Assessor Maps and Data: Key Building Blocks for Next Generation E-911

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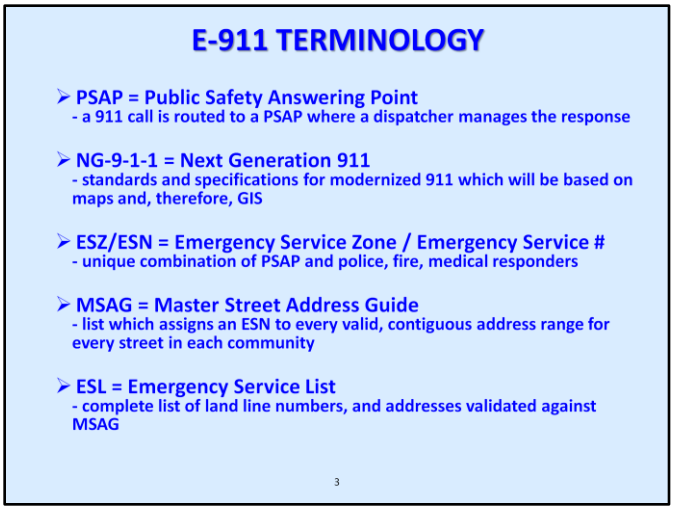
May 2014

PRESENTATION OVERVIEW

1. Intro to current E-911 system
2. Next-Generation E-911: overview
3. Standardized Parcel Mapping: Review and status
4. Maintaining Standardized Parcel Mapping
5. Time permitting: MassGIS' free municipal tool: MuniMapper



➢PSAP = Public Safety Answering Point

- a 911 call is routed to a PSAP where a dispatcher manages the response

➢NG-9-1-1 = Next Generation 911

- standards and specifications for modernized 911 which will be based on maps and, therefore, GIS

➢ESZ/ESN = Emergency Service Zone / Emergency Service #

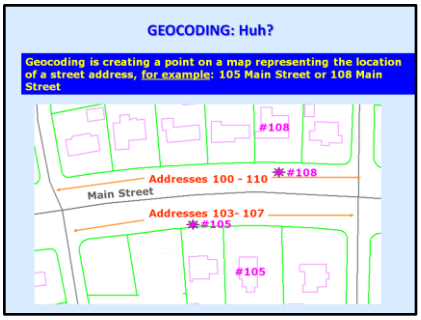
- unique combination of PSAP and police, fire, medical responders – Often NOT the same as community boundaries

➢MSAG = Master Street Address Guide

- list which assigns an ESN to every valid, contiguous address range for every street in each community

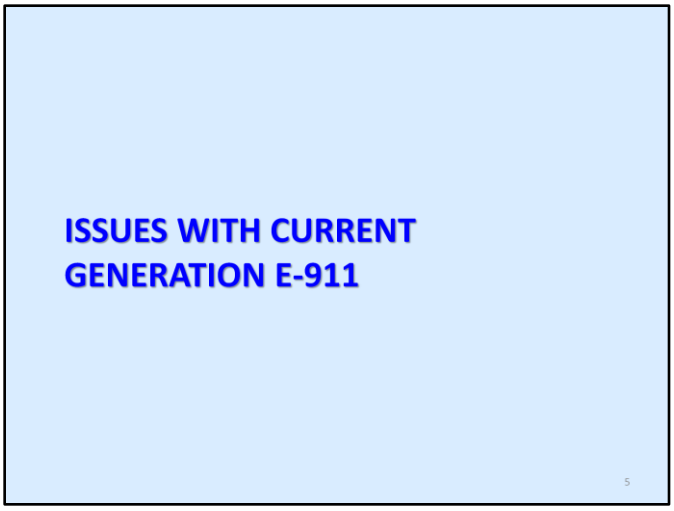
➢ESL = Emergency Service List

- complete list of land line numbers, new addresses validated against MSAG

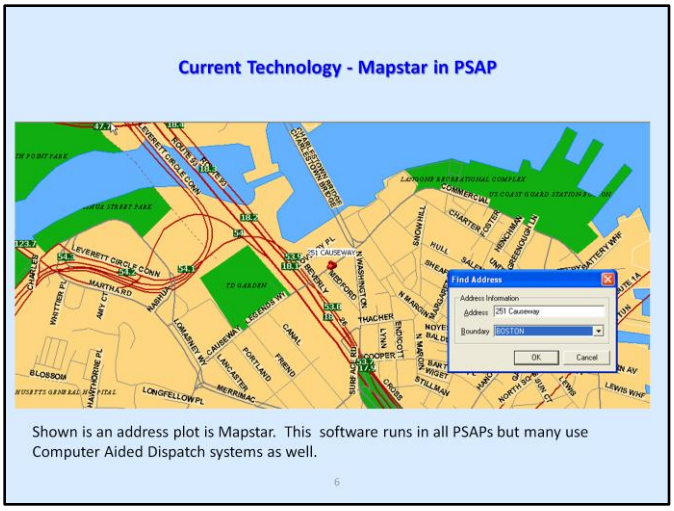


Geocoding is using software to put a point on map representing an address location. Software can only accomplish this as well as the underlying map information will permit.

Here's an illustration of how geocoding works. You see here a block on main street, also referred to as a street segment, and you see that on the left and right sides you have two address ranges – 100 to 110 and 103-107. If you're trying to get to 108, and all you have is the road centerline with its address range, then you estimate the location of 108 by assuming the addresses are evenly spaced along the block. This is called "linear geocoding" But as you can see on the bottom, that doesn't always work very well sometimes – number 105 estimated to be in the middle of the block winds up in front of the wrong house. This example is fairly tame and, for many situations, like service deliveries, the result is "good enough" ; however, linear geocoding can produce results that are often much worse. The reason for this error is because of the often incorrect assumption that the addresses in the range are evenly distributed along the street block. You can also geocoding to points representing the address on each parcel and this, of course, produces much more accurate locations. However, it also requires figuring out all addresses at the parcel level. Even more accurate is mapping addresses as points on buildings. This is particularly an improvement when you have more than one building on a parcel.

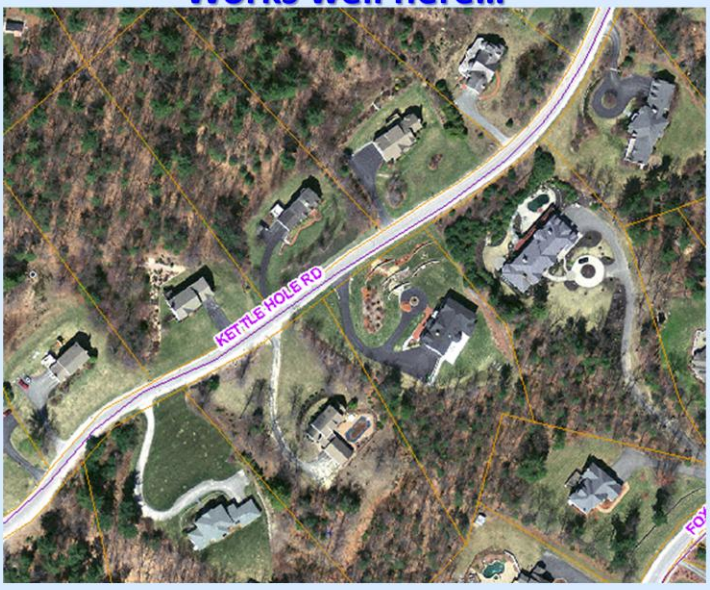


First I want to talk about current technology, the system that MassGIS currently supports on behalf of the State 911 Department

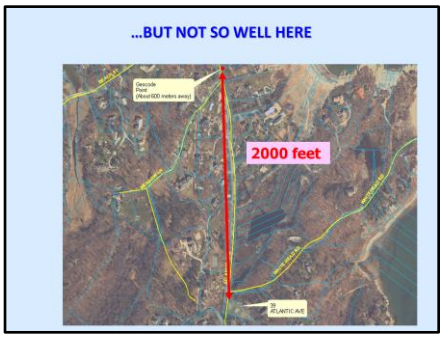


In the current 911 system, when a 911 call comes from a cell phone, it goes to one of three State Police call centers and they route the call to the appropriate PSAP for dispatch. Supporting that process is a map like the one you see here. The red dot is the location transmitted by the cell phone. The map information includes the range of addresses, high to low, on each street block. So as I explained earlier, the address location is approximated assuming that the addresses are equally distributed along each block.

APPROXIMATING ADDRESS LOCATIONS:
Works well here…



So in many situations, this approximation of address locations based on address ranges on street blocks works pretty well.



However, linear address matching often does not work so well.

At MassGIS we've done some testing of linear geocoding in Cohasset for a few thousand addresses. The mix of developed and sparsely developed areas in Cohasset is pretty typical of many communities in the state - The error here is on the high end, but not uncommon -- 39 Atlantic Ave is approx. 2000 feet away from where the software maps it based on the address range information. This is the worst case, but the average in our testing was 400 feet. As you can imagine this situation means that problems can, and do, arise.

Here's another example where finding a location based on address matching to an address range could be problem. There are thousands of these shared driveways; this one is a mile long with a couple of houses – who knows how well they are marked or how well an emergency vehicle could find them. The point here is that the address range associated with the street on which this long driveway starts will not help much with finding the location of the houses on this driveway.

…more shared driveway addressing confusion…

These properties are addressed off South Sandwich Road in Mashpee!

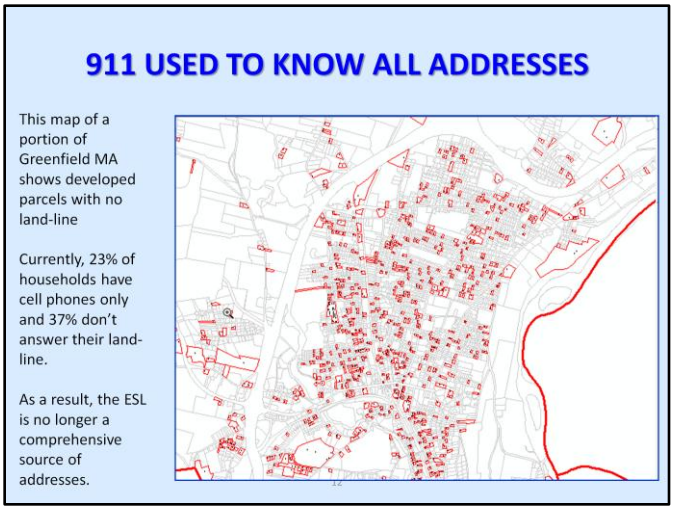
This shared driveway is ½ mile long with another long shared driveway off it.

National standards for addressing would strongly discourage this configuration.

These calls were getting mis-routed and/or not found. This is why point addressing is so important.

Here's a particularly problematic example of a shared driveway on the Mashpee-Sandwich town line.

In this example from another community we see a further example of the extent to which address assignment and actual building access can differ. Again, address ranges on street blocks are not going to be much help when it comes to finding some of these houses.



I've given you some idea about the limitations of the current 911 call system. This graphic illustrates he central reason why a new approach is needed to how E-911 systems work.

Highlighted in red are developed parcels for a portion of Greenfield, Mass, that no longer have a wired phone line.

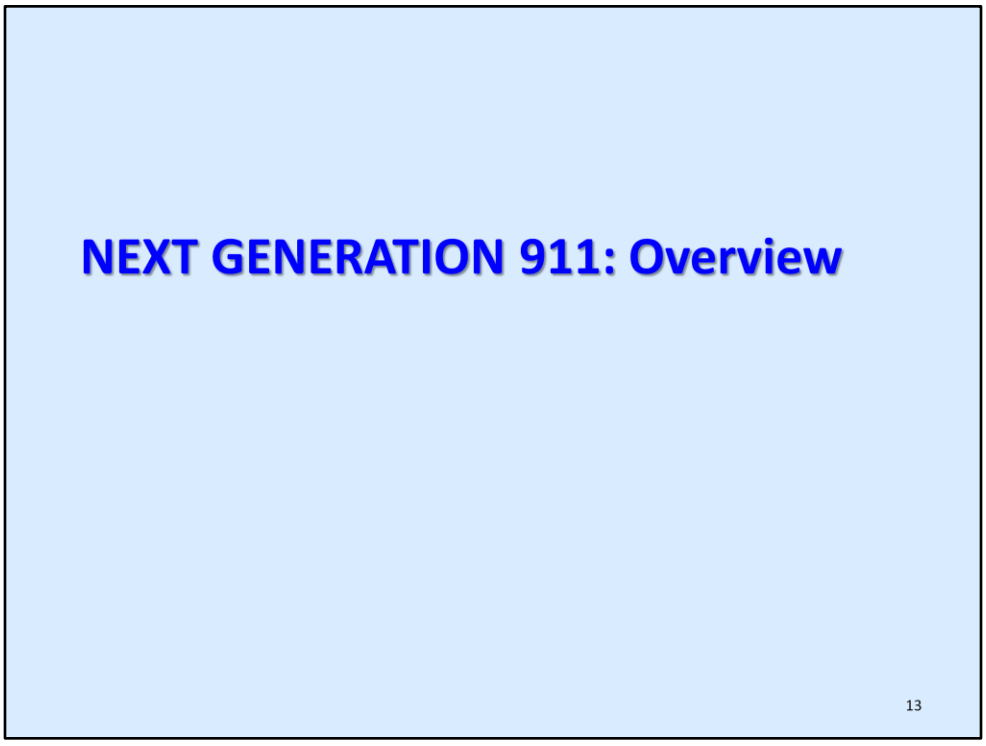
It used to be that when you called 911, your location was known because the address of the phone from which you were calling was stored by the phone company in a large database.

With the phone's address,your 911 call could be correctly routed to the appropriate 911 dispatch center.

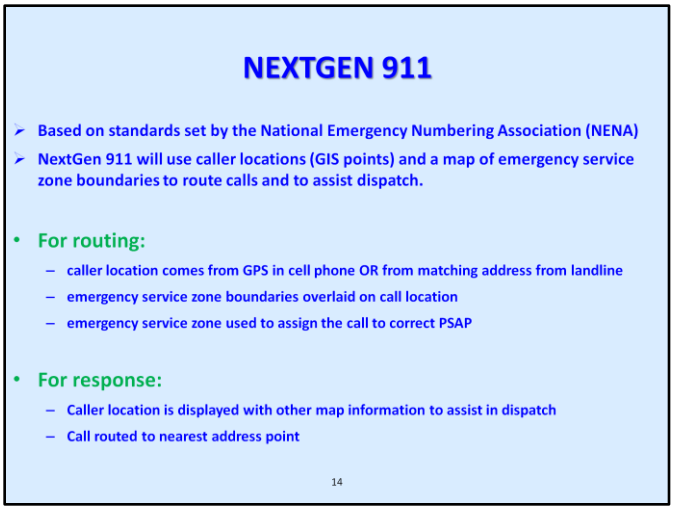
When a 911 call comes from a cell phone, you don't know the address, although you do have the location transmitted by the phone based on the GPS signal.

Obviously, if that person is able to answer questions, then you can find out their address, if they're calling from a place with a numbered address and the caller knows

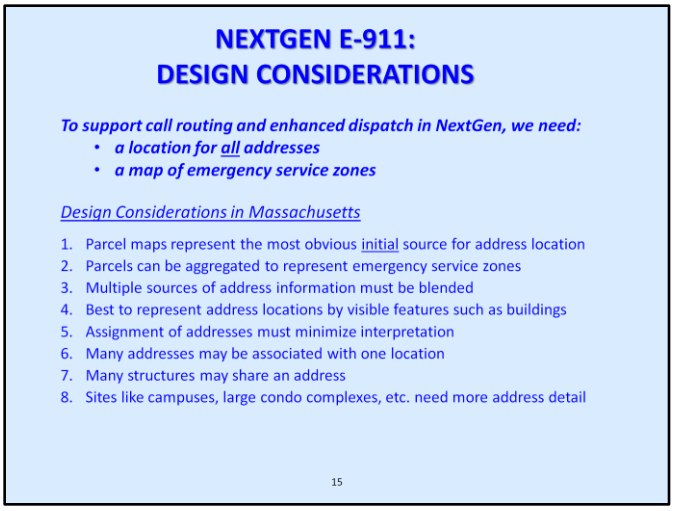
that information.



An alternative to matching addresses to a range on a street block, is to map individual addresses as points. With this sort of master address information, mapping software can display the exact location of an address. Similarly, the software will have much better information on the nearest address to a cell phone call location. It is this shift to point-based address matching and a map-centric 911 dispatch process that is at the heart of NextGen 911



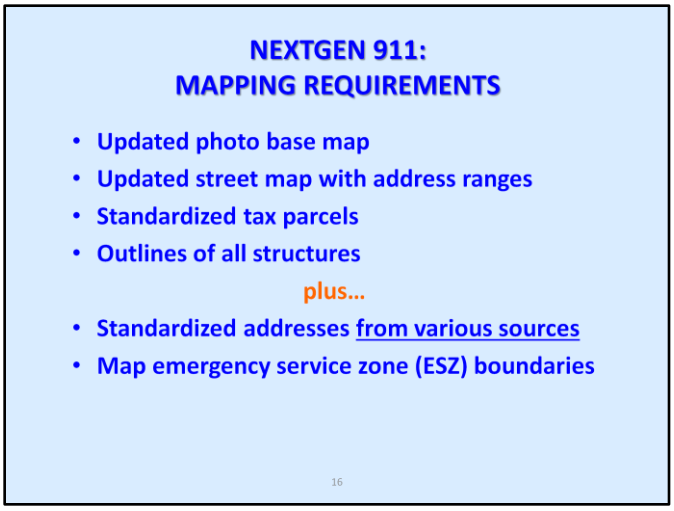
Next generation 911 is map-centric, that is it will be GIS driven – here's how the system will work, a point on a map display representing the caller location will map inside a polygon representing the emergency service zone area and that's how the call will be routed – in GIS terms that's called a point-in-polygon overlay. For the overlay to be effective, the location of the address has to be accurate. If we relied only linear geocoding as the number of 911 calls from cell phones climbs, the dispatching errors will only increase. In next gen systems the software in the PSAPs will include display of much more map information.



As I described earlier, to make Next Gen work, we need a location for every address and we need an accurate map of emergency service zones. What I've put up here is our analysis of the problem, and its worth spending a couple minutes on it. First, we realized that parcel maps and records would be the most cost-effective source for the initial round of addressing, if we could confirm site addresses from assessors records against addresses in the Emergency Service list and other sources we would be able to put the address onto the correct building or buildings.

Second, we also knew that we wanted to associate addresses with actual structures visible on the air photo base. In our work on addressing with mapping of broadband Internet access – or more correctly, lack of access - we had learned that it was a mistake to try to interpret which was the primary structure on a parcel – that's a key point. So we determined that you have to associate addresses with ALL structures. Of course, many addresses might be associated with a single location or even one structure, so from the beginning we new that the relationship of addresses and structures was complex. I'll show you more about that later.

Finally, for large sites like college campuses or trailer parks that typically have many structures that are addressed by name or by number, we knew that this additional address detail would have to be collected through field work. That's the stage that we are at now; we have finished processing the addresses from multiple sources and are getting ready for the field work.



This is the list of GIS mapping that we knew we needed for NextGen 911. These are the mapping inputs for building a next gen address database – The good news in all this is that in completing this we have also created the foundation of a multi-purpose GIS for municipal use, something that was identified as needed in our 2007 strategic plan – and all at no cost to municipalities.

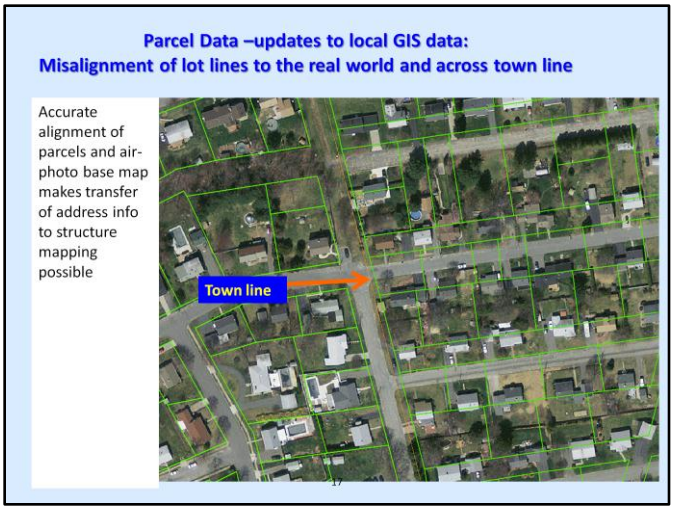
We are again updating the photo base map this spring.

We are maintaining a very complete map of streets with address ranges.

We have completed statewide standardized parcel mapping and statewide structure mapping.

We have standardized addresses from various sources.

We have completed mapping of emergency service zones. LETS LOOK AT SOME OF THE DETAILS…



The standardization of assessor parcel mapping for use in GIS was a huge project. We upgraded and standardized the local parcel data, be it paper map, CAD , poor or wonderful quality GIS data, it has all gone into the statewide database. In fact, because of this project, something like 45 communities, including some of you, now have a version of your parcel mapping in GIS format where you did not before. The key project requirements were a very high match to the tax list, over 99%, and that the parcel boundaries have to be accurate enough so that structures fall into the correct parcel. Unless of course they don't in reality, which is common. It took us almost three years and a lot of money to standardize 2.2 million parcels; we kept six vendors and four regional planning agencies very busy.

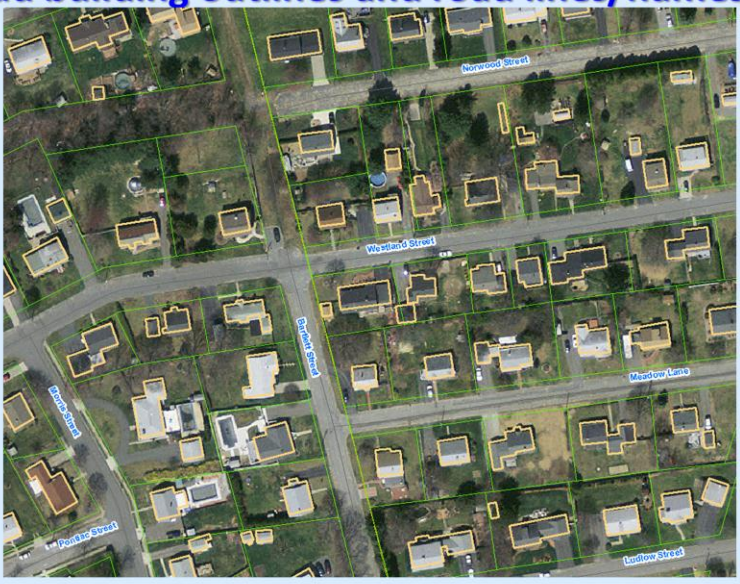
This sequence of graphics shows how parcel mapping is being cleaned up so that it correctly registers with the photo base map and with structures. Once the parcels are standardized we are confident that we can correctly associate assessor site addresses with structures, a key requirement for NextGen 911. Here the lot lines on the right of the town line do not align with the built environment and do not match with the lot lines from the adjacent community.

Parcel Data –updates to local GIS data: Lot lines align and match adjacent town

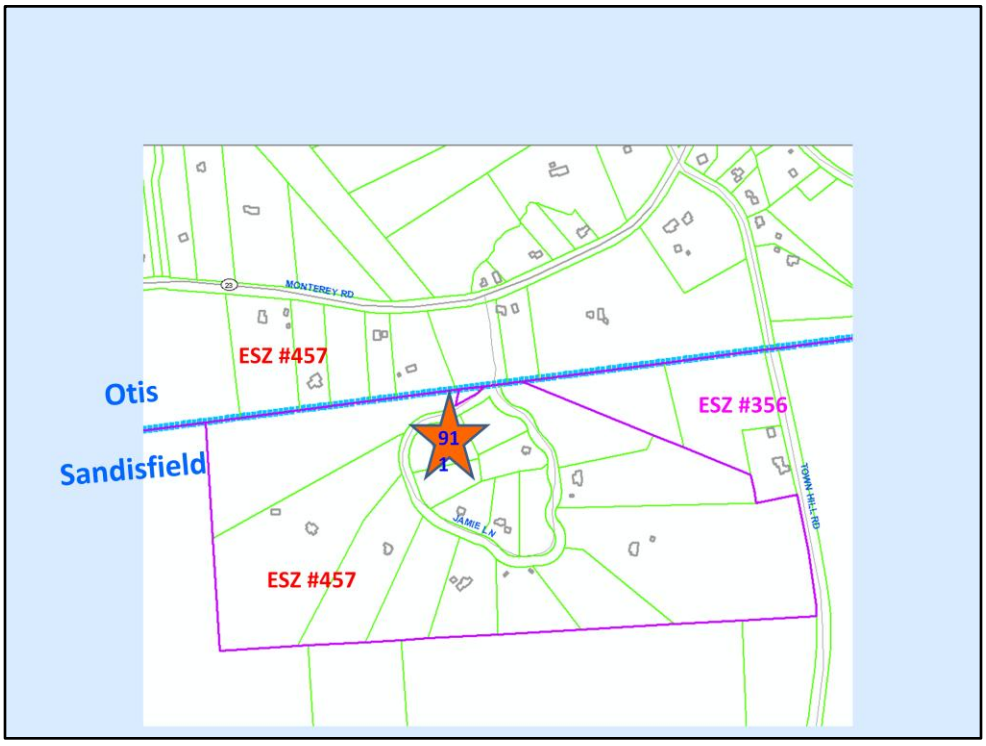
Field	Value
OBJECTID	1017991
PROP_ID	127E-187
LOC_ID	F_813124_2712598
BLDG_VAL	123400
LAND_VAL	130900
OTHER_VAL	0
TOTAL_VAL	254300
FY	2012
LOT_SIZE	0.28919
LS_DATE	20011105
LS_PRICE	100
USE_CODE	101
SITE_ADDR	919 WESTLAND ST
ADDR_NUM	919
FULL_STR	WESTLAND ST
LOCATION	<null>
CITY	NEW BEDFORD
ZIP	<null>
OWNER1	FERREIRA MARK A
OWN_ADDR	919 WESTLAND ST
OWN_CITY	NEW BEDFORD
OWN_STATE	MA
OWN_ZIP	<null>
OWN_CO	<null>
LS_BOOK	5222
LS_PAGE	263
REG_ID	<null>
ZONING	RA
YEAR_BUILT	1952
BLD_AREA	<null>
UNITS	1
RES_AREA	1764
STYLE	Colonial
NUM_ROOMS	7
LOT_UNITS	A
TOWN_ID	201

Here the lot line locations have been adjusted so that street pavement falls within the right-of-way (although sometimes it is correct for this to not be true) and structures appear on the correct parcel map lot. In addition, the assessing extract for both communities is the same. Thus you have a consistent quality tax map that is seamless across town lines.

Parcel Data –updates to local GIS data: Add building outlines and road lines/names



As I mentioned earlier, we have completed mapping of structure outlines state-wide. We needed these so that we have a correct location for address points that should be on a building. The structures line up correctly with the parcels and the parcels line up correctly with the lines representing the roads. With a map of emergency service zone boundaries (more on this in a moment) and a map of points representing address locations, we have the map information needed for Next Generation E-911.



I have mentioned emergency service zones. I will now give you a specific example of why standardized parcel mapping was essential in defining ESZs. Here's one example, from the Otis-Sandisfield line, the parcels inside the purple boundary are in Sandisfield, but you can only get there from Otis. That does not matter for police response which is all Berkshire County Sheriff. However, it does make a difference for the local volunteer fire response. So if you have a cell phone call from somewhere in this Jamie Lane subdivision (and I realize that this may not yet be possible!) ADVANCE GRAPHIC, you need to do the point location in polygon step that I mentioned earlier to know where the call location is and, therefore, what the fire response should be. Without the link between the phone number and an address that is possible with a wired phone, you don't know enough about the call location to identify the emergency response jurisdiction

ADDRESS SOURCES

- Assessor site addresses
- Emergency Service Listing
- Voter registration information system
- National Grid customer addresses

(other utilities to follow)

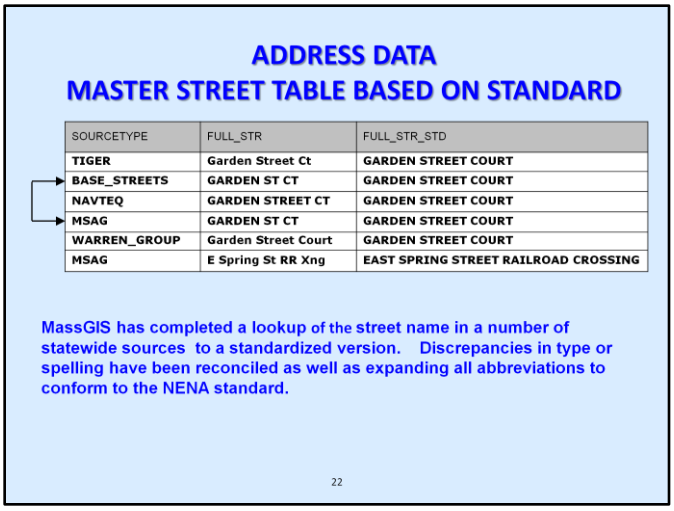
So that's a lot of info about maps. Lets shift gears and talk about addresses.
Now the one fact we know for sure is that there is no single source for all addresses in any one community, even in communities that think they have that list pinned down!

Thus creating a master address list requires assembling addresses from multiple sources.

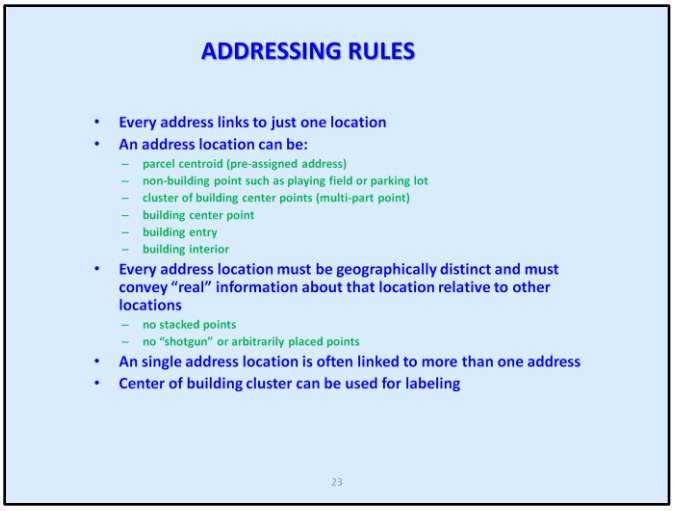
However, for that to work, we have to standardize addresses.

Without standardization we have no way of knowing when two addresses from two sources are the same or different without looking at each address individually.

We, of course, are not looking at individual addresses because the only practical way to complete this work is with a computer.



Here's an example of how once addresses from different sources are standardized you can compare them so you can determine when you have the same address from two sources. A human can tell that all these Garden Street addresses are the same, but a computer cannot unless they are standardized as on the right. Since it's not practical to have a human do all this, we had to write software so that a computer could do the standardization. So the standardization on the right was completed by the software, based on using the federal standard for addresses.



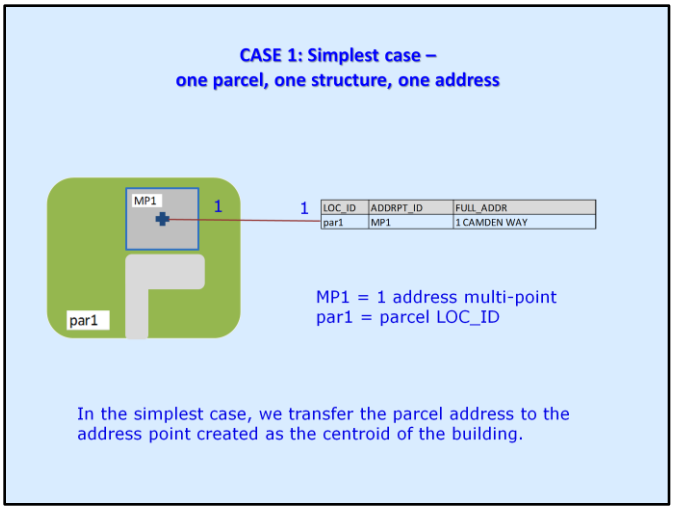
So how are we going to organize and manage all these addresses from different sources? Here are what you might call our principles of address location. The most basic rule is that every address links to an address location (geography).

An address location can be:
- a parcel center
- a non-building point like a parking lot
- a cluster of buildings grouped together
- a single building center point, it can be a building entry door
- or an interior point.

The key is that every address location represents a unique and distinct location

SKIP

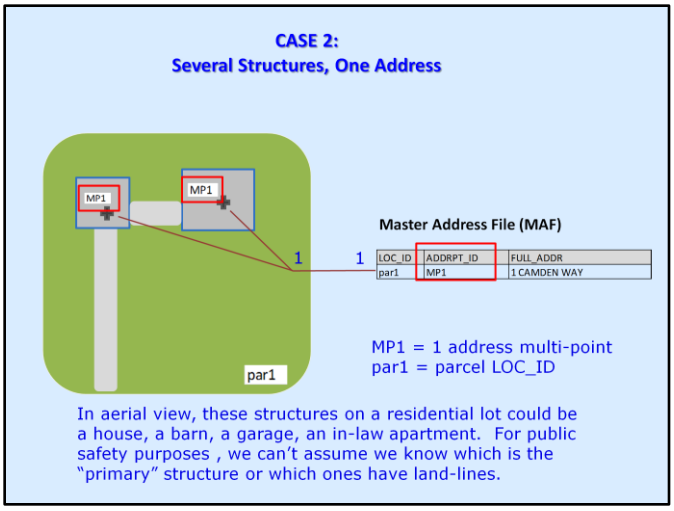
In a lot of systems where every address has its own point, a 100 condo units in a building will be represented by 100 points all stacked up but we think that's too awkward to manage, so we don't allow stacked points or another version that you see sometimes, arbitrarily scattered points.



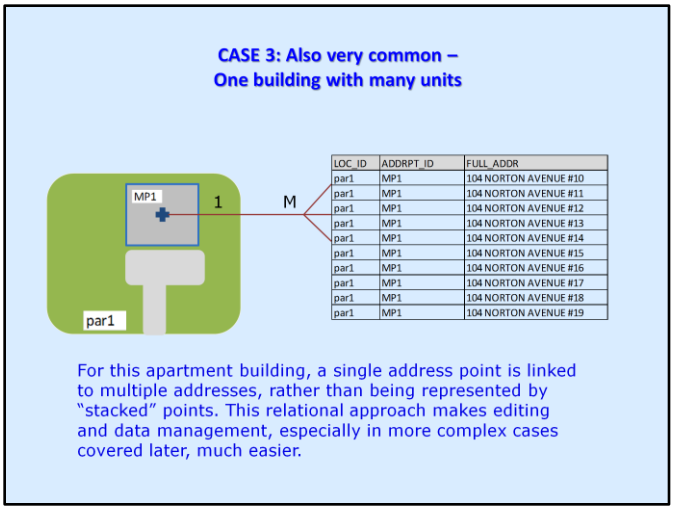
So how do these organizing principals play out in real life. I'm going to fairly quickly show you the eight distinct address situations we've identified with my primary purpose being to illustrate that addressing is pretty complicated. I think you will also see why it's difficult if not impossible for a database, like a CAMA database, that was not built to be a master address repository, to also be a master address resource.

Now remember, the objective is to put points where addresses can be found.

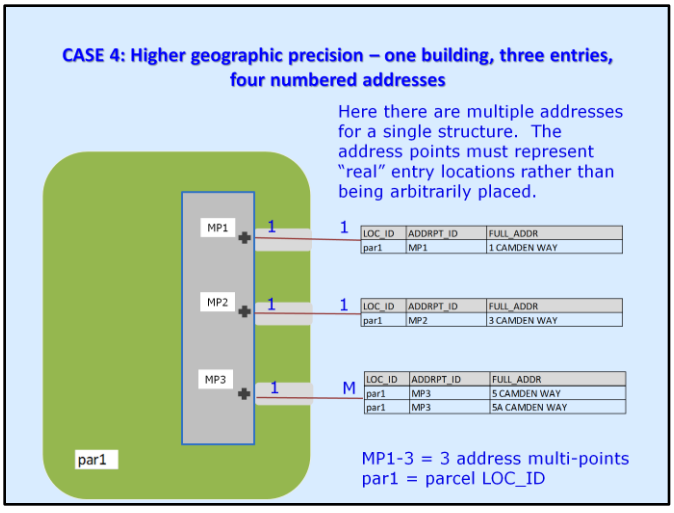
Here's the simplest address case: one parcel, one structure, one address – the address point ID, MP1 in this diagram, links the address record to the point. We start out with a map of all the structures and a list of all the addresses, and the process of building the database consists of filling in the address point ID in the address record.



This is most likely a house and a garage on a single family lot. both structures are linked to the address, because you can't always tell which is which , or maybe there's an in-law apartment or some other address that you don't know about. The point is that you shouldn't try to guess which is the primary structure, so both structures are assigned to this one address.



This case is also very common, an apartment building: every address is assigned to the same point representing the structure.



Now we're getting into more detail - this is a single structure, perhaps town houses, perhaps a strip malll building where you have separate numbered addresses, so the single address point has been replaced by 3 address points whose locations are collected in the field. Each one has its own address point ID and is individually linked to an address record.

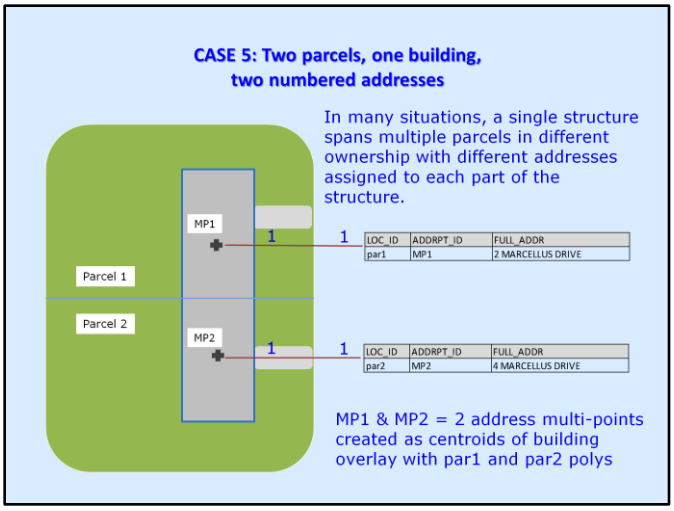
CASE 4 Example: Master Address Database – building entry or building interior points from local source

Large commercial building with multiple numbered addresses has just one recorded by assessor (perhaps main entrance).

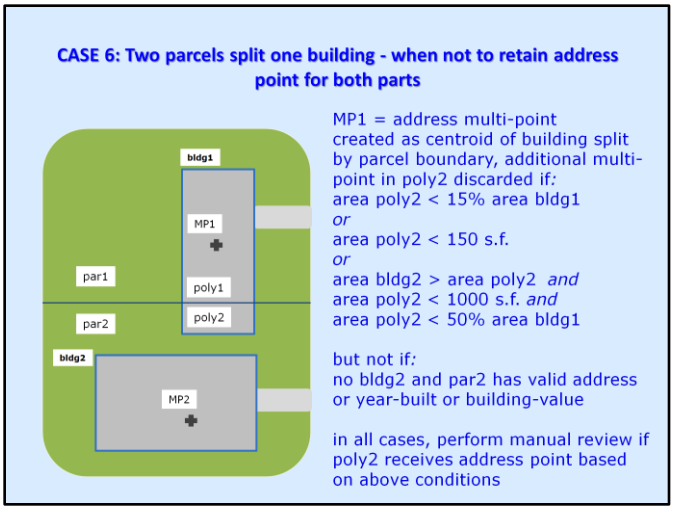
Other addresses appear as linear geocodes to indicated need for field verification. Address records not linked to structure will get addrpt_id for building interior points from fieldwork.

28

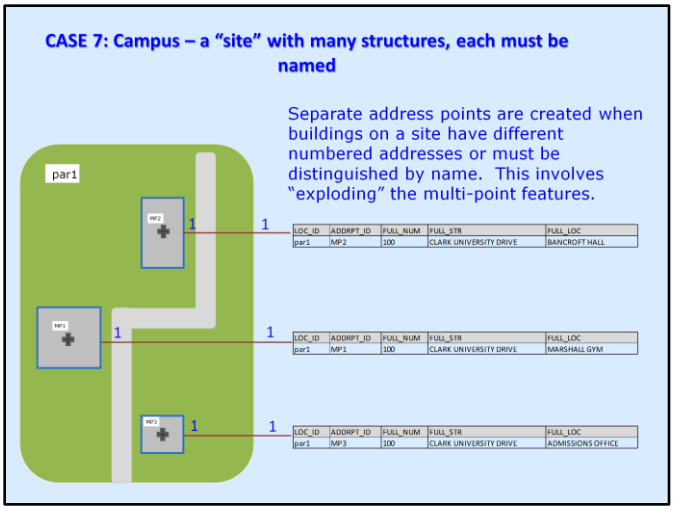
And here's an example of what that last case might actually looks like. The range of addresses on this building is 240 to 318.



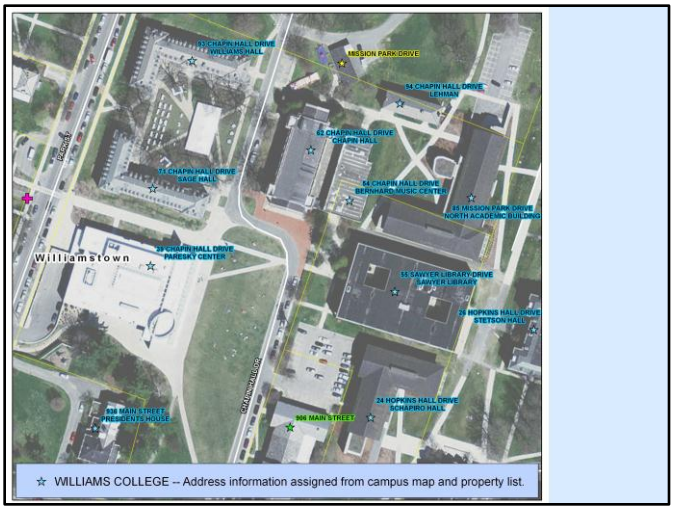
if a building spans a parcel boundary and you have two different addresses then we automatically generate two points, again each is a distinct feature.



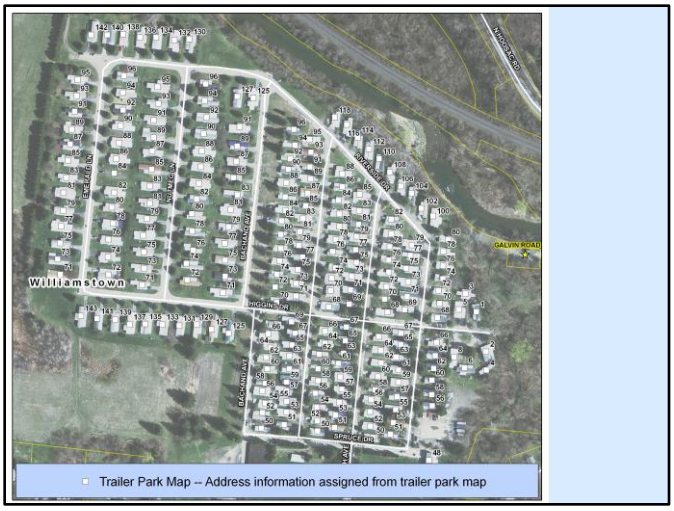
However, we don't always generate another point if the building is just hanging over the boundary – these are the rules that we use to determine if two points are needed…but in the interests of time I won't go into that level of detail. Just know that we are allowing for cases where a structure may sit on a property line, whether that is correct or not.



This is what we call a site, which is a polygon designated as an area within which individual buildings must be tagged for response purposes. So this is a mock campus, you have here the admissions building, the gym, Bancroft Hall, each addressed by name. You may aggregate parcels in common ownership to create sites, and you may in the field decide that you don't need to tag every structure, but that's the general idea..

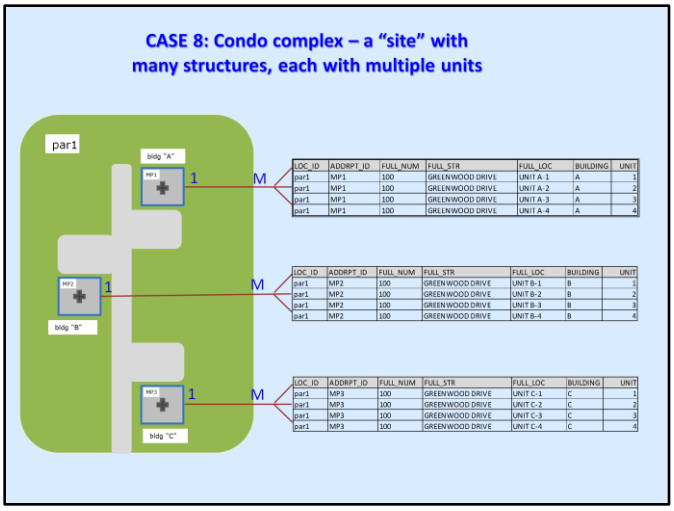


We worked with Williamstown MA a couple of years ago on address assignment and, of course, Williams College illustrates this multi-building site case.

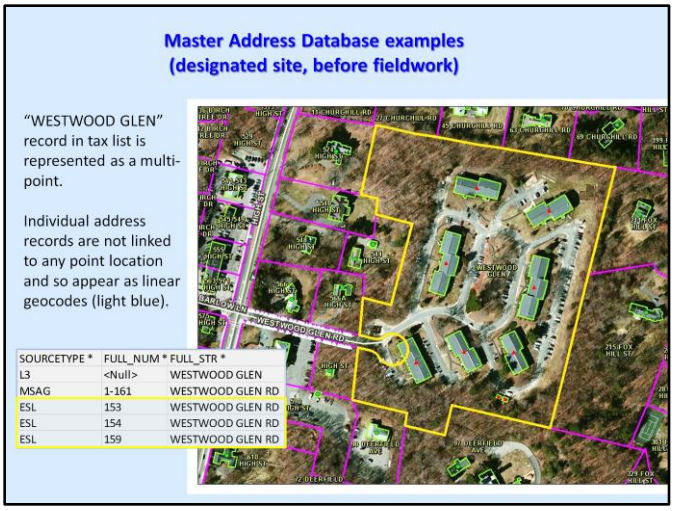


A trailer park is a different but similar case of a site.

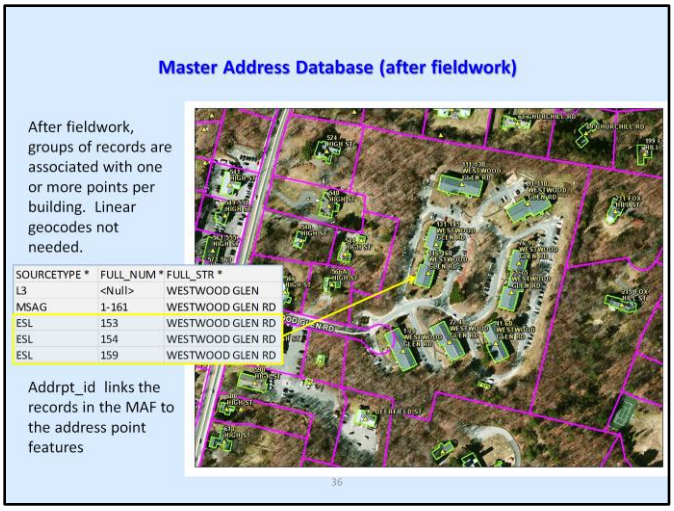
BTW, speaking of data maintenance problems. I've recently learned that since we worked on addressing in this trailer park, about ¾ of these trailers were obliterated by flooding from Hurricane Irene. Note that having point locations for the individual address locations can be important information for post-disaster work.



This is very common situation and the most problematic of the site configurations – many units spread across many buildings – this site could be 40 acres in size and have dozens of buildings. In the field, the unit records have to be assigned to the right building. The idea though is just the same as all the other cases, the address point ID is transferred to the address records found at that point…



Here's an example of this last case - a condo complex, Westwood Glen in Westwood MA, where you have seven big condo buildings and a total of 161 units to be assigned, I'm showing just a few of the unit records. Here you see in the top record labelled "L3" the assessor lists the address as just Westwood Glen the Master Street Address Guide (MSAG) shows Westwood Glen Road which we have mapped. However, the ESL lists many different individual addresses. So with existing map tools in the PSAP we can successfully geocode the individual address numbers – remember linear geocoding? - along that little stretch of Westwood Glen Road. But that's not much use if you want an ambulance to find you in one of the buildings in the condo complex that is the actual address location. So this is an example of a site which we know we have to visit. Each building has a single address point and we want at a minimum to assign the right addresses to each building.



Here's how it is after field work – the addresses now are linked to points actually representing sections of the buildings with separate entrances, so the three address records would now be linked via address point ID to the point I've indicated…Without this level of detail, the linear geocoding of these addresses would be points bunched up along the entrance street as it enters the complex.

MASTER ADDRESS LISTS STATUS

- A draft master address list exists for every community except Boston.
- We have a list of ~140,000 street names along with aliases that include common misspellings
- We have standardized and processed over three million addresses from multiple statewide sources
- We mapped approximately two million address points

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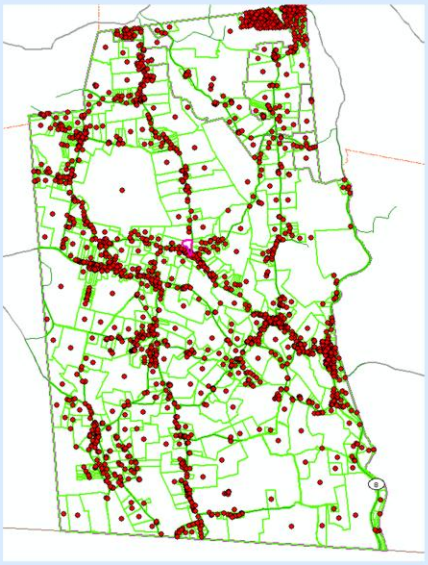
MASTER ADDRESS POINTS: SANDISFIELD, MA



What you do not see here is that besides the address points and parcels, we have all the structures, a draft master list of street names, and a draft master list of addresses.

NEXT STEP: NEXT GEN-911 ROLLOUT

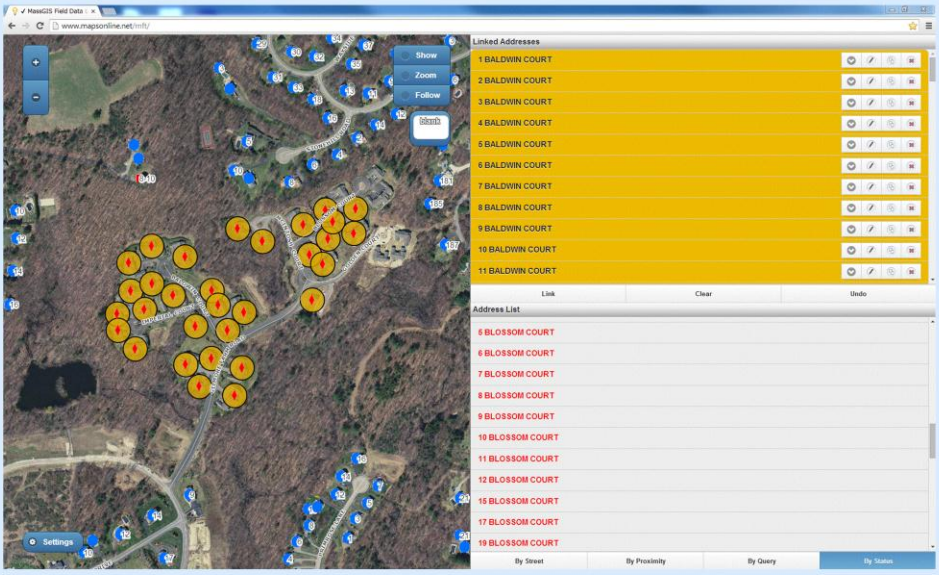
- **Challenges:**
  - Addresses that don't match parcels
  - Structures without addresses
  - Addresses with no location
  - Multi-building sites

- **Solution:**
  Local knowledge + MassGIS tool + field work

Some communities can complete the master address data themselves, particularly those communities with GIS staff or with paid fire department staff.

In some communities, State 911 will have to pay someone to complete the full master address compilation, although hopefully even in these situations someone will be able to contribute local knowledge.

FIELD DATA CAPTURE TOOL



This software tool will run on a tablet computer and be used in the field.

HOW WILL WE IDENTIFY NEW ADDRESSES?

- ESL updates identify new and changed records
- Link into local address assignment workflows

  (Notify MassGIS of new addresses: notify911address@state.ma.us)
- Other potential sources of address data in real-time are:
  - utilities, may capture location, limited number of sources, location will be electric drop, not always at building
  - Change detection on aerial and satellite imagery
  - Building permits (we license a statewide database)

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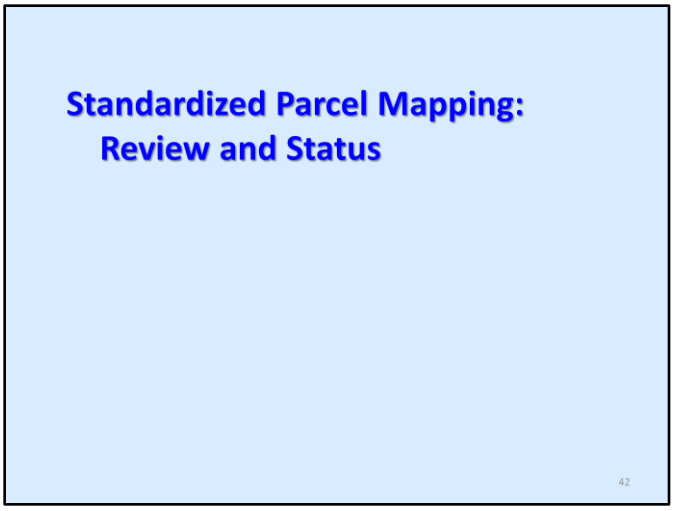


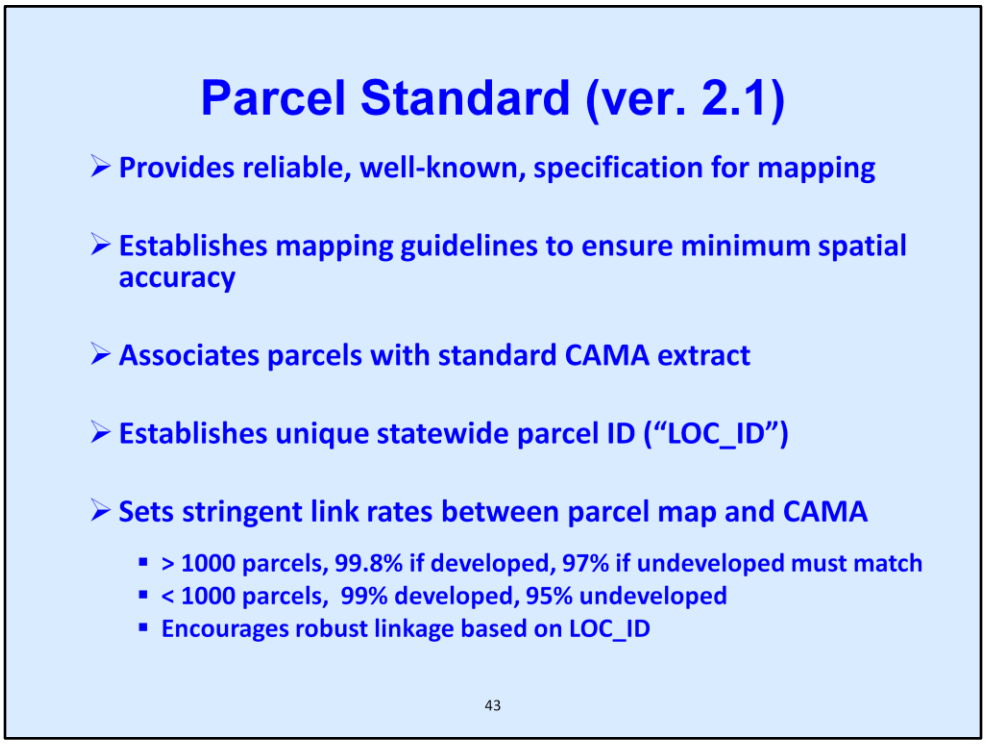
Well, I hope it's clear by now that NextGen 911 depends on the availability of standardized parcel mapping.

I also want to stress, that besides the needs of 911, there are many, many other benefits from statewide standardized tax mapping.

These included improved planning for and responding to wide-area disasters such as major flooding, as well as transportation planning and economic development.

There are anecdotes from all across the country of the consequences from not having this level of mapping quality.

Realistically, the world is changing, and in the 21st century we will do parcel mapping differently than we did in the 20th century.



First, the standard provides a reliable, well-known, specification for mapping

Second it:

- Establish mapping guidelines for minimum spatial accuracy
- Associates parcels with standard CAMA extract
- Establishes unique statewide parcel identifier ("LOC_ID")
  The LOC_ID is not a replacement for map/block/lot information, but it is an easier way to link the map and CAMA records
- Sets stringent link rates between parcel map and CAMA

I'M GOING TO BRIEFLY LOOK AT THESE ELEMENTS OF THE STANDARD

Parcel Standard: Mapping Guidelines

- Respect the accuracy of surveyed subdivision plans or other more accurate sources
- Remain faithful to original assessor map
- Align rights-of-way with streets visible on orthophoto
  - if as-built matches the subdivision plan!
- Align parcel boundaries with visible features on the airphoto base map
  - Roads
  - Stone walls and other boundary "clues"
  - Don't split structure (unless that is correct)
- Match lot lines across map sheets

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Here you see, in order of priority, the parcel mapping guidelines in the standard.

The key principal behind these guidelines is balancing how properties are depicted on the original tax map versus the reality visible on the air photo base map.

And of course the challenge is figuring out when disagreement between the map and what you see on the airphoto base map is correct.

At MassGIS we spent a LOT of time on this part of our quality assurance. We looked at 100% of the mapping in each community. We made our mapping vendors to a LOT of work in this area.

Despite this effort, we did not catch all the mistakes and sometimes we called for changes that should not have been made.

However, in many communities, the quality of the tax mapping was significantly improved.

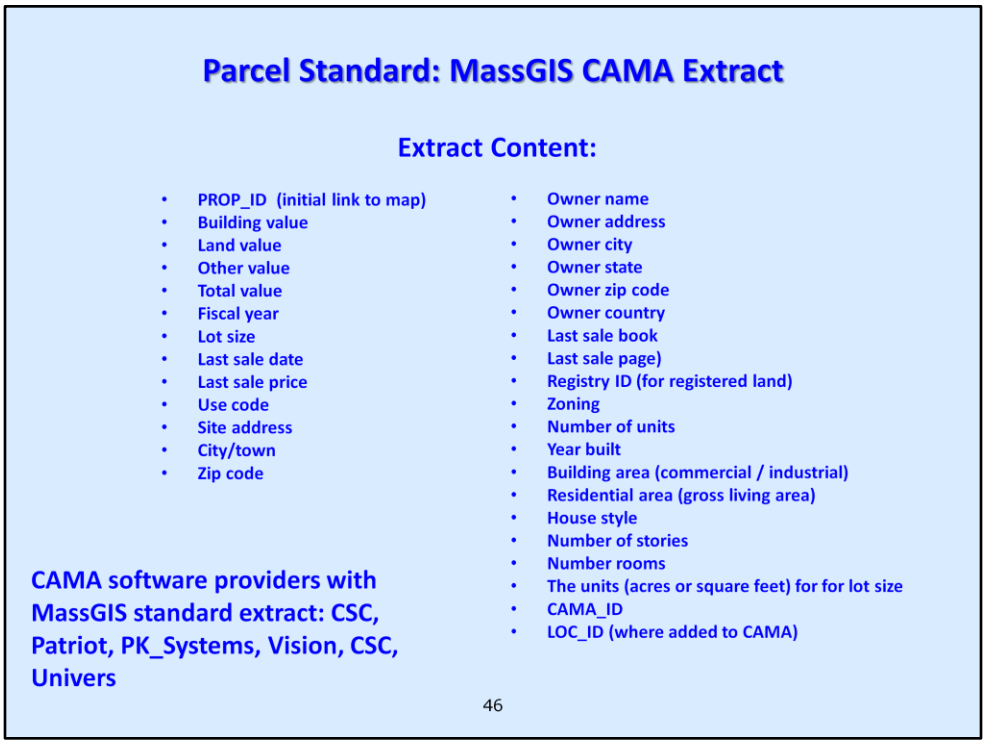
MAP QUALITY IMPROVEMENTS

Here's an example of what I'm talking about when I refer to improved mapping:

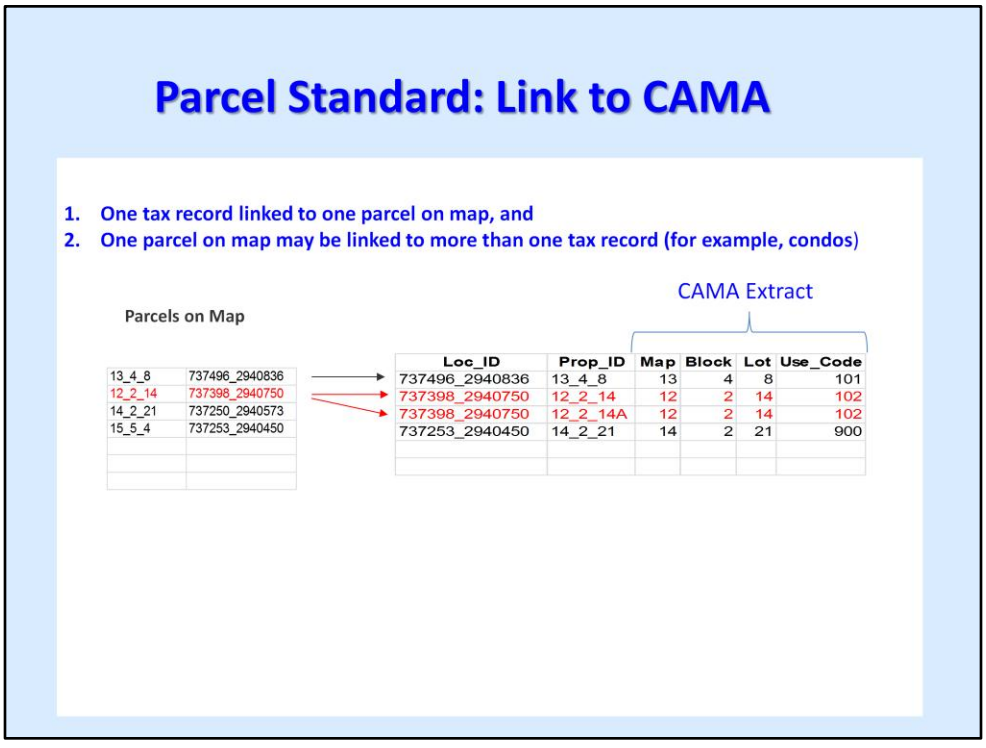
Lot lines don't slice through buildings

Lot lines match more closely with appropriate features in the built environment such as fences and walls

Street rights-of-way align with and generally contain the street pavement



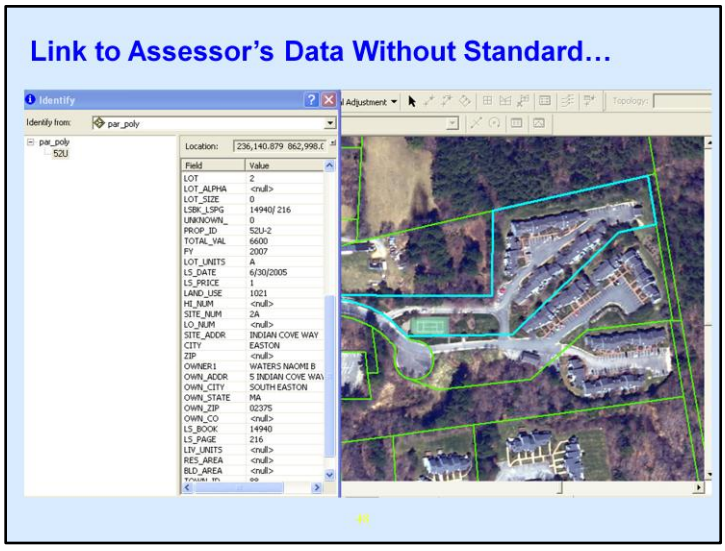
An extract or standard report for the MassGIS standard is provided by the many of your CAMA software providers, including all the major providers.



Here I'm illustrating rules about how the tax map is linked to the CAMA database and vice-versa using the unique ID (the "LOC_ID") from the standard. The LOC_ID is NOT intended to replace assessor map/block/lot numbering schemes, but it is a MUCH easier way to link parcels and their corresponding CAMA record and vice-versa. The problem with map/block/lot information is that is not unique statewide and we are assembling a statewide map. Also, map/block/lot information is maintained in separate fields in a CAMA database and has to be merged together (see "PRO_ID" column in graphic) so that it exactly matches the same information stored with the parcel. This merging and matching has to be every time you want to join a CAMA extract to the parcel map. The LOC_ID solves these problems.

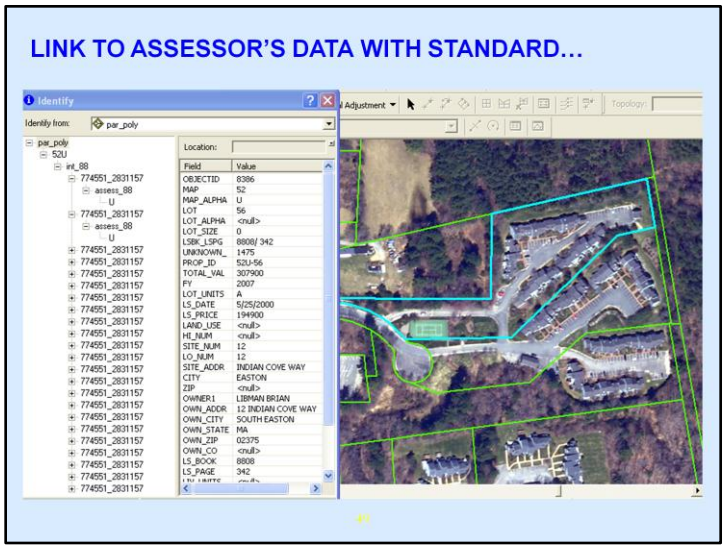
Each tax record linked to a single parcel
Each parcel linked to one or more tax records (e.g. condos)

(Highlight presence of LOC_ID on the parcel map and as an addition to the CAMA extract.)



Here's a simple but important example of what this linking between the map and the CAMA records achieves.

One parcel has many condos, each of which is a tax record.
Without standard or some equivalent, the link between the map and the tax list gets at most one of those condos.

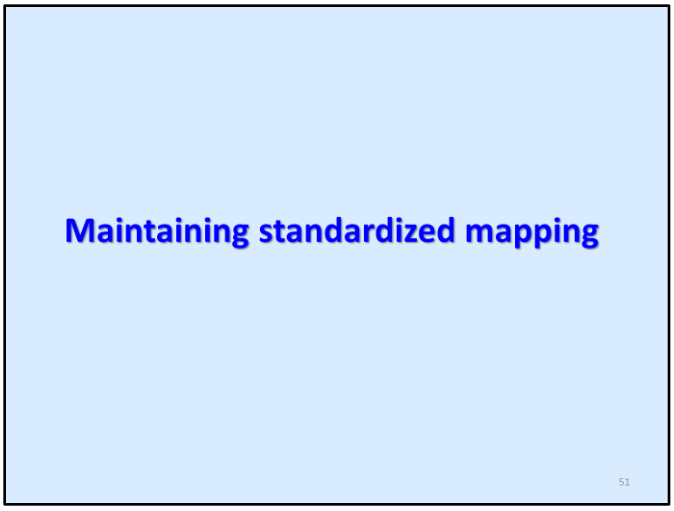


Here the link picks up all the condo records. This is important for a variety of reasons include abutter notifications and, of course, addressing.

ADVANTAGES OF STANDARD TO ASSESSORS

- High link rate between maps and CAMA and vice-versa
- Better quality, more broadly useful, assessor's maps
- Lowers consulting costs for developing software tools
- Parcel maps from adjacent communities will work with yours
- Consistent with DOR recertification guidelines
- LA3 info on-line can be backed by tax map & CAMA
- Makes MassGIS free "MuniMapper" useful

To summarize, besides NextGen 911's need for standardized parcel mapping, there are also advantages for assessors and other municipal staff.



Obviously, without maintaining the standardized parcel mapping, it will become obsolete and lose its value which would be a terrible waste.

So let's look at what's involved in maintaining the standardized mapping.

Maintaining Standardized Parcels

Three Steps

1. **Require Level 3 of standard for maintenance spec**

   MassGIS will do quality assurance at no charge

2. **Add the LOC_ID from standard to your CAMA database**

   CSC, Patriot, PK-Systems, Vision & Univers all prepared to help

3. **Require LOC_IDs for new/reconfigured lots**

Map maintenance provider must provide you with LOC_IDs for new lots

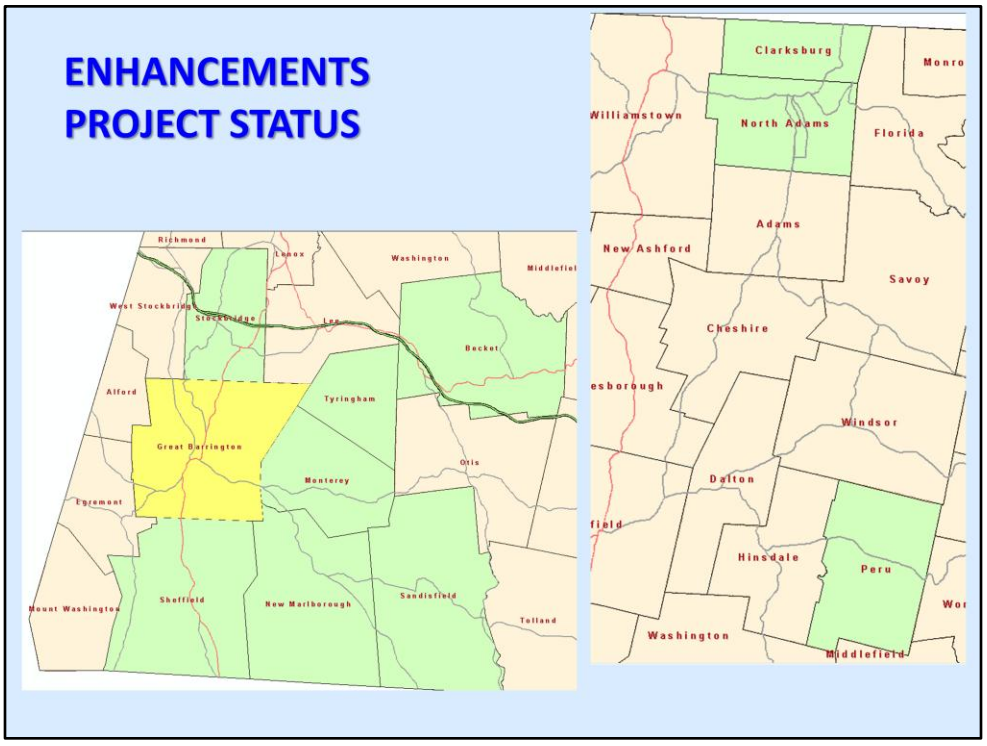
ON MAP	FOR CAMA
New/Changed Parcels	**New LOC_IDs**
195-12-10	M_190941_909393
195-12-11	M_190938_909349
195-12-12-A1	M_191133_909105
195-12-12-A2	M_191464_905332

ADDING UNIQUE ID
FROM STANDARD TO CAMA

Three Steps

1. Contact MassGIS and request file to send CAMA provider
2. Contact customer support at CAMA provider and request bulk load of "MassGIS LOC_ID" to your CAMA database
3. Send file from MassGIS to CAMA provider rep.

- PK-Systems has completed this for their customers
- CSC customers this has already happened or will happen soon



We learned after the standardization project was completed that many communities needed additional map content or assistance if they were to maintain the standardized mapping. So we launched the enhancements project. The communities in green and yellow are those from Berkshire County that requested to participate in this project. We received enhancement requests from 172 communities. We were able to fund work in 132 communities. I really regret not being able to fund the enhancements requested by GB.

Enhancements to Standardized Mapping

1. Adding dimension and other text
2. Updating standardized mapping
3. Creating map book production capability
4. Shifting existing dimension text in GIS to align with standardized parcels

OTHERS…but not requested by this audience

Here are the enhancements requested by communities represented here today. May of you made those requests on the recommendation of your mapping services provider, Cartographic Associates.

THANK YOU.
Questions?

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