Calculating Impervious Surface as a Stormwater Service Measure

Julia Cole

ESRI User Conference, July 2011

MSD in a Nutshell

- Formed in 1954, only special district in MO created under a provision of the State Constitution

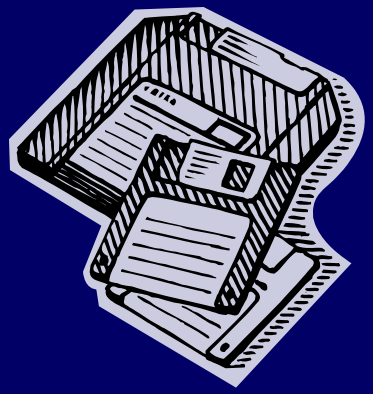
- Current Boundaries cover 525 sq miles (all City + 80% County)

- Serves population of approximately 1.4 Million; with 519,000+ accounts
- Operates 7 wastewater treatment facilities

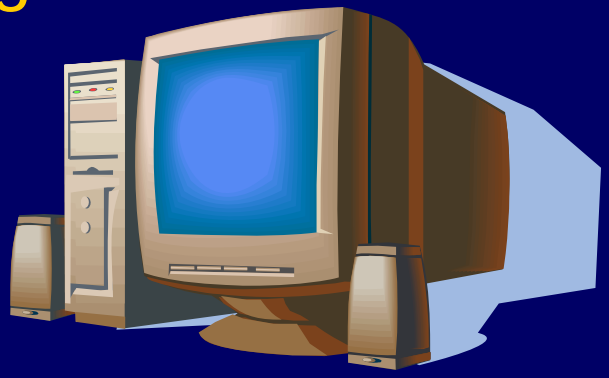
- Treats on average 330 million gallons of sewage per day

- Infrastructure includes 9,649 miles of sewer, from less than a year to over 150 years old

GIS at MSD



- 1954: Paper maps submitted by municipalities
- Late 1980’s: Digital facility maps (CAD)
- 2007: Conversion to ArcGIS SDE database
- 2011: Asset management integration



Billing system: How do we measure what we provide?

Sanitary service:

- “Winter Quarter” water meter readings provided by City of St.Louis, Missouri American Water, and City of Kirkwood
- Account is created for each address

How do we measure Stormwater service?

- A $0.24 charge on each sanitary account
- Taxes collected through a variety of special purpose taxing districts

  - Non-sanitary customers not billed for $0.24 as the postage exceeds collection
  - Taxing districts not dispersed equally
  - Loss of fees from tax-exempt entities

Impervious Surface Fee

Charging for rainwater?

- Allows measure based on environmental impact
- Would abolish inequitable storm taxes
- Allows equitable services to all within District
- Allows clear explanation to customer of how charges are determined
- Provides opportunity to diminish impact <u>and</u> fee through environmental practices

GIS Requirements to Implement Fee

- Polygon data for property boundaries with owners and addresses
- Polygon footprints for surface types
- Assignment of each footprint to a parcel
- Summary of surface area by parcel
- Transfer of calculation to billing system account
- Method for maintenance

Capture of Surfaces

Surfaces digitized from orthophotography

Attributes include:

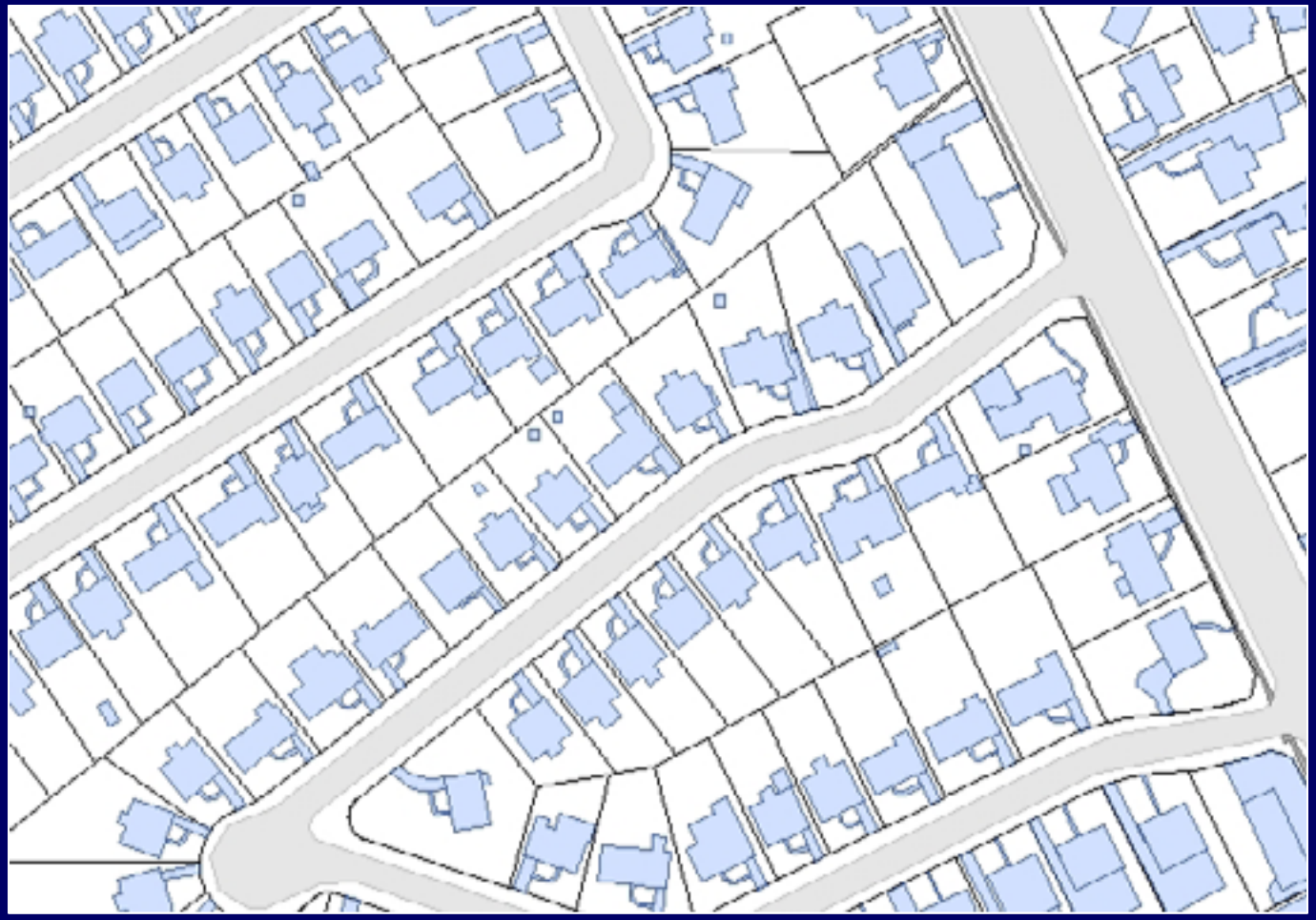
- Surface type
- Date of flight
- Status

Determine “Billable” by Classification

- Airport
- Buildings – Main
- Buildings – Out buildings
- Driveways Paved
- Parking Paved
- Patio / Concrete Slab
- Recreation Areas
- Sheds
- Sidewalks (Private)
- Tanks

- Area Under Construction
- Bridge
- In Ground Swimming Pool
- Paved Drains
- Parking Island / Unpaved
- Roads / Paved
- Roads / Unpaved
- Sidewalks (Public)
- Transportation Islands
- Water

Surfaces were clipped to the parcels:



Assigning ownership

- Straight intersect between Surfaces and Parcels: RES vs. NON-RES
- Multi-parcel development, multi-unit parking
- Accommodating property boundary errors

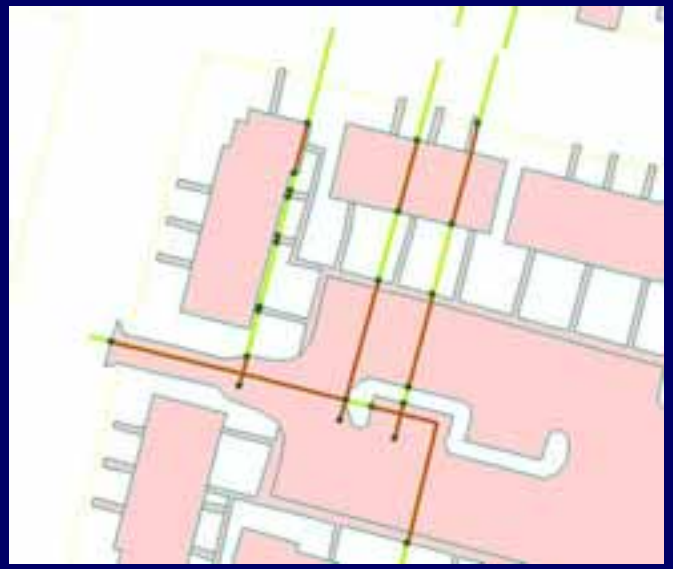
Residential Landuse

Part I: Governed Split Process

Adjusted property lines are accepted “as is” – topology corrections

- Impervious surfaces clipped to Parcels (ROW)
- “Split lines” are clipped by impervious area polygons
- Multi-part split lines are converted to Single Part
- All split lines are broken into individual segments where they intersect using “Planarize”

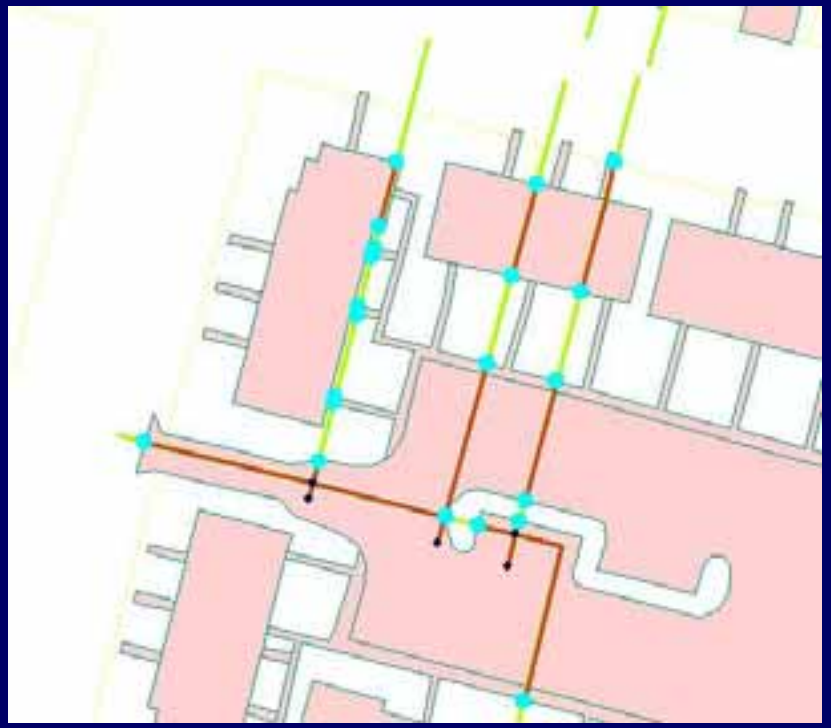
1. Impervious features are converted to lines
2. Split lines are merged with impervious lines
3. New polygons are constructed from the merged line file



Governed Split Process continued

1. New label points are created for the impervious polygons
2. Spatial intersect is performed on the new labels to assign the value of the original underlying surface (FC_NAME)
3. Spatial join is used to assign values to the polygons from the label points
4. FC_NAME values of NULL created as a result of the new polygon creation are deleted from the file

Result “Split_Imperv_Surface”



Part II: Greatest Overlap logic

Inputs:
(A) Split_Imperv_Surface – impervious polygons, split by mapping staff
(B) PC_area – parcels adjusted by mapping staff

1. Add field "PerC" to ImpervSample; set Type to Double
2. Populate the PerC cell values with "100"
3. Run Make Feature Layer tool

Parameters
Input Features: ImpervSample
Output Layer: Accept the default name ImpervSample_Layer
In Field Info, set PerC FieldName Split Policy to RATIO

4. Create a PERSONAL geodatabase, eg: ImpervSurf
– NOTE the process below will not work with a FILE geodatabase

5. Run the Intersect tool
Parameters:
Input Features: ImpervSample_Layer, ParcelSample
Output Feature Class: ImpervSample_Intersect

Greatest Overlap logic continued

6. Run query on the ImpervSample_Intersect feature class:
[PerC] in (select max([PerC]) from ImpervSample_Intersect group by [FID_ImpervSample])

7. Export selected results from ImpervSample_Intersect to a DBF table named
Max_Export_Output.dbf and bring the table into MXD

8. Run the Delete Field tool on Max_Export_Output.dbf table
Delete all but the following fields:
FID_Imperv
PIN
IMP_LUCODE

9. Join ImpervSample shapefile to Max_Export_Output.dbf using FID
and FID_Imperv as the relate fields.

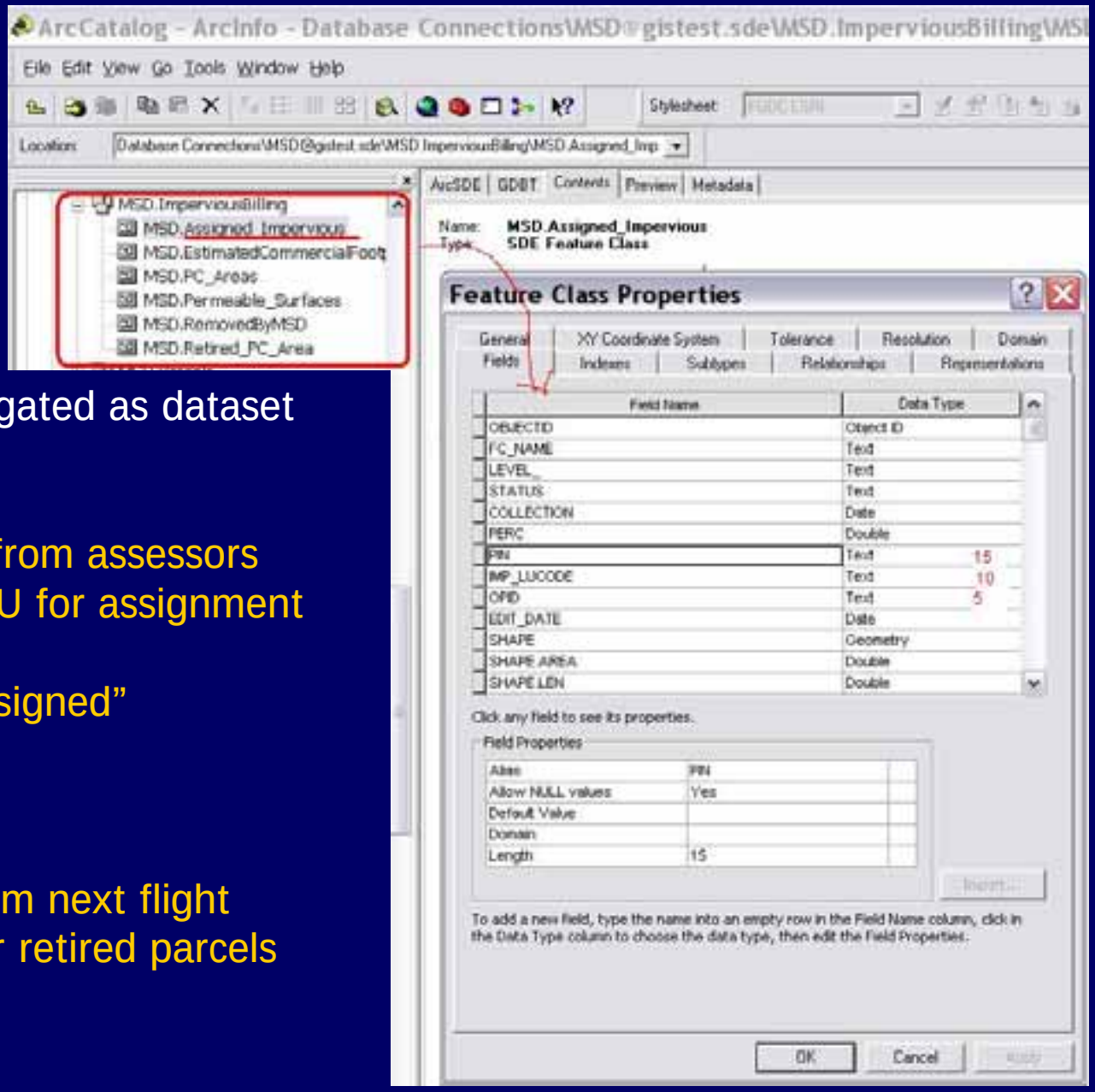
10. Add a new field to ImpervSample shapefile called Par_PIN; set Type to Text

11. Copy PIN values into PAR_PIN field, IMP_LUCODE to LUCODE

12. Remove ImpervSample join

Non-RES LUCODE

- Straight intersect between Surfaces and parcels
- Multi-parcel development, parking, etc split on parcel boundary



Impervious data segregated as dataset

Parcels:

Combination from assessors

Generalized LU for assignment

Surfaces:

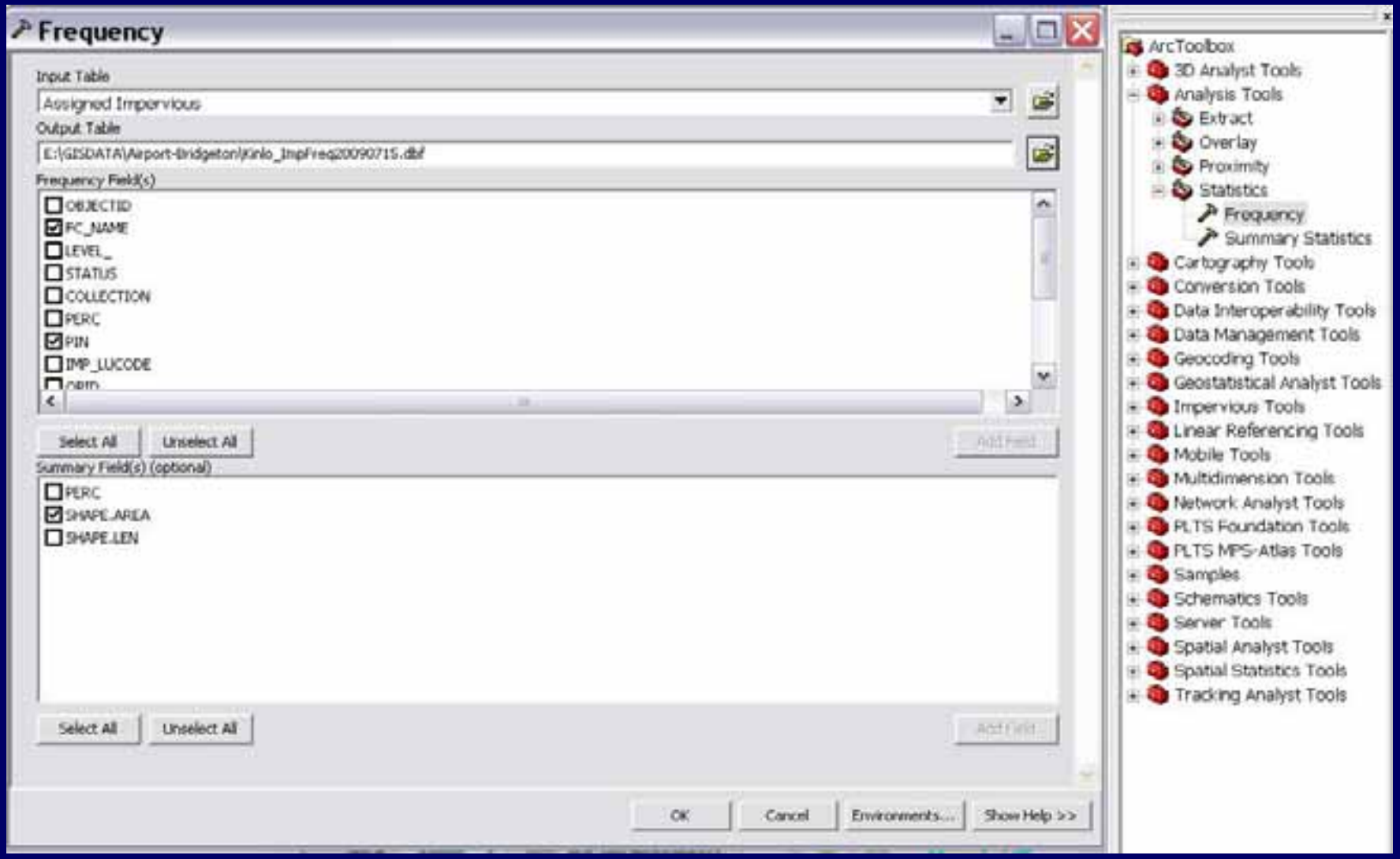
Billable = “Assigned”

Non-billable

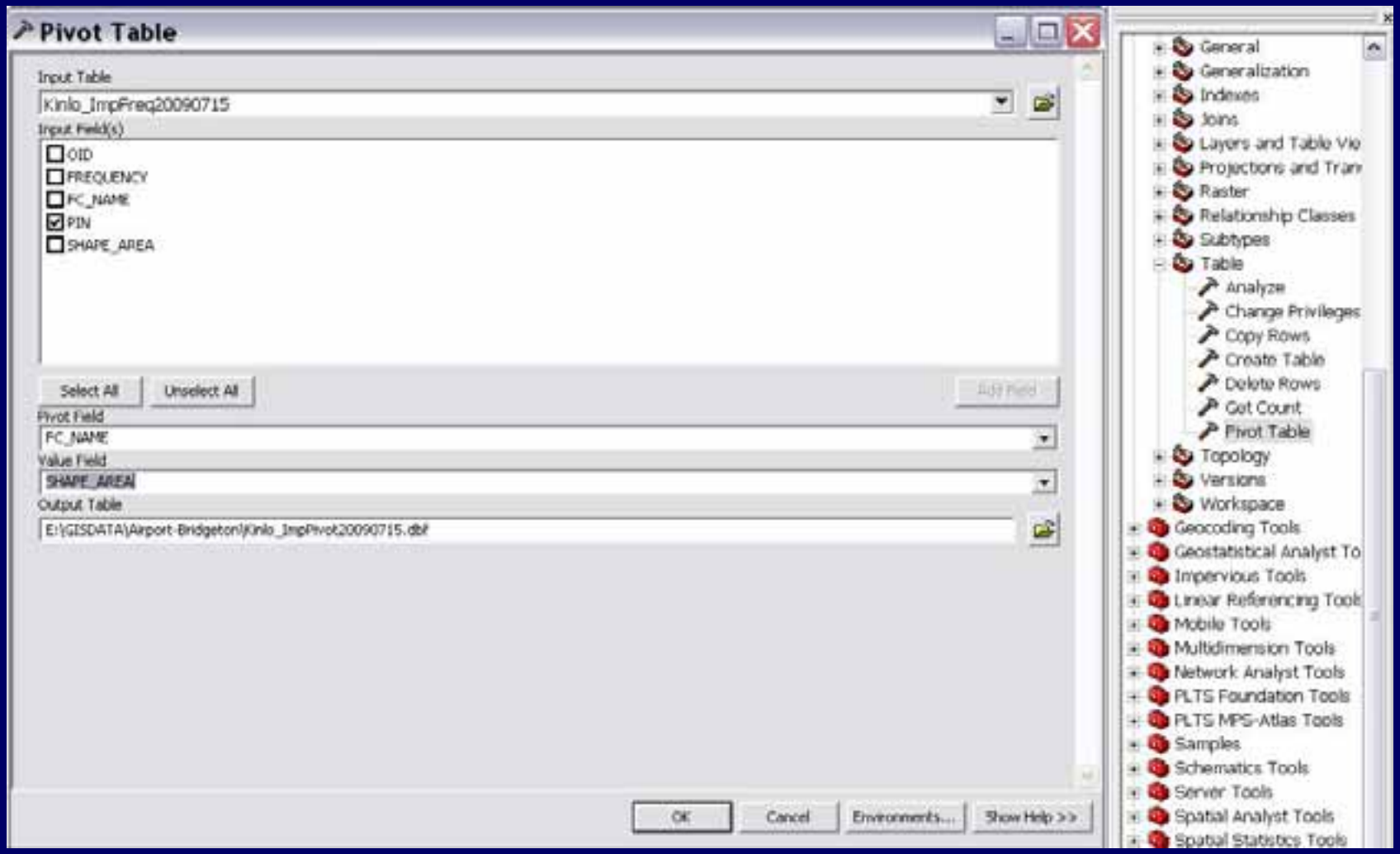
Archival:

- Prohibit recapture from next flight
- Billing comparison for retired parcels

Summarizing by Surface Category

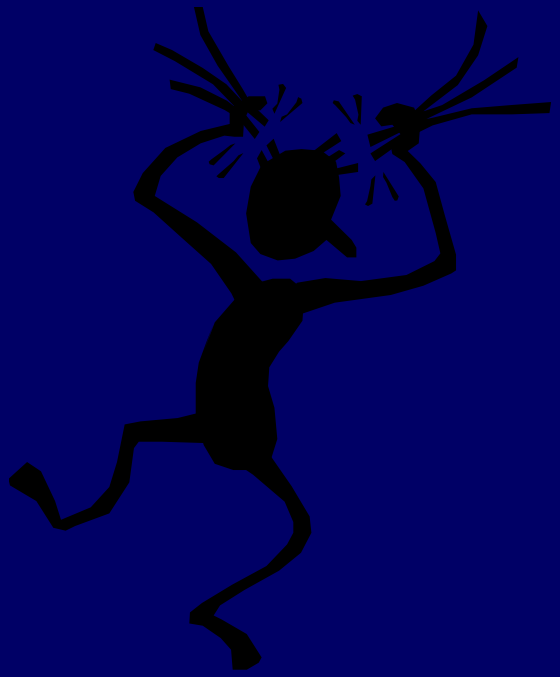


Total by Parcel



Updating Surface Data

- 2008 Billing based on 2005 capture
- Update to 2007 capture by December
- Complete re-process!



An alternative approach

- 2009 capture updated as two-way replica
- Contractor submitted replica to TEST db
- MSD review & acceptance
  - Manage change records
- Archive production
- Update TEST to PROD

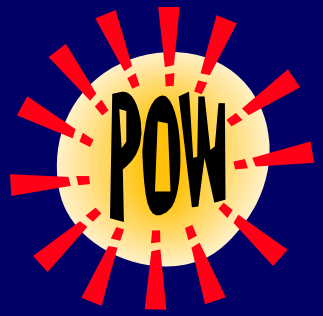
Benefits of Replication

Parcels

- Allow selection of new parcels, assignment of surface
- Review of Retired parcels

Surfaces

- Status field allowed review of change <u>only</u>
- Checked for “orphaned” surfaces
- General QC of existing



Replication cut 2-3 months off update schedule!

Updating Parcel Data

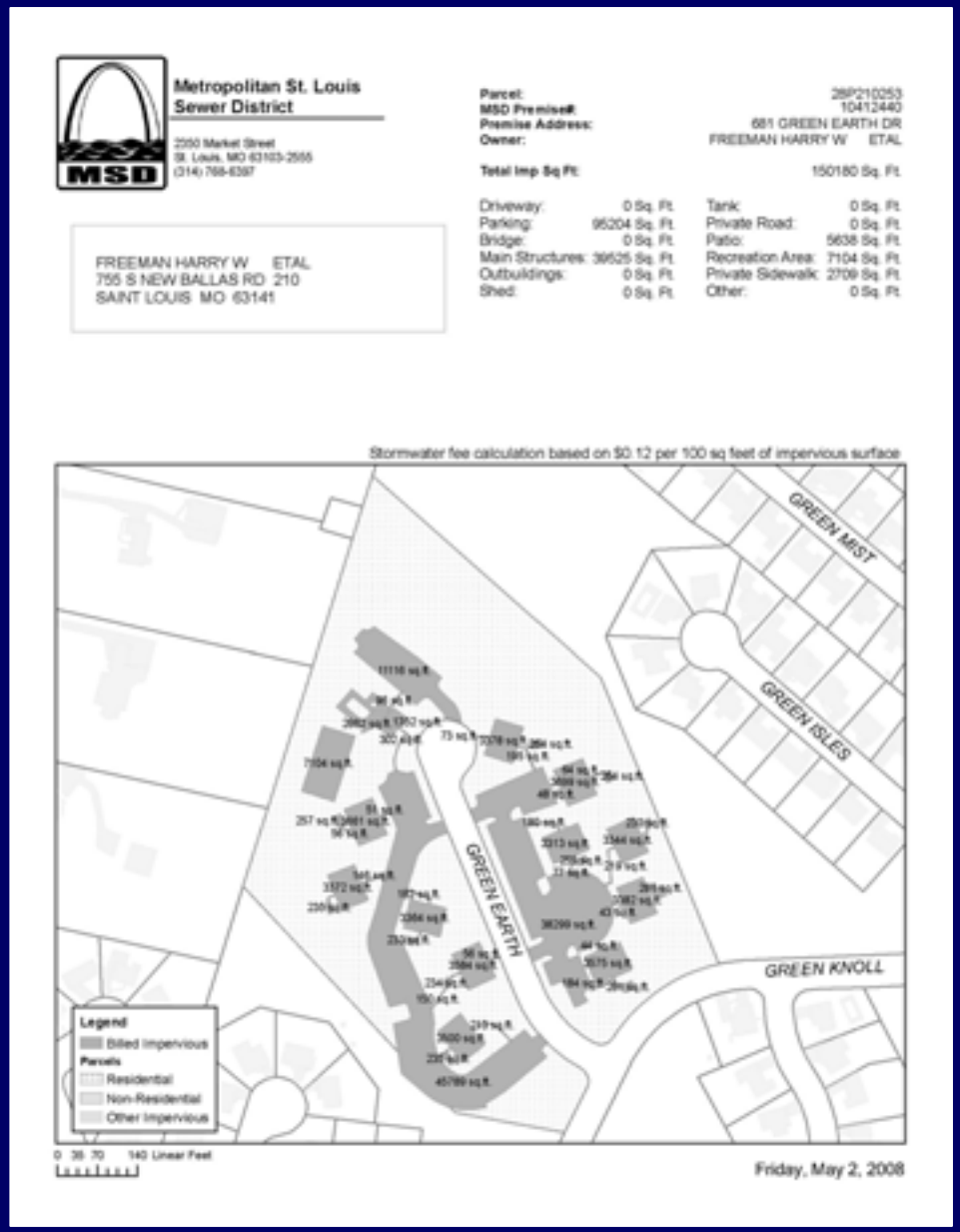
- Receive data from City & County Assessors
- Review PC_Area features for change
- Track retired parcels
- Adjust ownership on affected surfaces
- Pass updated records to Billing

Special Cases

- “MSD Parcels”
- “Green” Surfaces
- Estimated surfaces

Appeals map

- Review by MSD staff for errors
- Details for customer the total of surface type
- Display shows all surfaces involved
- Map sheet formatted for envelope fold



Metropolitan St. Louis Sewer District
2350 Market Street
St. Louis, MO 63103-2555
(314) 768-6397

Parcel:	28P210053
MSD Premise#:	10412440
Premise Address:	681 GREEN EARTH DR
Owner:	FREEMAN HARRY W ETAL
Total Imp Sq Ft:	150180 Sq. Ft.

FREEMAN HARRY W ETAL
755 S NEW BALLAS RD 210
SAINT LOUIS MO 63141

Driveway:	0 Sq. Ft.	Tank:	0 Sq. Ft.
Parking:	95204 Sq. Ft.	Private Road:	0 Sq. Ft.
Bridge:	0 Sq. Ft.	Patio:	5638 Sq. Ft.
Main Structures:	39525 Sq. Ft.	Recreation Area:	7104 Sq. Ft.
Outbuildings:	0 Sq. Ft.	Private Sidewalk:	2709 Sq. Ft.
Shed:	0 Sq. Ft.	Other:	0 Sq. Ft.

Stormwater fee calculation based on $0.12 per 100 sq feet of impervious surface

Friday, May 2, 2008

(Back side of appeal)

- Explanation of surface calculation / fee
- Contact information at MSD
- Instructions if customer appeals MSD determination

Instructions for Completing this Impervious Area Appeal Form

The front of this page contains all of the information associated with the impervious surface* area used in calculating your storm water charge reflected on your MSD bill. The computer generated plot of your parcel shows your property boundary and the impervious surfaces upon it.

- If the property shown does not belong to you, or was recently sold, please indicate such on the front of this form. In the case of a sale, include the sale date and purchaser information.
- If you believe the square footage of the impervious surfaces are incorrect, you can perform the measurements yourself and submit them back to the District for review. The measurements required are the length in feet multiplied by the width in feet to arrive at the total square footage of a surface. ***Please show these measurements on the sketch provided on the front of this form.*** The actual billing rate for an impervious surface is $.0012 per sq. foot (or $.12 per one hundred square feet). Multiply the total square feet of surface by the rate of .0012 to arrive at the total charge for that surface. The sum of all of the surfaces should equal your total charge. Please be aware that buildings are measured at the 'roofline' and not the 'footprint'. These measurements are subject to verification by use of geographic information systems and aerial photography. If deemed necessary by MSD Storm Water Management Staff, a site visit may be made.
- New construction for residential properties will get an estimated impervious surface charge based upon the average residential charge within that property's zip code. New construction for commercial properties will get an impervious surface charge based on the amount of impervious surfaces declared on their permit application filed with the District. These estimated charges will apply until the next aerial update, at which time, the actual impervious surface calculations will supersede the estimated values. Future billings will reflect actual measurements as they are acquired.

If you have questions regarding the completion of this form, please contact an Impervious Surface Representative by phone, email or visit. Upon completion, sign this appeal form and submit back to the District address below.

Contact:
Impervious Surface Representative
Phone: 314-768-6397
Email: stormwater@msdmsd.com

Return Appeal Form to:
Impervious Surface Appeals
Metropolitan St.Louis Sewer District
2350 Market St.
St. Louis, MO 63103

**Impervious surfaces are those that don't allow rainfall the opportunity to soak into the ground like a natural earth surface and result in run-off of almost all rainfall. Property owners may NOT appeal the inclusion of gravel drives or parking as an impervious surface. Green roofs and surfaces paved with concrete, asphalt, or rock that are designed and constructed to allow water to pass through the paved surface to a sub-base that allows water the opportunity to soak into the earth surface below should not be counted as impervious surface. The determination of this kind of surface usually requires the investigation of an engineer.*

I certify that all statements made in this appeal are true, complete and correct to the best of my knowledge and belief. I further acknowledge that any information provided by me is subject to verification and understand that MSD staff may conduct an on site investigation to visit my property as needed.

Applicant's Signature **Daytime Phone Number** **Date**

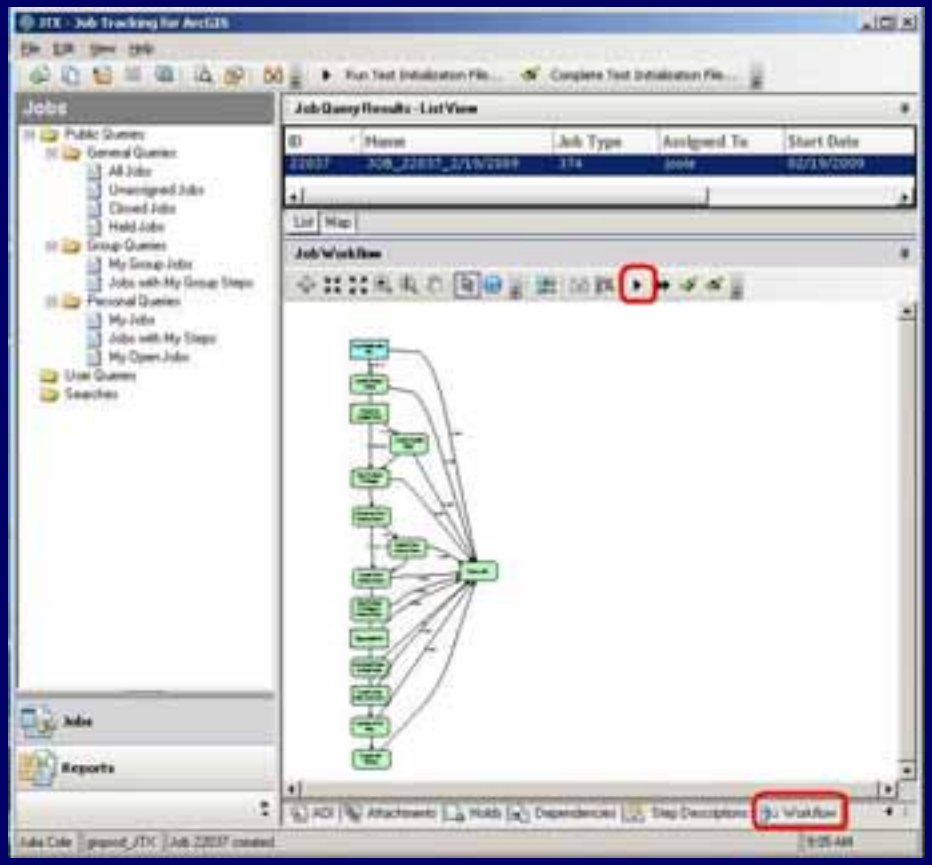
Your signature is required for processing of this appeal. Please retain a copy of this form for your records.

FOR OFFICE USE ONLY

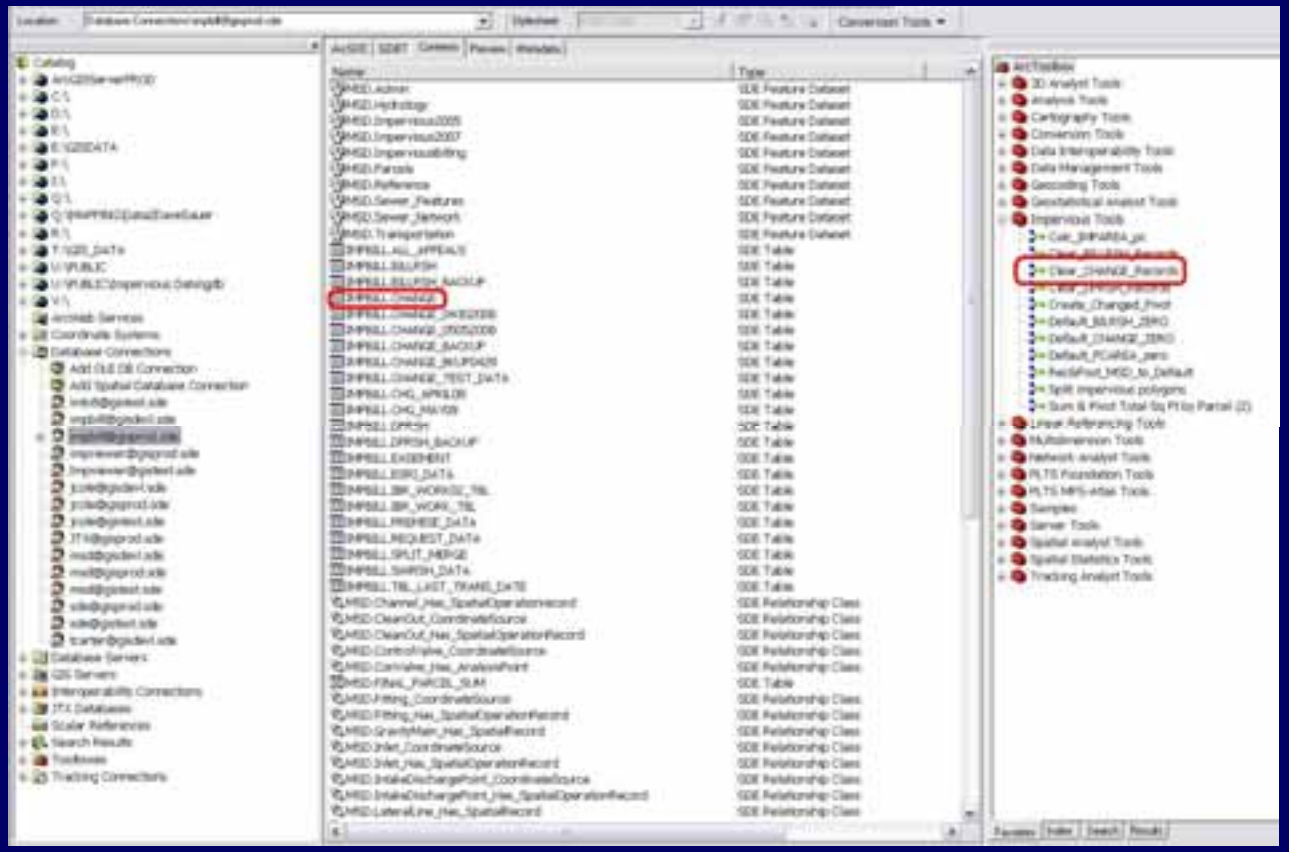
Date Received:	**Reviewed By:** **Approved By:** ☐ **Appeal denied** ☐ **Appeal approved** **Fee Adjustment Issued** ☐ **YES** ☐ **NO** **Resolution Date:**
☐ **Graphics corrected**	

Automated map generation

- Customer calls logged in support system include Parcel ID
- Appeals or research extracted daily
- Parcel IDs used to generate individual map sheets



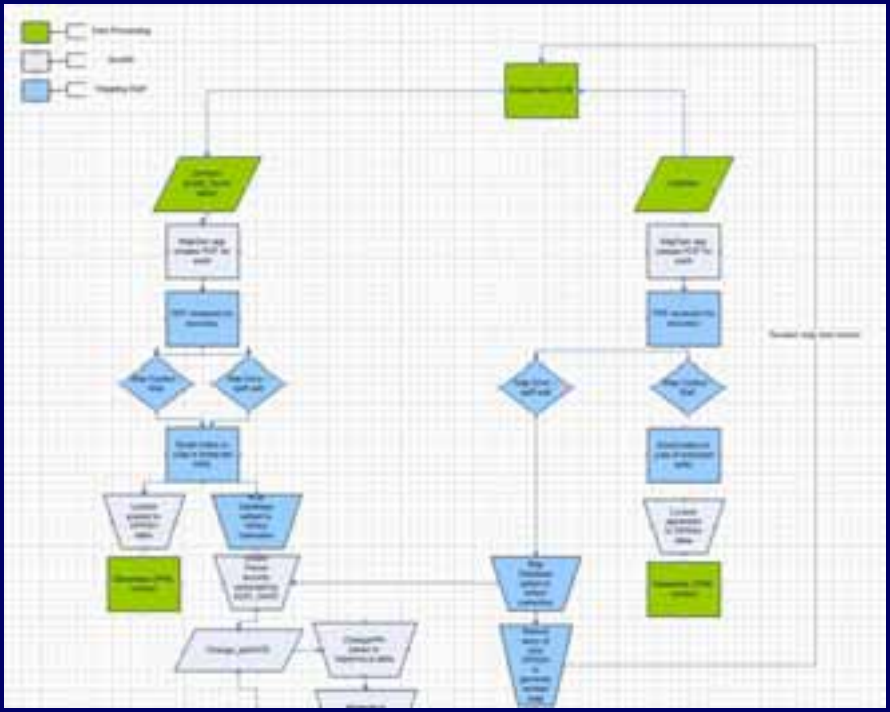
Records to Billing



Internal workflow for Processing Appeals

Customer Service

- Incoming calls to Customer Service
- Automated next-day maps
- Review by GIS department staff

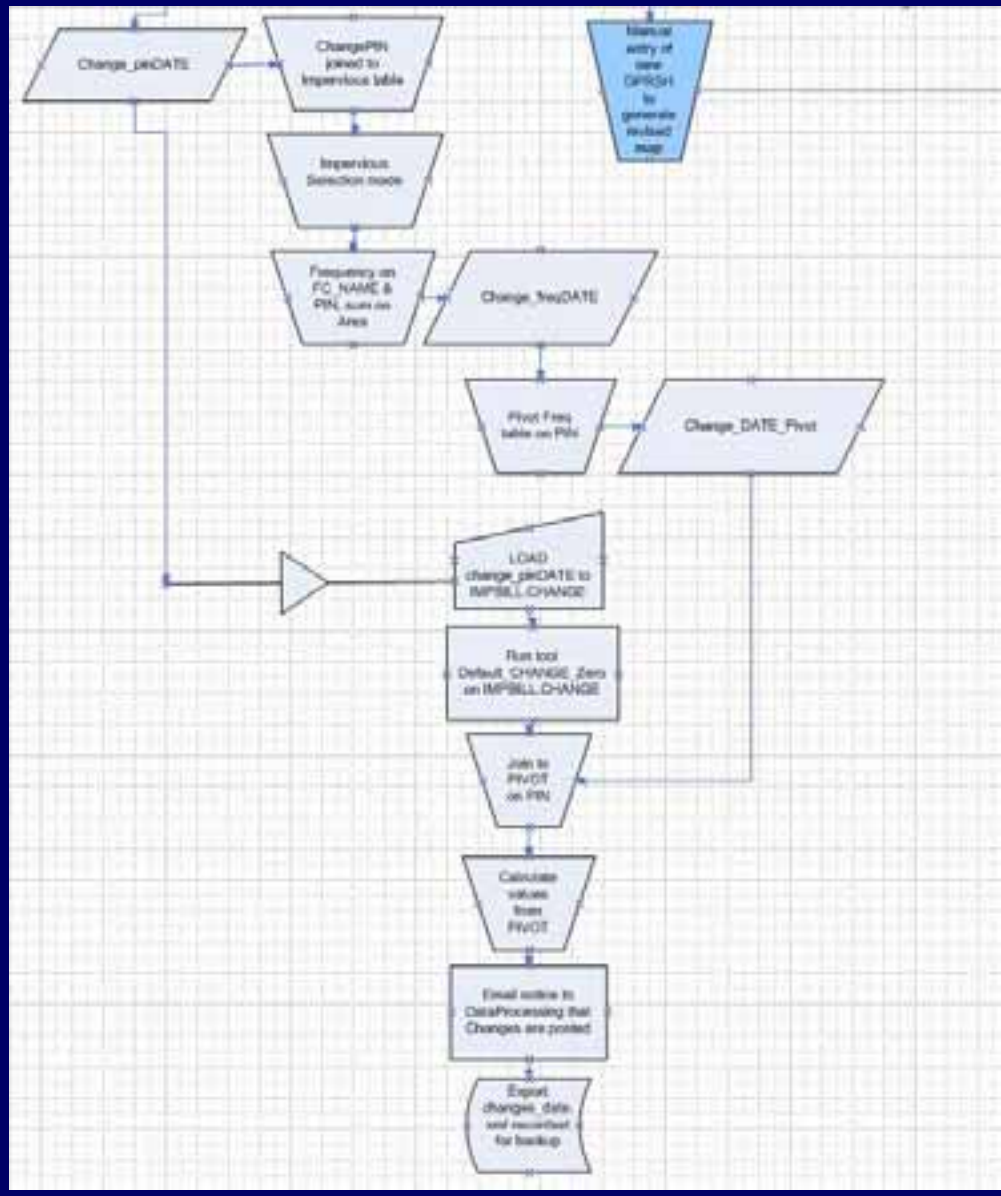


Mapping/GIS Department

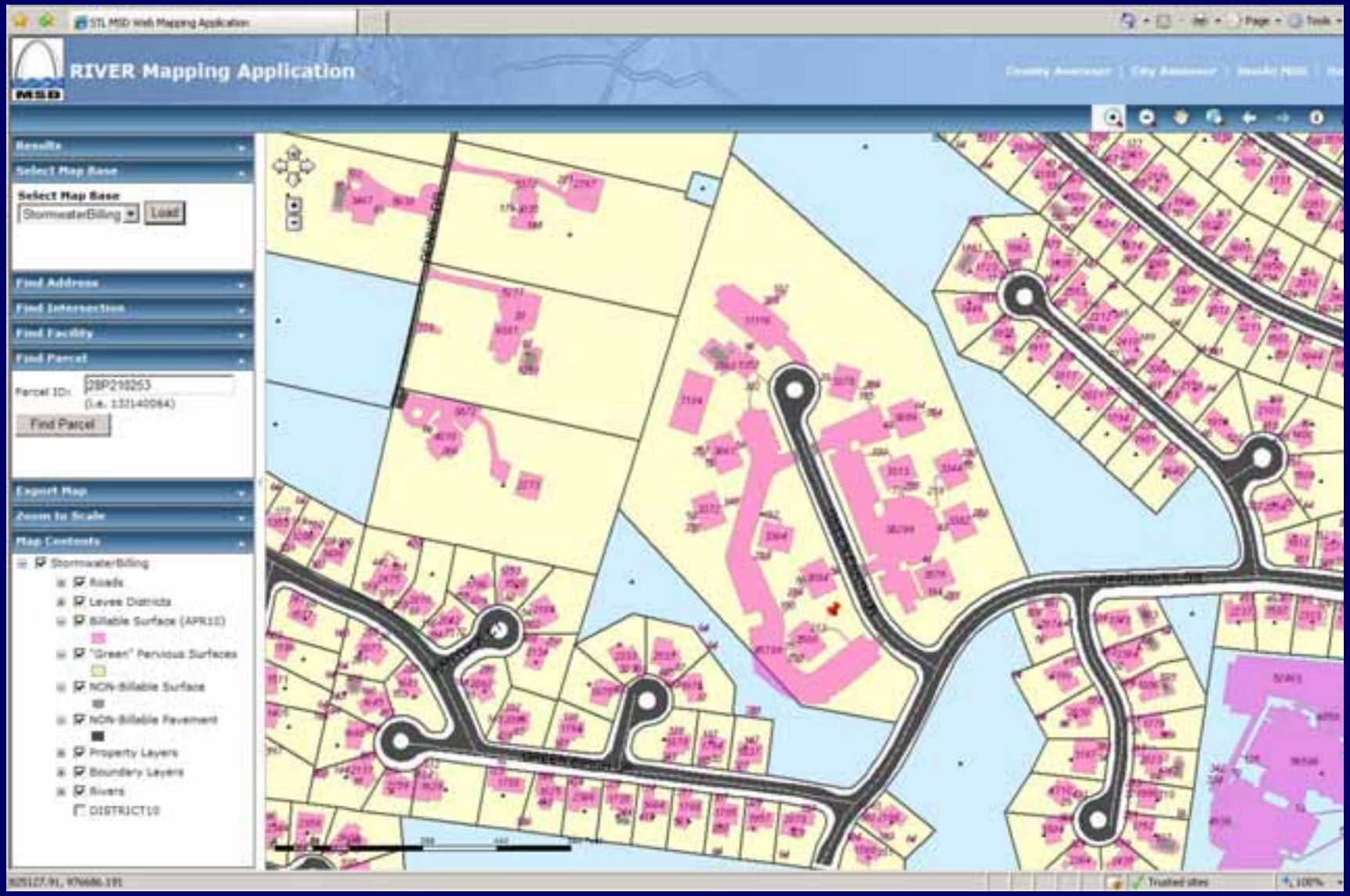
- Changes made as versioned edit
- End of day query for modified parcels
- Summarize assigned impervious by parcel
- Load summary into shared table for update into billing system
- Generate a new map if surface assignment has been altered

Billing Department

- Updates processed to correct sq footage on customer account
- Overcharge is refunded
- Customer gets notification of change
- Send explanation and revised map to customer



Intranet access



Lessons learned

- Inter-departmental Impervious “team”
- Response to Customer
- Real time editing vs. periodic updates
- Off-site access
- Availability to all staff

To find out what's going at MSD

- http://www.stlmsd.com

Thank you for your attention…