

GPS & GIS for Hurricane Debris Removal



City of Miami
Miami, Florida

June 19, 2007

ESRI UC 2007

Presenters



Regina L. Hagger

GIS Developer

City Of Miami

Department of Public Works



Michael Schmedt

GIS Analyst

HDR Engineering, Orlando, FL

City of Miami

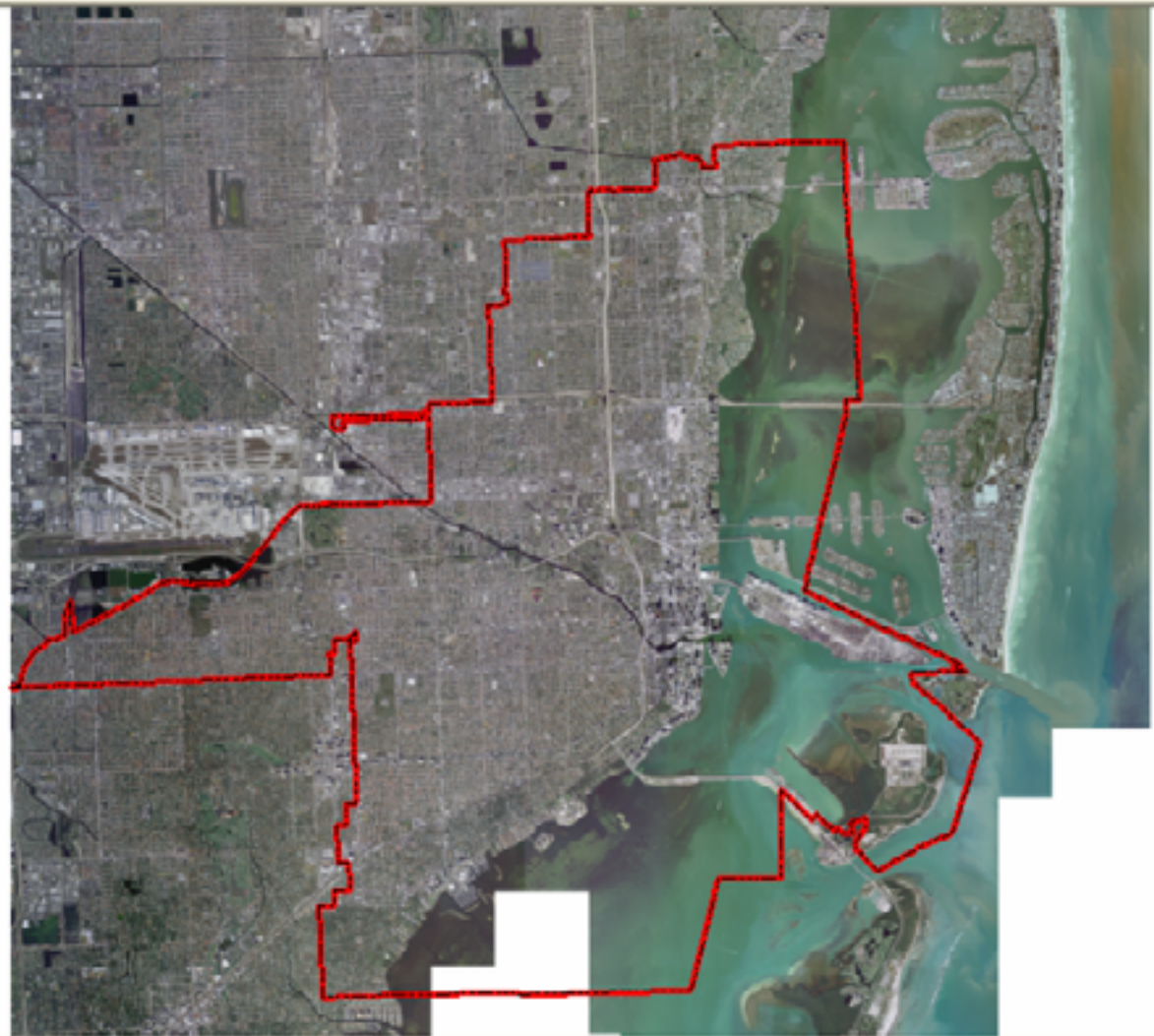


City of Miami, FL

- Location: Miami-Dade County, Florida
- Incorporated: July 28, 1896
- Population:
 - 2000 362,470
 - 2019 (projected) 390,191
- Area: 35 Square Miles
- Climate: Subtropical
- Elevation: 12 Feet above Sea Level
- Temperature:
 - Annual Average 75.9°
 - Average January 67.2°
 - Average July 82.6°

City of Miami

- City Landmarks
- City Addresses
- City EOP
- Miami Streets
- Water Bodies
- City Parcels
- City Boundary
- 2006 Aerial (Color)
- 2005 Aerial (Color)
- 2003 Aerial (B&W)



Hurricanes 2005

■ Katrina

- 8.25.05
- Tropical Storm => Hurricane Level 1

■ Rita

- 9.20.05
- Tropical Storm => Hurricane Level 1

■ Wilma

- 10.24.05
- Hurricane Level 3

Historical Hurricane Tracks - Microsoft Internet Explorer

Address: <http://maps.csc.noaa.gov/hurricanes/viewer.html>

NOAA Coastal Services Center

Historical Hurricane Tracks

Legend Find Results Print Help Info

Hurricane Track Over 100 matching attribute records found. Only 100 can be displayed at a time.
[New window](#)

Rec	YEAR	MONTH	DAY	STORM NAME	
1	2005	8	23	KATRINA	30
2	2005	8	24	KATRINA	30
3	2005	9	23	RITA	120
4	2005	9	23	RITA	115
5	2005	9	23	RITA	115
6	2005	9	23	RITA	110
7	2005	9	24	RITA	105
8	2005	9	24	RITA	100
9	2005	9	24	RITA	65
10	2005	9	24	RITA	45
11	2005	9	25	RITA	35
12	2005	9	25	RITA	30
13	2005	9	25	RITA	25
14	2005	9	25	RITA	25
15	2005	9	26	RITA	20
16	2005	10	15	WILMA	25
17	2005	10	16	WILMA	25

US DOC | NOAA | NOS
 NOAA Coastal Services Center

[Privacy policy](#)
 Contact NOAA Coastal Services Center
 Updated on August 15, 2006

Internet

Source: <http://maps.csc.noaa.gov/hurricanes/viewer.html>

City Needs

- Assessment of tree damage caused by Hurricane Wilma
- Method to help monitor and coordinate tree debris collection
- Documentation of damage and debris removal for clean-up reimbursement by FEMA

Solution

- Collecting tree debris data using mobile GIS (**Tree Debris Inventory**)
- Compiling a comprehensive citywide tree debris database (**Database Processing**)
- Creating maps and reports visualizing and detailing tree debris information (**Maps and Reports**)

Tree Debris Inventory

- Trained 4 two-person field crews on inventory methodology and mobile GIS
- Crews equipped with laptop, GPS device, and digital camera
- Inventory consisted of field data collection, followed by nightly database synchronization



Tree Debris Inventory

- Developed ArcPad data entry forms to be used by the field crews
- Forms designed to collect information on:
 - Debris type (fallen tree, tree limb, property damage)
 - Trunk diameter; limb diameter/length (important for FEMA Eligibility)
 - Location address
 - Location coordinates (lat/long)
 - Photo ID

Tree Debris Inventory

Miami Tree Debris

Fallen Tree/Stump Hanging Limbs Property Debris

Debris ID: 1028 HL101 0001 SP East: 826967.867392988

Date: 10/28/2005 SP West: 553591.391657228

Limbs resting on power lines

Street Address:
1000 NE 86TH ST

Zip Code: 33138

Photo ID:

Photo ID 2:

Additional Comments:

OK Cancel

Miami Tree Debris

Select Debris Type Fallen Tree/Stump Hanging Limbs

Debris ID: 1028-ST101-0001 SP East: 926967.867392988

Date: 10/29/2005 SP West: 553591.391657228

Tree resting on power lines Stump Diameter:

Street Address:
1000 NE 86TH ST

Zip Code: 33138

Photo ID:

Photo ID 2:

Additional Comments:

OK Cancel

Tree Debris Inventory

- Set up GIS database to be used by field crews
- Data derived from the Miami database includes:
 - City and district boundaries
 - Garbage collection zones
 - Street and address data
 - City-owned parks
 - Water features
 - Aerial imagery

Tree Debris Inventory Results



- **Fallen Trees**

■ Citywide (in road right-of-way)	0760
■ Parks	0340
■ Total	1100



- **Trees with Hanging Limbs**

■ Citywide (in road right-of-way)	6166
■ Parks	0653
■ Total	6819



- **Property Damage**

■ Citywide (in road right-of-way)	87
■ Parks	05
■ Total	92

Database Processing

- Office staff managed master GIS database, workflow included:
 - merging individual uploads into one comprehensive debris database
 - Address matching (performing spatial join)
 - Checking for potential duplicate records
 - Picture matching
 - Screening of records for FEMA Eligibility
 - Screening of comments for additional information
 - Calculating lat/long coordinates
 - General QA/QC

Database Processing



- Generating and maintaining comprehensive tree debris database

A screenshot of a data table with many columns and rows. The columns are labeled with various identifiers and names, and the rows contain numerical and text data. The table is displayed in a window with a standard Windows-style title bar and menu bar.

Maps and Reports

- Generated maps for individual City zones and districts detailing fallen trees, broken limbs and property damage
- Generated a series of Access™ reports detailing debris locations with corresponding attributes and photos

Maps and Reports

CITY OF MIAMI



Hurricane Wilma
Debris Management

Citywide Fallen Tree
and Property Damage
District 1

Commissioner: Angel Gonzalez

Districts
City of Miami -
Overview



Legend

- Green diamond: Fallen Tree
- Orange circle: Property Damage
- Thick yellow line: Federal / State / County Roads
- Thin grey line: Streets
- Blue shaded area: District 1



Maps and Reports



Hurricane Wilma Debris Recovery
 Fallen Tree Stump and Hanging Limbs Removal
 FCMA No. 1005-DR, Florida



Monitoring Services Program Manager
 HDR Engineering, Inc.
 15450 New Barn Road, Suite 304
 Miami Lakes, FL 33014-2109

Report for Collection Zone: 111

FEMA
 Eligible

Map ID: 13
 Collection Zone: 111
 Debris ID: 1104-ST111-0086
 Date: 11/4/2005 3:32:53 PM
 X Coordinate (Longitude): -80.21009110730
 Y Coordinate (Latitude): 25.78007214110
 Tree Rest on Power Lines:
 Stump Diameter (Inches): 48

FALLEN TREE



Picture 078.jpg

Comments:

3-4 FEET DIAMETER FALLEN
 LIMB + BRUSH W/ K HANGING-D
 DUE TO TREE / PLUS LIMBS

Address:

2405 NW 13TH CT
 MIAMI, FL 33142

Photo 2:



Picture 079.jpg

FEMA
 Eligible

Map ID: 14
 Collection Zone: 111
 Debris ID: 1104-ST111-0089
 Date: 11/4/2005 3:52:53 PM
 X Coordinate (Longitude): -80.21026045000
 Y Coordinate (Latitude): 25.80490260500
 Tree Rest on Power Lines:
 Stump Diameter (Inches): 48

FALLEN TREE



Picture 082.jpg

Comments:

BIG FALLEN TREE BLOCKING
 SIDEWALK / 4 FEET DIAMETER

Address:

1181 BISCAYNE BLVD
 MIAMI, FL 33146

Photo 2:



Picture 083.jpg

FEMA
 Eligible

Map ID: 24
 Collection Zone: 111
 Debris ID: 1107-ST111-0142
 Date: 11/7/2005 2:06:04 PM
 X Coordinate (Longitude): -80.20914500700
 Y Coordinate (Latitude): 25.80012941700
 Tree Rest on Power Lines:
 Stump Diameter (Inches): 36

FALLING TREE



Picture 151.jpg

Comments:

FALLING TREE / DIAM 3 FEET
 APPROX / PROPERTY DAMAGE /
 TREE RESTING OVER A
 FENCE, AND BLOCKING
 PUBLIC SIDEWALK

Address:

3415 NW 8TH AVE
 MIAMI, FL 33127

Photo 2:



Picture 152.jpg

Benefits

- Database helping the City:
 - Verifying reports from calling residents about tree debris
 - Updating existing tree inventory
- Reports and maps resulted in cost savings for the City by:
 - Serving as basis for debris removal contractors
 - Allowing the City to define amount and location of debris removal
 - Limiting the possibility of cost overruns by collecting out of scope debris

Benefits

- Reports and maps provided FEMA field staff with valuable information, facilitating FEMA workload and saving time and money

Lessons Learned

- Extensive training of field crews and standardized collection effort will reduce time and effort of data processing considerably
- Provide field crews with the latest master collection file in order to avoid potential collection of duplicates
- Standardizing and streamlining caption of pictures:
 - Unique picture names
 - No portrait pictures
 - 1st picture showing whole area of damage, 2nd showing a close up

Why GPS?

- Accuracy & Quality Control
 - Positional
 - Attribute
- Data Stakeholders
- Cost Efficient
- City Staff “existing experts”



2006 USDA Grant

- Division of Forestry conducted a visual assessment of the City of Miami post hurricane damage in February 2006 during a mini-tour.
- 75% of the mature trees showed hurricane damage
- Tree Canopy (National avg.): 20%
- Tree Canopy for the City: 5%

2006 USDA Grant

The City of Miami received a 2006 Urban and Community Forestry Grant from the Florida Dept of Agriculture's Division of Forestry for \$25,000.

■ Hardware	\$45,140
■ Software	<u>\$4,840</u>
■ Total	\$49,980
■ USDA Grant	-\$25,000
■ City Match	\$24,980

2006 USDA Grant

- 6 Geo XT GPS handheld units
- 4 RICOH Pro G3 Cameras & WI-FI cards
- 1 Contour XLRic Laser Rangefinder - bluetooth & hardware
- 1 Zephyr Antenna, Pole & hardware
- 1 GPS Analyst Extension (includes ArcPad 7 & GPS Correct software
- 3 copies of ArcPad 7 software
- 5 copies of Trimble GPS Correct software

Purchase Status

- In the City procurement process
 - Currently utilizing the following units borrowed from other Departments:
 - Geo XM
 - Geo XH
- | |
|-------------|
| Parks Dept |
| IT/GIS Dept |

Project Staff

■ GIS Developers

- Regina Hagger – Public Works
- Ruth Dagnan – IT/GIS

■ GIS/CADD Technician

- Martin Arteaga – Public Works

■ Parks Naturalists

- Juan Fernandez
- Ernesto Martinez



Field Testing

1/12/06 GPServe, Inc. and

2/21/06 NEI, Inc.

- Trimble GeoXH handheld with TerraSync software:

- Total # of structures collected: 35
- Fire Hydrants – 4
- Bus Benches – 3
- Catch Basins/Inlets – 16 (City)
- Catch Basins/Inlets – 2 (FDOT)
- Trees – 10
- Nature Trail – 1 mile
- Accuracy:
 - Vertical: from 0.6 feet (8 inch) to 4.5 feet
 - Horizontal: from 0.4 feet to 2.8 feet



- Trimble ProXRS backpack with Recon and ArcPad

- 7.0 software:

- Total # of structures collected: 27
- Fire Hydrants – 3
- Bus Benches – 2
- City Storm Water Catch Basins/Inlets – 12
- Trees – 10



Field Testing Results

Microsoft Excel - GPS Points2_21_06

File Edit View Insert Format Tools Data Window Help

100%

Cor Type

	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
	GPS Date	GPS Time	Update Sta	Feat Name	Datalite	Unit Pos	Feat Pos	Data Dict	Week	GPS Second	GPS Height	Var Prec	Hzrc Prec	Sht Dev	Northing	Easting	Point_ID	
1	2/21/2006	03:53:56pm	New	Point_ge	R022111B.cor	2	2	Seaview	1363	244450.000	0.091	1.2	0.0	0.000000	523182.428	920130.750	1	
2	2/21/2006	03:54:26pm	New	Point_ge	R022111B.cor	2	2	Seaview	1363	244480.000	0.094	0.7	0.5	0.000000	523186.018	920085.483	2	
3	2/21/2006	03:54:56pm	New	Point_ge	R022111B.cor	1	1	Seaview	1363	244510.000	0.304	0.7	0.5	0.000000	523196.477	920130.814	3	
4	2/21/2006	03:55:31pm	New	Point_ge	R022111B.cor	1	1	Seaview	1363	244545.000	-0.522	0.7	0.5	0.000000	523163.366	920200.857	4	
5	2/21/2006	03:55:51pm	New	Point_ge	R022111B.cor	2	2	Seaview	1363	244555.000	-0.719	0.7	0.5	0.000000	523121.421	920205.453	5	
6	2/21/2006	03:57:16pm	New	Point_ge	R022111B.cor	1	1	Seaview	1363	244650.000	-1.669	0.6	0.5	0.000000	523240.272	920202.521	7	
7	2/21/2006	03:58:46pm	New	Point_ge	R022111B.cor	1	1	Seaview	1363	244740.000	-1.146	0.6	0.4	0.000000	523479.879	920197.270	10	
8	2/21/2006	03:59:11pm	New	Point_ge	R022111B.cor	1	1	Seaview	1363	244765.000	-0.408	0.6	0.4	0.000000	523477.036	920254.207	11	
9	2/21/2006	03:59:26pm	New	Point_ge	R022111B.cor	2	2	Seaview	1363	244780.000	-0.495	0.6	0.4	0.000000	523447.274	920280.857	12	
10	2/21/2006	03:59:51pm	New	Point_ge	R022111B.cor	1	1	Seaview	1363	244805.000	-1.178	0.6	0.4	0.000000	523409.310	920281.373	13	
11	2/21/2006	04:00:11pm	New	Point_ge	R022111B.cor	1	1	Seaview	1363	244825.000	-1.030	0.6	0.4	0.000000	523359.346	920267.268	14	
12	2/21/2006	04:00:46pm	New	Point_ge	R022111B.cor	1	1	Seaview	1363	244860.000	-1.693	0.6	0.4	0.000000	523232.262	920258.637	15	
13	2/21/2006	04:01:16pm	New	Point_ge	R022111B.cor	1	1	Seaview	1363	244890.000	-1.630	0.6	0.4	0.000000	523123.830	920258.970	16	
14	2/21/2006	04:02:11pm	New	Point_ge	R022111B.cor	2	2	Seaview	1363	244945.000	0.261	0.7	0.4	0.000000	523056.261	920201.862	17	
15	2/21/2006	04:02:46pm	New	Point_ge	R022111B.cor	2	2	Seaview	1363	244980.000	1.337	3.3	2.2	0.000000	523161.004	920202.959	18	
16	2/21/2006	04:03:21pm	New	Point_ge	R022111B.cor	1	1	Seaview	1363	245015.000	2.439	2.6	1.7	0.000000	523114.402	920127.541	19	
17	2/21/2006	04:03:56pm	New	Point_ge	R022111B.cor	1	1	Seaview	1363	245050.000	-10.559	7.4	4.2	0.000000	523116.859	920083.269	20	
18	2/21/2006	05:03:16pm	New	Point_ge	R022111B.cor	15	15	Seaview	1363	248610.000	9.451	2.1	1.4	0.000000	518758.380	920555.838	23	
19	2/21/2006	05:06:36pm	New	Point_ge	R022111B.cor	25	25	Seaview	1363	248810.000	-23.708	2.0	1.2	0.000000	518955.569	920670.646	24	
20	2/21/2006	05:11:10pm	New	Point_ge	R022111B.cor	28	28	Seaview	1363	249064.000	24.929	2.4	1.6	0.000000	518873.757	920781.431	25	
21	2/21/2006	05:15:46pm	New	Point_ge	R022111B.cor	16	16	Seaview	1363	249360.000	10.996	1.3	1.0	0.000000	518943.293	920909.436	26	
22	2/21/2006	05:18:58pm	New	Point_ge	R022111B.cor	16	16	Seaview	1363	249552.000	30.291	4.5	2.8	3.280320	518837.812	921076.403	27	
23	2/21/2006	05:29:07pm	New	Point_ge	R022111B.cor	20	20	Seaview	1363	250161.000	41.775	2.4	1.8	0.000000	518759.845	921098.541	28	
24	2/21/2006	05:32:22pm	New	Point_ge	R022111B.cor	20	20	Seaview	1363	250356.000	4.059	1.7	1.2	0.000000	518695.313	920904.722	29	
25	2/21/2006	05:34:14pm	New	Point_ge	R022111B.cor	15	15	Seaview	1363	250468.000	21.469	2.1	1.4	0.000000	518736.898	920885.688	30	
26	2/21/2006	05:36:47pm	New	Point_ge	R022111B.cor	15	15	Seaview	1363	250621.000	17.868	3.7	2.7	10.031257	518762.850	920781.449	31	
27	2/21/2006	05:42:11pm	New	Point_ge	R022111B.cor	13	13	Seaview	1363	250945.000	23.321	1.5	1.0	0.000000	518689.195	920658.311	33	
28	2/21/2006	06:03:36pm	New	Point_ge	R022111B.cor	9	9	Seaview	1363	252229.000	22.132	1.5	1.0	0.000000	518303.931	920668.001	35	
29	2/21/2006	06:05:17pm	New	Point_ge	R022111B.cor	9	9	Seaview	1363	252331.000	16.960	3.9	2.4	1.358330	518270.915	920707.724	37	
30	2/21/2006	06:05:45pm	New	Point_ge	R022111B.cor	6	6	Seaview	1363	252359.000	12.868	1.3	0.8	0.000000	518211.516	920711.944	38	
31	2/21/2006	06:06:39pm	New	Point_ge	R022111B.cor	10	10	Seaview	1363	252413.000	12.526	1.3	0.8	0.000000	518210.429	920667.222	39	

Ready

Hardware

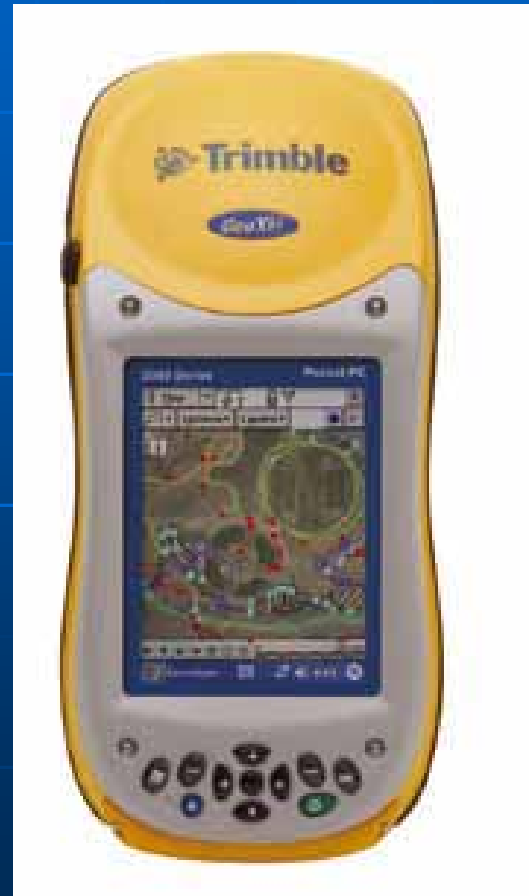
- Trimble Geo XM
 - 1 – 3 meter GPS accuracy real time and Post Processing (PP)
 - Accuracy suitable for asset management (benches, news racks, bus stops, payphones, fire hydrants, trees...)
 - Price: \$ 2,335 Hardware only
 - Software & Hardware Bundle Price: \$ 3,150 (includes ESRI ArcPad & Trimble GPScorrect software)



Hardware

■ Trimble Geo XH

- Sub-meter GPS accuracy in the field (sub 30cm Post Processed {PP})
- Accuracy suitable for storm water infrastructure & asset management (catch basins, manholes, outfalls...)
- Hardware Price: \$ 4,765.
- Hardware & software Bundle Price: \$ 5,350 (includes ESRI ArcPad & Trimble GPSCorrect software)



Hardware

Zephyr Antenna & Pole

- Why do you want this?
- 'Canyon & Canopy' effect
 - Assists in collecting in Urban canyon aka 'Downtown' and in Tree Canopy – Coconut Grove
- Antenna \$2000
- Pole \$235
- Bracket \$175



Hardware

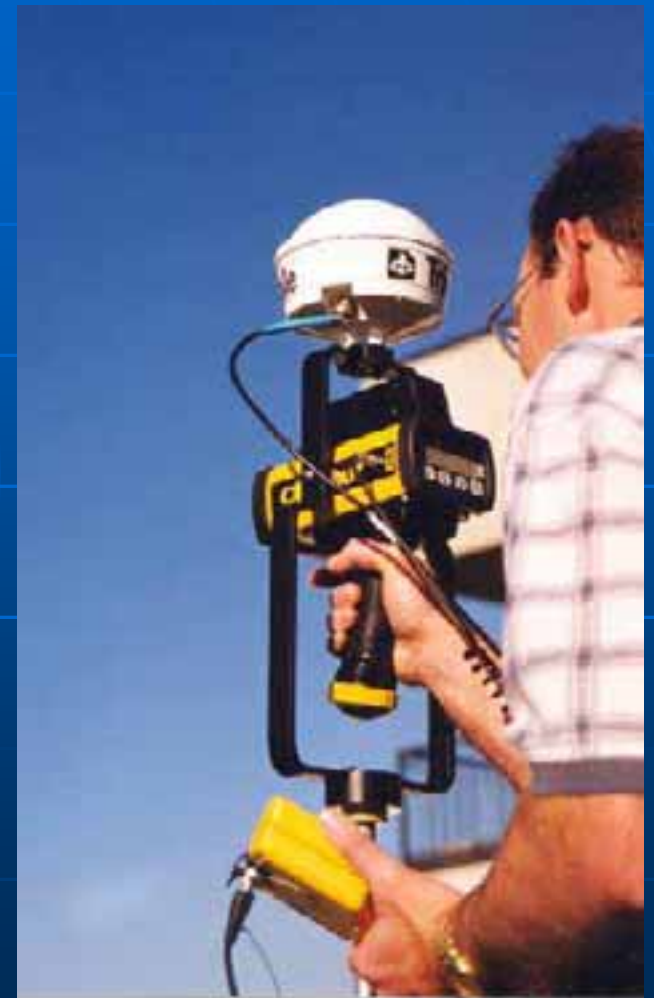
- Ricoh Pro G3 GPS Camera
 - Requires Compact flash WI-FI Card
 - Price \$870.00 (camera)
 - Speeds data collection by documenting actual condition of asset (tree)



Future Hardware

Lasercraft Contour Laser Rangefinder

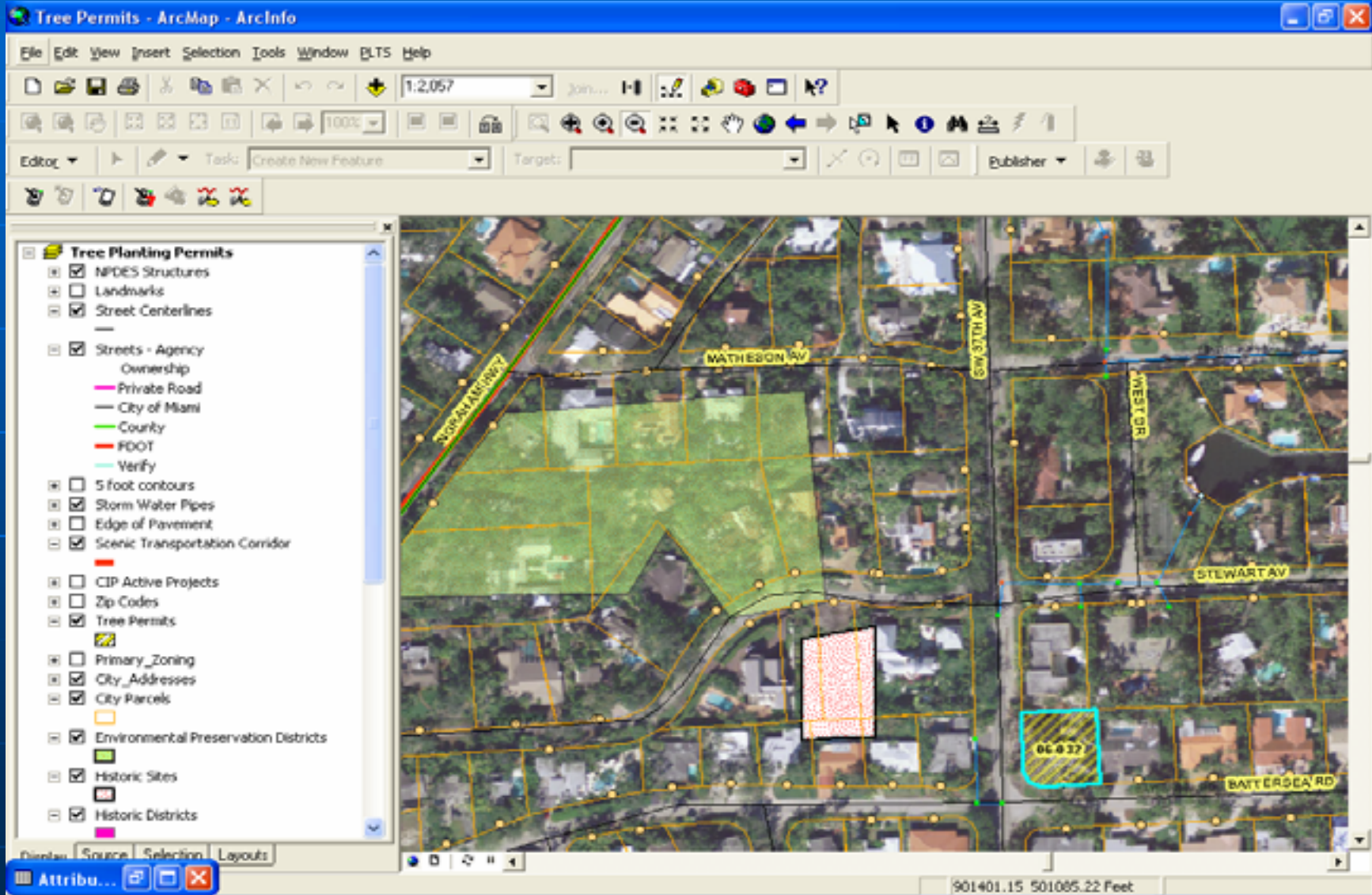
- Why do you need this?
 - Measures heights of buildings, trees
 - Can collect many assets you may not be able to reach physically
 - Across canals, streams & rivers
 - Construction or industrial sites that are fenced, hazardous, or inaccessible
- \$4,195 Rangefinder
- \$200 Yoke Assembly
- \$145 Bipod for Laser Pole



City Goals

- Plant 100,000 trees by 2010
- Inventory all trees in the Road Right of Way and on City Property using GIS
- Track current tree inventory
- Implement effective Tree Management practices
- Become a Tree City USA
- Annual City-wide Arbor Day Celebration
- Create an Urban Forestry Plan

Tree Permits



GPS Pilot Project

- GPS Data Collection on Virginia Key
 - Collection of rare and endangered trees and shrubs on Virginia Key
 - Documentation of the habitat restoration project
 - NOAA Grant to The Parks Department
 - Started Data collection in July 2006 w/Geo XM



- Virginia Key
 - Shrubs
 - + <all other values>
 - Native
 - Exotic
 - Native
 - Trees
 - Native
 - Street Centerlines
 - ManBoundary
 - Man_Land_Mess
 - Water Bodies
 - 2006_miami-dade_co_3.sid
 - Man03_15_1.sid
 - AERIAL_COLOR
- Location map



Virginia Key

- Hydrant
- GPS POINTS 2-21-06
- Fire_Hydrants1020043L
- test2
- NPDES Structures
- Furniture
- Trees
- Payphone_final
- Marlin Structures
- Street Centerlines
- NatureTrail
- Line_gen
- Road
- ammover
- amrail
- MS4_Pipes
- Water Bodies
- Grant Boundary
- CityParcels2_2006
- MiamiBoundary
- 2006_miami-dade_co_3.sid
- MiamiR 15 1.cdl

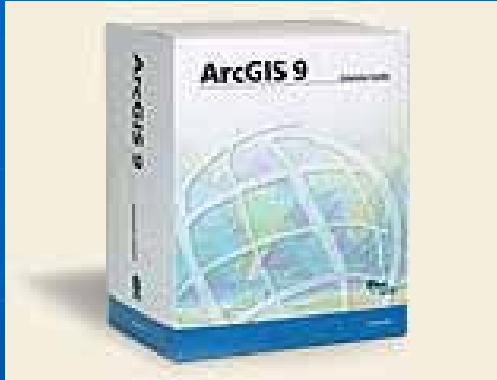




20 m



Software



ArcSDE 9.0

ArcGIS 9.1

ArcPad 7

Active Sync 4.2

ArcPad Application Builder 7

Trimble GPS Correct

Database Fields

Trees

Common Name
Genus & Species
DBH
HT_FT
HT_IN
In ROW
Condition
Gender
Insp_Date
Insp_By
Flowers
Flower color
Image
Native
Permit_NO
TAG_NO



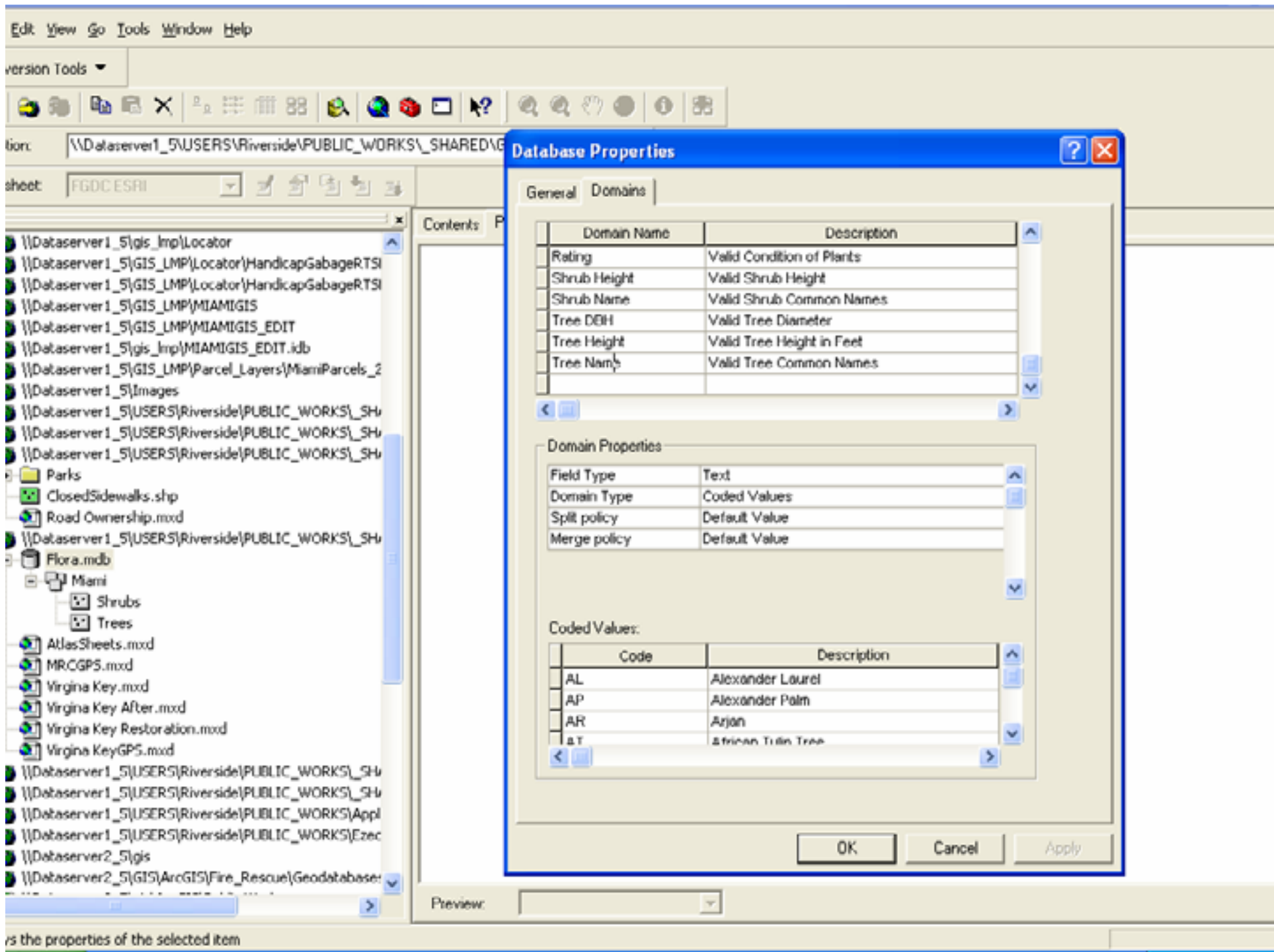
Shrubs

Common Name
Genus & Species
DBH
HT_IN
In ROW
Condition
Gender
Insp_Date
Insp_By
Flowers
Flower color
Image
Native
TAG_NO

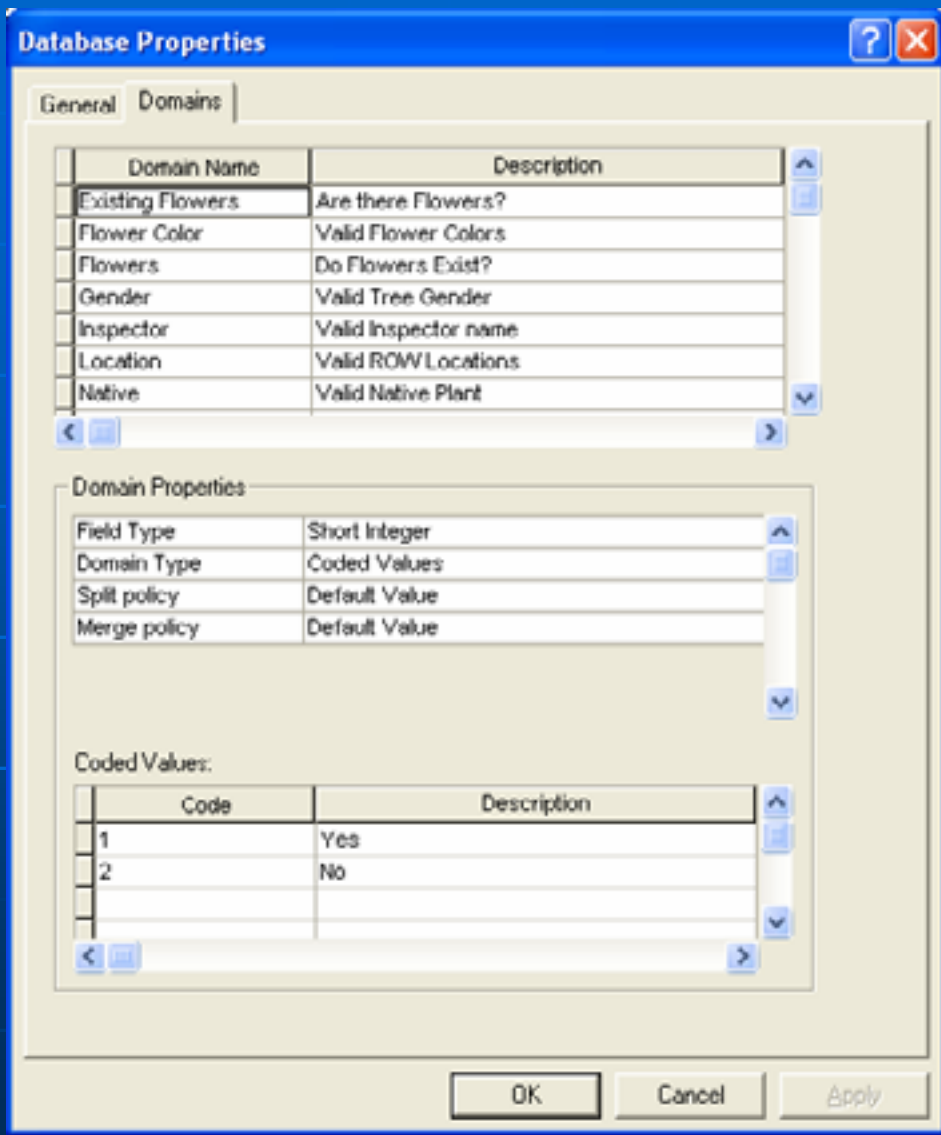
Trees

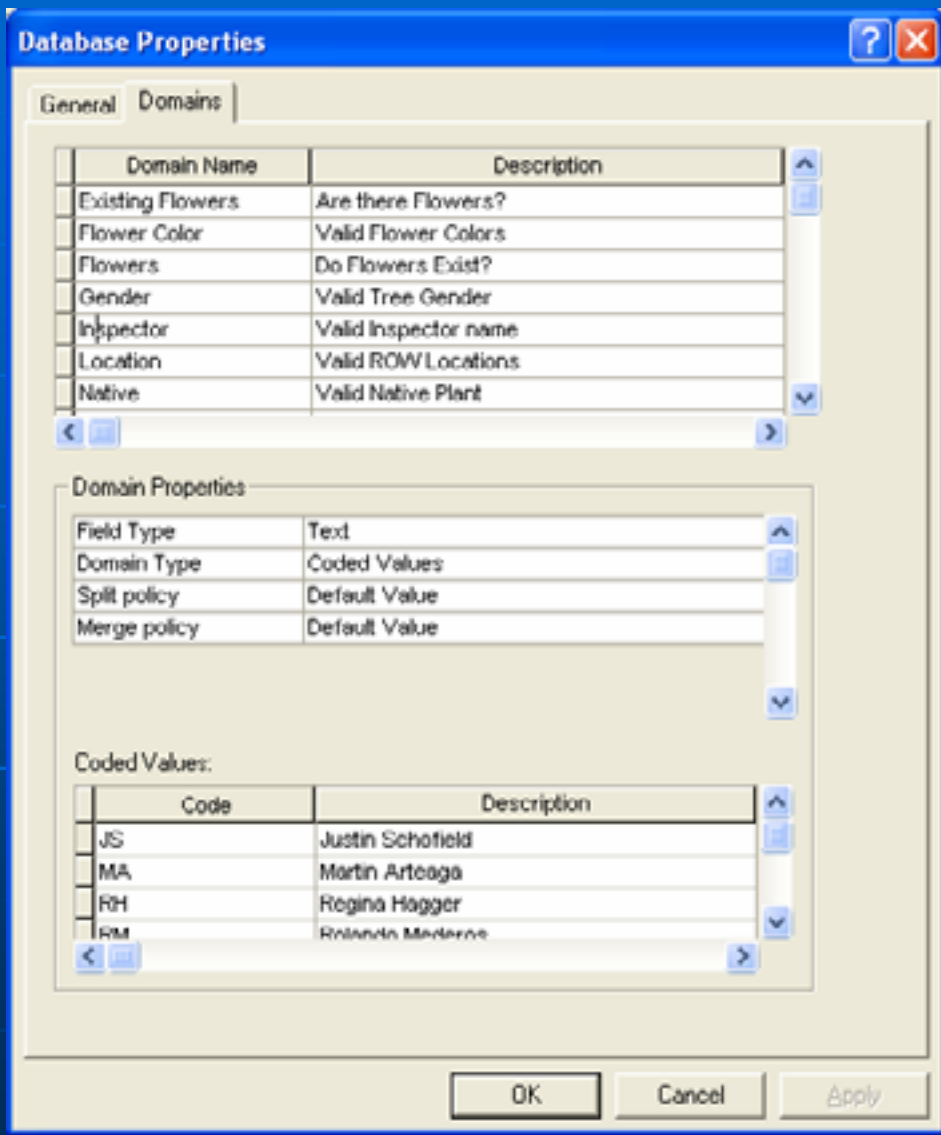
- 131 Tree Types
- 52 Shrub Types





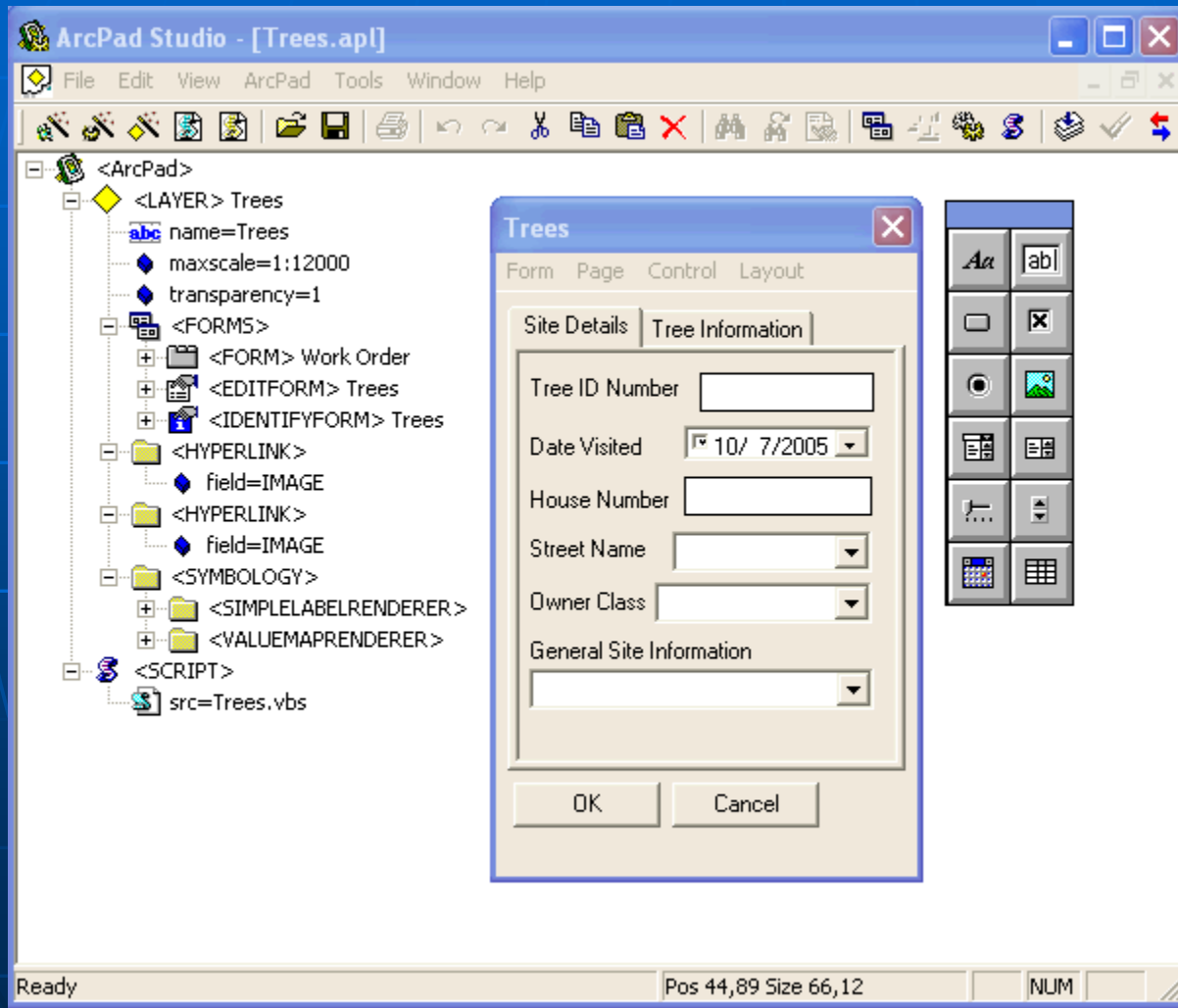
rs the properties of the selected item





Software

ArcPad Application Builder 7



Future Software

ESRI GPS Analyst
Trimble Terra Sync



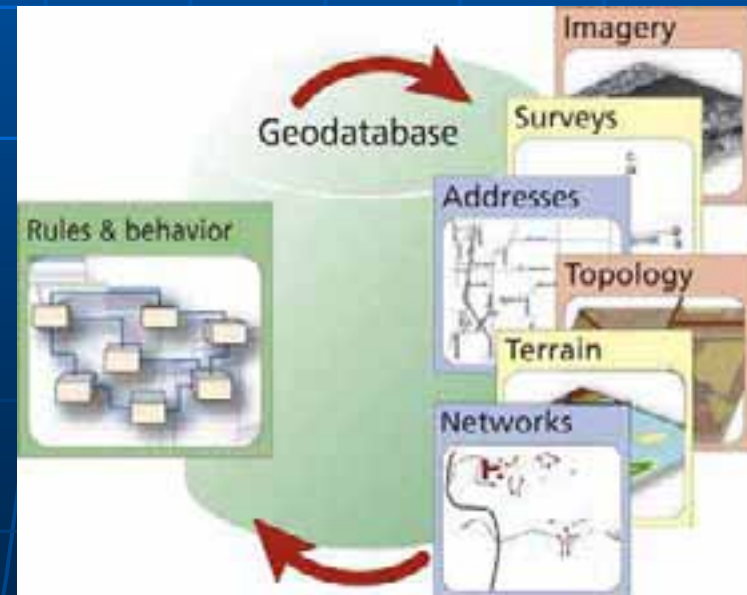
Lessons Learned

- Planning
- Batteries
- Aerials (think twice!)
- Consider doing a field test of equipment (hardware & software)
- Compare notes with a GIS network resource
- Borrow equipment from another Dept.



Suggestions

- Start with a geo-database
- Budget for storage space to store pictures
- Data Collection Teams minimum of 2 people



Presenters Information



Regina L. Hagger

GIS Developer

City of Miami

Department of Public Works

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Miami, FL 33130

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Orlando, FL 32801-1949

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E-mail: michael.schmedt@hdrinc.com

End Notes

- All Photographs were taken by City of Miami employees or contractors, with the exception of:
 - Trimble Hardware & Software
 - ESRI Hardware & Software
 - Ricoh Hardware