

# EXTENDING THE CAPABILITIES OF DENVER'S MULTI-AGENCY INTEGRATED ARCIMS SITE

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## **Abstract**

Locate, View, Map – Denver's multi-agency integrated ArcIMS intranet solution delivers 700+ layers of spatial data and analysis tools for employees of the City and County of Denver. The application framework has been designed to support the rapid development of extensions with additional functions. These functions leverage the component architecture of the city-wide application to allow agencies specific tools for specific needs. These extensions, or "plug-ins", support the goal of meeting data entry, storage, analysis, and display needs for agencies, while reducing maintenance, training and development costs.

## **1 Introduction**

Denver's city and county are combined into a single jurisdiction which is comprised of a diverse group of offices, departments and agencies. For simplicity, these organizational groups will be referred to as 'agencies' throughout this paper. The main GIS internal web application, Locate, View, Map will be referred to as LVM, and the words 'extensions' and 'plugins' are used interchangeably.

Locate, View, Map is Denver's multi-agency integrated ArcIMS intranet solution. LVM delivers 700+ layers of spatial data and analysis tools for the use of all employees of the City and County of Denver. LVM is delivered through a standard web browser and is available to all city employees. LVM is the primary GIS tool used throughout the City, and is, in fact, referred to as 'the GIS' by these personnel.

The diverse agencies that comprise City and County of Denver government benefit from the delivery of GIS data within a single integrated application. Maintenance of the data layers and the application is managed at one point, eliminating the greater cost and possibility of error from duplication of effort. Several of the agencies that use LVM provide (and maintain) the spatial data that is part of LVM, but the data layers are managed and published by DenverGIS as one centralized application.

Access to all agency data layers and GIS functionality in a single interface allows inter-agency data relationships to be analyzed. An opposing challenge is to provide agencies with specific data layers and tools for their specific needs. The application framework has been designed to support the rapid development of extensions with additional functions. These functions leverage the component architecture of the city-wide application to provide city agencies specific tools for specific needs. These extensions, or "plug-ins", support the goal of meeting data entry, storage, analysis, and display needs for agencies, while reducing maintenance, training and development costs.

## **2 Background**

*(Condensed from "Locate, View, Map": Denver's Multi-Agency Integrated ArcIMS Intranet Solution, Allan Glen, 2005)*

LVM is a web-based application using ASP, JavaScript, HTML, and XML. The database tier uses ArcSDE on Oracle 10g and houses data layers from all agencies. The component based architecture of LVM uses tools, dialogs, display objects and map operations (called handlers) that tie into a core framework. The core represents general application layout such as browser frames, status bars, table of contents, etc. and manages startup tasks, sessions, database access, etc.

Client-side and server-side libraries are exposed to components through application programming interfaces (APIs). The client-side provides web browser functionality such as window management, map control, tool handling, map events, etc. The server-side provides access to ArcIMS requests, database access, map operations, etc. Application components include tools (e.g., pan, zoom, select), dialogs (e.g., address geocoding windows, query windows), display objects (e.g., lines from measuring tools) and handlers (components that interface with the map, such as buffering, layer visibility, etc.). Handlers process parameters submitted by a map request and collectively produce the output map.

### **3 Extensions**

The following sections discuss specific the agency extensions now in use. The discussion includes requirements that led to the creation of the extension, unique characteristics of the extension, some background on the agency needs and previous business processes, and the usage of the extension. The characteristics demonstrate the wide variety of needs that are met through a single web entry point (LVM), and the usage includes some discussion of the re-usable LVM components included in the extension.

#### *3.1 TCG (The Collaboration Group)*

Public Works (multiple departments)

**Requirements:**

Create hard copy and digital display of city infrastructure projects throughout the designated calendar year, used for primarily for eliminating conflicts.

**Characteristics:**

Feature identification, database creation and storage, multi-agency coordination and collaboration.

The Collaboration Group (formerly the Transportation Collaboration Group) has the mission of coordinating all projects that impact public right-of-way infrastructure in the City and County of Denver (such as streets, sidewalks and alleys). The goal is to optimize resources to save money, time, and duplication of effort; for instance, preventing tearing up a newly-paved street to repair storm or sanitary facilities. Project information is collected in the fall of the year prior to the report year, and mapped to display project conflicts. In the past, projects were delivered to the mapping group by way of a variety of formats, including sketches, spreadsheets, diagrams, etc. 2-3 GIS personnel were required over a period of days to digitize this information.

The TCG extension allows project managers select features from existing data layers and place them in a database. This process takes from less than an hour to a few hours, and has the advantage that the project manager, presumably an expert on the projects being entered, is responsible for placement and attribution of the project.

**Usage:**

The project editor creates a project which specifies a data layer and a project type. The appropriate layers are selected and made visible by making calls from the client to the map handler. The editor navigates to the area in which the project is planned, and uses the select tool (one of the re-usable

LVM components) to click on a desired feature (a street segment, a pipe segment, a park, etc.) The unique ID of the feature is stored in a database on the server, along with project information (project type, name, etc.) The feature table can be related to the SDE layer by the unique ID and mapped in ArcGIS relatively quickly and efficiently. Project managers can have next year's planned projects entered at any time throughout the year prior to the specified project year.

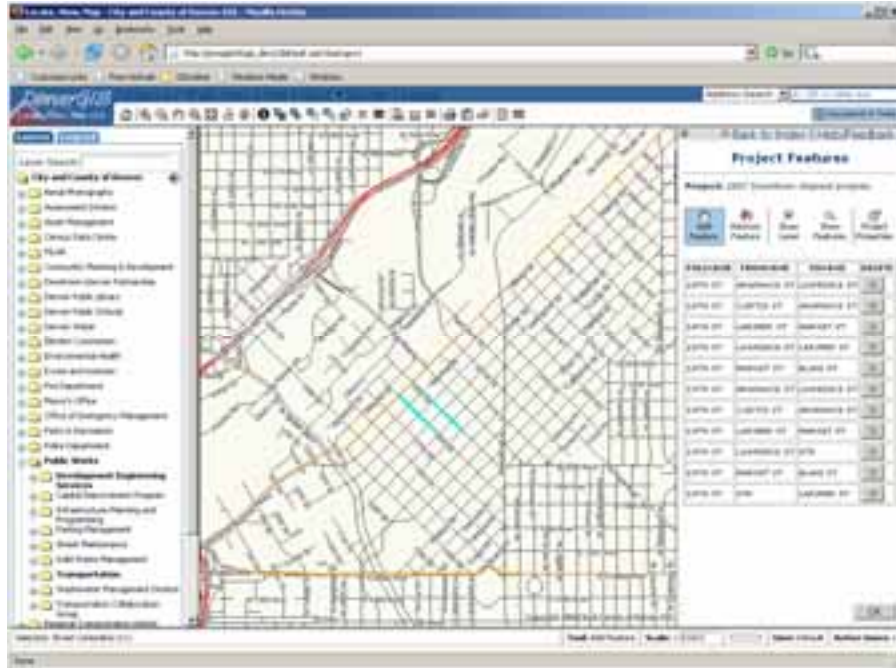


Figure 1: TCG feature selection page, showing sample database entries for checking purposes.

### 3.2 SiteInfo (Historical/Environmental site information)

Office of Economic Development/Division of Housing and Neighborhood Development (OED/DHND)

**Requirements:**

Location and attributes of various historical/environmental features within a distance of an address, delivered as maps and reports.

**Characteristics:**

Dynamic reporting, map display

DHND is responsible for the distribution of all U.S. Department of Housing and Urban Development (HUD) funds in the City and County of Denver. There are well over 1000 projects on a yearly basis, totaling millions of dollars in federal funds, for which this office is responsible. In addition, this office is responsible for HUD funding utilized by all other entities within the City, including the Mayor's Office of Economic Development (MOED), Denver Housing Authority, the State of Colorado Division of Housing, Habitat for Humanity, and others. No dollar amount is tracked for these projects, but it is again in the millions.

Before any federal dollars can be spent from the City's allocation of these funds, an environmental and historical clearance is required by federal regulations. These requirements are met with maps and reports detailing the features of the site being analyzed. GIS needs were at first met by using hard copy maps and paper reports, then an ArcView 3x application (written by a consultant) which was difficult, cumbersome, and expensive to update and maintain. The extension developed for this

division makes use of the existing LVM components and has access to the most up-to-date database layers possible, since the database layers are updated on a (sometimes) daily basis.

**Usage:**

Information on layer names and table attributes to be used for the DHND reports is stored in an XML file, for easy maintenance. The user clicks on a map location or enters an address of the site for which information is needed. The address dialog tool is identical to the one used for LVM, and is placed on the extension interface for ease of use. Layers specified in a list box are turned on, and the map handler is directed by the client code to zoom into an area 3000 square feet surrounding the site. Lines defining a 3000' radius buffer area, and a 1000' radius buffer area surrounding the site are displayed, and a dialog containing the attributes for features within the 1000' buffer can be created. The map of the site and surrounding features and the report comprise the required deliverables for the DHND's report on the site.



Figure 2: Siteinfo – display of the requested site with its surroundings.

Delete & Row  
Report Date: Thursday, October 13, 2006

Parameters are not submitted  
District: All  
Month: All  
Year: 2006

SWEEP DISTRICT	SWEEP MONTH	YARDS SWEEPED	PILE YARDS	CLEANLINESS	DAY	EVENT
11001000	Jun	11	00	0.0	0	0
11001000	Jul	16	02	0.27	0	0
11111000	Apr	80	100	0.84	0	0
11111000	Apr	80	100	0.84	0	0
11111000	Jun	50	103	0.51	0	0
11111000	Jul	19	77	0.25	0	0
11111000	Aug	10	108	0.10	0	0
11111070	Apr	80	100	0.84	0	0
11111100	May	80	104	0.82	0	0
11111010	Jun	10	101	0.10	0	0
11111010	Jul	19	77	0.25	0	0
11111100	May	11	100	0.11	0	0
11111000	Apr	80	100	0.84	0	0

Street Sweeping Report  
Report Date: Wednesday, October 11, 2006

Parameters are submitted  
District: All  
Month: All  
Year: 2006

SWEEP DISTRICT	SWEEP MONTH	YARDS SWEEPED	PILE YARDS	CLEANLINESS	DAY	EVENT
11001100	Jun	11	00	0.0	0	0
11001100	Jul	16	02	0.27	0	0
11111100	Apr	170	200	1.27	0	0
11111100	Jun	10	100	0.10	0	0
11111100	Jul	19	77	0.25	0	0
11111100	Aug	11	100	0.11	0	0
11111170	Apr	80	100	0.84	0	0
11111170	May	80	104	0.82	0	0
11111170	Jun	10	101	0.10	0	0
11111170	Jul	19	77	0.25	0	0
11111170	Aug	11	100	0.11	0	0

Figure 3: Siteinfo – dialogs for reporting or deleting a row

### 3.3 *Liquor License Site Evaluation*

#### Excise & Licenses (E&L)

##### **Requirements:**

Display and report on all liquor licenses within a specified distance from a proposed liquor license.

##### **Characteristics:**

Dynamic reporting, map display

The Liquor Licensing Division is responsible for accepting, processing, and issuing or denying all liquor licenses in the City of Denver. This includes new applications, applications for changes in ownership, applications for modifications, and all other changes and documents required to be filed with the local liquor licensing authority. The Division schedules and conducts public hearings on all new applications, on applications for changes in ownership as appropriate, and on modifications as appropriate.

The Division is tasked with determining “undue concentration of liquor licenses” within a particular area around a requested permit. The area surrounding the address of the permit request is set at 9 square blocks in the downtown area, and 25 square blocks in the rest of the city. The division was using paper maps and street guides to do their undue concentration analysis, an extremely slow and cumbersome process.

##### **Usage:**

The extension created for the Excise and License Division takes a map location point (single mouse click on a point on the map), or an address, and returns the appropriate rectangular area outlined in red. This outline is a display object, one of the components available for use through the LVM architecture. All existing liquor licenses within this box are selected. The buffer handler for this operation was extended to include buffers of different shapes and sizes, as required by E&L. The table for liquor licenses displays all selected features (within the buffer) with accompanying attributes, and can be exported as a spreadsheet.

The map display can be printed, and this map along with the spreadsheet comprises the report that E&L requires for its analysis and determination. This process takes seconds as opposed to hours for the previous process.



Figure 4: Liquor license selection area with selected liquor licenses.

### 3.4 Street Sweeping

#### Public Works/Street Maintenance (PWSM)

##### **Requirements:**

The agency has need of a web-based single-point entry and storage application for street sweeping data, and map rendering of street cleanliness factors.

Denver's streets are swept once a month from April through November, with the aim of improving water and air quality. In 2006, an estimated 36,436 cubic yards of debris was removed from a total 93,848 miles of street. PWSM used spreadsheets to track the data from street sweeping.

##### **Characteristics:**

Database entry, reporting, spatial analysis

The extension allows entry of sweep data, viewing and printing of reports by year, month, and district; and rendering of cleanliness factor (cubic yards of debris/miles swept) by district. PWSM uses these data to determine optimal use of sweeping resources.

##### **Usage:**

The user selects a district for data entry, and enters the cubic yards, miles swept and the date. There is a checkbox for unusual day events such as dust storms, street fairs, etc. Data are stored in an Oracle database, and are backed up and maintained frequently. On a separate tab, the user can select report parameters and retrieve data from the database in a report dialog, which can be streamed to an Excel spreadsheet. Any combination of districts and sweep months can be selected for reporting and rendering. The rendering is done on the ArcIMS acetate layer.

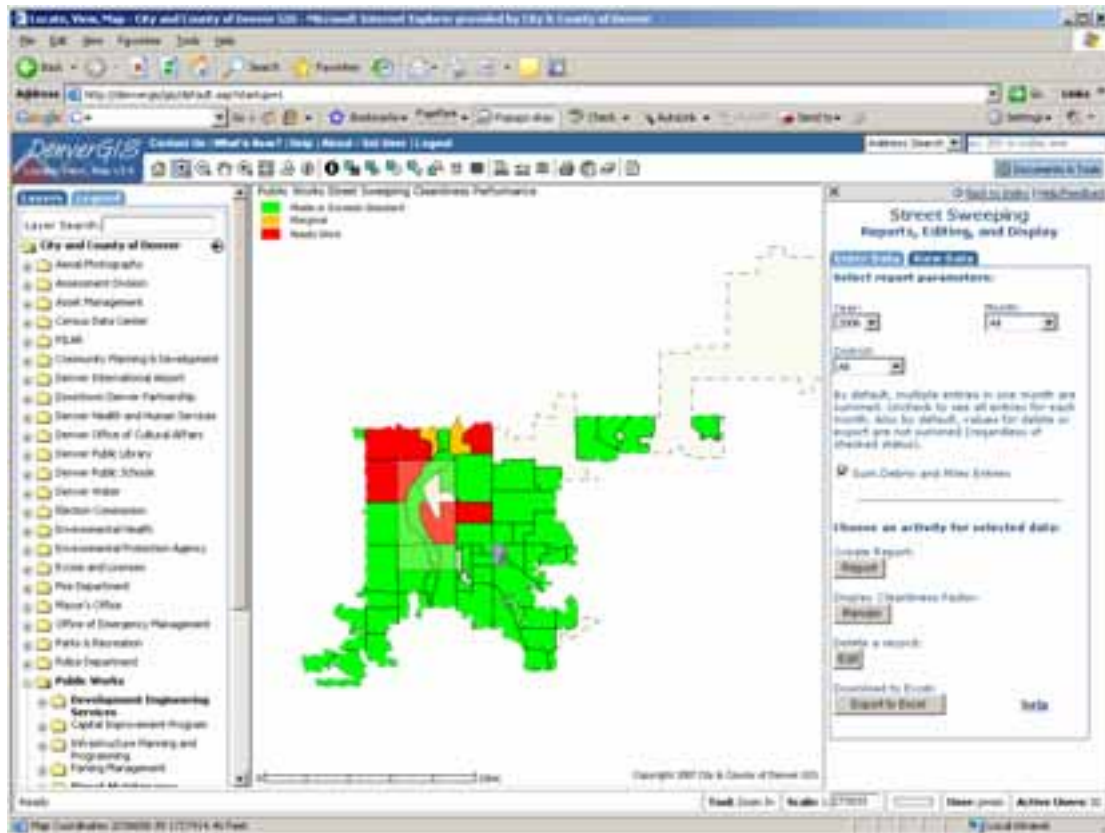


Figure 5: Street sweeping cleanliness factors rendered dynamically according to selected parameters

### 3.5 Snow Routes

#### Characteristics:

Dynamic mapping, reporting, rendering

#### Public Works/Street Maintenance (PWSM)

PWSM needs to monitor the progress of snow removal during a snow event. PWSM maintains its own database which is updated during the event by radio logging of snowplow progress along snow routes. As there is not yet AVL on the snowplows, the logging is accomplished by operators calling in at the point of starting a route, and ending the route. Back at headquarters, the supervisor enters the appropriate information in the database. The extension displays these progress data by connecting to the PWSM database and rendering the snow routes layer according to the progress indicators. This extension is implemented using a map handler, and differs from the others in that there is no user interface; it is for display only.

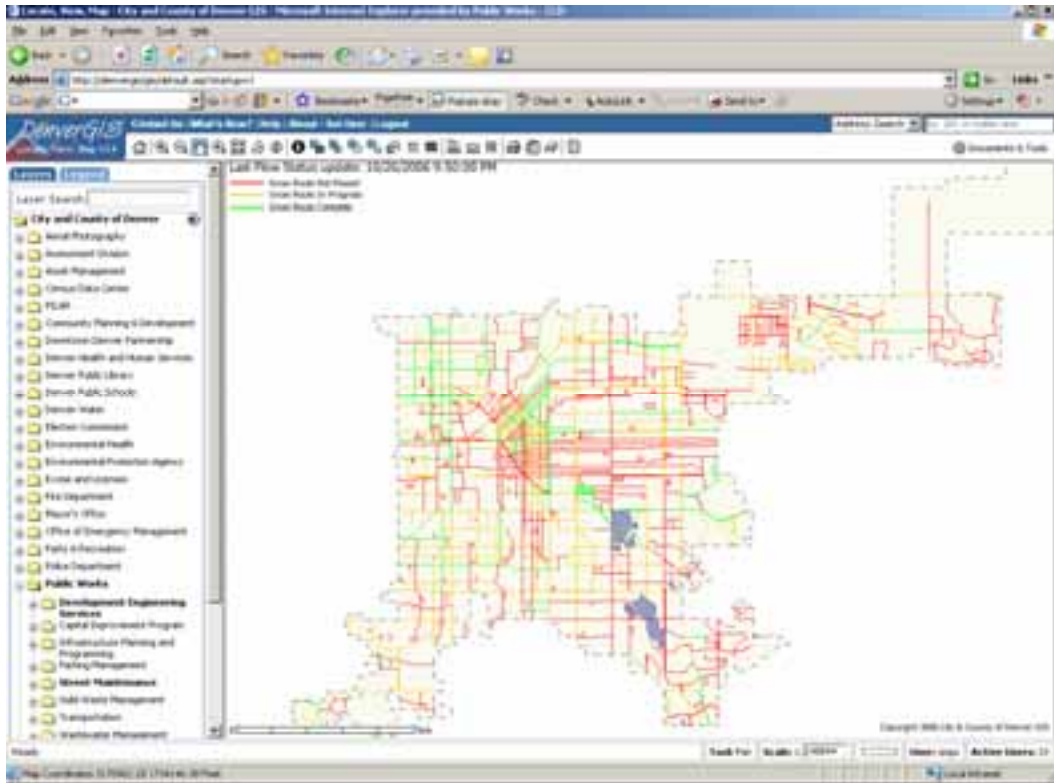


Figure 6: Snow route plowing status dynamically rendered from remote database.

### 3.6 Incident Search Tool

Denver Police Department (DPD)

**Requirements:**

Provide a rapid and easy-to-use web-based query engine for crime analysis.

The DPD Incident Search Tool is basically a query engine that allows officers to pick crime types, a geographical area (district or precinct), and a time period, resulting in a display of the specified crime type as points in the specified area. These queries are accessible to users of LVM, but the crime search tool allows them to be done with minimal training.

**Characteristics:**

Spatial analysis, reporting

**Usage:**

The queries in the background of this extension can also be handled through the various query dialogs that are part of the LVM component architecture. Training the entire police force to build and execute fairly complex spatial queries was, however, deemed impractical. The user need only make selections from radio buttons, dropdown menus, and calendars to display the information needed.



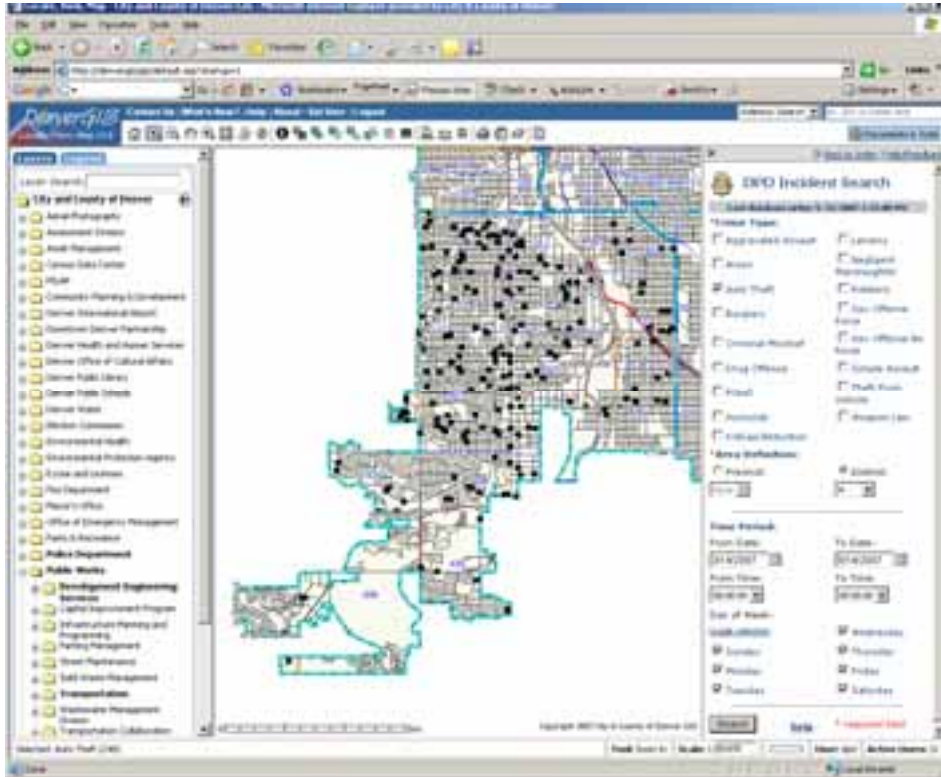


Figure 5: Selected crime display by type for selected area and specified time period

**4 Conclusion**

Extensions to Denver’s ArcIMS Intranet site, Locate, View, Map optimize the core application by re-using application components for specific agency purposes. These extensions serve to focus functionality on business processes and objectives for particular agencies within the city. These agencies are able to take advantage of the city-wide Intranet site with hundreds of up-to-date data layers, while using the specific extensions created for their needs.

**5 Acknowledgements**

LVM is developed and maintained by the City and County of Denver Technology Services Geographic Information Systems group (DenverGIS). DenverGIS is supervised by David Luhan.

Many of the features available in LVM are inspired by feedback from City and County of Denver staff.

For more information about “Locate, View, Map” please contact:  
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## **6 References**

*“Locate, View, Map”: Denver’s Multi-Agency Integrated ArcIMS Intranet Solution, Allan Glen, ESRI UC, 2005*