ArcIMS-Based Land Development Monitoring: Prototype for Harford County, Maryland

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ABSTRACT

The goal of this project was to design and develop a prototype web-GIS site that would facilitate monitoring of local urban development. In face of persistent problems with urban sprawl and increasing efforts to curb it with smart growth and other policies, this web site would allow the various stakeholders to: a) review the location, pattern, and intensity of previous development; b) examine the development capacity allowed by existing land use regulations; and c) explore the development setting in terms of environmental sensitivity, demographic and economic trends, and availability and accessibility to local amenities. The prototype is created using ArcIMS and customized using JavaScript for online selection, display, editing, and analysis of GIS data and land monitoring indicators. It will be used for developing web sites for other counties in Maryland and extending to multiple time periods. The project is sponsored by the National Center for Smart Growth Research and Education, University of Maryland.
http://arcims.rehearsal.uiuc.edu/website/harford

INTRODUCTION

As a result of population and economic growth and immigration, urban areas are continuously expanding. Almost 90 percent of the population increase in the United States since 1980 has occurred in cities, towns, and urban areas (Porter 1997). The U.S. Bureau of the Census projects that by 2050 the population will reach 400 million (http://www.census.gov, accessed in September 2004). Cities are annexing new lands, reviewing development proposals, redeveloping deteriorated or underused areas, and imposing various new regulations. Decisions and actions are taken on daily basis by many actors involved in the land development process. How can cities effectively manage this process? How can they track the changes over time? How can they assess the availability of land for new development? How can they learn about the effects planning documents have on the urban development process? How can they prevent the negative effects of urban sprawl and promote sustainable development? We propose that geographic information systems (GIS) based land monitoring tools could be used to manage urban development and address the problems associated with urban growth.

Urban growth contributes to extensive consumption of land, especially at the urban fringe (Porter 1997), environmental damage and pollution (Brower et al, 1991), increased cost of land and housing (Bollens and Godschalk, 1987), and expanded ecological footprint resulting from increased use of local and global natural resources (http://www.infoforhealth.org/pr/m16/m16chap4.shtml 2004). Land monitoring emerged

in the 1970s as a way of managing urban growth and dealing with its consequences. Land monitoring involves recording of land use information and changes over time in order to track land development, analyze the patterns of development, and evaluate potential future uses of land by taking zoning and other regulations into consideration (Knaap 2001; Moudon 2000). The suggested benefits of this approach include: promotion of smart urban growth; support for orderly and efficient growth patterns; improved social and economic opportunities; and protection of rural landscape.

Land monitoring has become increasingly important during the 1990s with more pronounced concerns with urban sprawl and the heightened sense of their urgency (Moudon 2000). Although the automated (computerized) land monitoring has been practiced for over two decades (Bollens and Godschalk, 1987), it is also in the 1990s that the affordability, user-friendliness and accessibility of geographic information systems (GIS) technology promises to enhance the challenging task of monitoring urban growth. However, despite this potential, GIS tools are not used extensively in land monitoring activities as evidenced by the survey 'Assessment of Regional GIS Capacity for Transportation and Land Use Planning' (Knaap and Nedovic-Budic, 2003). The survey results suggest that in majority of metropolitan areas land monitoring and urban growth management are not practiced and that GIS is rarely used for these purposes. The main obstacles for GIS employment are the unavailable data, outdated datasets, and difficulties in data integration at the regional level. Clearly, accurate, complete, and current GIS database is crucial for land monitoring to be performed.

The problems of database development and maintenance notwithstanding, more recent developments in Internet-based GIS offer additional possibilities in access and sharing of spatial data (Kingston et al, 2000; Dragicevic, 2004; Peng, 2001). Some of the advantages of Internet-based GIS over the standard desktop GIS include:

- More user-friendly interface that allows users not knowledgeable in GIS functions to perform spatial inquiries and analyses;
- Less costly access by the users;
- Customization with additional links and information, and thus increased information sharing capacity; and
- Better interaction facility through 'on-the-fly' drawing and commenting.

Extending on the previous efforts in developing tools to aid urban land monitoring and growth management, we pursue two main objectives:

1. Identification of a set of GIS-based indicators to be used in a land development monitoring system; and
2. Development of an Internet-based GIS tool that facilitates and assists monitoring of land development.

This web site would allow various urban development stakeholders to review the location, pattern, and intensity of previous development; examine the development capacity allowed by existing land use regulations; and explore the development setting in terms of environmental

sensitivity, demographic and economic trends, and availability and accessibility to local amenities.

METHODOLOGY

Our approach includes identification of land development indicators as an integral initial part of the project. Indicators provide "an empirical interpretation of reality" (Crane and Daniere, 1996) and are commonly used to present quantitative and often simplified account of a complex situations or processes. They often point out or identify phenomena that are not immediately visible, audible or perceived. Indicators translate data and statistics into succinct information that can be readily understood and used by a variety of interested groups. Banerjee (1996) proposes the following purposes of indicators:

- Measuring performances of policies and programs;
- Examining trends;
- Monitoring the condition of a city or a region;
- Informing decision-makers;
- Raising awareness of the public;
- Defining targets and setting planning objectives; and
- Raising red flags in an early warning system.

We identify a comprehensive set of GIS-based indicators for land development monitoring. The indicators are grouped under 9 main themes: 1. Land Utilization & Consumption, 2. Development Capacity, 3. Regulation and Administration of Development, 4. Environment and Land Preservation, 5. Housing, 6. Economy, 7. Transportation, 8. Utilities and Services, and 9. Demographics (Appendix A).

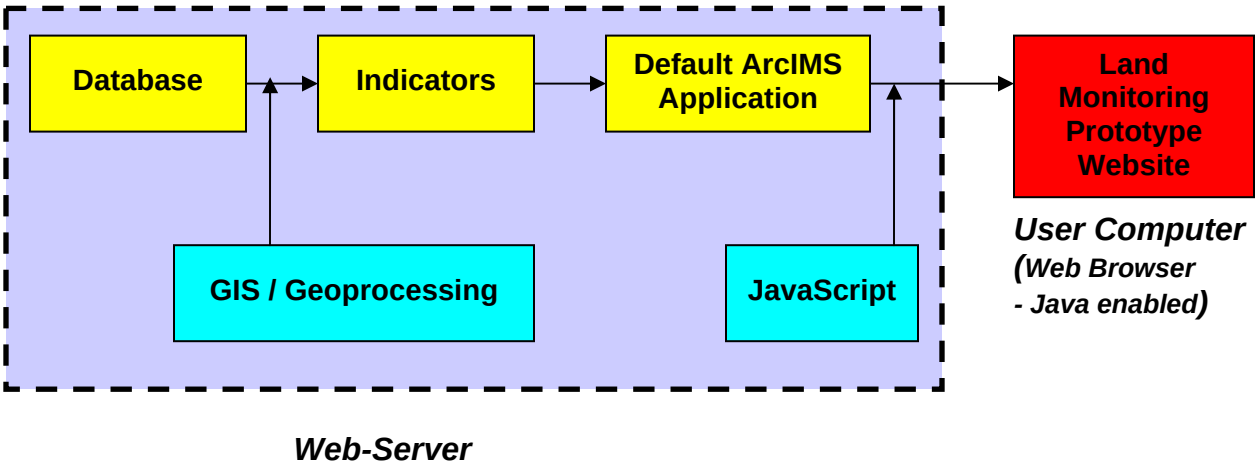
Project data in GIS and table (spreadsheet) formats are derived from a variety of sources, including:

- The University of Maryland;
- Maryland Department of Planning (http://www.mdp.state.md.us/);
- Environmental Systems Research Institute (http://www.esri.com);
- United States Bureau of the Census (http://www.census.gov);
- State Soil Geographic (STATSGO) Database (http://www.ncgc.nrcs.usda.gov/products/datasets/statsgo/); and
- GIS Data Depot (http://data.geocomm.com/)

The essential dataset for this study is the *Property* point data developed by the State of Maryland Department of Planning. The dataset contains important information about individual properties, such as: improvement value, land use, zoning, and parcel/lot area. This information is integrated with other sources and used for deriving most of the GIS-based indicators. The other GIS data include: priority funding areas (PFA), municipal boundaries, preserved areas, urban areas, wetlands, floodplains, prime farmlands, slope, roads, railroads, and census tracts.

Indicators are derived using basic ArcGIS functions, such as geoprocessing tools (merge, union, intersect), querying and selecting by attribute and/or location, buffering, creating new fields, calculating values, and re-classifying layers. Appendix B contains detailed steps used in GIS data processing. ArcIMS 4.0 is used to provide the Internet-based functionality to allow for viewing and analysis of maps and GIS data via the World Wide Web. Finally, the prototype application was customized with JavaScript (Figure 1). At the user end, the browser has to be JAVA enabled. The application is viewed with ESRI's ArcIMS Viewer, which is prompted for download at the first attempt to access the application.

Figure 1. Prototype Development Framework



PROTOTYPE DEVELOPMENT

The project objectives are accomplished by developing a prototype Internet GIS-based land monitoring site for Harford County, Maryland. Maryland is chosen for this development for its extensive growth rates over the past several decades (35% growth from 1970 to 2000), high urban densities (6th most dense state in the U.S.), its long history of proactive management of urban growth issues, and reliance on land monitoring tools. The legislative initiatives that started with 1974 Land Use Act have been recently complemented with 1997 Smart Growth Legislation and 2003 Priority Places Executive Order. The order enabled the Maryland Department of Planning to establish statewide Priority Funding Areas (PFA) and rural legacy areas.

The main frame of the prototype web site has five sections (Figure 2): 1. Navigation and Drawing Tools; 2. Main Map; 3. Overview Map; 4. Indicators; and 5. Legend.

NAVIGATION & DRAWING TOOLS: Navigation Tools allow to: a) navigate (Zoom, Pan) on the MAIN MAP, b) conduct GIS analysis (Query, Buffer, Measure), and c) get information about the layers (Identify, Show Select). Drawing Tools allow to add text and/or graphics to the MAIN

MAP and to store them as a data layer (See Appendix D for more information).

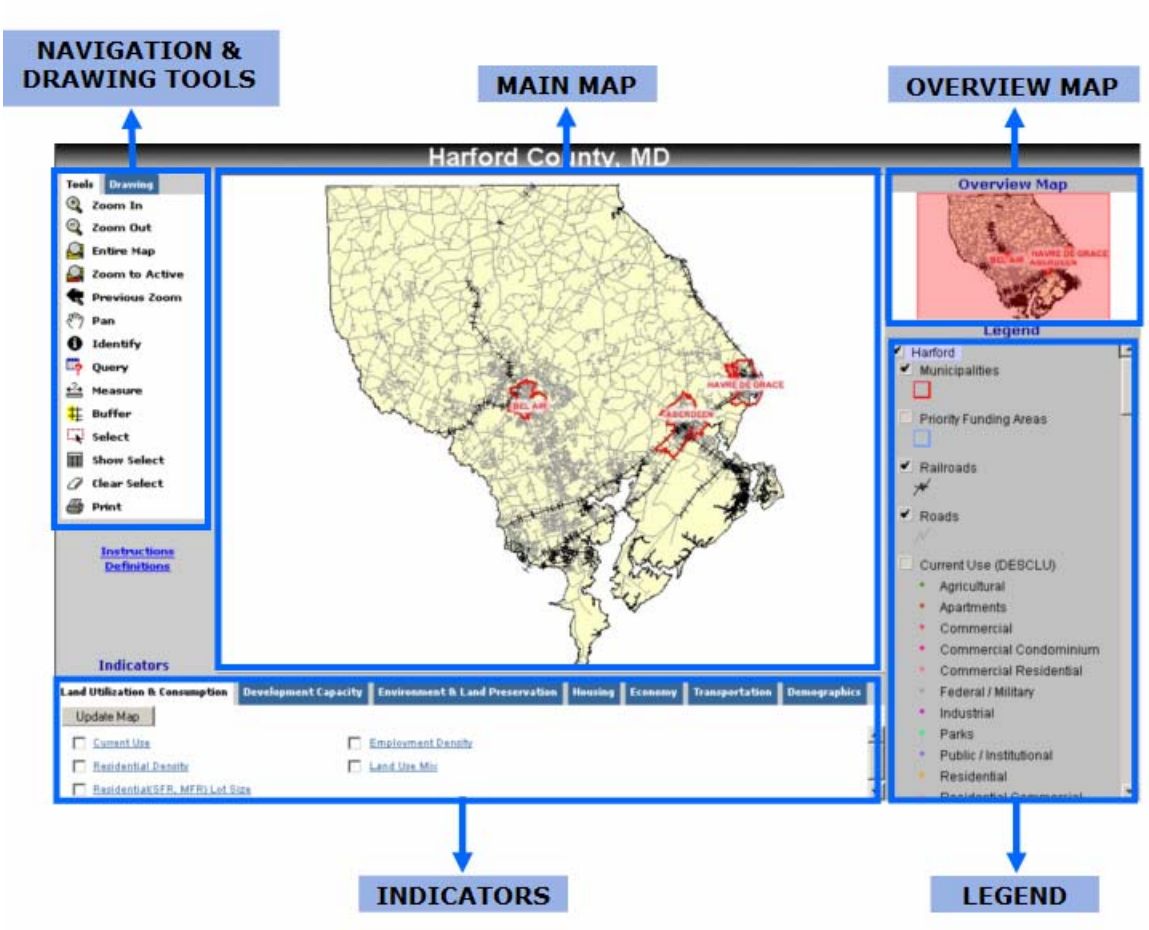
MAIN MAP displays layers by either clicking on the LEGEND or INDICATORS.

OVERVIEW MAP allows to view the whole county and identifies the extent of the MAIN MAP with a red box. Dragging the box by holding the left mouse button will move the current extent of the MAIN MAP.

INDICATORS allow to select, display, and examine the land development indicators.

LEGEND allows to: a) Displays the layers on the MAIN MAP by clicking on the checkbox next to the layer name (to exclude a layer from the MAIN MAP, uncheck the box); b) View the shapes (line, point, and polygon) and colors that the layers contains; c) Change the order of the layers by activating the layer and moving it up or down the LEGEND by holding the mouse button over that layer; some layers may not be visible even when checked due to being covered with features of other layers.

Figure 2 – Prototype Home Page Layout



The prototype application is created using ESRI's ArcIMS software and customized using JavaScript for the following features: a) Links that explain how an indicator is

derived (procedure and data used) and demonstrate pre-calculated results of the indicators; b) Checkboxes & Update Map button that displays the relevant layer on the MAIN MAP. Additionally, to make the website more user-friendly, explanations of NAVIGATION & DRAWING TOOLS are written next to each tool; INSTRUCTIONS link is provided to explain each part of the website and to further instruct the users how to do their own analysis using GIS tools; and layout of the default website is customized so that the MAIN MAP has a larger display area. The programming script for the frame and for the indicators is provided in Appendix C. Instructions for use of the navigation and drawing tools are in Appendix D.

Display and examinination of the land development indicators is the main functionality of this prototype ArcIMS application. The indicators are selected by first choosing one of the seven categories under which they are organized and then clicking on the checkbox next to the indicator's name. Clicking on the *Update Map* button displays in the MAIN MAP area the layer associated with the selected indicator (Figure 3); the layer is also automatically checked in the LEGEND. Clicking on the indicator's name opens the screens with tables (Figure 4) and charts (Figure 5) associated with that particular indicator. To display another indicator, the user has to check the box next to the newly desired indicator, uncheck the previous indicator, and click on the *Update Map* button.

The application also provides for a basic editing functionality that allows the user to add text and graphics by using Drawing Tools. The possible edis include: line, polygon, rectangle, circle, text, image, and freehand drawings. Editing results in a new layer that can be saved and retreived for later display and use. Finally, to be able to take advantage of the GIS quirying functions, the layer has to be made active by clicking on the layer's name. The box around the layer's name looks raised.

Figure 3. Selecting an Indicator and Displaying a Layer

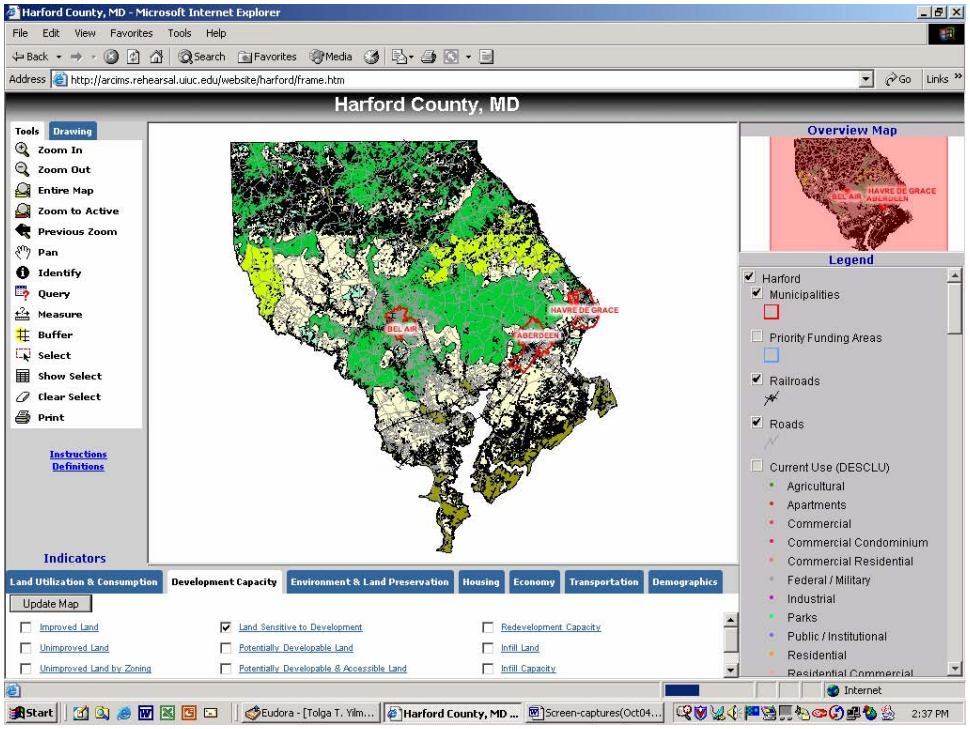
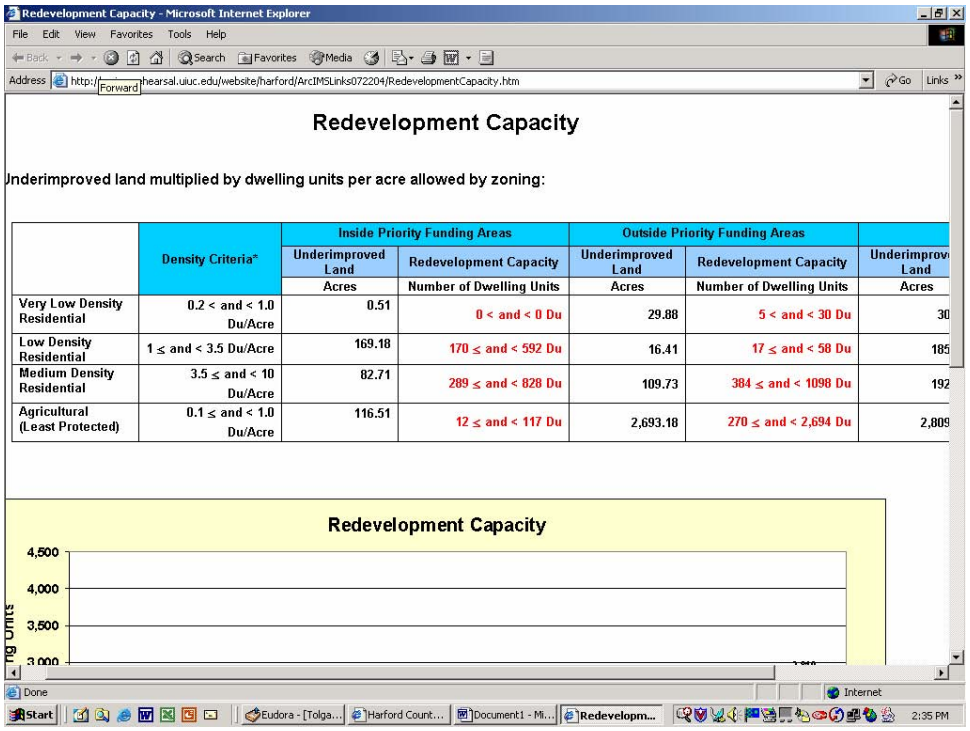
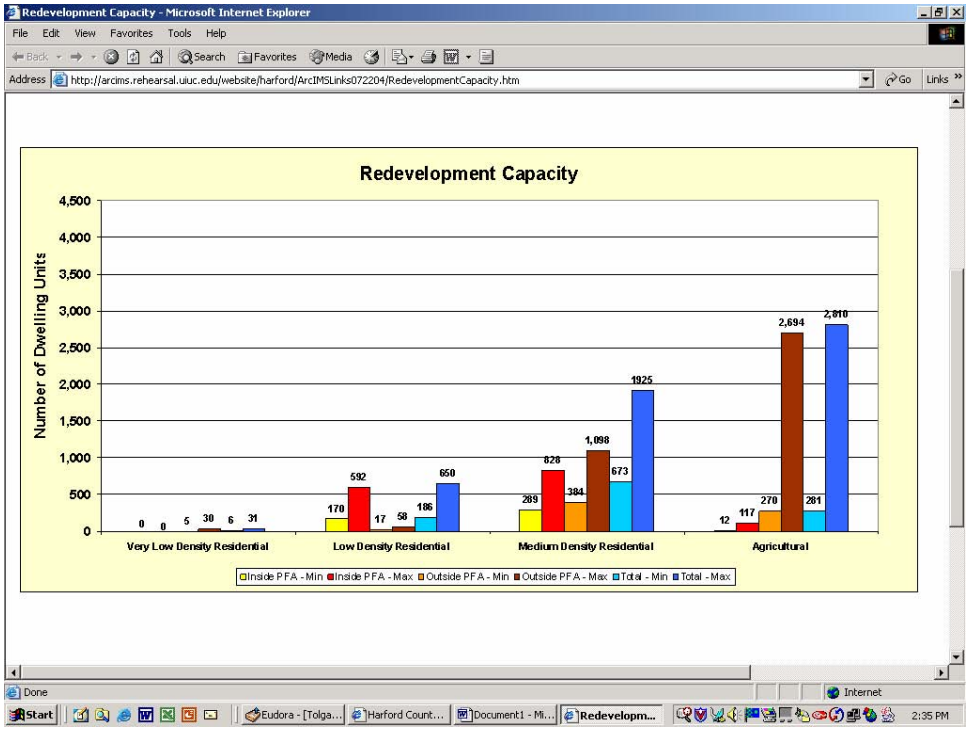


Figure 4. Displaying a Table Associated with an Indicator



	Density Criteria*	Inside Priority Funding Areas		Outside Priority Funding Areas		
		Underimproved Land	Redevelopment Capacity	Underimproved Land	Redevelopment Capacity	Underimprov Land
		Acres	Number of Dwelling Units	Acres	Number of Dwelling Units	Acres
Very Low Density Residential	0.2 < and < 1.0 Du/Acre	0.51	0 < and < 0 Du	29.88	5 < and < 30 Du	30
Low Density Residential	1 ≤ and < 3.5 Du/Acre	169.18	170 ≤ and < 592 Du	16.41	17 ≤ and < 58 Du	185
Medium Density Residential	3.5 ≤ and < 10 Du/Acre	82.71	289 ≤ and < 828 Du	109.73	384 ≤ and < 1098 Du	192
Agricultural (Least Protected)	0.1 ≤ and < 1.0 Du/Acre	116.51	12 ≤ and < 117 Du	2,693.18	270 ≤ and < 2,694 Du	2,809

Figure 5. Displaying a Chart Associated with an Indicator



CONCLUSION

The Internet-based GIS for land development monitoring has been prototyped as an approach that allows the user to interact and analyze GIS data and display a set of predetermined indicators. Such ArcIMS-based application can be a useful resource for city, county, metropolitan, or state level planning agencies and a variety of other organizations in public, private, and non-profit sector. For example, planning agencies could use this website to:

1. Inform the other agencies and the public about the latest trends in the region's land development;
2. Rely on the indicators to explore the local development conditions, e.g., locate undevelopable land or calculate development capacity;
3. Compare development patterns over time, monitor the changes, and plan accordingly;
4. Employ the system in charettes, public meetings, and open houses to inform and discuss future developments with various stakeholders;
5. Perform spatial analyses using the GIS functionality.

The general public might use the website to learn about their region's development. For instance, a citizen may use the system to:

1. Spot the improved and unimproved properties in their neighborhood;

2. Measure distance between development points;
3. Examine the differences among various parts of the county in terms of per-capita-income, commute-time, and housing value;
4. Check into the zoning regulations;
5. Edit the maps to record their ideas, complaints or suggestions about a certain area;
6. Learn more about the location of preserved areas and environmentally sensitive lands.

Finally, land developers might use the website to access information about the unimproved and/or under-improved lands, their location, size, distance to a facility (school or park), and surrounding land uses.

In face of persistent problems with urban sprawl – extensive consumption of land, damaged environmental quality, overexploited natural resources, increased cost of land and housing, and expanded ecological footprint – the prototype application described in this paper facilitates land development monitoring and assists management of urban growth and dealing with its implications. The main challenge of providing a complete and comprehensive land development monitoring system lies in the availability of current and historic data. Beyond this prototype, further developments are needed to include other counties in the State of Maryland and to incorporate multi-year datasets and indicators for monitoring change and performance over time.

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APPENDIX A – Land Development Monitoring Indicators

	LAND MONITORING INDICATOR	MEASURE	MEASUREMENT UNIT	BENEFITS OF THE INDICATOR
Land Utilization & Consumption	Current Use	1. Areas in various land uses (land use defined by local code) 2. Areas under different land cover categories (based on satellite image)	1. Acres and % of total 2. Acres and % of total	Evaluation of the current pattern and determining the future opportunities for development
	Residential Density	1. Total population divided by total residential acres 2. Total households divided by total residential acres 3. Total dwelling units divided by total residential acres 4. Residential lot size mean / medium (SFR, MFR)	1. Persons per Acre 2. Households per Acre 3. Dwelling Units per Acre 4. Acres	Monitoring of population growth and residential pattern over time and consideration of the locations of future residential developments
	Employment Density	Total employees divided by the sum of commercial, industrial, and institutional acres	Employees per Acre	Monitoring of employment growth and pattern over time and evaluation of the locations of future employment centers
	Land Use Mix	Sum of commercial, industrial, and public land use acres divided by total number of housing units	Acres per Dwelling Unit	Assessing the balance and pattern of land uses within the county
	Land Consumption by Sector	Difference in area under residential, industrial, or commercial use within two consecutive years	Acres per year	Determining the pace of land conversion by sector
	Intensity of Growth	Population change divided by consumption of land by land use type within the same period	Persons per Acre (total and by land use)	Assessment of the conversion of buildable land relative to population growth and of the expected land consumption
Development Capacity	Developed Land	Sum of areas under commercial, industrial, public and residential use	Acres	Promotion of sustainable growth patterns, better quality of development, efficient provision of infrastructure, and preservation of open space, protection of farm and forest lands, significant natural areas, wetlands, and endangered species
	Vacant Land	Land parcels with $0 value of improvement	Acres	
	Vacant Land by Zoning	Vacant land parcels zoned residential, industrial, commercial, and mixed use	Acres	
	Net Vacant Buildable Land	Total area of vacant land minus sum of environmentally constrained land, federal, state, county, or city-owned land, acres of plotted single-family lots, streets, schools, parks, places of worship acres	Acres	

	Undevelopable Land	Total area of public ownership, underwater lands, lands that have slope equal or more than 15%, wetlands, prime and unique farmlands, floodzones, significant natural areas, and lands within environmental zone	Acres	
	Potentially Developable Land	Total area of all lands not classified as undevelopable: Currently undeveloped, privately-owned, sites not underwater, and having an average slope of 15% or less, excluding wetlands, prime and unique farmlands, floodzones, and significant natural areas	Acres	
	Potentially Developable and Accessible Land	Total area of potentially developable lands within 10km of a major roadway and within 10km of existing urban development	Acres	
	Underdeveloped Land	Nonvacant land parcels that have improvement value less then the value of 1 percentile and the ratio of improvement to land value less than the value of 1 percentile	Acres	
	Redevelopment Capacity	Underdeveloped land multiplied by dwelling units per acre or floor areas allowed by zoning - total, residential, commercial and industrial	Number of Dwelling Units, Commercial Floor Area, Industrial Floor Area	
	Infill Land	Vacant land parcels smaller than 1 acre and surrounded by developed land	Acres	
	Infill Capacity	Area of infill land multiplied by dwelling units per acre or floor areas allowed by zoning - total, residential, commercial, and industrial	Number of Dwelling Units, Commercial Floor Area, Industrial Floor Area	
	Development Capacity	Development allowed by zoning minus existing development - total, residential, commercial, and industrial	Acres, Number of Dwelling Units, Commercial Floor Area, Industrial Floor Area (ratio?)	
	Transit-Oriented Development Capacity	Land adjacent to transit stations minus developed land	Acres, square feet	
Development Regulations & Programs	Subdivision Process	Number of applications, number approved, median time between application and final decision.		Monitoring the development processes, evaluating the plan

	Building Permit Process	Number of applications, number approved, median time between application and final decision.		implementation tools and programs.
	Zoning Process	Number of applications, number approved, median time between application and final decision, change in development capacity.		
	Brownfield Redevelopment			
	Rehabilitation of Housing			
	Renovation of Historic Buildings (historic tax credit program)			
	Open Space Acquisition	1. Amount of land acquired over time 2. Cost of acquisition		
Environment & Land Preservation	Parks	Areas under park use	Acres	
	Linear Green Space	Area under greenways and trails	Acres	
	Recreation Accessibility	1. Population within walking distance (1/4 mile) of public parks, greenways and trails 2. Areas that are within walking distance (1/4 mile) of public parks, greenways and trails (buffer using the street network)	1. Number and Percentage of People 2. Acres and Percentage of Total	Identification of the areas with limited access to parks and open spaces; planning for improvement
	Forest Cover		Acres	Protection of the environment and promotion of sustainable growth patterns
	Environmentally Sensitive Land	Total area in environmentally sensitive areas (Note: Sensitive includes wetlands, floodplains)	Acres	
	Land Conserved / Protected	Total acres in conservation by program (Various types of conservation programs, including rural legacy program, farmland protection programs); cost	Acres	
	Contiguity Of Protected Lands			
	Waste Recovery Generation		Dollars per Acre	
Housing	Dwelling Units by Type	Total number of housing units (SFR, MFR)	Dwelling Units	
	Ratio of Housing	Total SFR/MFR acres divided by total residential acres	Percentage	
	Housing Growth	Change in the number of dwelling units by type (SFR, MFR)	Dwelling Units per Year	Evaluation of the housing trends and future needs.
	Value Of Housing	Average equalized assessed value for SFR, MFR	Current Dollars	
	Housing Price	Median sales price of single family homes	Current Dollars	Assessment of the housing market, housing affordability, and supply.
	Housing Affordability Gap	Difference between median sales price and the price of a house affordable to a median income family.	Current Dollars	

	Housing size (sq feet)			
	Homeownership rates			
	Housing Starts	SF, MF		
	Projected population demand for housing			
Economy				
	Firms	1. Total number of firms 2. Total number of firms by sector	Number of Firms	
	Earnings	1. Total earnings 2. Total earnings by sector	Total Dollars	
	Jobs	1. Total number of jobs 2. Total number of jobs by sector 3. Jobs per developed industrial land 4. Jobs per developed commercial land	1-2. Number of FTE Jobs 3-4. Number of Jobs per Acre	Evaluates current patterns and conditions and assesses potential job creation areas. Ensures fiscal and social equities among communities.
	Employment Capture Rate	The proportion of the region's employment		
	Employment Growth	Employment growth by industry by census tracts	Number of Jobs	Evaluates the employment & population growth and assesses the future population and employment increases.
	Employment Forecast	Employment forecast by industry by census tracts		
	Median Family Income	Median family income by census tract	Current Dollars	Ensures fiscal and social equities among communities.
	Per capita Income			
	Poverty Rate			
Transportation	Vehicle Miles Traveled	Total miles traveled by vehicles	Miles	Evaluates transportation infrastructure and promotes compact, sustainable growth patterns and prevents urban sprawl. As a result lowers the cost of infrastructure.
	Vehicles Registered			
	Bus/Transit Ridership	Total trips on bus and transit systems	Number of Trips	
	Commute Time	Average commute time.	Minutes	
	Pedestrian Accessibility	Percent of households within 1/4 network mile of parks, commercial uses, transit and bus stops	Percent of Households	
	Transit Accessibility	Percent of parks, commercial floor space, institutional acres within 1/4 network mile of transit stop or bus line	Percent of Acres	Promotes accessible and higher quality environments.
	Miles of bike lanes			
	Transit Investment - Percent of Roads vs. Transit vs. Bike and			

	Pedestrian			
	Number of bad air quality days per year (and comparisons with other cities)			
	Measurements of connectivity			
	Miles of sidewalks and trails constructed			
	Lane miles of new roads constructed per year			
Utilities & Services	School Service	Capacity - ratio of number enrolled students divided by total capacity	Percent	
	School Construction Funds	1. Total dollars of school construction funds spent 2. State and local funds spent on public school construction 3. Old schools vs. new schools 4. Ratio of school construction funds spent inside growth/priority areas divided by total funds spent 5. Amount or percent of school construction funds spent on renovation vs. new construction	1. Total Dollars 2. Total Dollars 3. Total Dollars 4. Percent 5. Total Dollars / Percent	
	Water Service	1. Water network capacity 2. Treatment capacity		
	Wastewater Treatment Capacity			
	Sewer Service	1. Sewer network capacity 2. Treatment capacity 3. Planned extension		
	Fire Service	1. Population served (by station) 2. Average response time (by station)	1. Number of People 2. Minutes	Evaluation of location, capacity and quality of infrastructure services; provision of timely and efficient infrastructure.
Demographics	Population	Population based on decennial census and local estimates	Number	
	Birth Rate			
	Households	1. Total number of households 2. Average household size		
	Population Growth	Population growth by census tracts	Number, percentage, rate	Evaluates the employment & population growth and

	Population Forecast	Population forecast by census tracts		assesses the future population and employment increases.
	Capture Rate (population, household)	The proportion of the region's population and household growth	Number, percentage	Measures how effectively the county is accommodating growth compared with the larger regional area.
	Migration			

APPENDIX B – Indicator Derivation - Steps

LAND UTILIZATION & CONSUMPTION: Current Use	· Select the records from ***Properties*** layer that have Improvement Value larger than $0 and include 'Agricultural' and 'Park' land uses [NFMIMPVL > $0 OR DESCLU = 'Agricultural' OR DESCEXCL = 'Parks' OR DESCEXCL = 'Parks and Recreation'] · Re-Classify 'Exempt' and 'Exempt Commercial' land uses into 'Federal / Military' [DESCEXCL = 'Military Installations'], 'Parks' [DESCEXCL = 'Parks' OR DESCEXCL = 'Parks and Recreation'], and 'Public / Institutional' [DESCEXCL <> 'Military Installations' AND DESCEXCL <> 'Parks' AND DESCEXCL <> 'Parks and Recreation'] · Determine land use types that are inside or outside PFA using the PFA field (ex: DESCLU = 'Agricultural' and PFA = 'Outside PFA') · Calculate total area of each land use type using the ACRES_1 field · Apply Land-Based Classification Standards (LBCS) color code for the color scheme of the Current Use: "Jeer, Sanjay. 2001. *Land-Based Classification Standards*: American Planning Association: Chicago, Illinois." http://www.planning.org/LBCS
LAND UTILIZATION & CONSUMPTION: Residential Density	· Select the records from ***Properties*** layer that have Improvement Value larger than $0 and exclude 'Agricultural' and 'Park' land uses [NFMIMPVL > $0 AND DESCLU <> 'Agricultural' AND DESCEXCL <> 'Parks' AND DESCEXCL <> 'Parks and Recreation'] · Identify residential properties using the DESCLU field * Residential properties consist of: 'Residential', 'Residential Condominium', 'Residential / Commercial', 'Apartments' from the land use categories [DESCLU = 'Residential' or DESCLU = 'Residential Condominium' or DESCLU = 'Residential Commercial' or DESCLU = 'Apartments'] · Determine residential properties that are inside or outside PFA using the PFA field (ex: PFA = 'Outside PFA') · Calculate total area of residential properties using the ACRES_1 field · Obtain population and households numbers from 2000 Census Summary File Three from Maryland Department of Planning: http://www.mdp.state.md.us/msdc/dw_census2000.htm · Calculate the dwelling unit number from the DWLL_NUM field in the ***Properties*** layer · Divide Population, Number of Households, and Number of Dwelling Units with the total area of residential properties
LAND UTILIZATION & CONSUMPTION: Residential Lot Size	· Select the records from ***Properties*** layer that have Improvement Value larger than $0 and exclude 'Agricultural' and 'Park' land uses [NFMIMPVL > $0 AND DESCLU <> 'Agricultural' AND DESCEXCL <> 'Parks' AND DESCEXCL <> 'Parks and Recreation'] · Identify residential properties using the DESCLU field * Residential properties consist of: 'Residential', 'Residential Condominium', 'Residential / Commercial', 'Apartments' from the land use categories [DESCLU = 'Residential' or DESCLU = 'Residential Condominium' or DESCLU = 'Residential Commercial' or DESCLU = 'Apartments'] · Reclassify 'Residential' category as Single Family Residential (SFR) · Reclassify 'Residential Condominium', 'Residential / Commercial', 'Apartments' categories as Multi-Family Residential (MFR) · Determine SFR & MFR uses that are inside or outside PFA using the PFA field (ex: PFA = 'Outside PFA') · To find the mean lot size: Right click on the ACRES_1 field and select *statistics* · To find the median lot size: Sort out the ACRES_1 field in ascending order, then select the median property's value

LAND UTILIZATION & CONSUMPTION: Employment Density	· Select the records from ***Properties*** layer that have Improvement Value larger than $0 and exclude 'Agricultural' and 'Park' land uses [NFMIMPVL > $0 AND DESCLU <> 'Agricultural' AND DESCEXCL <> 'Parks' AND DESCEXCL <> 'Parks and Recreation'] · Identify commercial, industrial, and public properties using the DESCLU field * Commercial properties consist of: 'Commercial', 'Commercial Condominium', 'Commercial Residential', 'Residential Commercial' from the land use categories [DESCLU = 'Commercial' or DESCLU = 'Commercial Condominium', or DESCLU = 'Commercial Residential', or DESCLU = 'Residential Commercial'] * Industrial properties consist of: 'Industrial' land use category [DESCLU = 'Industrial'] * Public properties consist of: 'Public / Institutional' category [DESCLU = 'Public / Institutional'] · Determine commercial, industrial, and public properties that are inside or outside PFA using the PFA field (ex: PFA = 'Outside PFA') · Calculate total area of the commercial, industrial, and public properties using the ACRES_1 field · Obtain employment numbers from 2000 Census Summary File Three (Population 16 years and over / in labor force / civilian labor force / employed): http://www.mdp.state.md.us/msdc/PFA/2000census/sf3/harf_P4.pdf · Divide total employees by total area of the commercial, industrial, and public properties
LAND UTILIZATION & CONSUMPTION: Land Use Mix	· Select the records from ***Properties*** layer that have Improvement Value larger than $0 and exclude 'Agricultural' and 'Park' land uses [NFMIMPVL > $0 AND DESCLU <> 'Agricultural' AND DESCEXCL <> 'Parks' AND DESCEXCL <> 'Parks and Recreation'] · Identify commercial, industrial, and public properties using the DESCLU field * Commercial properties consist of: 'Commercial', 'Commercial Condominium', 'Commercial Residential', 'Residential Commercial' from the land use categories [DESCLU = 'Commercial' or DESCLU = 'Commercial Condominium', or DESCLU = 'Commercial Residential', or DESCLU = 'Residential Commercial'] * Industrial properties consist of: 'Industrial' land use category [DESCLU = 'Industrial'] * Public properties consist of: 'Public / Institutional' category [DESCLU = 'Public / Institutional'] · Determine commercial, industrial, and public properties that are inside or outside PFA using the PFA field (ex: PFA = 'Outside PFA') · Calculate total area of the commercial, industrial, and public properties using the ACRES_1 field · Calculate total number of dwelling units from the DWLL_NUM field in the ***Properties*** layer · Divide total area of commercial, industrial, and public properties by total number of dwelling units
DEVELOPMENT CAPACITY: Improved Land	· Select the records from ***Properties*** layer that have Improvement Value larger than $0 and exclude 'Agricultural' and 'Park' land uses [NFMIMPVL > $0 AND DESCLU <> 'Agricultural' AND DESCEXCL <> 'Parks' AND DESCEXCL <> 'Parks and Recreation'] · Determine the records that are inside or outside PFA using the PFA field (ex: PFA = 'Outside PFA') · Calculate total area of the records using the ACRES_1 field

DEVELOPMENT CAPACITY: Unimproved Land	· Select the records from ***Properties*** layer that have Improvement Value equals to $0 and exclude 'Agricultural' and 'Park' land uses [NFMIMPVL = $0 AND DESCLU <> 'Agricultural' AND DESCEXCL <> 'Parks' AND DESCEXCL <> 'Parks and Recreation'] · Determine the records that are inside or outside PFA using the PFA field (ex: PFA = 'Outside PFA') · Calculate total area of the records using the ACRES_1 field
DEVELOPMENT CAPACITY: Unimproved Land by Zoning	· Select the records from ***Properties*** layer that have Improvement Value equal to $0 and exclude 'Agricultural' and 'Park' land uses [NFMIMPVL = $0 AND DESCLU <> 'Agricultural' AND DESCEXCL <> 'Parks' AND DESCEXCL <> 'Parks and Recreation'] · Categorize the records using unique values and using ZONING2 field · Determine records that are inside or outside PFA using the PFA field (ex: PFA = 'Outside PFA') · Calculate total area of each zoning type using the ACRES_1 field
DEVELOPMENT CAPACITY: Net Unimproved Buildable Land	· Select the records from ***Properties*** layer that have Improvement Value equal to $0 and exclude 'Agricultural' and 'Park' land uses [NFMIMPVL = $0 AND DESCLU <> 'Agricultural' AND DESCEXCL <> 'Parks' AND DESCEXCL <> 'Parks and Recreation'] · Select the records that are outside the ***Environmentally Constrained Land*** and that are Privately Owned * Merge layers: Wetlands and 100 and 500-Year Floodplains (Harford County, MD) Agricultural Preservation Program and Rural Legacy Program (ESRI), Prime Farmland (STATSGO), and Areas that have Slope of 15% or More (GIS Data Depot) to determine the ***Environmentally Constrained Land*** * Overlay the ***Properties*** layer with ***Environmentally Constrained Land*** and select the records from ***Properties*** layer that are completely outside the ***Environmentally Constrained Land*** layer * Select the records from ***Properties*** layer that have Exempt Status equal to 0 [EXSTATUS = '0'] in order to find the Privately Owned Properties · Determine the records that are inside or outside PFA using the PFA field (ex: PFA = 'Outside PFA') · Calculate total area of the records using the ACRES_1 field
DEVELOPMENT CAPACITY: Land Sensitive to Development	· Merge layers: Wetlands and 100 and 500-Year Floodplains (Harford County, MD) Agricultural Preservation Program and Rural Legacy Program (ESRI), Prime Farmland (STATSGO), and Areas that have Slope of 15% or More (GIS Data Depot) to determine the ***Environmentally Constrained Land*** · Select the records from ***Properties*** layer that have Exempt Status not equal to 0 and Exemption Code Description not equal to 'Military Installations' [EXSTATUS <> '0' AND DESCEXCL <> 'Military Installations'] in order to find the Public Owned Properties · Overlay ***Environmentally Constrained Land*** layer with the ***Priority Funding Areas*** layer to find the ***Environmentally Constrained Land*** that is inside or outside PFA · Dissolve the ***Environmentally Constrained Land*** layer · Find the area of the ***Environmentally Constrained Land*** layer using the ACRES field · Select the records from the Public Owned Properties that are outside the ***Environmentally Constrained Land*** and calculate their area using the ACRES_1 field · Calculate the total area of the Land Sensitive to Development by adding the area of the ***Environmentally Constrained Land*** and the area of the records from the Public Owned Properties that are outside the ***Environmentally Constrained Land***

DEVELOPMENT CAPACITY: Potentially Developable Land	· Select the records from ***Properties*** layer that have Improvement Value equal to $0 and exclude 'Agricultural' and 'Park' land uses [NFMIMPVL = $0 AND DESCLU <> 'Agricultural' AND DESCEXCL <> 'Parks' AND DESCEXCL <> 'Parks and Recreation'] · Merge layers: Wetlands and 100 and 500-Year Floodplains (Harford County, MD) Agricultural Preservation Program and Rural Legacy Program (ESRI), Prime Farmland (STATSGO), and Areas that have Slope of 15% or More (GIS Data Depot) to determine the ***Environmentally Constrained Land*** · Select the records that are outside the ***Environmentally Constrained Land*** and that are Privately Owned * Overlay the ***Properties*** layer with ***Environmentally Constrained Land*** and select the records from ***Properties*** layer that are completely outside the ***Environmentally Constrained Land*** layer * Select the records from ***Properties*** layer that have Exempt Status equal to 0 [EXSTATUS = '0'] in order to find the Privately Owned Properties · Determine the records that are inside or outside PFA using the PFA field (ex: PFA = 'Outside PFA') · Calculate total area of the records using the ACRES_1 field
DEVELOPMENT CAPACITY: Potentially Developable and Accessible Land	· Select the records from ***Properties*** layer that have Improvement Value equal to $0 and exclude 'Agricultural' and 'Park' land uses [NFMIMPVL = $0 AND DESCLU <> 'Agricultural' AND DESCEXCL <> 'Parks' AND DESCEXCL <> 'Parks and Recreation'] · Merge layers: Wetlands and 100 and 500-Year Floodplains (Harford County, MD) Agricultural Preservation Program and Rural Legacy Program (ESRI), Prime Farmland (STATSGO), and Areas that have Slope of 15% or More (GIS Data Depot) to determine the ***Environmentally Constrained Land*** · Select the records that are outside the ***Environmentally Constrained Land*** and that are Privately Owned * Overlay the ***Properties*** layer with ***Environmentally Constrained Land*** and select the records from ***Properties*** layer that are completely outside the ***Environmentally Constrained Land*** layer * Select the records from ***Properties*** layer that have Exempt Status equal to 0 [EXSTATUS = '0'] in order to find the Privately Owned Properties · Buffer ***Major Roads*** and ***Urban Areas*** layers by 10kms · Overlay the selected records from ***Properties*** layer with the 10km buffer and select the intersecting records · Determine the records that are inside or outside PFA using the PFA field (ex: PFA = 'Outside PFA') · Calculate total area of the records using the ACRES_1 field
DEVELOPMENT CAPACITY: Underimproved Land	· Select the records from ***Properties*** layer that have Improvement Value larger than $0 and exclude 'Agricultural' and 'Park' land uses [NFMIMPVL > $0 AND DESCLU <> 'Agricultural' AND DESCEXCL <> 'Parks' AND DESCEXCL <> 'Parks and Recreation'] · Select the records that have Improvement Value less than $25,000 and Ratio of Improvement to Land Value less than 1 [NFMIMPVL < '25,000' AND RATIO < '1'] · Determine the records that are inside or outside PFA using the PFA field (ex: PFA = 'Outside PFA') · Calculate total area of the records using the ACRES_1 field

DEVELOPMENT CAPACITY: Redevelopment Capacity	· Select the records from ***Properties*** layer that have Improvement Value larger than $0 and exclude 'Agricultural' and 'Park' land uses [NFMIMPVL > $0 AND DESCLU <> 'Agricultural' AND DESCEXCL <> 'Parks' AND DESCEXCL <> 'Parks and Recreation'] · Select the records that have Improvement Value less than $25,000 and Ratio of Improvement to Land Value less than 1 [NFMIMPVL < '25,000' AND RATIO < '1'] · Categorize the records using unique values and using ZONING2 field · Obtain density criteria by zoning category from the Maryland Department of Planning: http://www.mdp.state.md.us/info/newmaps/zoneCategory.htm · Determine the records that are inside or outside PFA using the PFA field (ex: PFA = 'Outside PFA') · Calculate total area of the records using the ACRES_1 field · Multiply the area of under-improved land inside each zoning category with its density criteria to find the Redevelopment Capacity
Infill Land	· Select the records from ***Properties*** layer that have Improvement Value equal to $0 and exclude 'Agricultural' and 'Park' land uses [NFMIMPVL = $0 AND DESCLU <> 'Agricultural' AND DESCEXCL <> 'Parks' AND DESCEXCL <> 'Parks and Recreation'] · Overlay the selected records with the ***Urban Areas*** layer and choose the records that are completely within ***Urban Areas*** layer · Select the records that have parcel area smaller than 1 Acre using the ACRES_1 field · Determine the records that are inside or outside PFA using the PFA field (ex: PFA = 'Outside PFA') · Calculate total area of the records using the ACRES_1 field
DEVELOPMENT CAPACITY: Infill Capacity	· Select the records from ***Properties*** layer that have Improvement Value equal to $0 and exclude 'Agricultural' and 'Park' land uses [NFMIMPVL = $0 AND DESCLU <> 'Agricultural' AND DESCEXCL <> 'Parks' AND DESCEXCL <> 'Parks and Recreation'] · Overlay the selected records with the ***Urban Areas*** layer and choose the records that are completely within ***Urban Areas*** layer · Select the records that have parcel area smaller than 1 Acre using the ACRES_1 field · Classify the records using ZONING2 field (ex: ZONING2 = 'Agricultural') · Gather the zoning categories and their density criteria from the Maryland Department of Planning: http://www.mdp.state.md.us/info/newmaps/zoneCategory.htm · Determine the records that are inside or outside PFA using the PFA field (ex: PFA = 'Outside PFA') · Calculate total area of the records using the ACRES_1 field · Multiply the area of infill land inside each zoning category with its density criteria to find the Infill Capacity

DEVELOPMENT CAPACITY: **Development Capacity**	· Select the records from ***Properties*** layer that have Improvement Value larger than $0 and exclude 'Agricultural' and 'Park' land uses [NFMIMPVL > $0 AND DESCLU <> 'Agricultural' AND DESCEXCL <> 'Parks' AND DESCEXCL <> 'Parks and Recreation'] · Classify the records using ZONING2 field (ex: ZONING2 = 'Agricultural') · Gather the zoning categories and their density criteria from the Maryland Department of Planning: http://www.mdp.state.md.us/info/newmaps/zoneCategory.htm · Determine the records that are inside or outside PFA using the PFA field (ex: PFA = 'Outside PFA') · Calculate total area of the records within each zoning category using the ACRES_1 field · Calculate total dwelling unit number of the records within each zoning category using the DWLL_NUMB field · Calculate total area of each zoning category using the ACRES field of ***Zoning*** layer · Subtract the area of improved properties inside each zoning category from the total area of that zoning category to find development capacity in acres · Multiply the total area of each zoning category with its density criteria and then subtract the total number of dwelling units of the improved properties inside each zoning category
ENVIRONMENT & LAND PRESERVATION: **Parks**	· Select the records from ***Properties*** layer that have 'Park' land uses [DESCEXCL = 'Parks' OR DESCEXCL = 'Parks and Recreation'] · Determine the records that are inside or outside PFA using the PFA field (ex: PFA = 'Outside PFA') · Calculate total area of the records using the ACRES_1 field
ENVIRONMENT & LAND PRESERVATION: **Access to Recreational Areas**	· Select the records from ***Properties*** layer that have 'Park' land uses [DESCEXCL = 'Parks' OR DESCEXCL = 'Parks and Recreation'] · Buffer the 'Park' land uses by 1/2 mile and 1/4 mile radius using the buffer tool · Select the ***Properties*** that are completely within the 1/2 mile buffer zone (do the same for 1/4 mile) · Determine the records that are inside or outside PFA using the PFA field (ex: PFA = 'Outside PFA') · Calculate total area of the records using the ACRES_1 field
ENVIRONMENT & LAND PRESERVATION: **Wetlands and Floodplains**	· Merge the ***Wetlands*** and ***Floodplains*** layers · Union the merged ***Wetlands & Floodplains*** layers with the ***Priority Funding Areas*** layer and determine the wetlands & floodplains that are inside or outside PFA · Calculate total area of the wetlands & floodplains using the ACRES field
ENVIRONMENT & LAND PRESERVATION: **Conserved / Protected Land**	· Merge the ***Agricultural Preservation Program*** and ***Rural Legacy Program*** layers · Union the merged ***Agricultural Preservation & Rural Legacy Program*** layers with the ***Priority Funding Areas*** layer and determine the wetlands & floodplains that are inside or outside PFA · Calculate total area of the Conserved / Protected Land using the ACRES field
HOUSING: **Dwelling Units**	· Classify the ***Properties*** layer by DWLL_NUMB field: Use Graduated Colors method, Natural Breaks classification, and 5 classes (If a message box appears asking you to change maximum sample size; click on Classify and then Sampling buttons and increase the maximum sample size number) · Determine records that are inside or outside PFA using the PFA field (ex: PFA = 'Outside PFA') · Calculate total area of each type using the ACRES_1 field

HOUSING: **Housing Types**	· Select the records from ***Properties*** layer that have Improvement Value larger than to $0 and exclude 'Agricultural' and 'Park' land uses [NFMIMPVL > $0 AND DESCLU <> 'Agricultural' AND DESCEXCL <> 'Parks' AND DESCEXCL <> 'Parks and Recreation'] · Identify residential properties using the DESCLU field * Residential properties consist of: 'Residential', 'Residential Condominium', 'Residential / Commercial', 'Apartments' from the land use categories [DESCLU = 'Residential' or DESCLU = 'Residential Condominium' or DESCLU = 'Residential / Commercial' or DESCLU = 'Apartments'] · SFR consists only of the value 'Residential': [DESCLU = 'Residential'] · MFR consists of the values 'Residential Condominium', 'Residential / Commercial', and 'Apartments'. [DESCLU = 'Residential Condominium' or DESCLU = 'Residential / Commercial' or DESCLU = 'Apartments'] · Determine the records that are inside or outside PFA using the PFA field (ex: PFA = 'Outside PFA') · Calculate total area of the records using the ACRES_1 field
HOUSING: **Housing Price**	· Download ***Census Tracts*** - 2000 from the census website (http://www.census.gov/ - under Maps / Boundary Files / Download Boundary Files) · Convert the downloaded interchange file first into a coverage: Open Arc Toolbox; select Import From Interchange File under Conversion Tools / Import to Coverage. Second export this coverage into a shapefile: In the Arc Toolbox, select Export From Interchange File under Conversion Tools / Export from Coverage · Download 2000 Census Summary File Three **-** Median Value (Dollars) for Specified Owner-Occupied Housing Units table: Click on Detailed Tables option, select Census Tract as the geographic level, choose the appropriate State and County, select All Census Tracts and click on Add. Click Next and select Median Value (Dollars) for Specified Owner-Occupied Housing Units table. Export and join this table with the ***Census Tracts*** layer · Classify the ***Census Tracts*** layer by MEDIANVALU field: Use Graduated Colors method, Manual classification, and 5 classes (0-100,000-150,000-175,000-Maximum Value)
HOUSING: **Housing Density**	· Download ***Census Tracts*** - 2000 from the census website (http://www.census.gov/ - under Maps / Boundary Files / Download Boundary Files) · Convert the downloaded interchange file first into a coverage: Open Arc Toolbox; select Import From Interchange File under Conversion Tools / Import to Coverage. Second export this coverage into a shapefile: In the Arc Toolbox, select Export From Interchange File under Conversion Tools / Export from Coverage · Download 2000 Census Summary File Three **-** Housing Units table: Click on Detailed Tables option, select Census Tract as the geographic level, choose the appropriate State and County, select All Census Tracts and click on Add. Click Next and select Housing Units table. Export and join this table with the ***Census Tracts*** layer · Recalculate the ***Census Tracts***' area: · Open the Attribute Table; right click on the AREA field and choose Calculate Values · Click on Advance box and type the following VBA statement in the first text box: Dim dblArea as double Dim pArea as IArea Set pArea = [shape] dblArea = pArea.area · Type the variable dblArea in the text box directly under the area field name and click OK · Add a new field by clicking on the Options and choosing Add Field on the Attribute Table of the ***Census Tracts***. Name it ACRES and select Double as the type

	· Right click on the ACRES field and choose Calculate Values. Select AREA field and divide that by 43560 (Sq Feet to Acres conversion) · Classify the ***Census Tracts*** layer by selecting HOUSINGU field as the value and ACRES field as the Normalization: Use Graduated Colors method, Defined Interval classification, and 5 classes (make sure the break value percentages are equal to: 20, 40, 60, 80, and 100)
ECONOMY: **Median Family Income**	· Download ***Census Tracts*** - 2000 from the census website (http://www.census.gov/ - under Maps / Boundary Files / Download Boundary Files) · Convert the downloaded interchange file first into a coverage: Open Arc Toolbox; select Import From Interchange File under Conversion Tools / Import to Coverage. Second export this coverage into a shapefile: In the Arc Toolbox, select Export From Interchange File under Conversion Tools / Export from Coverage · Download 2000 Census Summary File Three **-** Median Family Income in 1999 (Dollars) table: Click on Detailed Tables option, select Census Tract as the geographic level, choose the appropriate State and County, select All Census Tracts and click on Add. Click Next and select Median Family Income in 1999 (Dollars) table. Export and join this table with the ***Census Tracts*** layer · Classify the ***Census Tracts*** layer by selecting MEDINC_F field as the value; use Graduated Colors method, Manual classification, and 5 classes (45,000-55,000-65,000-75,000-Maximum Value)
ECONOMY: **Per capita Income**	· Download ***Census Tracts*** - 2000 from the census website (http://www.census.gov/ - under Maps / Boundary Files / Download Boundary Files) · Convert the downloaded interchange file first into a coverage: Open Arc Toolbox; select Import From Interchange File under Conversion Tools / Import to Coverage. Second export this coverage into a shapefile: In the Arc Toolbox, select Export From Interchange File under Conversion Tools / Export from Coverage · Download 2000 Census Summary File Three **-** Per Capita Income in 1999 (Dollars) table: Click on Detailed Tables option, select Census Tract as the geographic level, choose the appropriate State and County, select All Census Tracts and click on Add. Click Next and select Per Capita Income in 1999 (Dollars) table. Export and join this table with the ***Census Tracts*** layer · Classify the ***Census Tracts*** layer by PERCAPINC field: Use Graduated Colors method, Manual classification, and 5 classes (15,000-20,000-25,000-30,000-Maximum Value)
ECONOMY: **Poverty Rate**	· Download ***Census Tracts*** - 2000 from the census website (http://www.census.gov/ - under Maps / Boundary Files / Download Boundary Files) · Convert the downloaded interchange file first into a coverage: Open Arc Toolbox; select Import From Interchange File under Conversion Tools / Import to Coverage. Second export this coverage into a shapefile: In the Arc Toolbox, select Export From Interchange File under Conversion Tools / Export from Coverage · Download 2000 Census Summary File Three **-** Poverty Status in 1999 by Age table: Click on Detailed Tables option, select Census Tract as the geographic level, choose the appropriate State and County, select All Census Tracts and click on Add. Click Next and select Poverty Status in 1999 by Age table. Export this table and divide Income in 1999 Below Poverty Level number with the Total Population to attain Poverty Rate. Join this Poverty Rate field with the ***Census Tracts*** layer · Classify the ***Census Tracts*** layer by POVERTY_AA field: Use Graduated Colors method, Manual classification, and 5 classes (3-5-12.1-18-Maximum Value)
TRANSPORTATION: **Commute Time**	· Download ***Census Tracts*** - 2000 from the census website (http://www.census.gov/ - under Maps / Boundary Files / Download Boundary Files) · Convert the downloaded interchange file first into a coverage: Open Arc Toolbox; select Import From Interchange File under Conversion Tools / Import to Coverage.

	Second export this coverage into a shapefile: In the Arc Toolbox, select Export From Interchange File under Conversion Tools / Export from Coverage · Download 2000 Census Summary File Three **-** Mean Travel Time to Work table: Click on Detailed Tables option, select Census Tract as the geographic level, choose the appropriate State and County, select All Census Tracts and click on Add. Click Next and select Mean Travel Time to Work table. Export and join this table with the ***Census Tracts*** layer · Classify the ***Census Tracts*** layer by MEANTTWORK field: Use Graduated Colors method, Manual classification, and 5 classes (20-25-30-35-Maximum Value)
DEMOGRAPHICS: Population Density	· Download ***Census Tracts*** - 2000 from the census website (http://www.census.gov/ - under Maps / Boundary Files / Download Boundary Files) · Convert the downloaded interchange file first into a coverage: Open Arc Toolbox; select Import From Interchange File under Conversion Tools / Import to Coverage. Second export this coverage into a shapefile: In the Arc Toolbox, select Export From Interchange File under Conversion Tools / Export from Coverage · Download 2000 Census Summary File Three **-** Total Population table: Click on Detailed Tables option, select Census Tract as the geographic level, choose the appropriate State and County, select All Census Tracts and click on Add. Click Next and select Total Population table. Export and join this table with the ***Census Tracts*** layer · Recalculate the ***Census Tracts***' area: · Open the Attribute Table; right click on the AREA field and choose Calculate Values · Click on Advance box and type the following VBA statement in the first text box: Dim dblArea as double Dim pArea as IArea Set pArea = [shape] dblArea = pArea.area · Type the variable dblArea in the text box directly under the area field name and click OK · Add a new field by clicking on the Options and choosing Add Field on the Attribute Table of the ***Census Tracts***. Name it ACRES and select Double as the type. · Right click on the ACRES field and choose Calculate Values. Select AREA field and divide that by 43560 (Sq Feet to Acres conversion) · Classify the ***Census Tracts*** layer by selecting POP2000 field as the value and ACRES field as the Normalization: Use Graduated Colors method, Defined Interval classification, and 5 classes (make sure the break value percentages are equal to: 20, 40, 60, 80, and 100)
DEMOGRAPHICS: Households	· Download ***Census Tracts*** - 2000 from the census website (http://www.census.gov/ - under Maps / Boundary Files / Download Boundary Files) · Convert the downloaded interchange file first into a coverage: Open Arc Toolbox; select Import From Interchange File under Conversion Tools / Import to Coverage. Second export this coverage into a shapefile: In the Arc Toolbox, select Export From Interchange File under Conversion Tools / Export from Coverage · Download 2000 Census Summary File Three **-** Total Household Number and Average Household Size of Occupied Housing Units by Owner Occupied table: Click on Detailed Tables option, select Census Tract as the geographic level, choose the appropriate State and County, select All Census Tracts and click on Add. Click Next and select both Total Household Number and Average Household Size of Occupied Housing Units by Owner Occupied table. Export and join these tables with the ***Census Tracts*** layer · Recalculate the ***Census Tracts***' area: · Open the Attribute Table; right click on the AREA field and choose Calculate Values

	· Click on Advance box and type the following VBA statement in the first text box: Dim dblArea as double Dim pArea as IArea Set pArea = [shape] dblArea = pArea.area · Type the variable dblArea in the text box directly under the area field name and click OK · Add a new field by clicking on the Options and choosing Add Field on the Attribute Table of the ***Census Tracts***. Name it ACRES and select Double as the type. · Right click on the ACRES field and choose Calculate Values. Select AREA field and divide that by 43560 (Sq Feet to Acres conversion) · For Total Number of Households: Classify the ***Census Tracts*** layer by TOTALHH field: Use Graduated Colors method, Defined Interval classification, and 5 classes (make sure the break value percentages are equal to: 20, 40, 60, 80, and 100) · For Average Household Size: Classify the ***Census Tracts*** layer by AVGHHSIZE field: Use Graduated Colors method, Manual classification, and 5 classes (2.25, 2.50, 3.00, 3.50, and Maximum Value) · For Household Density: Classify the ***Census Tracts*** layer by selecting TOTALHH field as the value and ACRES field as the Normalization: Use Graduated Colors method, Defined Interval classification, and 5 classes (make sure the break value percentages are equal to: 20, 40, 60, 80, and 100)
DEMOGRAPHICS: **Population Growth**	· Download ***Census Tracts*** - 1990 from the census website (http://www.census.gov/ - under Maps / Boundary Files / Download Boundary Files) · Convert the downloaded interchange file first into a coverage: Open Arc Toolbox; select Import From Interchange File under Conversion Tools / Import to Coverage. Second export this coverage into a shapefile: In the Arc Toolbox, select Export From Interchange File under Conversion Tools / Export from Coverage · Download 2000 Census Summary File Three **-** Total Population table and 1990 Census Summary Tape File 1 - Total Population table: Click on Detailed Tables option, select Census Tract as the geographic level, choose the appropriate State and County, select All Census Tracts and click on Add. Click Next and select Total Population table. Export and join these tables with the ***Census Tracts*** layer · Add a new field by clicking on the Options and choosing Add Field on the Attribute Table of the ***Census Tracts***. Name it POPGROWTH and select Double as the type · Right click on the POPGROWTH field and choose Calculate Values. Subtract POP1990 field from POP2000 field · Classify the ***Census Tracts*** layer by selecting POPGROWTH field as the value and POP1990 field as the Normalization: Use Graduated Colors method, Defined Interval classification, and 7 classes (make sure the break value percentages are equal to: -20, 0, 20, 40, 60, 80, and 100)

APPENDIX C – JavaScript Programming

1. Frame: The website's frame was customized to place OVERVIEW map on the right upper section, to insert INDICATORS section at the bottom, and to make the display of the MAIN MAP larger. The JavaScript used for the frame was:

```
<frameset rows="30,*" frameborder="No" framespacing="0" border=0>
    <frame name="titleFrame" src="title.htm" marginwidth="5"    marginheight="0" scrolling="No" frameborder="0" noresize>
 <frameset cols="*,240" frameborder="No" framespacing="0" border=0>
   <frameset rows="*,120">
     <frameset cols="150,*" id="map_toc_frameset">
       <frameset id="title_toolbar_frameset" rows="20,*,20">
                        <FRAME NAME="titlebarFrame" SRC="titlebar.htm"  MARGINWIDTH="0" MARGINHEIGHT="0"
                        SCROLLING="NO" FRAMEBORDER="0" NORESIZE FRAMESPACING="0" BORDER="0">
                    <frame name="toolbarFrame" src="side.htm" marginwidth="0"  marginheight="0" scrolling="no" frameborder="0"
                    noresize framespacing="0" border="0">
                    <frame name="indicatorsFrame" src="indicators.htm"  marginwidth="0" marginheight="0" scrolling="no"
                    frameborder="0" noresize framespacing="0" border="0">
       </frameset>
              <frameset id="map_scalebar_frameset" rows="*,1"  frameborder="Yes" framespacing="0">
                    <frame name="mapFrame" src="map.htm" marginwidth="0"  marginheight="0" scrolling="No" frameborder="Yes"
                    resize="YES">
                    <frame name="scalebarFrame" src="side.htm" FRAMEBORDER="No" scrolling="No">
       </frameset>
     </frameset>
            <frameset id="tabmenu_frameset" rows="50,*" frameborder="No"  framespacing="0">
                <FRAME NAME="linksFrame" SRC="links.htm" MARGINWIDTH="0" MARGINHEIGHT="0" SCROLLING="NO"
                FRAMEBORDER="no" RESIZE="no">
                <frame name="layersFrame" src="links01.htm" FRAMEBORDER="No" scrolling="AUTO">
     </frameset>
   </frameset>
   <frameset rows="140,*" id="overview_toc_frameset">
            <frame name="overviewFrame" src="side.htm" frameborder="Yes" scrolling="No">
            <frame name="tocFrame" src="side.htm" marginwidth="0"  marginheight="0" scrolling="NO" FRAMEBORDER="NO"
            resize="YES">
   </frameset>
  </frameset>
</frameset>
```

2. Indicators: INDICATORS section was customized to place checkboxes next to each indicator, to insert links, and to insert an 'Update Map' button. The JavaScript used for the INDICATORS was:

```
            var visibleLayers = new Array();
            visibleLayers[0] ="Current Use";
            visibleLayers[1] ="Commercial,Industrial&Public Uses";
            visibleLayers[2] ="Residential";
            visibleLayers[3] ="Commercial,Industrial&Public Uses";
            visibleLayers[4] ="Residential";

            function updateLayers(form){
                        var visibleLayer;
                        var tocValue = parent.mapFrame.IMSMap.getToc();
                        for(var n=0; n<visibleLayers.length; n++){
                                    if(!(visibleLayers[n] == "none")){
                                                visibleLayer = parent.mapFrame.document.IMSMap.getSubLayer ('Harford',
visibleLayers[n]);
                                                if(form.LayerVisible[n].checked){
                                                            visibleLayer.setVisibleByInt (1);
                                                }else{
                                                            if (n!=4&&n!=3){
                                                                        visibleLayer.setVisibleByInt (0);
                                                            }
                                                }
                                    }
```

```
                        }
                        parent.mapFrame.IMSMap.redraw();
                        parent.tocFrame.IMSToc.refresh();
                }
</SCRIPT>
</HEAD>
<BODY bgcolor="FFFFFF" TEXT="Black" LEFTMARGIN=5 RIGHTMARGIN=0 LINK="336699" VLINK="336699" ALINK="336699"
TOPMARGIN=5 onload="startUp()">
<TABLE WIDTH="577" HEIGHT="40" CELLSPACING="0" CELLPADDING="1" BGCOLOR="FFFFFF">
  <FORM NAME="linksForm">
    <TR>
      <TD WIDTH="1" HEIGHT="21">  </TD>
      <TD WIDTH="22">
        <input type="Checkbox" name="LayerVisible" value="0">
      </TD>
      <TD WIDTH="250"><FONT FACE="Arial" SIZE="-2"><A HREF="ArcIMSLinks072204\CurrentUse.htm"
target="_blank">Current
        Use</A></FONT></TD>
      <TD WIDTH="22">
        <input type="Checkbox" name="LayerVisible" value="1">
      </TD>
      <TD WIDTH="306"><font face="Arial" size="-2"><a href="ArcIMSLinks072204\EmpDensity.htm"    target="_blank">Employment
        Density</a></font></TD>
    </TR>
    <TR>
      <TD HEIGHT="21">  </TD>
      <TD>
        <input type="Checkbox" name="LayerVisible" value="2">
      </TD>
      <TD><FONT FACE="Arial" SIZE="-2"><A HREF="ArcIMSLinks072204\ResDensity.htm" target="_blank">Residential
        Density</A></FONT></TD>
      <TD>
        <input type="Checkbox" name="LayerVisible" value="3">
      </TD>
      <TD><font face="Arial" size="-2"><a href="ArcIMSLinks072204\LandUseMix.htm" target="_blank">Land
        Use Mix</a></font></TD>
    </TR>
    <TR>
      <TD HEIGHT="21">  </TD>
      <TD>
        <input type="Checkbox" name="LayerVisible" value="4">
      </TD>
      <TD valign="center"><font face="Arial" size="-2"><a href="ArcIMSLinks072204\ResLotSize.htm"
target="_blank">Residential(SFR,
        MFR) Lot Size</a></font></TD>
      <TD></TD>
      <TD></TD>
    </TR>
```

APPENDIX D – Instructions for Navigation and Drawing Tools

NAVIGATION TOOLS

Navigation Tools allow you to: a) navigate (Zoom, Pan) on the MAIN MAP, b) conduct GIS analysis (Query, Buffer, Measure), and c) get information about the layers (Identify, Show Select).

Zoom In tool allows you to a) zoom into an area you define by holding down the left mouse button and dragging a box on the map or from a point on the map where you click and b) re-center the MAIN MAP display by the area you defined

Zoom Out tool allows you to a) zoom out from an area you define by holding down the left mouse button and dragging a box on the map or from a point on the map where you click and b) re-center the MAIN MAP display by the area you defined

Entire Map tool allows you to fully view the MAIN MAP by zooming out to the full extent of the layers

Zoom to Active tool allows you to fully view the data layer that is made *active** in the LEGEND menu

Previous Zoom tool allows you to go back to the previous MAIN MAP display

Pan tool allows you to drag the display in any direction with the mouse; to pan, move the cursor anywhere over the MAIN MAP, hold down the left mouse button, and drag in any direction; release the mouse button to leave the display in a desired position

Identify tool allows you to view the information on any feature shown on the MAIN MAP; note: the Identify tool works only one layer at a time and that layer has to be *active**; in order to accurately select the feature of your interest, you might have to zoom in to a larger scale

Query tool allows you to construct query statements and further analyze any of the layers from the LEGEND; note: see 'How To Do Your Own Search Using Query Tool' section for detailed explanation

Measure tool allows you to measure distances based on your clicks on selected points on the MAIN MAP; to measure, move the cursor anywhere over the MAIN MAP, click on a point, hold down the mouse button, drag to any location and release the mouse button; results are displayed in the top section of the MAIN MAP; measurement units are in miles; note: to clear the measured segments double click anywhere on the MAIN MAP

Buffer tool allows you to buffer the selected features from the *active** layer based on your choice of distance and lets you select features from any other layer that are within the buffer

Select tool allows you to select features from the *active** layer by clicking on the features of interest or by defining a box that captures those features

Show Select tool allows you to view the information about the selected features

Clear Select tool allows you to clear the selected features

Print tool allows you to print the main map

* ACTIVE - See LEGEND section for instructions on how to select a layer and make it active

How to Do Your Own Search Using Query Tool

1. Select the layer you want to analyze from the LEGEND on the right side of the screen by clicking on the layer name (i.e. Properties, Municipalities etc.); the layer name in the LEGEND should look raised
2. Click on the *Query* button from the NAVIGATION TOOLS menu on the left side of the screen
3. Select the *Field (attribute)* you want to analyze by scrolling down and double clicking on the field name (i.e. DESCLU); note: see definitions for more information on *Fields*
4. Click on the *Operator Sign* (i.e. '=', '>=', etc.) depending on which operation you need to perform
5. Click on one of the *Values* associated with the *Field* you have chosen (i.e. 'Commercial')
6. The final dialogue box should contain information similar to: (DESCLU = 'Commercial')
    a. To query more than one value within one or more layers click on either 'OR' or 'AND'
        i. 'OR': Any of the conditions can be true for a selection to take place
        ii. 'AND': All conditions must be true for a selection to take place
    b. Repeat the same steps from # 3
    c. The final dialogue box should look similar to: (DESCLU = 'Commercial' or DESCLU = 'Agricultural')
7. Click on the *Execute* button
8. The result of the query will be displayed in the *Query Results Table* and highlighted in yellow in the MAIN MAP
    a. To view all *Fields (attributes)* of the layer in the *Query Results Table* click on *Show All Attributes* button
    b. To view only one *Field* of the layer in the *Query Results Table* select the *Field (attribute)* from *Display Field*
    c. To select one or more records from the *Query Results Table* click on the records by holding 'ctrl' or 'shift'
    d. To highlight the selected records click on the *Highlight* button; to center the selected results click on the *Pan* button; to zoom to the selected results click on the *Zoom* button
9. Click on the *Statistics* button for statistical calculations (i.e. mean, sum, etc.); selecting a *Field* for which you want to get statistics calculated
    a. Check the *Use Query Results* to get only the statistics of the resulting query
    b. Uncheck the *Use Query Results* to get the statistics on all features in the layer that was selected in the step #1
10. To save the results click on the *Save* button
11. To create a new query click on the *Clear* button.

DRAWING TOOLS

Drawing Tools allow you to add text and/or graphics to the MAIN MAP and to store them as a data layer.

New Layer tool allows you to create a new layer; this is a necessary step when you start a new layer

Select Layer tool allows you to select previously created and saved layers

Delete Layer tool allows you to delete a layer; first select the layer you want to delete, then click on the Delete Layer tool

Description tool allows you to write information about the layer you created; after you create a new layer or select a previously created layer, click on description tool to write information about the layer

Submit tool allows you to save the layer you created and to save the changes you make by drawing or adding text to a previously created layer

Stop tool allows you to stop the drawing session and to clear the text or graphics from the MAIN MAP; when you activate the Drawing Tools menu tab, the information you submitted (saved)before will show up on the MAIN MAP again

Undo tool allows you to undo the immediately preceding action

Redo tool allows you to redo the immediately preceding action

Select tool allows you to select the text and graphics you created

Add Line tool allows you to draw a line by holding the left mouse button from the point where you want to begin your line to the point representing the end of your line; press the mouse button twice to end the drawing

Add Polygon tool allows you to draw a polygon by holding the left mouse button from the point where you want to begin your polygon, move to the next point where you release the mouse button; repeat the action until you come to the end point of your polygon and press the mouse button twice to end the drawing

Add Rectangle tool allows you to draw a rectangle by holding the left mouse button from the point representing one corner of your rectangle to the point representing the end point of your rectangle - opposite from the beginning point; release the mouse button to end the drawing

Add Circle tool allows you to draw a circle by holding down the mouse button from a point representing the center of your circle to a point representing the perimeter of your circle; release the mouse button to end the drawing

Add Text tool allows you to write text in the MAIN MAP; write down the text and change it to the font type and size on your preference; click on the MAIN MAP where you want the text to be displayed

Add Image tool allows you to insert an image in to the MAIN MAP by allowing you to search and select an image from your computer and then by clicking on a point where you want the image to be displayed

Add Freehand tool allows you to draw freehand by holding the left mouse button from the point you want to begin your drawing to the point representing the end of your freehand drawing; double click to end the drawing

Delete tool allows you to delete the text or graphics you created; to delete you first have to select the text or graphics you want to delete

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