

# Water Utility GIS - Company Property Assets

*Building a GIS Property Layer, Dynamic Map Template, and  
Web Mapping Application to Provide Instant Access & Analysis*

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## **Introduction**

New Jersey American Water Company (NJAW) is a wholly owned subsidiary of American Water (AW), a publicly traded water utility on the New York Stock Exchange (NYSE). AW has subsidiaries that own and/or operate water and wastewater systems in 32 states and Canada. NJAW services approximately 2 million customers with quality drinking water across the most densely populated areas of New Jersey. Similar to its parent company, NJAW has grown over the years through acquiring certain Municipal Water Systems or competing private water systems within the state. Records, and record keeping workflows, within the acquired organizations ran the gamut from old paper maps & institutional knowledge to simple Geographic Information Systems (GIS). At significant cost, in 2008 NJAW converted all water utility assets to an enterprise GIS system. Resources, however, precluded the inclusion of the significant NJAW parcel & easement holdings in this conversion. Prior to this project's completion, NJAW property data remained widely variable and scattered across various departments within the company. Mapping and/or GIS analysis requests regarding property holdings were extraordinarily time consuming to prepare.

The approximately five hundred properties New Jersey American water owns, while significant, hardly warranted the development of a robust property management system. The properties, however, do represent a significant investment in their respective communities. Some offer host communities

large tax contributions. Others hold offices where hundreds work. All told, they house hundreds of thousands of pieces of machinery & equipment. The land holdings also represent a myriad of environmental opportunities ranging from farmland leasing, to solar panels, to well protection, to tank sites, and so on. Management and field personnel should have instant access to accurate spatial information about all assets, not only 'network' assets, to make informed real time decisions. Optimally, a workflow and application should exist that not only provides access but also editing capabilities, as well as value-add information and analysis through GIS overlay techniques. In short, a business need existed for the formal inclusion of a real property layer within the New Jersey American Water Geographic Information System.

## **Objective**

The objective of this project is to create efficient ways to access, analyze, & edit New Jersey American Water property information along with related, contextual GIS layers. The primary goal is to design and build an up to date, seamless GIS property layer for New Jersey American Water. The secondary goal is to provide efficient ways to access, analyze, query, edit, and print property information for end users with *and* without GIS knowledge. The tertiary goal is to design an internet base map that uses cartographic design principles to support users in a variety of web-based geospatial water utility tasks.

## **Methodology**

### **i. identify business need**

The business reality & need described above became increasingly clear with an uptick in regulatory property map requests in early 2008, culminating in the request for over 80 printed maps, each with a moderate amount of overlay analysis. Many of these properties were not covered at all by municipal parcel layers, and these had to be hand digitized prior to analysis & mapping.

**ii. determine objective**

The objective for this project was constructed after careful review of the business needs, data available, the ongoing state parcel project, and the NJAW proposed project timeline.

**iii. requirements / data gathering**

Stakeholders & data providers were identified early on in the process. Geometry was determined to eventually be provided by the state after completion of the statewide parcel layer. In the interim, geometry was drawn via digitization, CAD conversion, or as existing non edge-matched parcel layers from source material. The tax, legal, environmental compliance, and asset planning departments all contributed databases.

**iv. schema design**

The core NJAW Parcel Layer schema was designed to be lean, containing mostly basic geographic information, as well as the KEY field. The KEY field (called PAMS\_PIN), originated from the official state schema for an upcoming statewide, seamless parcel layer. This layer covers roughly 70% of the NJAW service area. At this time, there are several towns / counties that do not have immediate plans to participate. The use of the PAMS field as the NJAW key field will ensure a smoother integration with updated geometry for parcels as they become available from the state.

**v. related table design**

There is a significant amount of tabular data related to each property. It is ideal to organize this data according to subject. For instance, all tax data belongs in one table, facility data in another, environmental data in yet another, and so forth. Four distinct related tables were created for this project. They are **(1)**Tax Table **(2)**Land Use **(3)**Environment **(4)**Near. These tables, along with the core Property layer fields, were chosen and constructed to fully take advantage of ArcMap dynamic text for rapid map production. In addition, they will eliminate or greatly simplify the need for the most common overlay analysis. Facility data will be linked in a future project.

**vi. database population**

The creation of the main GIS property layer was an iterative process of conflation between four tabular sources, an online tax map database, various GIS & CAD parcel geometry sources, and property deeds. The minimum requirement, however, to be considered a 'property', was inclusion (on some level) within a tax record. Occasionally, multiple tax records existed where geometry could not (ex. a separate cell tower or sewer bill). Other times multiple parcels existed for a single tax record. For simplicity, a one-to-one relationship was maintained by creating consolidations or 'splits' where necessary.

The creation of the four related tables followed a more technical path. The original tax tables were reformatted into a single "GIS friendly" dbf format. The Environment & Land Use tables were created using the final Property Layer with a single field enabled (PAMS) and spatial overlay techniques. The Land Use has, necessarily, a many-to-one

relationship with the Property layer. The conservation 'score' field in the Environment table was calculated via a custom VB field calculation. This script reclassifies several text fields to binary values, then executes a weighted overlay equation to arrive at the conservation score. The Near table was created via the Near Table creation tool in ArcToolbox, however, its bearing field was calculated using a custom field calculation script written in VB to correct for the default values.

**vii. dynamic map template design**

One of the main objectives of this project was to ensure the rapid and accurate response to mapping & overlay requests regarding property information. The creation of a map template is integral to this, however, a dynamic map template provides far more time savings than a simple data frame and title block type template. A dynamic template incorporates a variety of dynamic objects that read values live from the data in the map data frames. Most GIS users are familiar with the scale & legend tools' dynamic capability to update as the data frame adjusts. Dynamic text (and other objects) use this same technology. For instance, when the GIS user zooms to property 'A' with Elevation 'Z', that Z can be reported instantly in the dynamic text "Elevation = Z" Any field can be reported, so long as it is vector data. Additionally, the tools give the user the ability to write VB scripts to further enhance & control what is reported. The final template for this project incorporated over 50 separate dynamic elements, including over 30 separate field values. Using ArcMap atlas tools, a map atlas of all NJAW properties was produced in both PDF & printed/bound form from the dynamic map template. The PDF will be available online. Of course, custom maps can now be made extremely quickly by a GIS professional using the template as well.

**viii. web base map design**

Access was a major objective goal of this project. The online and printed PDF atlas addresses some of this goal, as does improving the office GIS professional's time management. The ultimate access, however, is internet access. In order to facilitate a smooth internet user experience, it was necessary to create an appropriate base map specific to a utility user. Most open source web base maps available for reference in web mapping applications do not contain sufficient zoom capability to provide the detail so often needed in the utility industry. For example, some NJAW property holdings are 2 feet wide, and many infrastructure features are within inches of one another.

A custom base map was created, which could be used in a variety of web applications, not simply property map applications. The base map was created for 20 scale levels, using roughly 40 layers at most levels. The scales ranged from a full zoom of 1:25 (1ft = 25ft), all the way to 1:1,200,000 at the fullest extent. The map cartography was vetted against several different topography types across the state (hilly, wetlands, ultra-urban, sub-urban, coastal, etc). In addition to the base map, custom query & charting tools were written to effectively mine, display, export, and print the information in the property layer and its related tables.

## **Results**

The project accomplished all of its stated goals to a satisfactory degree. There is now a seamless GIS property layer, including a number of specialty overlay tables, within the New Jersey American Water GIS. Common overlay inquiry & map production of property has been automated. A printed & digital atlas has been produced. The web base map was created and is very effective. Several query & chart tools are now available in a web application to investigate the new layers interactively, as well as download tables, and print maps. The next steps will be to continue to develop and improve the web application, as some of the tools are not very intuitive to use. A developer may be hired to create applications that are more user friendly, and perhaps directed at specific user groups. On the database side, summer interns will be utilized to hand digitize all facility buildings within the new property layer boundaries. Various facility databases will be assembled, in similar fashion to the property information, to determine appropriate ways to include and/or link them to the GIS.

## **Summary**

The GIS Parcel layer project was initiated with respect to clearly defined business needs & realities. A centralized, yet comprehensive approach to mapping and analysis for New Jersey American Water property was desired. The key to designing a clean & manageable database was to create subject oriented schemas for each property layer or table. The central parcel layer contained only core information, along with a PAMS\_PIN that provided the linkage to all related subject tables, as well as a link to updated geometry as released via the State of New Jersey.

Access was an important objective of this project. There were four main use cases. First - the GIS professional himself. The resource management struggle due to time spent researching and data gathering was a major contributing factor to starting the project. The GIS professional's workflow is now far more efficient and powerful. Second - reference guide users. The printed atlas is designed for this

user. Despite wonderful technology available, in an engineering department, nothing beats a good reference atlas for many users. Thirdly - casual web users. This group includes employees mostly outside of engineering. This group includes employees in Tax, Legal, Government Affairs, etc who might need some quick information or simple printed map. Finally, there are the enthusiasts. This user group wants all the bells and whistles. They will mine the data, create fancy SQL queries, build charts, excel tables, request unreasonable enhancements, and point out any and all programming errors. While sometimes hard to please, this last user group often proves to be vocal and influential promoting the ROI of GIS within an organization.

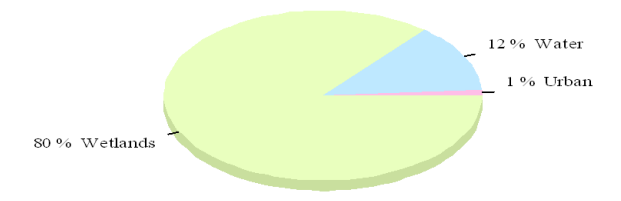
While all of the initial goals of the project were completed, there do remain some programming bugs to work out with regard to the web tools. For instance, the query tool is a bit clumsy to use. There are also some changes that could be made to the base map to further enhance the cartography, like using one source of geometry for river features to avoid unsightly overlap in some areas. The database population took far too long; several passes through the entire database were needed to clean it up after the initial population. Despite this setback, time remained toward the end of the project to format the related tables to provide quite a bit of GIS 'value-add' information. Access to this data was included in the Property Map template, as well as through web inquiry tools. The addition of the field calculation to perform a weighted overlay analysis (usually a raster function) using only vector data was an especially gratifying late add-on. The solar energy potential was another late addition included, more than anything else, to wet the GIS appetites of a management that is sincerely applying green technology across the business. In the end, and after a year, this project accomplished all its stated goals, and several optional goals. It is a fine example of the efficiency and analytical power of storing location based business data in a company GIS.

Figure 1 - Dynamic Map Template



# Property Report

Route 31  
Clinton Town, Hunterdon Co.



Solar kwts/m<sup>2</sup> - Avg: 5816 Max: 5842 Min: 5791

PAMS Pin Code: **1005\_14\_33**

Block: 14	<a href="#">Latest Tax Info (2008)</a>
Lot: 33	Ownership Status: "Own"
Zoning: OB-3	Land Value: \$56,400.00
Legal Acres: 6.14	Bldg Value: \$0.00
GIS Acres: 5.32	Total Value: \$56,400.00
Vacant: Yes	Tax Paid: \$1,311.86
Use Lease: No	

### Environmental Overlay Data

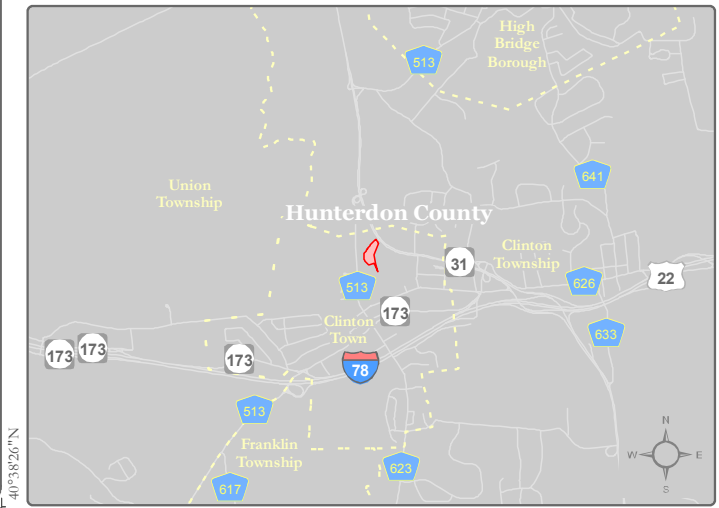
- Smartgrowth: 100%    Conservation Score: **9.1** of 10
- State Park: No, None
- Local or County Park: No, None
- Historic: Yes, 60 1/2 Halstead Street
- DEP Contiguous Buffer Zone: Yes
- Environmentally Sensitive: Yes
- Critically Environmentally Sensitive: Yes
- Shortest Well Head Travel Time: 2 Years
- River: Yes, Raritan River
- Watershed: Raritan River SB (above Spruce Run)

### Nearby Features (Name, Distance & Bearing)

*These results indicate features within 2,000 feet only if no directly overlaying features exist.*

- Historic: None
- State Park: Spruce Run, 546' N 75 W
- Local Park: Dunham Park/so. Branch Rvr Res, 37' S 49 W
- River: None

main map: 1 inch = 150 feet



inset map: 1 in = 6,250 feet

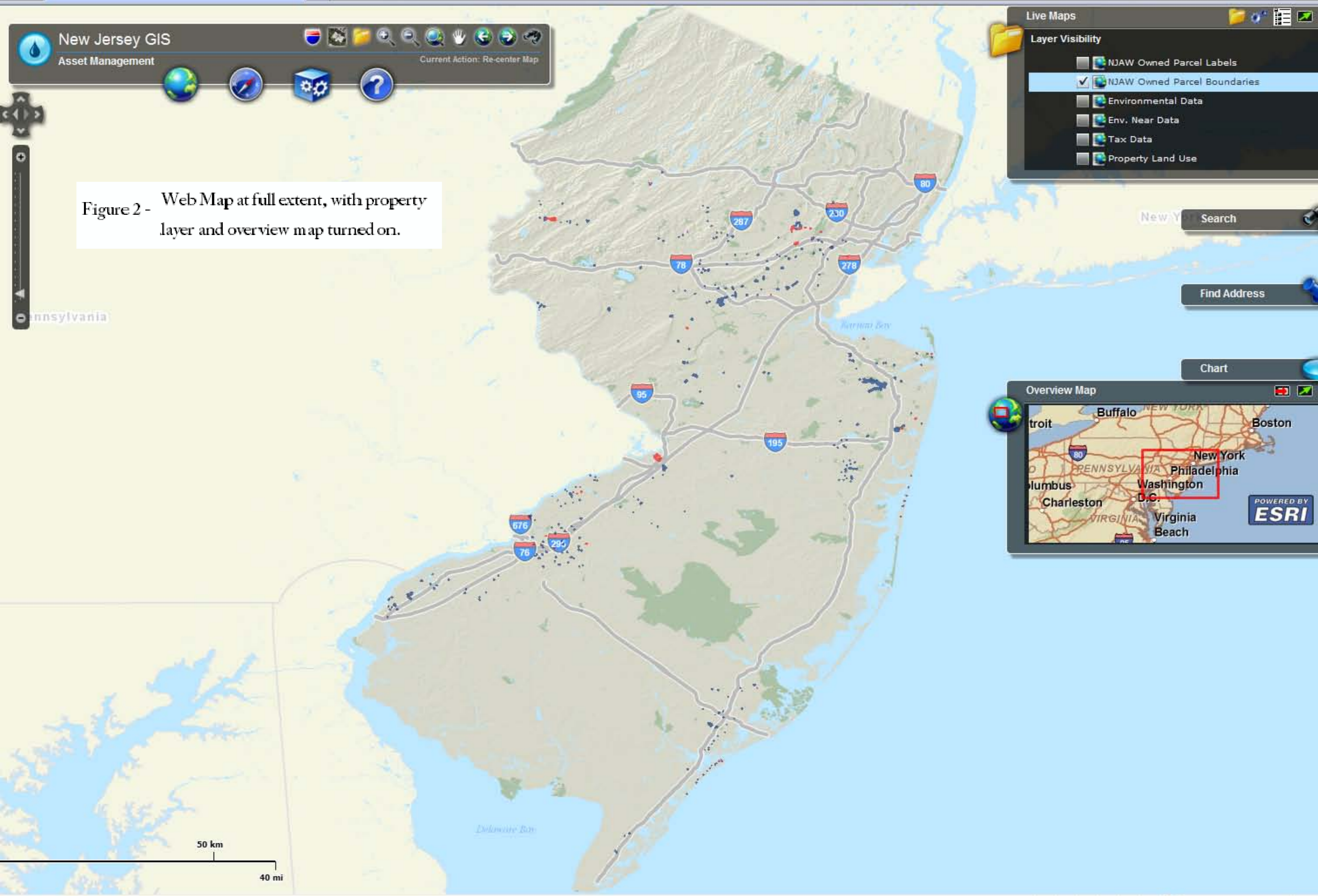


Figure 2 - Web Map at full extent, with property layer and overview map turned on.

50 km  
40 mi



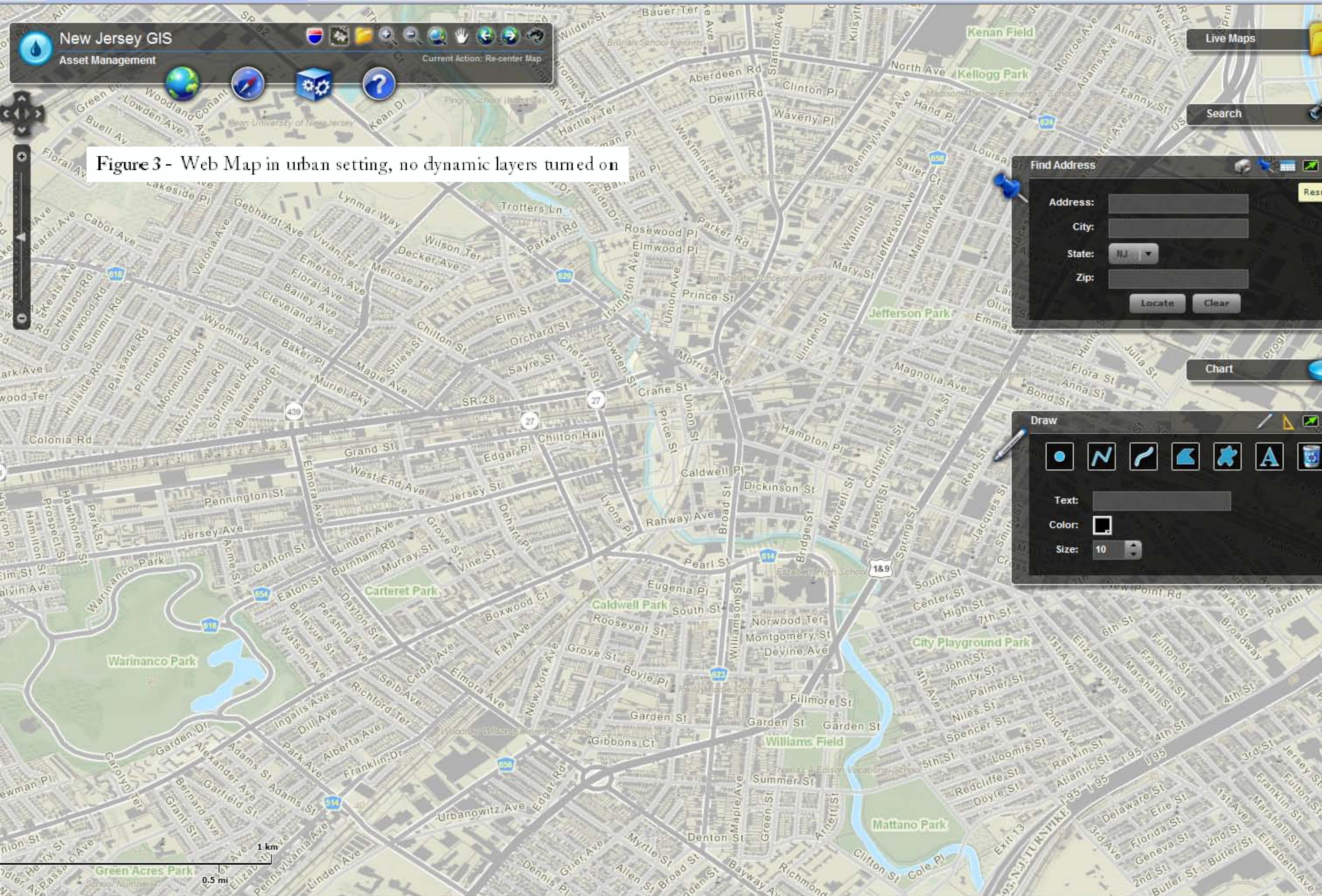


Figure 3 - Web Map in urban setting, no dynamic layers turned on

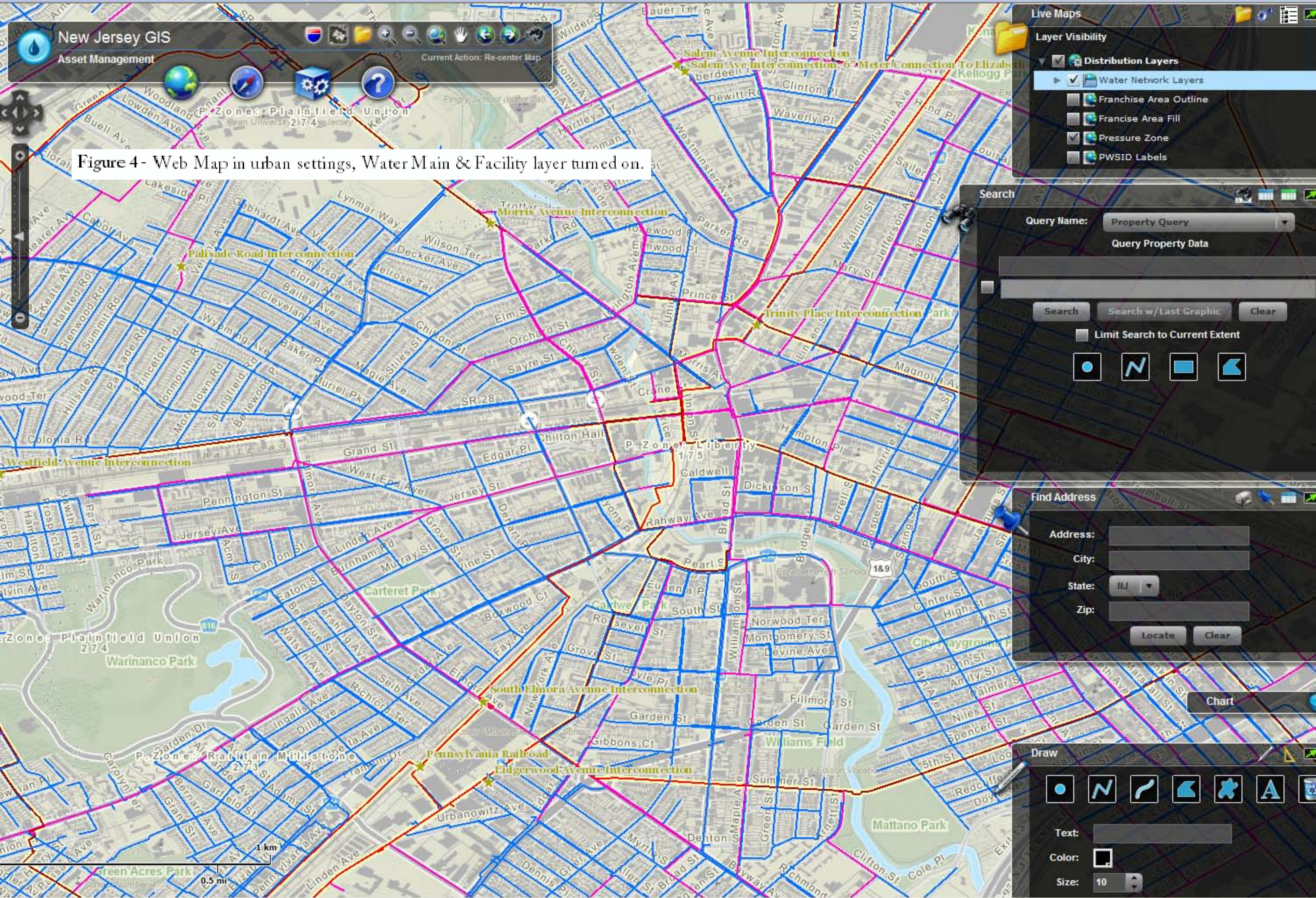


Figure 4- Web Map in urban settings, Water Main & Facility layer turned on.

Live Maps

Layer Visibility

- Distribution Layers
  - Water Network Layers
  - Franchise Area Outline
  - Franchise Area Fill
  - Pressure Zone
  - PWSID Labels

Search

Query Name: **Property Query**

Query Property Data

Search Search w/Last Graphic Clear

Limit Search to Current Extent

Navigation icons: Home, Previous, Next, Full Screen, Print

Find Address

Address:

City:

State: **NJ**

Zip:

Locate Clear

Draw

Navigation icons: Point, Line, Polygon, Polyline, Text, Image

Text:

Color:

Size: **10**

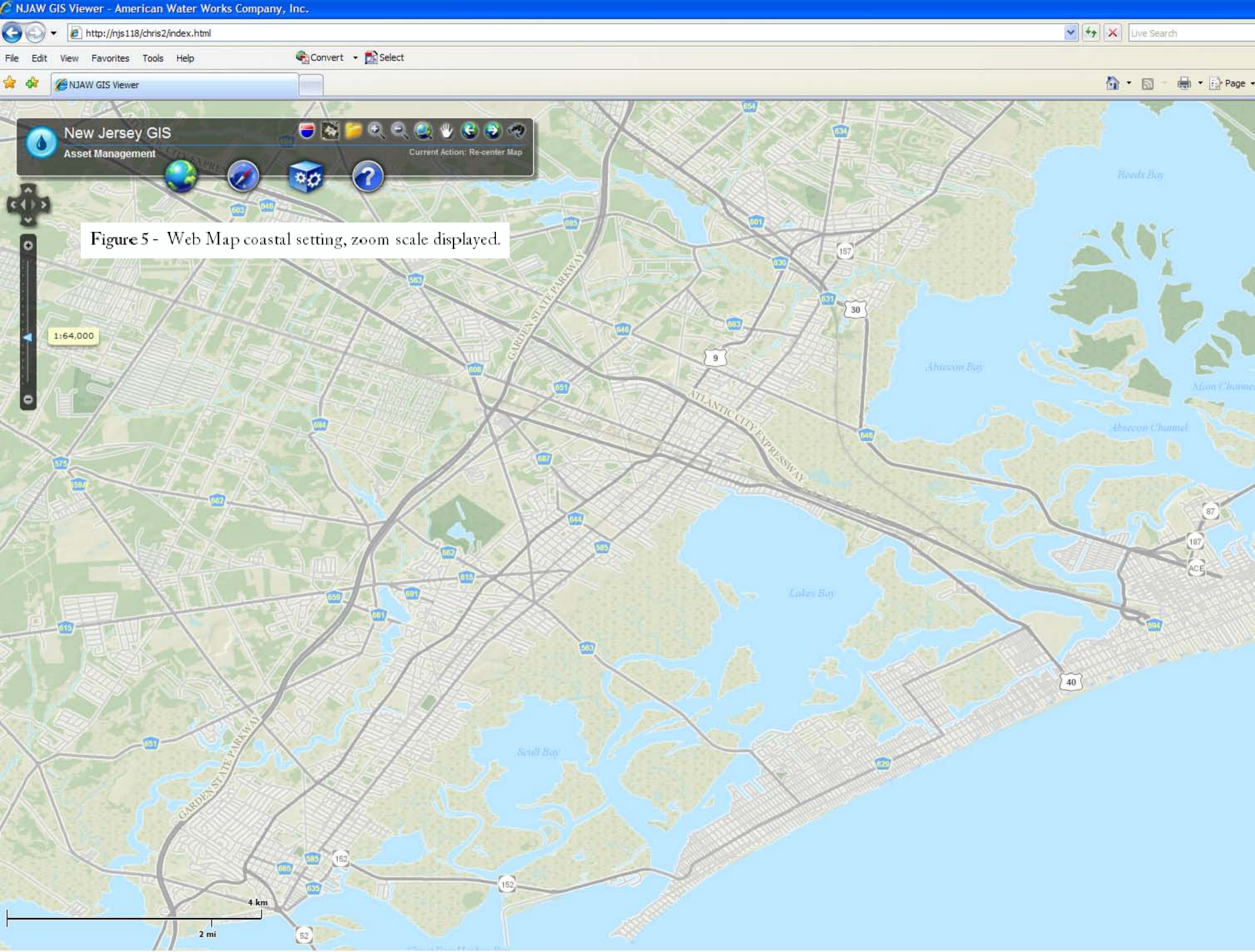


Figure 5 - Web Map coastal setting, zoom scale displayed.

Figure 6 - Advanced query option "return property w/ no cell phone tower, owned by NJAW, and is over .64 acres)."

**Query Builder**

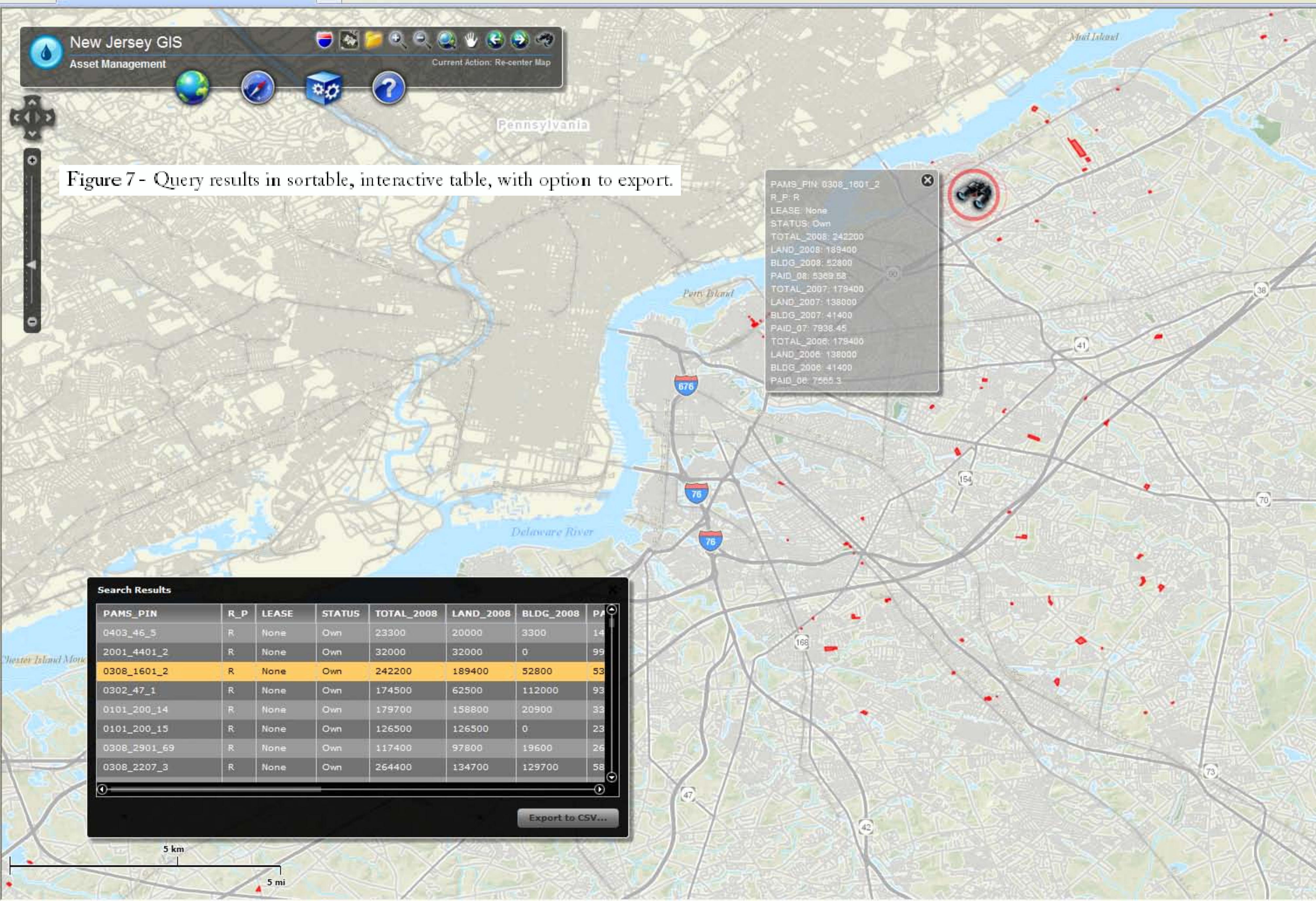
Target Layer:

Operators:      Fields:       Use Aliases      First 500 Sample Values:

<input type="button" value="="/>	<input type="button" value="&lt;&gt;"/>	<input type="button" value="Like"/>	PAMS_PIN	0.16
<input type="button" value="&lt;"/>	<input "="" type="button" value="&lt;="/>	<input type="button" value="Is Null"/>	Address	0.64
<input type="button" value="&gt;"/>	<input "="" type="button" value="&gt;="/>	<input type="button" value="Not Null"/>	Status	0.22
<input type="button" value="and"/> <input type="button" value="or"/>			Vacant	2.2531
			UseLease	0.2738
			Acre_Legal	0.64

Query:

```
UseLease = 'N' and Status = 'Own' and Acre_Legal > 0.64
```



**New Jersey GIS**  
Asset Management

Current Action: Re-center Map

Figure 7 - Query results in sortable, interactive table, with option to export.

**Search Results**

PAMS_PIN	R_P	LEASE	STATUS	TOTAL_2008	LAND_2008	BLDG_2008	PAID_08
0403_46_5	R	None	Own	23300	20000	3300	14
2001_4401_2	R	None	Own	32000	32000	0	99
<b>0308_1601_2</b>	<b>R</b>	<b>None</b>	<b>Own</b>	<b>242200</b>	<b>189400</b>	<b>52800</b>	<b>53</b>
0302_47_1	R	None	Own	174500	62500	112000	93
0101_200_14	R	None	Own	179700	158800	20900	33
0101_200_15	R	None	Own	126500	126500	0	23
0308_2901_69	R	None	Own	117400	97800	19600	26
0308_2207_3	R	None	Own	264400	134700	129700	58

Export to CSV...

**PAMS\_PIN: 0308\_1601\_2**

R\_P: R  
LEASE: None  
STATUS: Own  
TOTAL\_2008: 242200  
LAND\_2008: 189400  
BLDG\_2008: 52800  
PAID\_08: 5369.58  
TOTAL\_2007: 179400  
LAND\_2007: 138000  
BLDG\_2007: 41400  
PAID\_07: 7938.45  
TOTAL\_2006: 179400  
LAND\_2006: 138000  
BLDG\_2006: 41400  
PAID\_06: 7565.3

