOG320 Cartography, GEOG418 Introduction to GIS, and other advanced GIS courses to start teaching our current students with the best GIS practices using ArcGIS Pro. It is worth mentioning that the upgrade is not simply a software update (e.g., from ArcMap 9.0 to ArcMap 10.0), but instead a paradigm shift in how the software deals with data sets, geoprocessing, and map documents using new graphical user interface (e.g., from desktop environment in ArcMap to online/mobile/cloud platforms). Therefore, the PI seeks the EUE funding to support his substantial time investment to: 1) learn the new ArcGIS Pro software; and 2) redevelop all 12 existing GEOG320 lab exercises using the new software. The successful completion of this project will help all geography majors and GIS minors lay a solid foundation using the new software and support those students who subsequently take GEOG418 Introduction to GIS as well as other advanced GIS courses. The successful completion of the project will have long-lasting impacts on student learning for years to come.

II. Proposed Project

The PI of this project is Professor Shunfu Hu, who teaches GEOG320 and many other advanced GIS courses. The project will be implemented in two steps. First, the PI will learn the ArcGIS Pro software. The PI will work through a series of lab exercises from ESRI's tutorial book titled *Getting to Know ArcGIS Pro* (Law and Collins, eds, Second Edition, 2019, 521 pages) (see Appendix A: Table of Contents). In addition, the PI will take ESRI's online seminars and web courses and watch ESRI's recorded videos on ArcGIS Pro (see Appendix B). Second,

the PI will redevelop the existing 12 lab exercises for GEOG320 using the ArcGIS Pro software. A sample of existing lab exercises is provided in Appendix C. These labs were developed within the ArcMap environment and provided the students with step-by-step instructions on data input, manipulation, analysis and visualization. They all need to be redesigned and redeveloped within the ArcGIS Pro software (see Table 1). The redeveloped lab exercises will be first used in GEOG320 course in summer 2020 and thereafter.

Table 1. Proposed redevelopment of 12 lab exercises for GEOG320 using ArcGIS Pro

Lab Exercises	Topics
Lab Exercise 1	Basics of ArcGIS Pro
Lab Exercise 2	Map Projections in ArcGIS Pro
Lab Exercise 3	Check, Define and Convert Coordinate Systems in ArcGIS Pro
Lab Exercise 4	Datum Transformation in ArcGIS Pro
Lab Exercise 5	Working with Map Layout in ArcGIS Pro
Lab Exercise 6	Base-map preparation for thematic mapping in ArcGIS Pro
Lab Exercise 7	Choropleth, proportional and dot mapping in ArcGIS Pro
Lab Exercise 8	Making a thematic map with inset maps in ArcGIS Pro
Lab Exercise 9	2016 Presidential Election Map with inset maps in ArcGIS Pro
Lab Exercise 10	Bi-variate Mapping in ArcGIS Pro
Lab Exercise 11	Making a World Map of Köppen-Geiger Climate Classification in ArcGIS Pro
Lab Exercise 12	Creating and Editing Map Features in ArcGIS Pro

The timeline of the project implementation is summarized in Table 2 below.

Table 2. Implementation Timeline.

Task	Spring 2020					Summer 2020		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Retraining: work through lab exercises for chapters 1 through 5 from <i>Getting to Know ArcGIS Pro</i> book	12 hrs							
Retraining: work through the lab exercises for chapters 6 through 10 from <i>Getting to Know ArcGIS Pro</i> book		14 hrs						
Retraining: take ESRI's online seminars and web courses, and watch ESRI's recorded videos on ArcGIS Pro		34 hrs						
Redevelop the existing 12 lab exercises for GEOG320				60 hrs				
Use of the redeveloped lab exercises in GEOG320 during the 2 nd five-week session of summer 2020.								
Submit the summary report to the Provost's Office								

III. Evaluation and Dissemination Plan

The final products of this project will be 12 redesigned lab exercises, all of which are run in ArcGIS Pro software. Evaluation is an integral part of the project's implementation. There are two components in the project evaluation. First, Dr. Stacey Brown, another instructor of GEOG320, will evaluate all newly redesigned lab exercises. Second, the PI will ask three students from his GEOG320 in spring 2020 to test run the new labs. Their feedback will be used to further refine the lab instructions. All the lab exercises will be disseminated in the GEOG320 course the PI plans to teach during the second five-week session of summer 2020, so the students will have an opportunity to evaluate the effectiveness of the new course materials. In addition, all new lab exercises will be made available to other instructors of GEOG320, including Dr. Stacey Brown, who will also plan to teach the course in the future.

IV. Qualifications of the PI

The PI frequently teaches GEOG320. In addition, the PI teaches GEOG424 Vector-Based GIS, GEOG420 Interactive and Animated Cartography, GEOG421 Digital Elevation Modeling, and GEOG432 Web-based Online Mapping, so he is knowledgeable about the existing GIS curriculum beyond GEOG320, and he strongly feels the need to be proactive in the preparation of bringing the next generation of GIS software to the classroom. This project will provide the PI an opportunity to learn the new ArcGIS Pro software, redevelop the existing lab exercises for GEOG320, and subsequently enhance those upper level GIS courses as well. Finally, the implementation of the project is best suited for the PI because he is also a research expert in the utilization of GIS in many fields, such as multimedia mapping, online mapping, transportation planning, hydrological modeling, etc. The PI has recently published over 15 research papers related to GIS and geospatial technologies (e.g., Onuoha, Hu and Odemerho, 2018; Hu, Karna

and Hildebrandt, 2018; Hildebrandt and Hu, 2017; Du, Zheng, Xu, Hu and Xu, 2016; Hu, 2012a, 2012b, 2012c; Hildebrandt and Hu, 2013; Hu and Dai, 2013).

V. Budget and Budget Justification

Item	Justification		Cost
	Tasks	Time needed	
Dr. Hu at 0.75-month summer salary	Retraining: work through lab exercises for chapters 1 through 5 from <i>Getting to Know ArcGIS Pro</i> tutorial book	12 hrs	\$7,147
	Retraining: work through lab exercises for chapters 6 through 10 from <i>Getting to Know ArcGIS Pro</i> tutorial book	14 hrs	
	Retraining: take ESRI’s online seminars and web courses, and watch ESRI’s recorded videos on ArcGIS Pro	34 hrs	
	Redevelop the existing 12 lab exercises in ArcGIS Pro for GEOG320: Cartography	60 hrs	
	Prepare the EUE final report		
	Dissemination of the new lab exercises in GEOG320 during the second summer session of 2020		
Subtotal		120 hrs (=3 weeks)	\$7,147
Three undergraduate students to test run the lab exercises	The PI will work closely and iteratively with three students to get their feedback about the effectiveness of the new lab exercises.	2 days each	\$480
Dr. Brown as evaluator	The PI will invite Stacey Brown, Associate Professor to serve as an evaluator of this project.	1 day	\$200
Total			\$7,827

References

- Du, J., D. Zheng, Y. Xu, S. Hu, C. Xu, 2016. Evaluating Functions of Reservoirs' Storage Capacities and Locations on Daily Peak Attenuation for Ganjiang River Basin Using Xinanjiang Model, *Chinese Geographical Science*, 26(6): 789–802. doi: 10.1007/s11769-016-0838-6
- Hildebrandt, K. A. and S. Hu. 2017. Areal analysis of language attitudes and practices: A case study from Nepal. In Hildebrandt, Kristine A., Carmen Jany, and Wilson Silva. (Eds) *Documenting Variation in Endangered Languages*. Language Documentation & Conservation Special Publication no. 13. [PP 152-179] Honolulu: University of Hawai'i Press
- Hu, S. 2012a. Online Mapping for Fire Service First Responders Using Google Maps API, *Papers of the Applied Geography Conference*, 35: 54 - 63.
- Hu, S. 2012b. Multimedia Mapping on the Internet Using Commercial APIs, in *Online Maps with APIs and Mapservices* (M. P. Peterson, ed.), Springer, pp. 61-71.
- Hu, S. 2012c. Online Map Service Using Google Maps API and Other JavaScript Libraries: An Open Source Method, in *Online Maps with APIs and Mapservices* (M. P. Peterson, ed.), Springer, pp. 265-278.
- Hu, S. 2015. The Use of GIS, Remote Sensing and Virtual Reality in Flooding Hazardous Modeling, Assessment and Visualization, in *Evolving Approaches to Understanding Natural Hazards* (G.A. Tobin and B.E. Montz, eds.), Cambridge Scholars Publishing: Newcastle-Upon-Tyne, pp 230-239.
- Hu, S., B. Karna and K. Hildebrandt, 2018. Web-based Multimedia Mapping for Spatial Analysis and Visualization in Digital Humanities: a Case Study of Language Documentation in Nepal, *Journal of Geovisualization and Spatial Analysis*, 2:3, [DOI: 10.1007/s41651-017-0012-4](https://doi.org/10.1007/s41651-017-0012-4).
- Hu, S. and T. Dai. 2013. Online Map Application Development Using Google Maps API, SQL Database and ASP.NET, *International Journal of Information Communication Technology Research*, 3(3): 102 - 110.
- Jalayer, M., S. Hu, H. Zhou, and R. Turochy. 2015. Evaluation of Geo-tagged Photo/Video Logging Method to Collect Geospatial Highway Inventory Data for Supporting Highway Safety Manual Implementation, *Papers in Applied Geography*, 1(1): 50 - 58.
- Jalayer, M., J. Gong, H. Zhou, S. Hu, and M. Grinter. 2014. A Comprehensive Assessment of Highway Inventory Data Collection Methods, *Journal of Transportation Research Forum*, 53(2): 73-92.
- Law, M. and A. Collins (eds.). 2019. *Getting to Know ArcGIS Pro*, 2nd edition, ESRI Press, 521 pp.
- Onuoha, H., S. Hu and F. Odemerho, 2018. Analysis of Urban Growth in Edwardsville/Glen Carbon, Illinois Using Remote Sensing, Population Change Data, and Landscape Expansion Index, *Papers in Applied Geography*, [DOI:10.1080/23754931.2017.1394905](https://doi.org/10.1080/23754931.2017.1394905)

Curriculum Vitae

Shunfu Hu, Ph.D

2011 - present: Professor, Department of Geography, SIUE
2006 - 2011: Associate Professor, Department of Geography, SIUE
2002 - 2006: Assistant Professor, Department of Geography, SIUE

GIS Courses taught

GEOG320 Cartography
GEOG418 Introduction to GIS
GEOG424 Vector-based GIS
GEOG420 Interactive and Animated Cartography
GEOG421 Digital Elevation Modeling
GEOG431 Web-based Online Mapping

Research Experience (including grants)

- 2016 - 2019 "EarthCaching for Pre-Service Teachers: Examining Attitudes and Intentions towards Informal Science Learning"
Grant awarded by the National Science Foundation (NSF)(\$299,547)
Dr. Sharon Locke (PI, STEM Center, SIUE), Dr. Shunfu Hu (co-PI), Dr. Tom Foster (co-PI, Department of Physics, SIUE), and Georgia Bracey(co-PI, STEM Center, SIUE)
- 2012 - 2017 "Documenting the Languages of Manang, Nepal for Local and International Impact"
Grant awarded by National Science Foundation (NSF)(\$400,000)
Dr. Kristine Hildebrandt (PI, Department of English, SIUE), Dr. Shunfu Hu and Dr. Jessica Krim (School of Education, SIUE)
- 2012 - 2013 "Investigation of Methods & Approaches for Collecting & Recording Highway Inventory Data"
Grant awarded by the Illinois Department of Transportation (\$215,000)
Dr. Shunfu Hu (co-PI), Dr. Huaguo Zhou (PI, School of Engineering), Dr. Jie Gong (co-PI, School of Engineering), and Mr. Mark Grinter (co-PI, School of Engineering)
- 2008 - 2009 Orthorectification of Aerial Images from 1983 in Madison County, Illinois
Grant awarded by Madison County, Illinois (\$40,000)

Recent Peer-reviewed Publications

Locke, S. L., G. Bracey, T. Foster, S. Fraine, **S. Hu**, K. Lacombe, and C. Wilson. 2018. Connecting formal and informal learning to enhance elementary teacher preparation in geosciences. *Terra Didactica*, 14((3):283-289. URL: <http://www.ige.unicamp.br/terraedidactica/>.

Onuoha, H., **S. Hu** and F. Odemerho. 2018. Analysis of Urban Growth in Edwardsville/Glen Carbon, Illinois Using Remote Sensing, Population Change Data, and Landscape Expansion Index, *Papers in Applied Geography*, [DOI:10.1080/23754931.2017.1394905](https://doi.org/10.1080/23754931.2017.1394905)

- Hu, S.**, B. Karna and K. Hildebrandt. 2018. Web-based Multimedia Mapping for Spatial Analysis and Visualization in Digital Humanities: a Case Study of Language Documentation in Nepal, *Journal of Geovisualization and Spatial Analysis*, 2:3, [DOI: 10.1007/s41651-017-0012-4](https://doi.org/10.1007/s41651-017-0012-4).
- Hildebrandt, K. A. and **S. Hu**. 2017. Areal analysis of language attitudes and practices: A case study from Nepal. In Hildebrandt, Kristine A., Carmen Jany, and Wilson Silva. (Eds) *Documenting Variation in Endangered Languages*. Language Documentation & Conservation Special Publication no. 13. [PP 152-179] Honolulu: University of Hawai'i Press
- Du, J., D. Zheng, Y. Xu, **S. Hu**, C. Xu, 2016. Evaluating Functions of Reservoirs' Storage Capacities and Locations on Daily Peak Attenuation for Ganjiang River Basin Using Xinanjiang Model, *Chinese Geographical Science*, 26(6): 789–802. doi: 10.1007/s11769-016-0838-6
- Hu, S.** 2015. The Use of GIS, Remote Sensing and Virtual Reality in Flooding Hazardous Modeling, Assessment and Visualization, in *Evolving Approaches to Understanding Natural Hazards* (G.A. Tobin and B.E. Montz, eds.), Cambridge Scholars Publishing: Newcastle-Upon-Tyne, pp 230-239.
- Jalayer, M., **S. Hu**, H. Zhou, and R. Turochy. 2015. Evaluation of Geo-tagged Photo/Video Logging Method to Collect Geospatial Highway Inventory Data for Supporting Highway Safety Manual Implementation, *Papers of in Applied Geography* , 1(1): 50 - 58.
- Du, J., C. Li, and **S. Hu**. 2014. The Long-term Hydrological Impact Assessment of Land Use and Land Cover Changes using L-THIA Model in the Qinhuai River Watershed of Jiangsu Province, China, *Proceedings of the ASPRS 2014 Annual Conference*.
- Jalayer, M., J. Gong, H. Zhou, **S. Hu**, and M. Grinter. 2014. A Comprehensive Assessment of Highway Inventory Data Collection Methods, *Journal of Transportation Research Forum*, 53(2): 73-92.
- Hildebrandt, K and **S. Hu**. 2013. Multimedia Mapping on the Internet and Language Documentation: New Directions in Interdisciplinarity, *Polymath: An Interdisciplinary Arts and Sciences Journal*, 3 (3): 51 - 61.
- Hu, S.** and T. Dai. 2013. Online Map Application Development Using Google Maps API, SQL Database and ASP.NET, *International Journal of Information Communication Technology Research*, 3(3): 102 - 111.
- Hu, S.** 2012. Online Mapping for Fire Service First Responders Using Google Maps API, *Papers of the Applied Geography Conference*, 35: 54 - 63.
- Hu, S.** 2012. Multimedia Mapping on the Internet Using Commercial APIs, *Online Maps with APIs and Mapservices* (M. P. Peterson, ed.), Springer, pp. 61-71.
- Hu, S.** 2012. Online Map Service Using Google Maps API and Other JavaScript Libraries: An Open Source Method, *Online Maps with APIs and Mapservices* (M. P. Peterson, ed.), Springer, pp. 265-278.

SOUTHERN ILLINOIS UNIVERSITY
EDWARDSVILLE

Date: March 8, 2019

To: EUE Committee

From: Susan Hume, Chair, Department of Geography



RE: EUE Proposal Support Statement

I strongly support Dr. Hu's proposal to retrain and redesign the GEOG320 Cartography curriculum by transitioning the course's software from ArcMap to ArcGIS Pro and redevelop twelve lab assignments to reflect this crucial technological change. Geographic Information Systems (GIS) software is widely used for modern-day mapmaking, and the transition from ArcMap for Desktop to the online-based ArcGIS Pro represents a dramatic shift in how users access and interface with this technology. Additionally, a particularly important feature of ArcGIS Pro is that it enables a project team to create and share maps, data layers, geoprocessing tools, and even entire projects among its members. Dr. Hu recognizes that he will have to adopt ArcGIS Pro and redevelop GEOG320 Cartography for the course to remain relevant. Dr. Hu is requesting a ¾ month of summer salary to support his profession development for mastering ArcGIS Pro, and then redeveloping twelve labs using ArcGIS Pro.

GEOG320 Cartography is a required core course for all Geography majors and for undergraduates from other disciplines pursuing the GIS minor. Among the 40 current GIS minors are SIUE students majoring in Biology, Criminal Justice, Earth and Space Science Education, and Engineering Mechatronics & Robotics. GEOG320 is the prerequisite for GEOG418 Introduction to GIS and a foundational course for GEOG420 Interactive and Animated Cartography, GEOG421 Digital Elevation Modeling, GEOG432 Web-based Online Mapping, and other GIS-related courses. GEOG320 Cartography is offered every semester and summer, and reaches approximately 75 SIUE students per year. The Department of Geography is committed to funding the adoption of ArcGIS Pro software for this course and other subsequent courses.

If you need additional information, please do not hesitate to contact me at 650-2091 or shume@siue.edu.

To: Excellence in Undergraduate Education

From: Greg Budzban, Dean, College of Arts and Sciences



Subject: Dean's Memo of Support

Date: 12 March, 2018

The College of Arts and Sciences strongly supports the application of Dr. Shunfu Hu for an EUE grant to learn use of ArcGIS Pro software and redesign lab exercises for GEOG 320. The integration of up-to-date applications is important to ensuring students are prepared professionally for use of industry standard techniques. As Dr. Hu notes, the course is a key component of the GIS-related curriculum, which is in high demand by students in Geography and other disciplines.

The majority of the budget is faculty salary to compensate effort in learning the new software and developing revised lab exercises. Additional funds for wages supports evaluation of the new exercises to ensure they will work as intended for the course. The project provides benefits beyond the project year, as the redesigned course components would continue to be used in future years.

Prior EUE Support

Project Director	Project Number	Award Amount	Project Dates
Shunfu Hu	2017-014	\$5,940	07/2016 – 06/2017

Prior Results

The project title: Using Experiential Learning Opportunities in the Virtual National Parks to Enhance Undergraduate Geoscience General Education

The Project Director, Dr. Shunfu Hu, proposed to use the National Park Service's national parks as "models" to develop virtual national parks (VNPs) in order to offer students the experiential learning opportunities in ESCI111: Introduction to Physical Geology and Physical Geography, Geog210: Physical Geography, and Geog211: Meteorology in the Department of Geography.

The PI completed the project successfully. The web site of the project is: <https://www.siue.edu/~shu/VNP.html>, which is an online interactive map to display the locations of the ten selected national parks with clickable icons displayed on the map. Each icon is hyperlinked to the multimedia information about each park, including a 3D fly-through animation (discussed next), panoramic and close-up digital photographs of the points of interest (e.g., Delicate Arch in the Arches National Park), and walk-through video clips along trails to provide the map user (e.g., students) with a sense of real presence in the park. Supplemental educational materials were developed to provide basic information of the park and points of interest for students to explore (see attached sample material for Kenai Fjords National Park).

The VNP online map has been shared among all the instructors of ESCI111, GEOG210, and GEOG211 in the Department of Geography.

Glacier: a part of hydrologic cycle and rock cycle

Background Information

A glacier is a thick mass of ice that originates on land from the accumulation, compaction, and recrystallization of snow (a solid state of water). There are two types of glaciers you can find on the Earth's surface: Alpine (valley) glaciers and ice sheets. Alpine glaciers exist in mountainous areas and flow down a valley from an accumulation center at its head called a cirque. Alpine glaciers usually form in a mountain valley, so their sizes are relatively small. For instance, the west branch of the Hubbard Glacier runs through 70 miles of mountainous terrain in Alaska and the Yukon Territory. Ice sheets, on the other hand, are much larger scale than valley glaciers, such as Antarctic Ice Sheet of 5.4 million square miles and 14,000 feet thick. Ice flows out in all directions from one or more snow accumulation centers.

Glaciers move at a very slow speed, but they can make major impact on the landscape at the places where they form and move over through erosion and deposition. Glaciers are capable of great erosion, primarily in two ways, plucking (uplifting loosening rocks) and abrasion (Rocks within the ice acting like sandpaper to smooth and polish the surface below). Landforms created by glacier erosion include cirques, tarns, arêtes, horns, hanging valleys, abrasion and fjords (Figure 1). A **cirque** (French for "circus") is an amphitheater-like valley, or valley head, formed at the head of a glacier by erosion. A **tarn** is a small lake in the shallow excavated depression of rock benches of a glacial trough or cirque. A pyramidal peak, or sometimes in its most extreme form called a **glacial horn**, is a mountaintop that has been modified by the action of ice during glaciation and frost weathering. U-shaped valleys are formed in river valleys which, during the ice age, have been filled by a large glacier. These glaciers have deepened, straightened and widened the valley by plucking and abrasion. A **hanging valley** is a smaller side valley left 'hanging' above the main u-shaped valley. **Glacial striations** or **glacial grooves** are scratches or gouges cut into bedrock by process of glacial abrasion. A **fjord** is a long, narrow inlet with steep sides or cliffs, created in a valley carved by glacial activity.

Landforms created by glacier deposition include tills, lateral moraines, medial moraines, drumlins, kames and kettle holes (Figure 2). **Till** is composed of sediment materials deposited directly by ice. Moraines are layers or ridges of till. A **lateral moraine** is located at the side of a glacier. A **medial moraine** is located at the center of a glacier or at the confluence of two glaciers. **Drumlins** are smooth, elongated, parallel hills. A **kame** is steep-sided hill composed of sand and gravel, originated when sediment collected in openings in stagnant glacier ice. **Kettle holes** are depressions created when blocks of ice become lodged in a glacial deposits and subsequently melt.



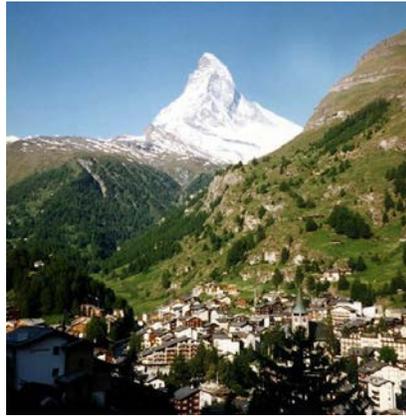
a. Cirque



b. Tarn



c. Arête



d. Horn



e. Hanging valley



f. Glacial striations



g. Fjords

Figure 1: Glacier Erosional Landforms



a. Till



b. Lateral moraine



c. Medial moraine (blue arrows) (Amy Harris)



d. Drumlin (Terry Poulton)



e. Kame



g. Kettle holes

Figure 2: Glacier depositional Landforms

Virtual Field Trip

Step 1. Visit the web site: www.siue.edu/~shu/IUSE.html

Step 2. Select **Kenai Fjords National Park** from the dropdown list and click **Search** button

Step 3. Choose the **Satellite** option to see a general overview of the Kenai Fjords National Park

Question 1. What does the white color represent from this satellite image?
(answer: snow, ice and glaciers)

Question 2. What are those long, narrow inlets from this satellite image?
(answer: fjords)

Step 4. Zoom further into the satellite image and explore the Kenai Fjords National Park.

Question 3. What other glacier landforms can you see?
(answer: Arêtes, cirques, lateral and medial moraines)

Step 5. Zoom out to find the google balloon and click on the balloon. An information window will start

Step 6. Play the video (10 minutes). (Note: you can play the same video in YouTube)

Question 4. According to the YouTube video, how much percent of the glaciers at the Kenai Fjords National Park retreated between 1950 and 1985?
(answer: 5%)

Question 5. What kind of maps were used to study the glacial change?
(answer: topographic maps)

Question 6. What new technology is used to study the glacial retreat today?
(answer: GPS)

Step 7. Click on the **3D Fly Through** link to watch another YouTube video (3 minutes)

Question 7. What are those cracks you see on the surface of the ice fields are called?
(answer: crevices)

Step 8. Click on the **Link to NPS Web Site** to learn more about the Kenai Fjords National Park

Use of Google Earth Pro

Step 1. Download the **Kenai_Fjords_National_Park.kmz** file from the Blackboard

Step 2. Download three photos: DSC02764. jpg, DSC02764.jpg, DSC02764.jpg from the Blackboard.

Step 3. Double click on the kmz file to launch the Google Earth Pro (assuming you have the Google Earth Pro installed on the computer you're using)

Step 4. Double click each of the points in Google Earth Pro to answer the following questions and confirm your answers using the close-up photos

Point 1. 59.796568, -150.072

What type of glacial landform can you see at this point? Use DSC02774.jpg to confirm your answer.

Answer: medial moraine

Point 2. 59.875751, -150.0913

What type of glacial landform can you see at this point? Use DSC02765.jpg to confirm your answer.

Answer: Glacial striations

Point 3. 59.8370, -150.05094

What type of glacial landform can you see at this point (find a red arrow in the photo)? Use DSC02765.jpg to confirm your answer.

Answer: Arêtes

Appendix A

Getting to Know ArcGIS Pro (Law and Collins, eds., Second Edition, 2019, 521 pages)

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Chapter 1 Introducing GIS

Exercise 1a: Explore ArcGIS Online

Chapter 2 A first look at ArcGIS Pro

Exercise 2a: Learn some basics

Exercise 2b: Go beyond the basics

Exercise 2c: Experience 3D GIS

Chapter 3 Exploring geospatial relationships

Exercise 3a: Extract part of a dataset

Exercise 3b: Incorporate tabular data

Exercise 3c: Calculate data statistics

Exercise 3d: Connect spatial datasets

Chapter 4 Creating and editing spatial data

Exercise 4a: Build a geodatabase

Exercise 4b: Create features

Exercise 4c: Modify features

Chapter 5 Facilitating workflows

Exercise 5a: Manage a repeatable workflow using tasks

Exercise 5b: Create a geoprocessing model

Exercise 5c: Run a Python command and script tool

Chapter 6 Collaborative mapping

Exercise 6a: Prepare a database for data collection

Exercise 6b: Prepare a map for data collection

Exercise 6c: Collect data using Collector for ArcGIS

Chapter 7 Geoenabling your project

Exercise 7a: Prepare project data

Exercise 7b: Geocode location data

Exercise 7c: Use geoprocessing tools to analyze vector data

Chapter 8 Analyzing spatial and temporal patterns

Exercise 8a: Create a kernel density map

Exercise 8b: Perform a hot spot analysis

Exercise 8c: Explore the results in 3D

Exercise 8d: Animate the data

Chapter 9 Determining suitability

Exercise 9a: Prepare project data

Exercise 9b: Derive new surfaces

Exercise 9c: Create a weighted suitability model

Chapter 10 Presenting your project

Exercise 10a: Apply detailed symbology

Exercise 10b: Label features

Exercise 10c: Create a page layout

Exercise 10d: Share your project

Appendix B

ArcGIS Pro tutorials, online seminars and videos by ESRI

Title	Type	Cost	Time (hrs)
Getting Started with ArcGIS Pro	Tutorial	Free	2.5
ArcGIS Pro: An Introduction	Video	Free	1
ArcGIS Pro Editing Essentials	Online Seminar	Free	1
ArcGIS Pro: Using Imagery	Video	Free	1
ArcGIS Pro Tasks: An Introduction	Video	Free	1
Processing Raster Data Using ArcGIS Pro	Web Course	Free	1
Spatial Analysis and Modeling with ArcGIS Pro	Online Seminar	Free	1
Querying Data Using ArcGIS Pro	Web Course	Free	0.5
Displaying Data in ArcGIS Pro	Web Course	Free	1
Managing Map Layers in ArcGIS Pro	Web Course	Free	1
Understanding the Suitability Modeling Workflow	Tutorial	Free	3
Cartographic Creations in ArcGIS Pro	Tutorial	Free	2
ArcGIS Pro Essentials for ArcMap Users	Online Seminar	Free	1
ArcGIS Pro: Mapping and Visualization	Video	Free	1
Performing Viewshed Analysis in ArcGIS Pro	Web Course	Free	1
Displaying Raster Data Using ArcGIS Pro	Web Course	Free	3
ArcGIS Pro: Analysis and Geoprocessing	Video	Free	1
Labeling Features Using ArcGIS Pro	Web Course	Free	0.5
Terrain Analysis Using ArcGIS Pro	Web Course	Free	2.5
Integrating Data in ArcGIS Pro	Web Course	Free	1
Sharing Maps and Layers with ArcGIS Pro	Web Course	Free	3.5
Preparing to Perform Analysis Using ArcGIS Pro	Web Course	Free	1
Building Geoprocessing Models Using ArcGIS Pro	Web Course	Free	2.5
Total			34

Appendix C

Sample Lab Exercise

Lab Exercise 3

Basic of ArcGIS

In this lesson, you will learn:

- about the three ArcGIS applications (ArcCatalog, ArcMap and ArcToolbox) that comprise ArcGIS
- terminology used in ArcGIS
- features and functions in ArcGIS

Part I

Explore ArcCatalog and ArcMap

In this exercise, you will explore the ArcGIS applications ArcCatalog and ArcMap. You will learn how to use ArcCatalog to find maps and data and how to display maps in ArcMap. Additionally, you will perform some geoprocessing tasks on spatial data.

Step 1 Start ArcCatalog and open a geodatabase

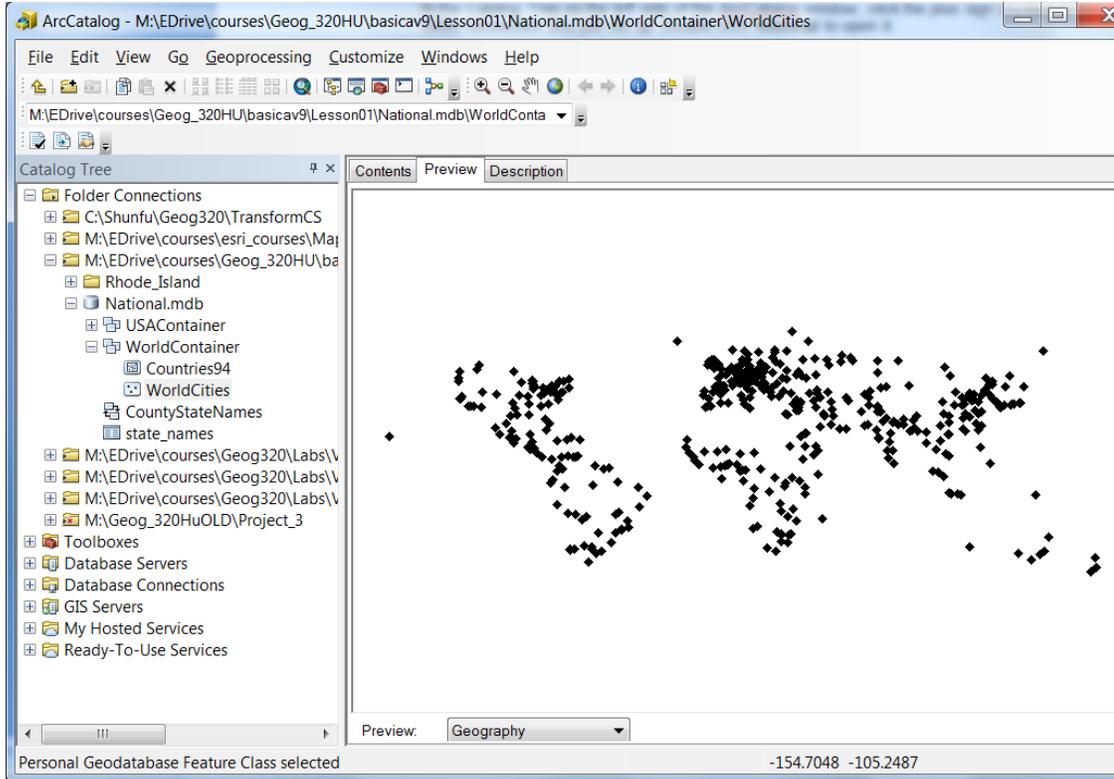
When ArcCatalog opens, click the Connect to Folder button . Navigate to **C:\Geog_320HU\basicAV9\Lesson01**. Click OK.

In the Catalog Tree on the left side of the ArcCatalog window, click the plus sign (+) next to the folder connection you just set up. Double-click **National** to open it.

National.mdb, which has a symbol of , is a **personal geodatabase** and it is a new data model introduced with ArcGIS. You will learn more about geodatabases later in the course.

Step 2 Preview features from the geodatabase

On the right side of the ArcCatalog window, click the Preview tab to make it active. In the Catalog Tree, double-click on WorldContainer or click the plus sign  next to the WorldContainer. WorldContainer is a **feature dataset** with the symbol of . There are two feature classes inside this feature dataset: Countries94 and WorldCities. They are called **feature classes**. The symbol  indicates the feature class is a polygon feature class and the symbol  indicates the feature class is a point feature class.



Click **Countries94** to make it active and a map of the world is displayed on the right side of the ArcCatalog window.

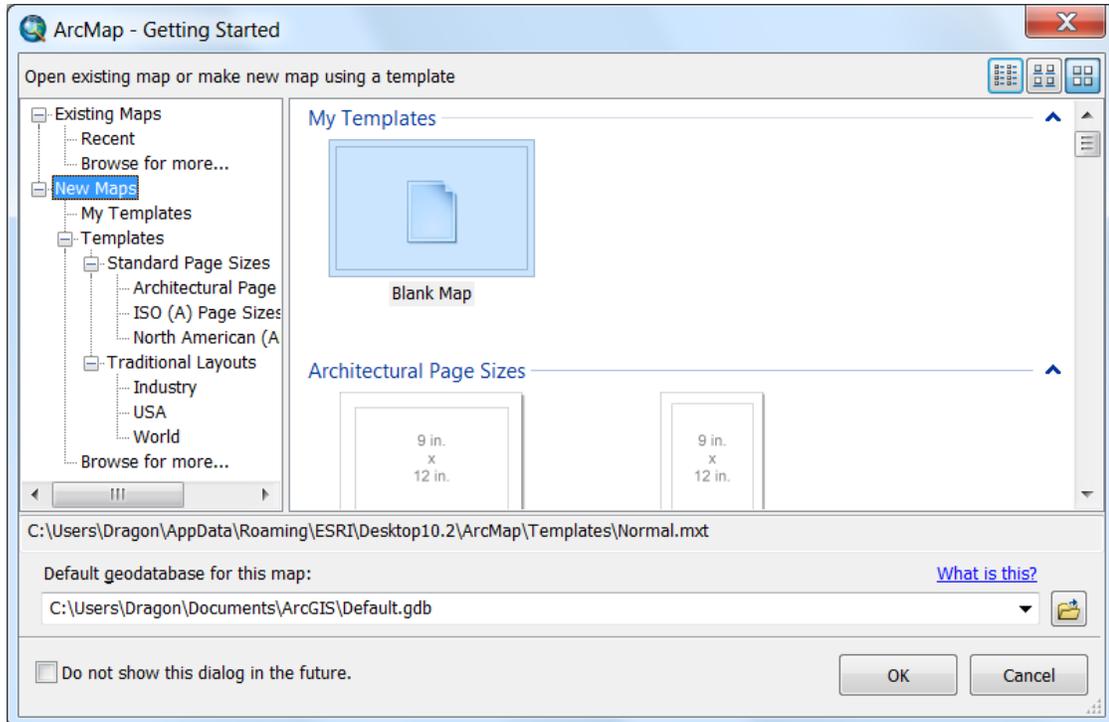
Now click **WorldCities** to preview the world cities.

In the Preview dropdown list below the preview area, choose **Table**. Now you see the World Cities attribute table. Examine its fields.

Take a few moments and examine the other data in the **C:\Geog_320HU\basicAV9\Lesson01** folder using either the Preview or Contents tabs.

Step 3 Start ArcMap

Click the Launch ArcMap button  in ArcCatalog program. Click "New Maps", "Blank Map" and then click OK.



Step 4 Drag and drop data into ArcMap

In ArcCatalog, click the Contents tab, then in the Catalog Tree, click WorldContainer. Click Countries94 and drag it into the ArcMap map display area.

The world countries are displayed in ArcMap.

Now drag the WorldCities from ArcCatalog into ArcMap to add them to the display.

Minimize ArcCatalog.

Step 5 Change the symbology for world countries

In this step, you will change the color of the country polygons.

In the Table of Contents, right-click the Countries94 polygon symbol (the square).



The Symbol Selector displays. Experiment with changing the colors of the country polygons.

Step 6 Zoom in to South America

On the Tools toolbar,



click the Zoom In button . Draw a box around the South American continent.

ArcMap zooms in to the contents of the box.

Step 7 Label map features

In this step, you will label features on a map and add map tips. A map tip is a way to see attribute information about a feature.

In the Table of Contents, right-click WorldCities (its name, not the symbol) and click Label Features. Labels appear for the cities. If some of the cities are not labeled, enlarge (hint: Zoom in) the display area.

Next, you will add the map tips.

Again, in the Table of Contents, right-click WorldCities and click Properties. In the Layer Properties dialog, click the Display tab, then check the box next to Show Map Tips.

Show MapTips using the display expression

Click OK. Move your mouse pointer over a city on the map to see the associated map tip.

The map tip appears in a box and should be the same as the city's label.

Step 8 Start an analysis project

For the remainder of this exercise, you will work with data from Aquidneck Island, Rhode Island to perform geoprocessing (GIS spatial analysis) tasks that are part of a fast food restaurant location analysis.

As part of your analysis, you need to find busy roads in several strategic ZIP Codes.

First, you will buffer the target ZIP Codes by 1.5 kilometers. You will then overlay the buffer polygons with the island's street network to isolate those streets that fall within the buffers. In the second part of the analysis, you will identify the busy streets in the target areas.

First, you will buffer the ZIP Codes that fall within Aquidneck Island, Rhode Island.

Restore ArcCatalog.

In ArcCatalog, expand the Rhode_Island folder.

In ArcMap, click **File** menu and then **New**. Choose New Maps and Blank Map. Click OK.

Click **No** when prompted to save your changes.

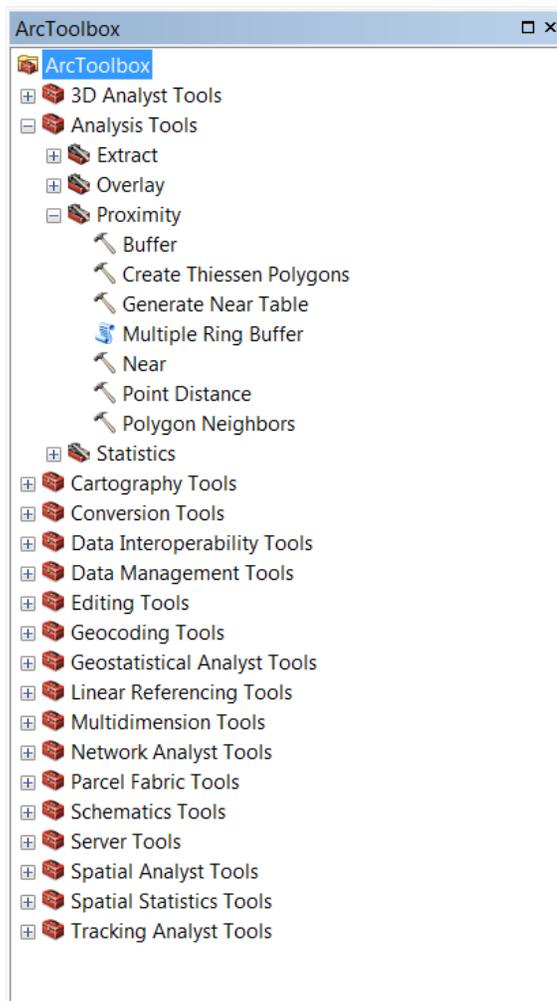
From ArcCatalog, drag the island, streets, and zip feature classes into ArcMap.

Minimize ArcCatalog.

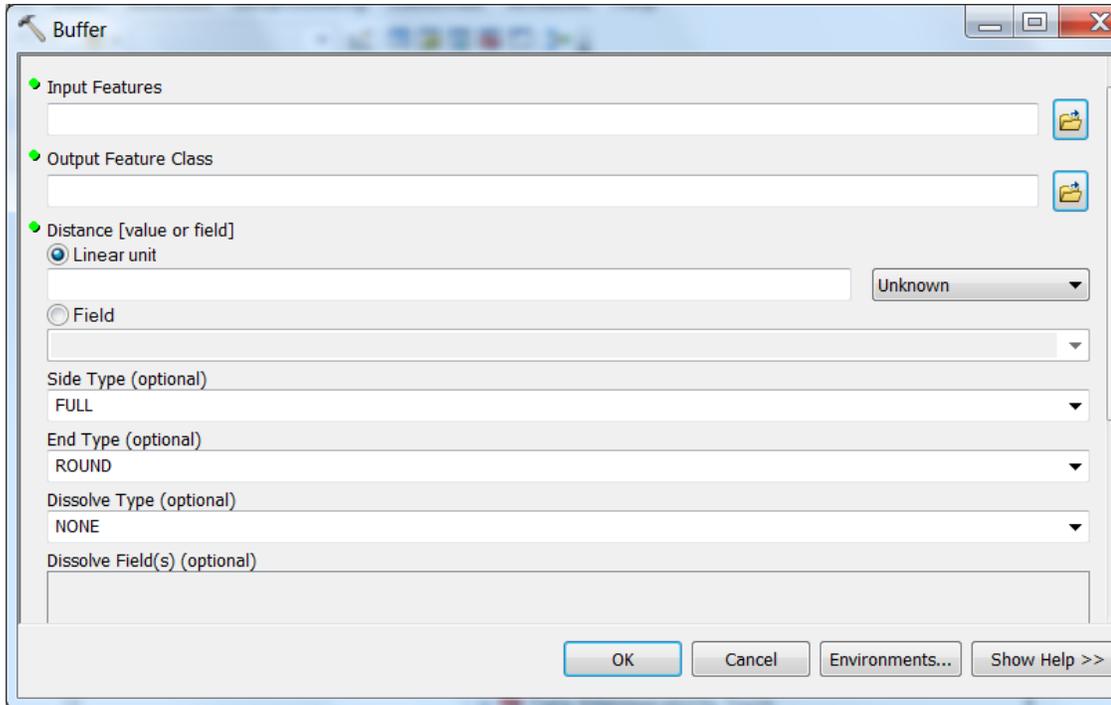
Step 9 Use the ArcToolbox - Buffer tool to create buffers

Now you'll open the ArcToolbox so you can buffer the target ZIP Codes.

Launch ArcToolbox  from ArcMap.



Click the plus sign (+) next to Analysis Tools, then Proximity and then double click the **Buffer** tool



Next, you need to specify the buffer parameters.

In the Input features, click Browse button  to choose zip point as the layer.

In the Output Features Class, Click the Browse button  and navigate to the **C:\Geog_320HU\basicAV9\Lesson01\Rhode_Island** folder and save the layer as a shapefile named **zipbuf**. (Note: if the file name already exists, type in a different name, for instance, zipbuf2, etc)

Note: As a common practice, you need to save the output layer to your working directory, in this case, **C:\Geog_320HU\basicAV9\Lesson01\Rhode_Island** folder.

Enter **1.5** for the buffer distance.

In the Distance units dropdown list, choose Kilometers.

Click OK to have the Buffer tool to create the buffers.

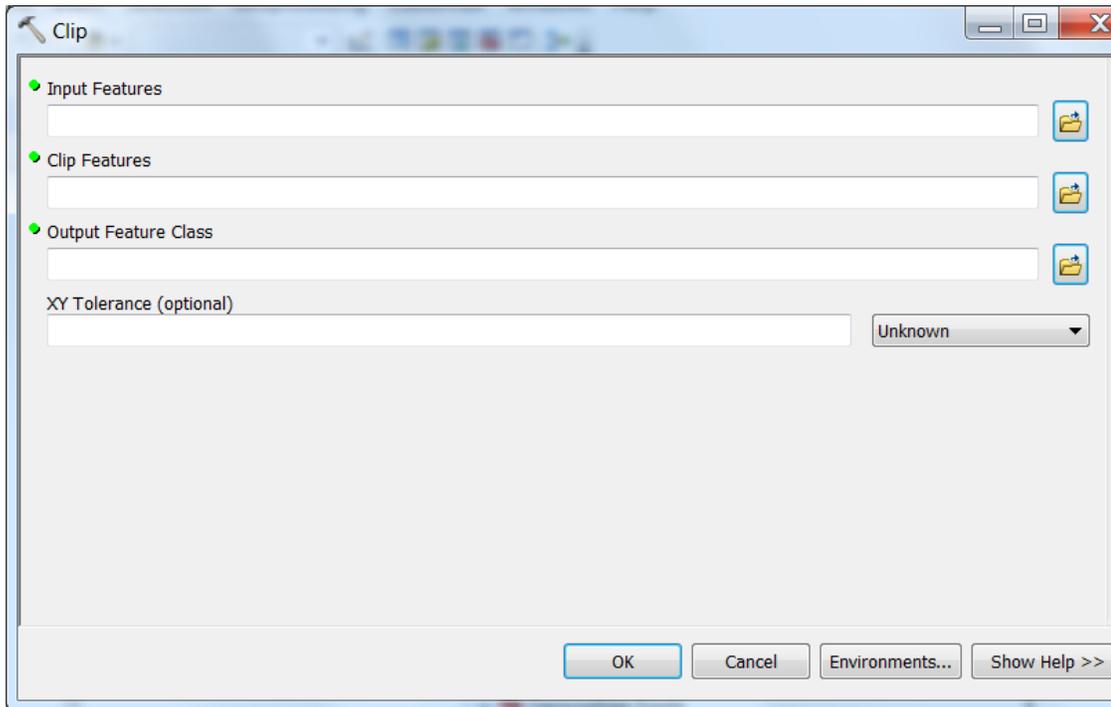
Step 10 Clip data with the ArcToolbox – Clip tool

When the Buffer tool is finished processing, the zipbuf layer is added to ArcMap.

Arrange the order of the layers in the Table of Contents so that zip is at the top, streets is underneath zip, island is underneath streets, and zipbuf is at the bottom.

Now you will use the ArcToolbox – Clip tool to clip the island's streets to the buffer polygons you created around the ZIP Code points.

In ArcToolbox, click the plus sign (+) next to Analysis Tools, then Extract and then double click the Clip tool.



Next, you need to specify the clip parameters.

For the Input Features to clip, choose streets arc. For the Clip Features, choose zipbuf. For the Output Feature Class, click the Browse button and save the output clip layer as a shapefile named **Busy_Roads.shp** in your **Rhode_Island** folder.

Click OK to clip the streets using the polygons from zipbuf. After a moment, the new layer is added to the Table of Contents.

Step 11 View the results in ArcMap

All the busy roads within 1.5 kilometers of the ZIP Code points are displayed in ArcMap.

In the Table of Contents, uncheck the streets arc layer. Now you see only the roads contained within the ZIP Code buffer polygons.

Step 12 Close ArcMap and ArcCatalog

Click **No** when you're prompted to save changes to the map document.

Part II

Use ArcCatalog to explore geodatabases

In this exercise, you will use ArcCatalog to examine a **personal geodatabase** along with its **feature datasets, feature classes, and tables**. You will view geometry types: points, lines, and polygons, and spatial references.

Step 1 Start ArcCatalog and connect to a data folder

First, you'll create a direct connection to the data for this exercise.

Click the Connect to Folder button . Navigate to **C:\GEOG_320HU\basicAV9\Lesson02** and click OK.

Step 2 Expand the folder and geodatabase

In the Catalog Tree, click the plus sign next to the folder connection you just set up to expand its contents.

The folder contains a personal geodatabase named Subdivision.

Expand the Subdivision geodatabase by clicking the plus (+) next to it in the Catalog Tree.

The Subdivision geodatabase contains one feature dataset named Water, a table named Maintenance, and a feature class named SubdivisionParcels.

Step 3 Expand the feature dataset

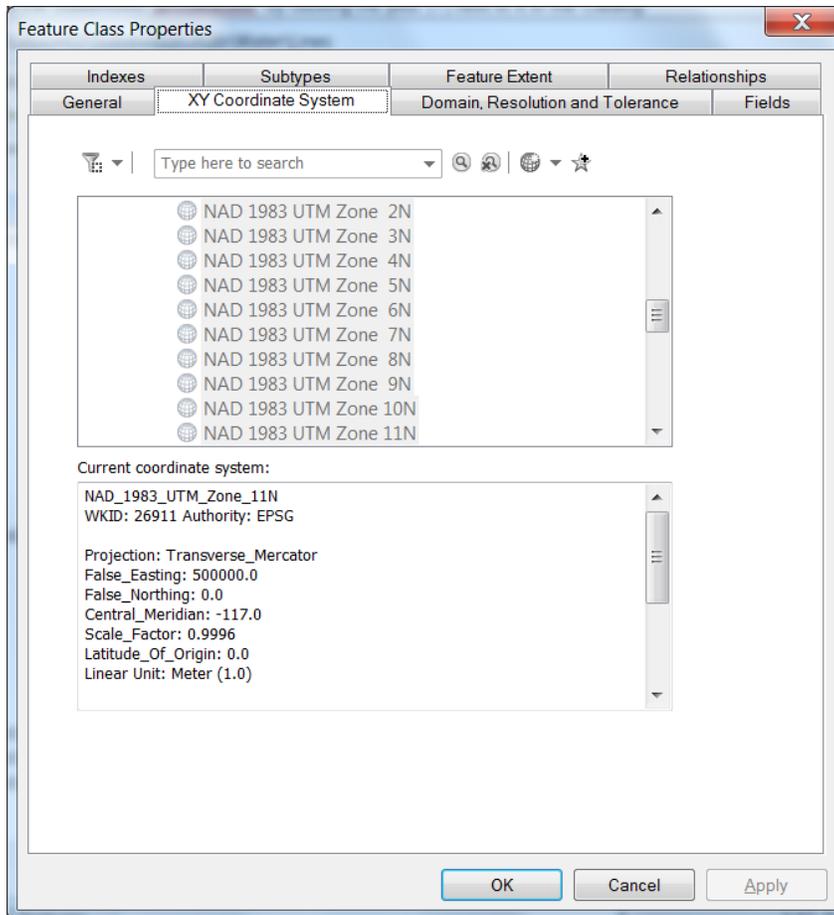
Expand the Water feature dataset.

This feature dataset contains two feature classes: Lines and Wells. The Subdivision geodatabase contains three feature classes in all: Lines, Wells, and SubdivisionParcels. The Lines and Wells are stored in the Water feature dataset, while SubdivisionParcels is a stand-alone feature class.

Step 4 Examine a spatial reference

All feature classes within a feature dataset have the same **spatial reference** (i.e., **datum, ellipsoid, map projection, coordinate system, map unit**).

In the Catalog Tree, right-click Water and click Properties. The Feature Class Properties window is displayed (see the graphic below).



Click on the **Coordinate System** tab. The Current Coordinate System is in the NAD_1983_UTM_Zone_11N.

Make a note of all the parameters: map projection, False_easting, False_northing, Central_Meridian, Scale_Factor, Latitude_of_Origin and Linear Unit.

Note: UTM is a coordinate system; NAD 1983 is a datum and NAD stands for North American Datum; Zone 11 N is one of the 60 UTM zones that cover the entire globe.

Scroll down to take a look at the parameters for the Geographic Coordinate System. Make a note of them as well.

Note: All these parameters are elements of the spatial reference used for a feature class and a feature dataset. They will be discussed in Dr. Hu's lectures.

Click **OK**.

Step 5 Examine the geometry type for a feature class

In ArcCatalog, double-click the Wells feature class to display its properties. Click the Fields tab.

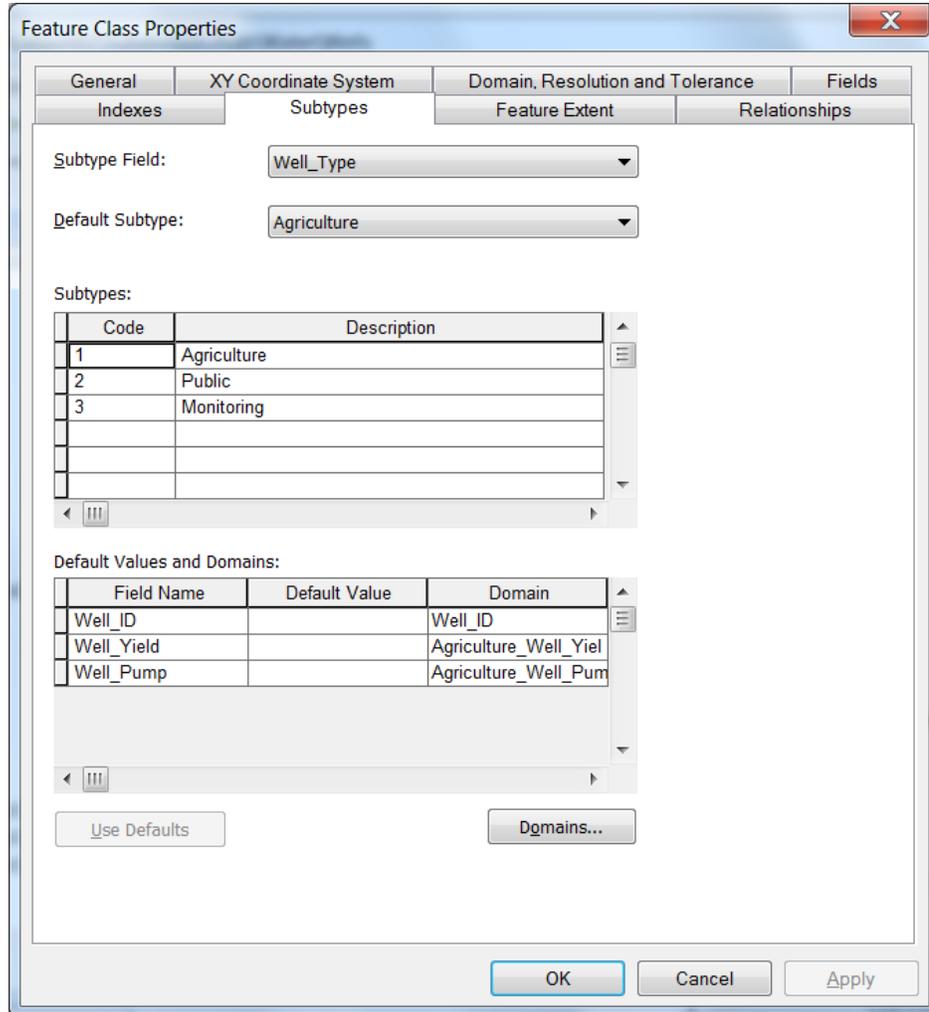
The geometry type is stored in the Shape field. Click the Shape field. The Shape field's properties display at the bottom of the dialog.

Notice that the Geometry Type is **Point**. The Wells feature class stores the wells as points.

Step 6 Examine subtypes

The Feature Class Properties dialog also allows you to view subtypes.

Click the Subtypes tab.



The Wells feature class has three subtypes: Agriculture, Public, and Monitoring. Subtypes are one method for making the features in your geodatabase more closely model real-world features.

Click Cancel.

Step 7 Preview a feature class

When previewing data, you can choose between two views: Geography and Table. First, you'll preview the geography of the SubdivisionParcels feature class.

In the Catalog Tree, click the SubdivisionParcels feature class, then click the Preview tab to the right.

Step 8 Preview a feature class table

Features are stored as rows in a feature class table. Click the Preview dropdown list at the bottom of the preview panel and choose Table.

Now you see a tabular view of the SubdivisionParcels feature class. Examine the fields in the table.

Each feature is stored as a row in the table. ArcGIS automatically stores each feature's length and area in the Shape_Length and Shape_Area fields.

Step 9 Exit ArcCatalog

When you're finished examining the table, exit ArcCatalog.

In this exercise, you explored a geodatabase, feature dataset, and feature class. You also examined spatial reference, geometry type, and subtypes. You'll learn more about the geodatabases later.

Part III

Use ArcMap to explore geographic data

This exercise will show you how geographic data is organized and displayed in ArcMap based on the "layer" it represents. You will also see how to access layer attribute data in ArcMap. Toward the end of the exercise, you'll perform some simple spatial analysis.

Step 1 Start ArcMap

Click the Launch ArcMap button  in ArcCatalog program. Click "New Maps", "Blank Map" and then click OK.

You see the interface of the ArcMap application.

Whenever you work in ArcMap, you are working with a map document. A map document can contain one or multiple data frames, which in turn are populated by geographic (spatial) datasets. However, a map document does not contain the spatial datasets and it establishes the links to those spatial datasets. A map document has the **.mxd** file extension.

Step 2 Examine feature layers

From the File menu, choose Open.

Navigate to the **C:\GEOG_320HU\basicAV9\Lesson02\Redlands**.

Select **Redlands.mxd**. (Remember: it is just a map document)

Click Open.

When the Redlands map document opens, you see a map of the City of Redlands, California. The map displays various geographic features organized into layers. Each ArcMap layer is a particular theme of information.

For instance, all the donut shops on the map are point features (represented with house symbols) and grouped into a layer called Donut Shops. The current land use for parcels in the City of Redlands is contained in a layer called Land Use. This layer groups the different land use polygons according to their land use type.

The area on the left side of the ArcMap application window contains the list of layers and is called the **Table of Contents**. The area on the right side of the application window contains the graphic display of the layers in the Table of Contents.

Step 3 Display another layer

The other layers in the map are railroads, streets, and the location of ESRI.

Check the box next to the Railroads layer. The railroad tracks in Redlands display.

Note: The ESRI layer does not display. You will learn how to display it later.

Step 4 Identify geographic features

In ArcMap, you can use the Identify button to find out what features are just by clicking on them in the map display area.

First, you'll zoom in so you can see individual features more clearly. To do this, you'll access an existing bookmark that stores a specific geographic region encompassing ESRI and neighboring streets.

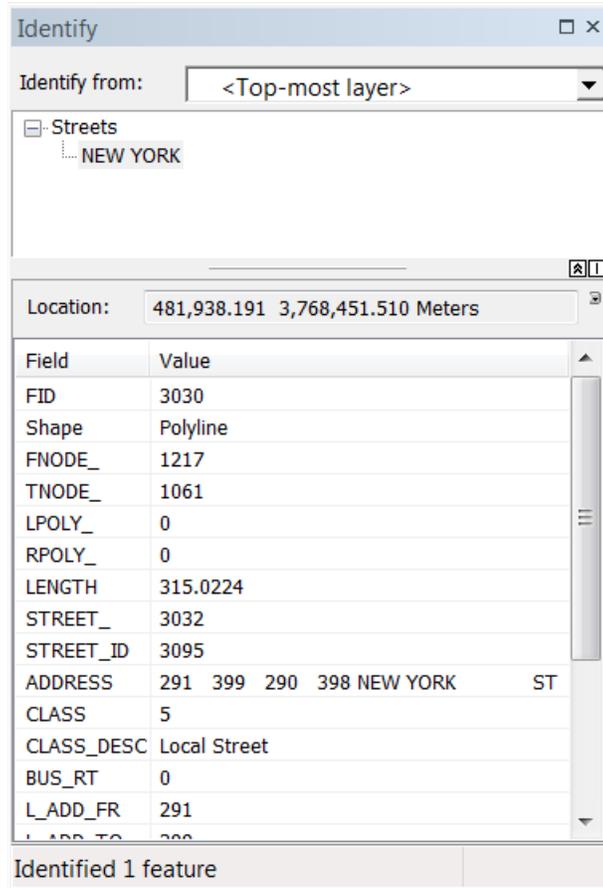
From the Bookmarks menu, click ESRI.

The display zooms in to ESRI. Notice that the streets are now labeled with their name and you can see the location of ESRI.

On the Tools toolbar, click the Identify button .

Click the line feature that represents New York Street (the red line just to the left of the street name).

The Identify Results window opens and displays all the attributes for New York Street that are contained in the database.



You can "flash" the feature that you just identified to see it in the display area.

In the left side of the Identify Results window, click New York (the name of the street) and observe the feature flash in the map display.

From the Layers dropdown list, choose All layers, then click the line representing New York Street again.

The Identify Results window now contains the attributes for the land use polygon that the street is located within.

On the left side of the Identify Results window, click the plus sign (+) next to Land Use, then click the first land use type listed (more than one may be listed). All the attributes for that specific land use polygon display.

Continue identifying other features in the display area by clicking them with the Identify button.

When you are finished, close the Identify Results window.

Step 5 Examine other attribute information

Before you explore the attribute information for some of the layers listed in the Table of Contents, you will return to the original geographic extent of the ArcMap document. This extent is also stored in a

bookmark. The bookmark was created to prevent the display from becoming cluttered and allows you to focus on only those layers you want to learn more about.

From the Bookmarks menu, click Original.

The layers displayed should be Donut Shops, Railroads, Streets, and Land Use.

In the Table of Contents, right-click Railroads and click Open Attribute Table.

The attribute table associated with the Railroads layer appears. Each record represents an individual feature in the Railroads layer.

Notice that the number of records is displayed at the bottom of the table window. Scroll to the right to see all the attributes describing this layer.

When you're finished examining the attributes, close the attribute table.

Next, in the Table of Contents, right-click Donut Shops and click Open Attribute Table. Examine this layer's attributes.

Close the attribute table when you're finished.

Finally, open the attribute table for the Land Use layer. Notice that each feature (record) has an LU_CODE attribute. In the map, each feature is displayed using the values in this attribute field.

Close the Land Use attribute table when you're finished examining it.

Step 6 Add map tips to your display

Map tips are text for a single feature attribute; map tips display when you hold the mouse pointer over a feature. They are an easy way for the map reader to get attribute information for a specific feature.

Hold your mouse pointer over the center of one of the symbols representing a donut shop and hold it there. The name of the donut shop displays.

You can specify which field displays by setting it in the layer's Properties dialog.

In the Table of Contents, right-click the **Donut Shops** layer name and click Properties. In the Layer Properties dialog, click the **Display** tab. Click the dropdown arrow for the field under Display Expression to see all the attribute choices.

You can specify that any one of these attributes be used as the map tip. The default that ArcGIS chose (Name) is usually the most useful for a map tip, but you are going to change it.

In the dropdown list, click Address.

Click OK. In the map display area, hold your mouse over any donut shop feature. The address should appear as a map tip.

Step 7 Display a layer using its attributes

The Streets layer is currently displayed using the same symbol for all the features, but you can display the features using their attributes.

First, turn off the display for Land Use by unchecking its box in the Table of Contents. Next, right-click Streets and click Properties. In the Layer Properties dialog, click the Symbology tab.

On the left side of the dialog, in the Show list, click Categories. Under Categories, click Unique Values. In the Value Field dropdown list to the right, click CLASS.

Click the Add All Values button.

Click Apply and move the Layer Properties dialog out of the way, if necessary, so that you can see the map display.

The streets now display with different symbols depending on their CLASS value.

Return the Streets layer to its previous setting by clicking Features in the Show list, then clicking OK to close the Layer Properties dialog.

Step 8 Select features using attributes

Often, you will want to display a feature (or features) that meets specific criteria. In this step, you will select and locate Interstate 10.

In the Table of Contents, uncheck the box next to Railroads to turn its display off.

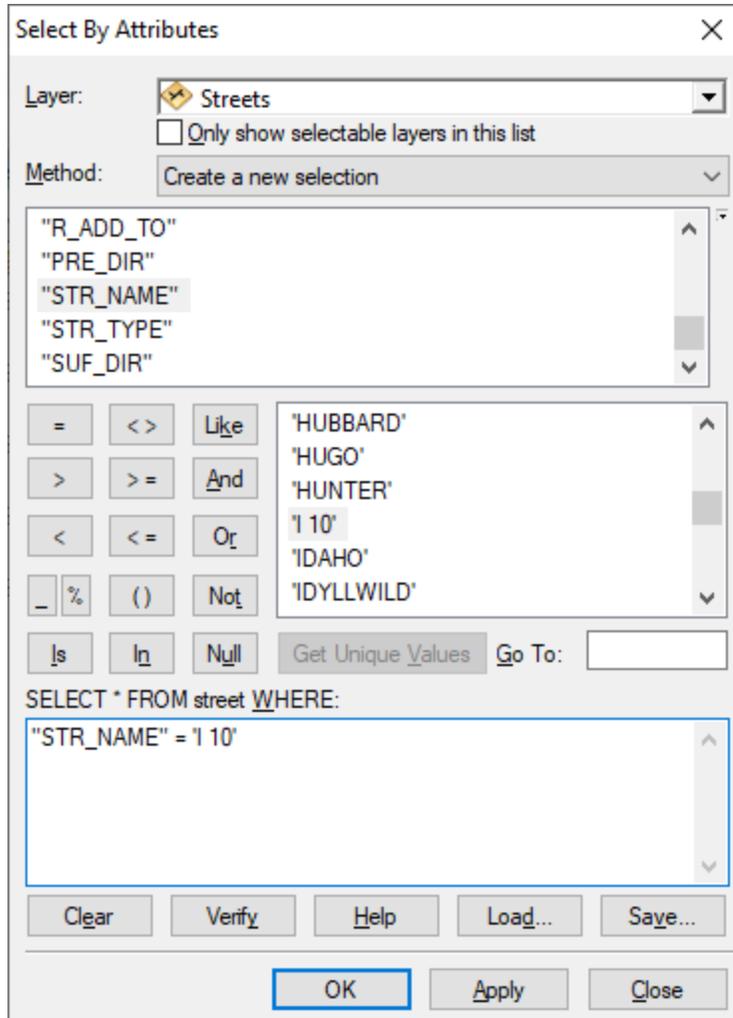
From the Selection menu, choose Select By Attributes.

The Select By Attributes dialog is where you construct queries for the layers in your map. You will query the Streets layer and create an expression using the attribute STR_NAME (for Street Name), which you will specify to be equal to I 10 (Interstate 10). This query will select the street segments that match the criterion in the map display area.

In the Layer dropdown list, click Streets. For Method, make sure "Create a new selection" is selected. In the Fields list, scroll down and double-click on STR_NAME. Click the equals sign button (=) in the middle of the dialog.

Next, click on "Get Unique Values" . Scroll down the list of unique values and double-click on I 10.

Your Select By Attributes dialog box should look like:



Click **Apply**. Move the Select By Attributes dialog out of the way so you can see the map display.

In the display area, I-10 is highlighted. The selected street segments are all part of Interstate 10.

Note: If you don't see the selected street segments, right-click on Streets in the Table of Contents, click Selection, and then click **Zoom to Selected Features**.

To clear selected feature, click the **Selection** menu and click **Clear Selected Features**.

Close the Select By Attributes dialog.

Step 9 Select geographic features using spatial relationships

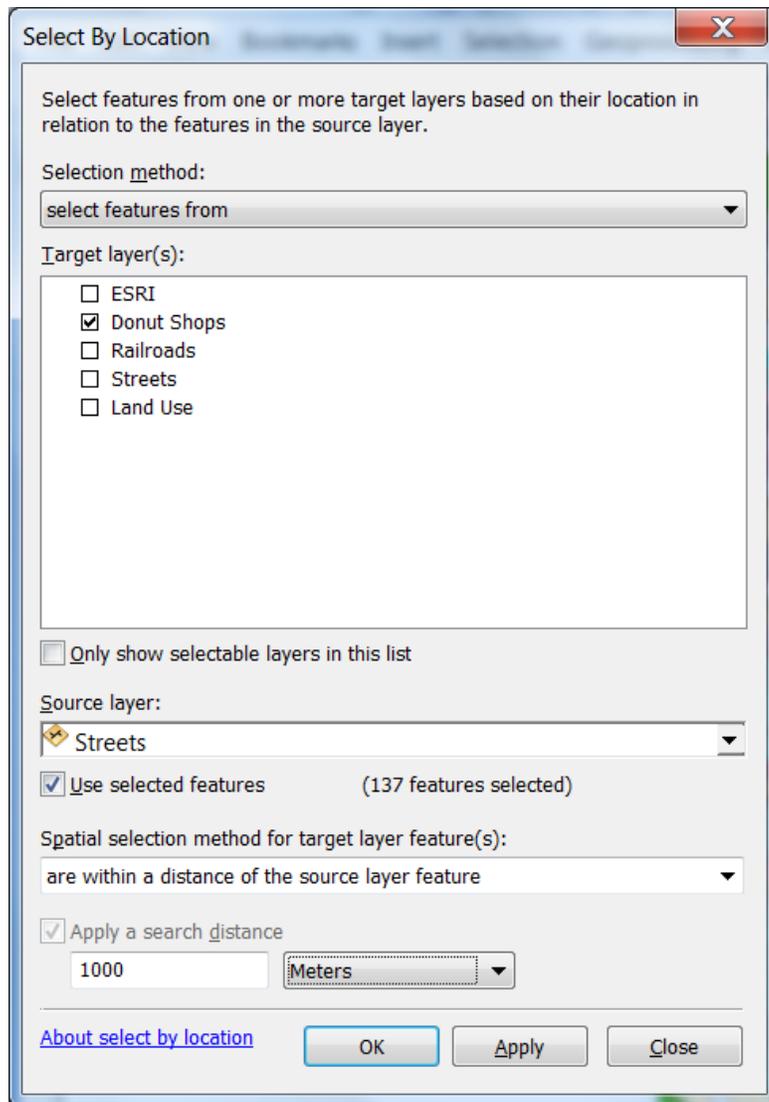
Now, you will select all donut shops that are within 1000 meters of Interstate 10 so that all the hungry commuters driving from Palm Springs to Los Angeles will know where to stop.

From the **Selection** menu, choose **Select By Location**.

In the Select By Location dialog, select items in the dropdown lists so that the selection query reads, "I want to select features from the Donut Shops layer that are within a distance of the features in the Streets layer."

For the Search distance, enter **1000**. From the dropdown list choose **meters**.

Make sure Donut Shops is the only layer checked in the list of layers from which you want to select. The Source Layer is Streets. Check the box next to "use selected features". Click Apply and close the Select By Location dialog.



The donut shops within 1000 meters of Interstate 10 are highlighted on the map.

In the Table of Contents, right-click Donut Shops and click Open Attribute Table. The records for the selected donut shops are also highlighted in the table. How many donuts shops have been selected?

Close the table.

You have just performed a spatial analysis operation in ArcMap.

Step 10 Exit ArcMap

From the File menu, choose Exit to close ArcMap. Click **No** when you're prompted to save changes.

In summary, you learned in this lab exercise about the basics of ArcGIS, including:

1. the three ArcGIS modules: ArcCatalog, ArcMap and ArcToolbox
2. the terminologies: map document (.mxd), geodatabase, feature dataset, feature classes, point features, polyline features, and polygon features
3. spatial analysis functions: buffer, clip, select by attribute, select by location
4. the concept of spatial reference: datum (e.g., NAD 1983), UTM coordinate system,...
5. the concepts of attributes, attribute fields, attribute table
6. how to change map symbology, add map tips and label map features

Write a summary report (one full page) about what you learned in this lab exercise, including your understanding of the basic concepts and functions of ArcGIS's three modules.

Due date: (one week from today). Submit your summary report to the Blackboard.