HSW Engineering, Inc.

ENVIRONMENTAL

CIVIL / LAND DEVELOPMENT

WATER RESOURCES

Spatially Integrated Model for Pollutant Loading Estimates

July 23, 2014

Derek Huston, P.E. dhuston@hsweng.com
Ken Watson, PhD kwatson@hsweng.com
HSW Engineering, Inc. (813) 968-7722

Background

HSW Engineering, Inc.

- SIMPLE:
  - Numerical model for Degree of Impairment
  - TMDL assessment
  - Defining BMAPs
  - Compliance Monitoring
- Similar to GIS-load model developed for Myakka River watershed in 1993
- 2009 - 1st version complete, Seasonal
- 2011 - Features added, Monthly
- 2013 – HSW updated Hydrologic engine

More About SIMPLE

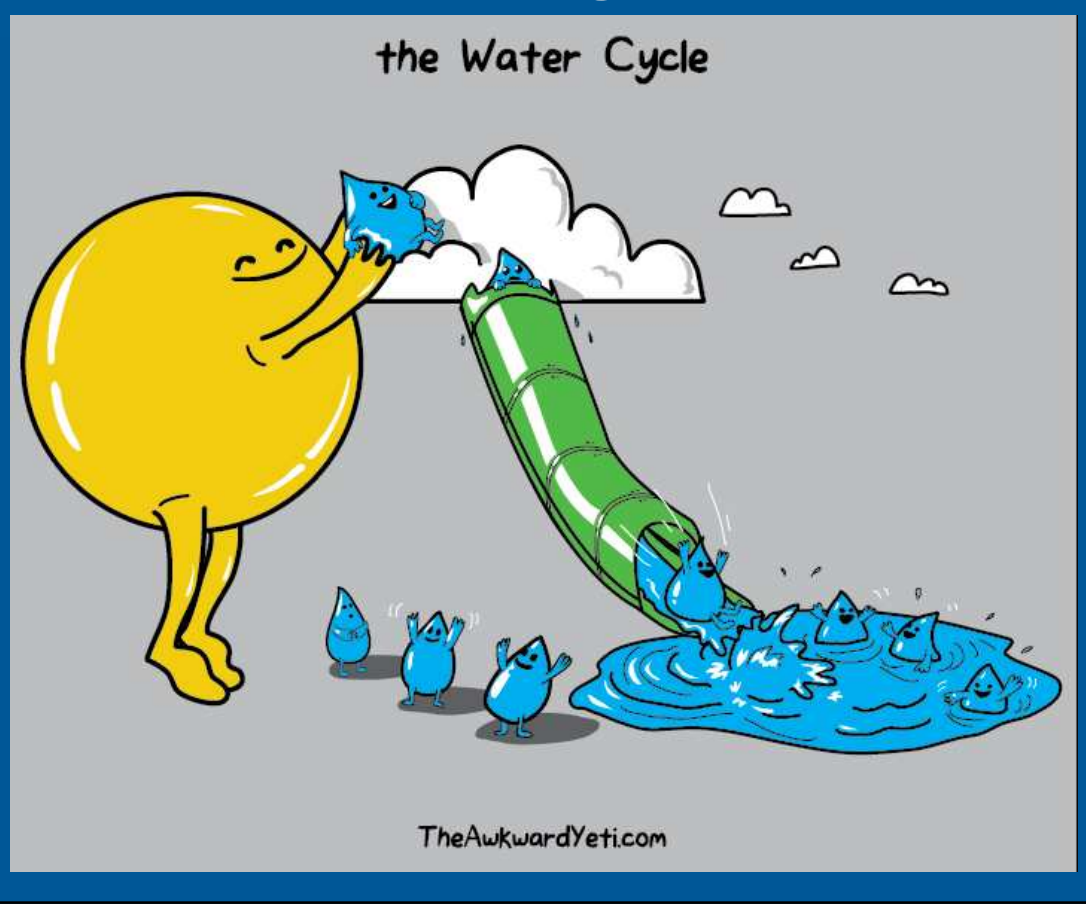
- GIS based (ArcGIS v. 9.3.2)
- Layers represent variables for chemical load calculations
- Assortment of modular elements
- Covers all areas contributing loads to Sarasota County
- Interactive
- Adaptable

Hydrologic Engine

Rainfall – ET – Runoff – Recharge = 0

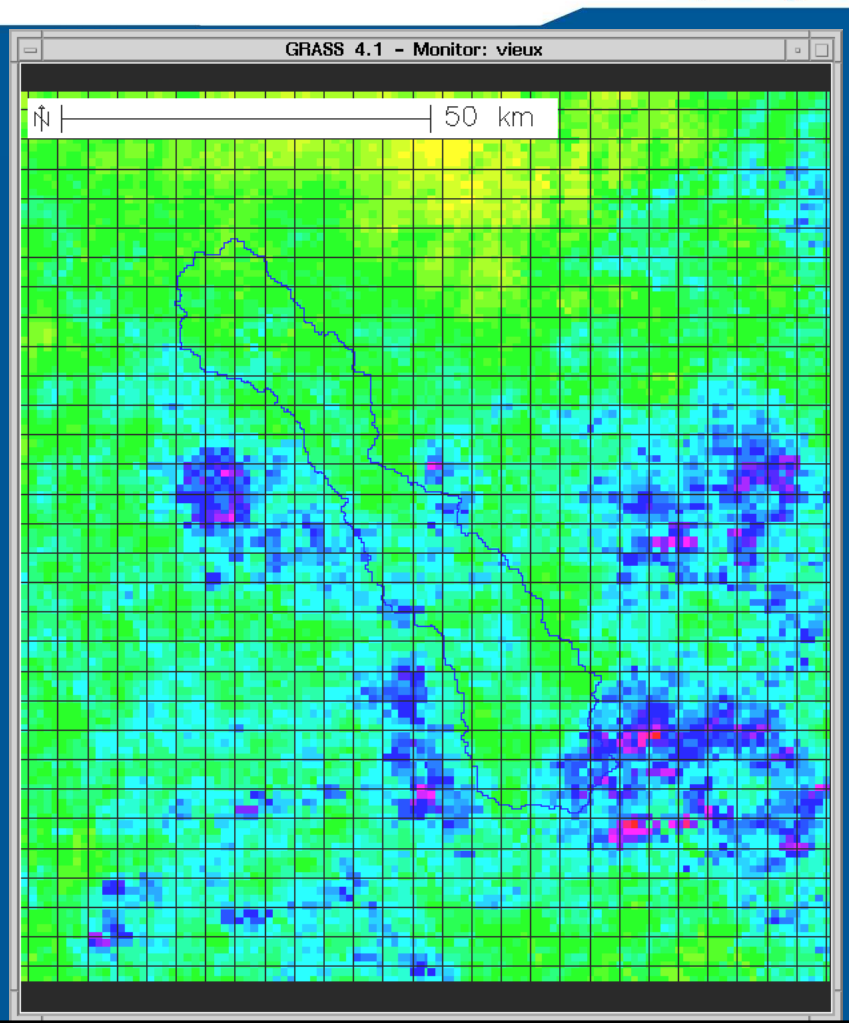
Calculates Monthly Water Balances

Daily time step



Rainfall (P)

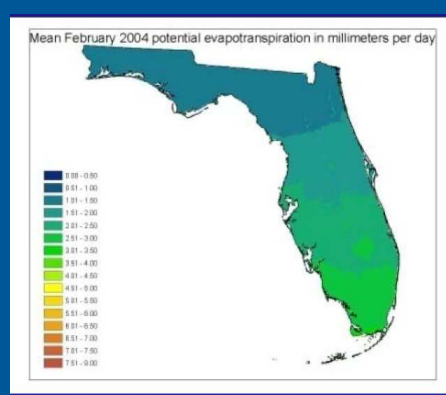
- NEXRAD (Next-Generation Radar)
- 15-minute values aggregated daily
- 2-km grid squares

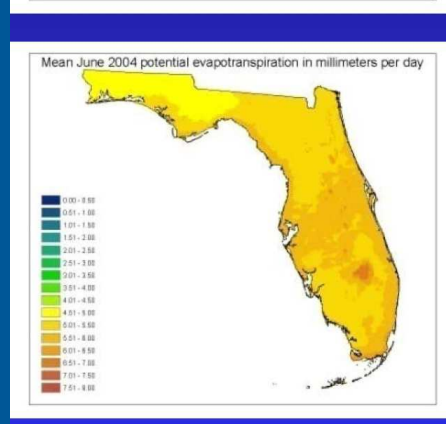


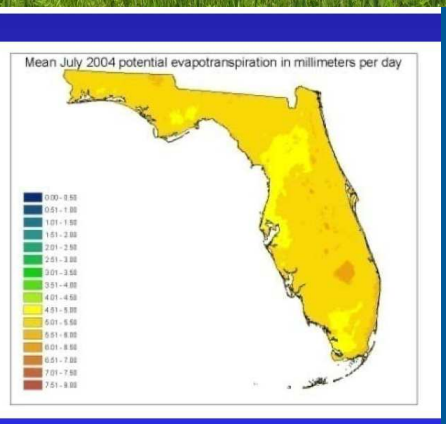
Source: SWFWMD

Evapotranspiration (ET)

- NEXRAD
- PET (Priestly-Taylor method)
- Averaged for County







Source: USGS

Hydrologic Variables

- **FLUCCS Codes Grouped by:**

• Forest Open Park	• Pasture	• Row Crops	• Generic Ag.
• Low Density	• Bay	• Med Density 1	• Commercial
• High Density	• Wetlands	• Med Density 2	• Transportation
• Golf Courses	• Water	• Med Density 3	• Light Industrial

- **Soil types by USDA NRCS**

A	**High infiltration**
B	Moderate infiltration
C	Slow infiltration
D	Very Slow Infiltration

Direct Runoff (Qd)

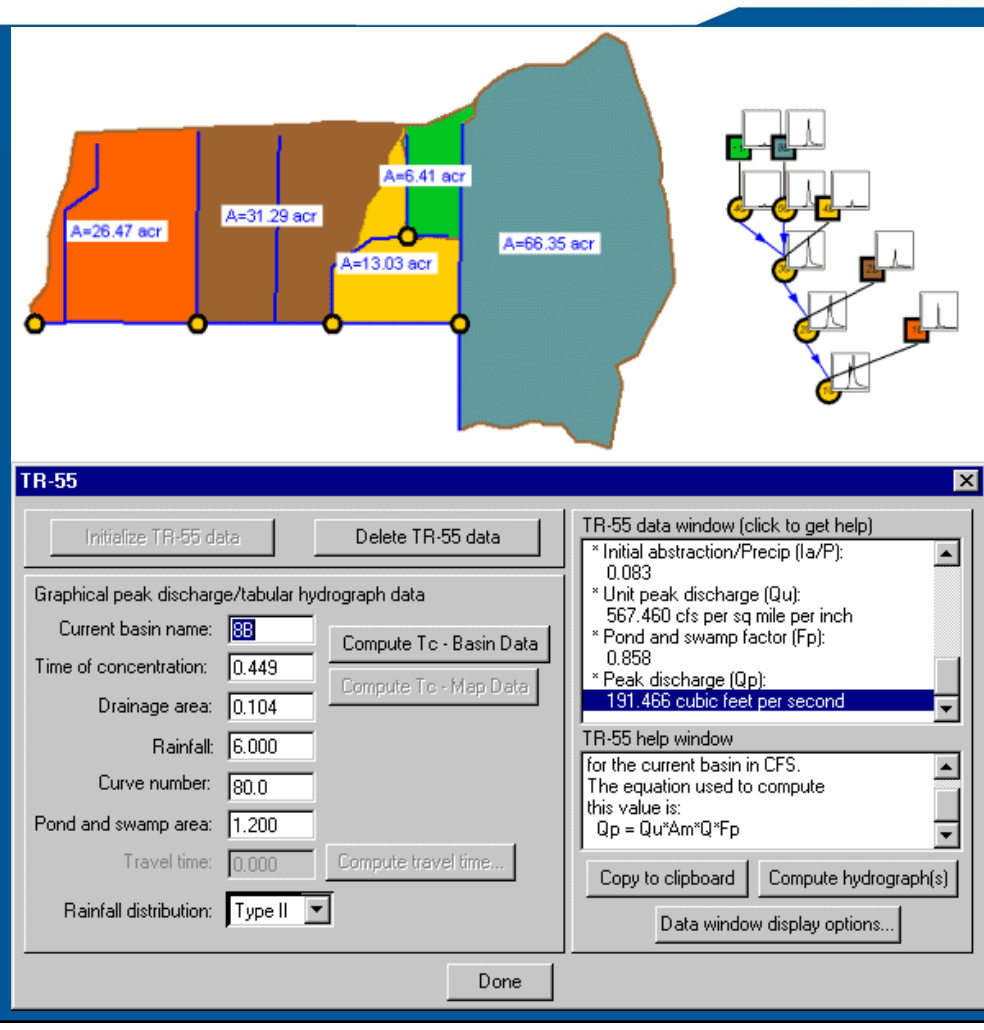
NRCS TR-55 method

$$Q_d = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

$$S = \frac{1000}{CN} - 10$$

$$S = Retention$$

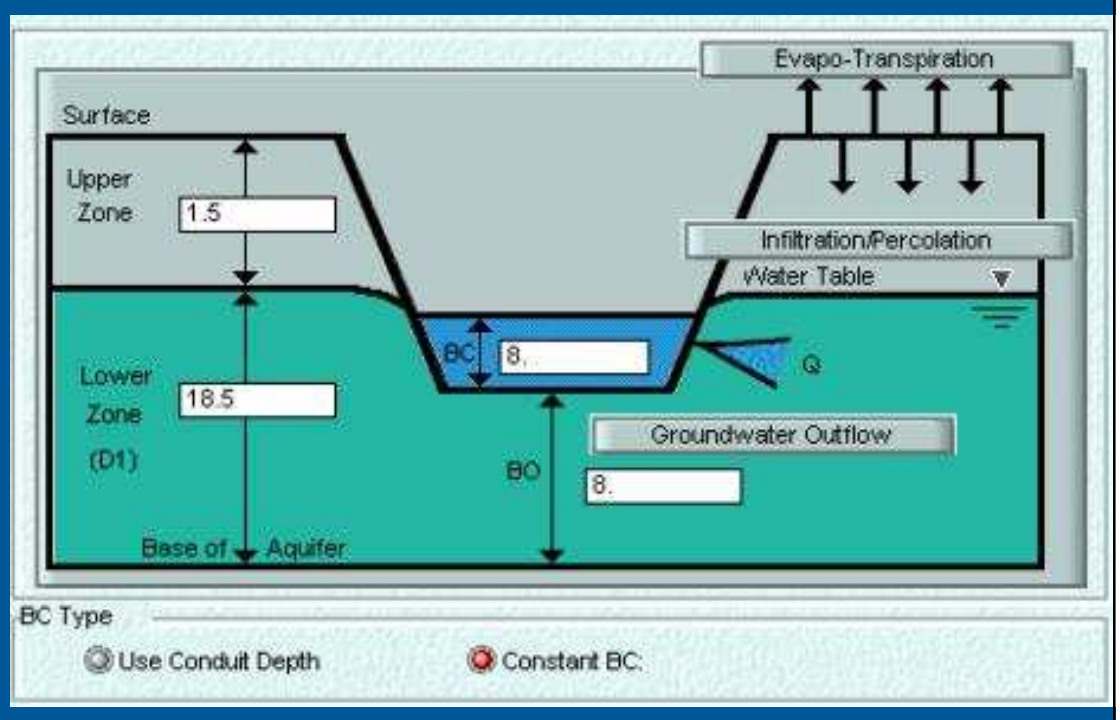
CN = Curve Number



Base Flow Runoff (Qb)

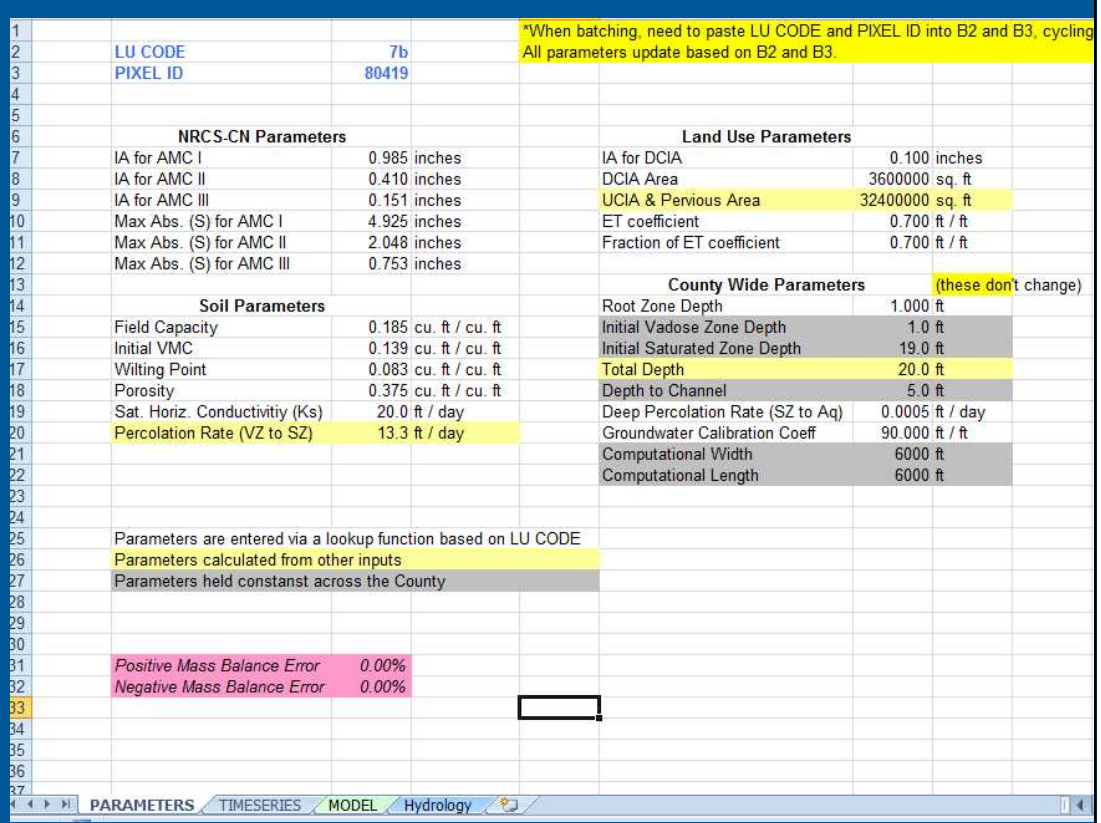
- USEPA SWMM based
- Dupuit-Forcheimer method
- Hydraulic conductivity (K) from soil layer

$$Q_b = (D1 - BC)^2 \times \frac{c \times k}{L^2}$$



Hydrologic Engine Update

- Replace Existing Engine
- Excel Macro
- Difficult to Update

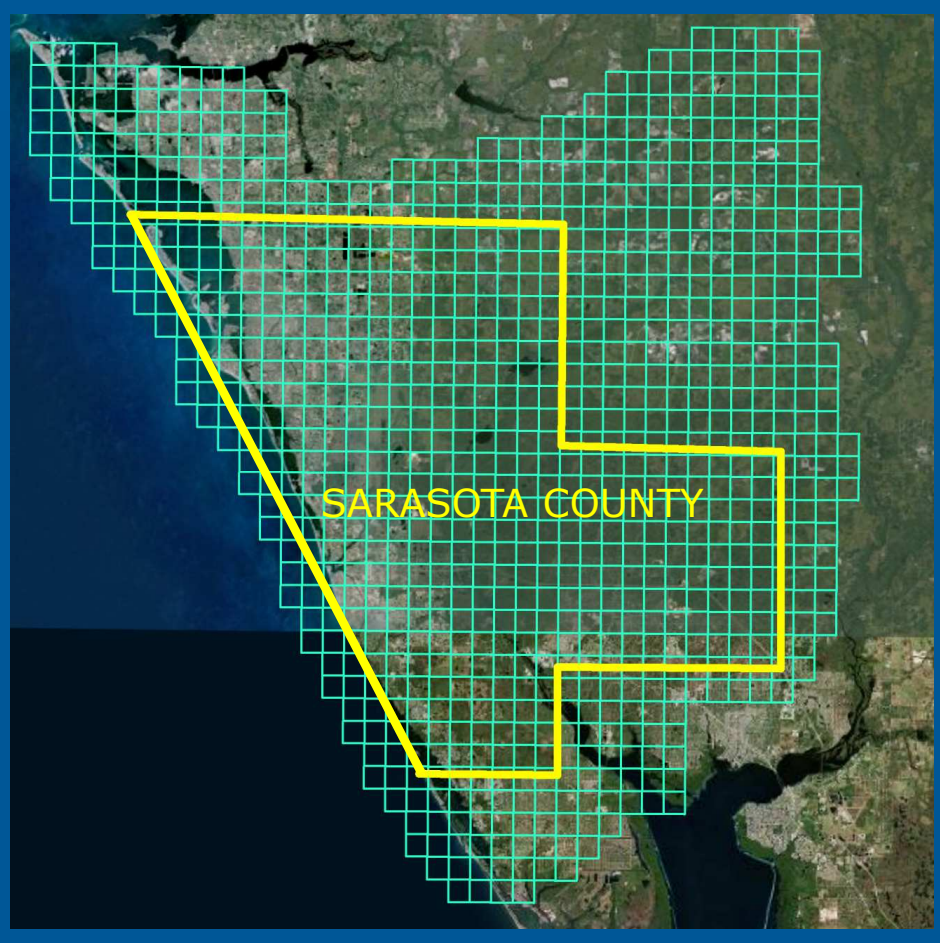


1				*When batching, need to paste LU CODE and PIXEL ID into B2 and B3, cycling		
2	LU CODE	7b		All parameters update based on B2 and B3.		
3	PIXEL ID	80419				
4						
5						
6	NRCS-CN Parameters			Land Use Parameters		
7	IA for AMC I	0.985	inches	IA for DCIA	0.100	inches
8	IA for AMC II	0.410	inches	DCIA Area	3600000	sq. ft
9	IA for AMC III	0.151	inches	UCIA & Pervious Area	32400000	sq. ft
10	Max Abs. (S) for AMC I	4.925	inches	ET coefficient	0.700	ft / ft
11	Max Abs. (S) for AMC II	2.048	inches	Fraction of ET coefficient	0.700	ft / ft
12	Max Abs. (S) for AMC III	0.753	inches			
13				County Wide Parameters		(these don't change)
14	Soil Parameters			Root Zone Depth	1.000	ft
15	Field Capacity	0.185	cu. ft / cu. ft	Initial Vadose Zone Depth	1.0	ft
16	Initial VMC	0.139	cu. ft / cu. ft	Initial Saturated Zone Depth	19.0	ft
17	Wilting Point	0.083	cu. ft / cu. ft	Total Depth	20.0	ft
18	Porosity	0.375	cu. ft / cu. ft	Depth to Channel	5.0	ft
19	Sat. Horiz. Conductivitiy (Ks)	20.0	ft / day	Deep Percolation Rate (SZ to Aq)	0.0005	ft / day
20	Percolation Rate (VZ to SZ)	13.3	ft / day	Groundwater Calibration Coeff	90.000	ft / ft
21				Computational Width	6000	ft
22				Computational Length	6000	ft
23						
24						
25	Parameters are entered via a lookup function based on LU CODE					
26	Parameters calculated from other inputs					
27	Parameters held constanst across the County					
28						
29						
30						
31	*Positive Mass Balance Error*	*0.00%*				
32	*Negative Mass Balance Error*	*0.00%*				
33						
34						
35						
36						
37						

PARAMETERS | TIMESERIES | MODEL | Hydrology

Hydrologic Engine Update

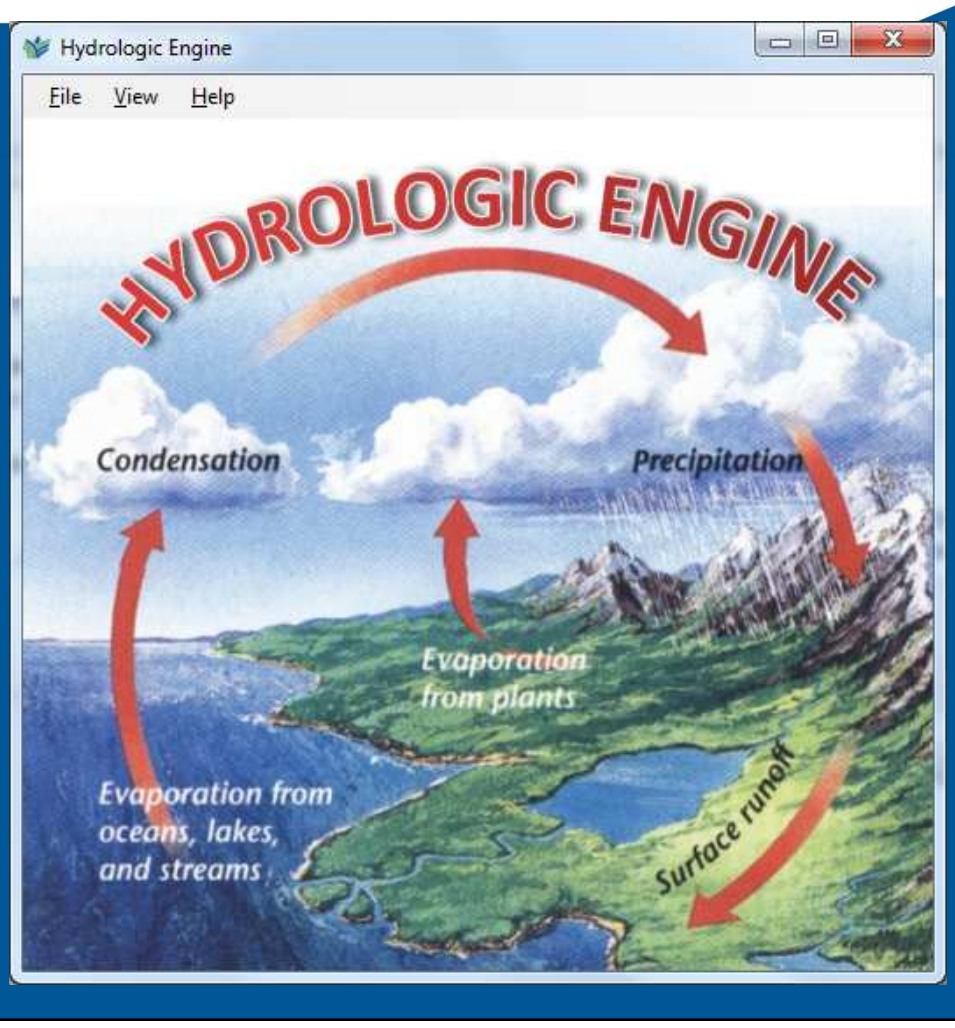
- 930 pixels, 6,575 dates, 16 land uses, and 4 soil types
- 391M Records
- 5GB of Data



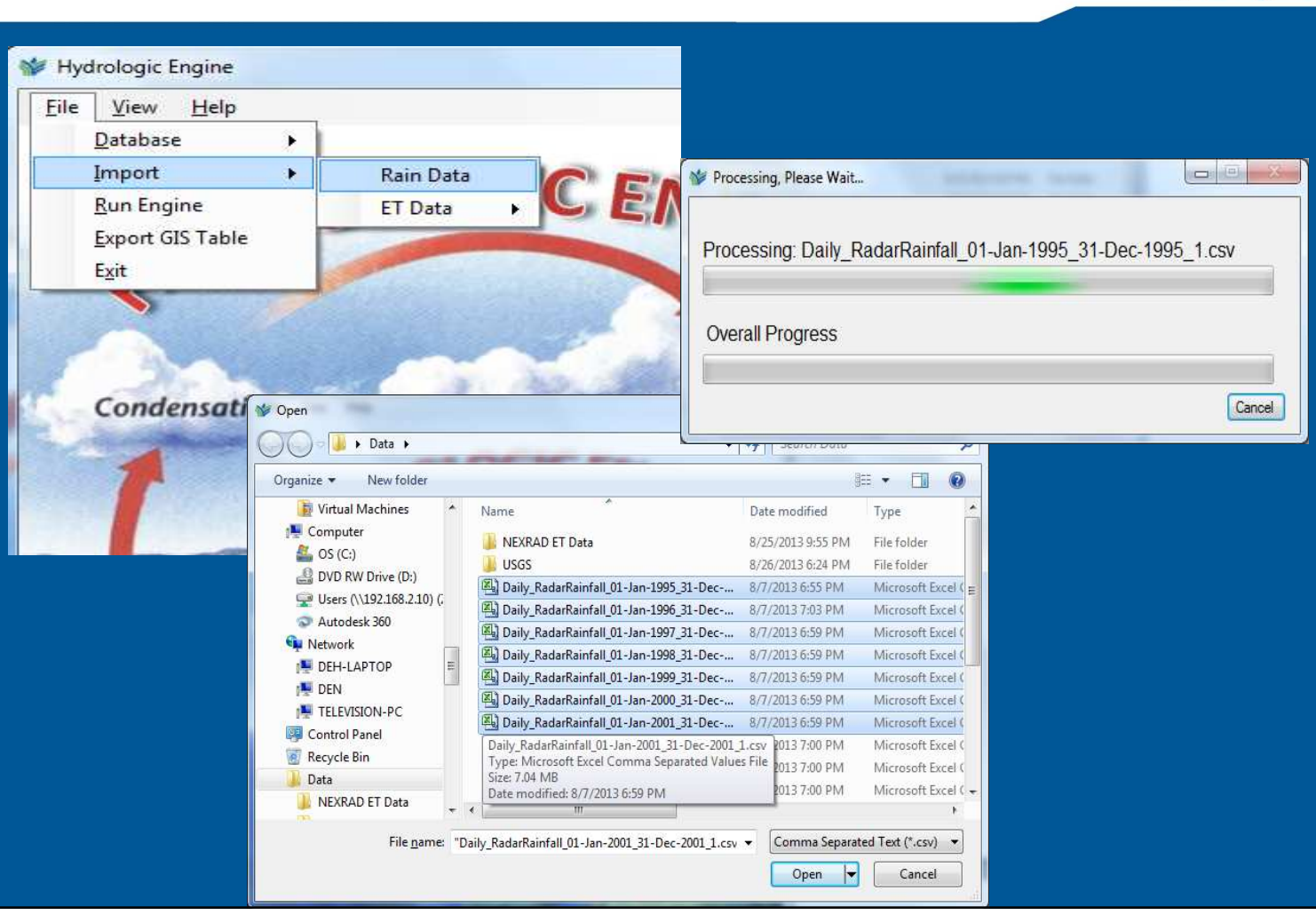
Hydrologic Engine Update

- Freely Available Tools
- Support Latest Versions
- Easy Installation

Hydrologic Engine Update

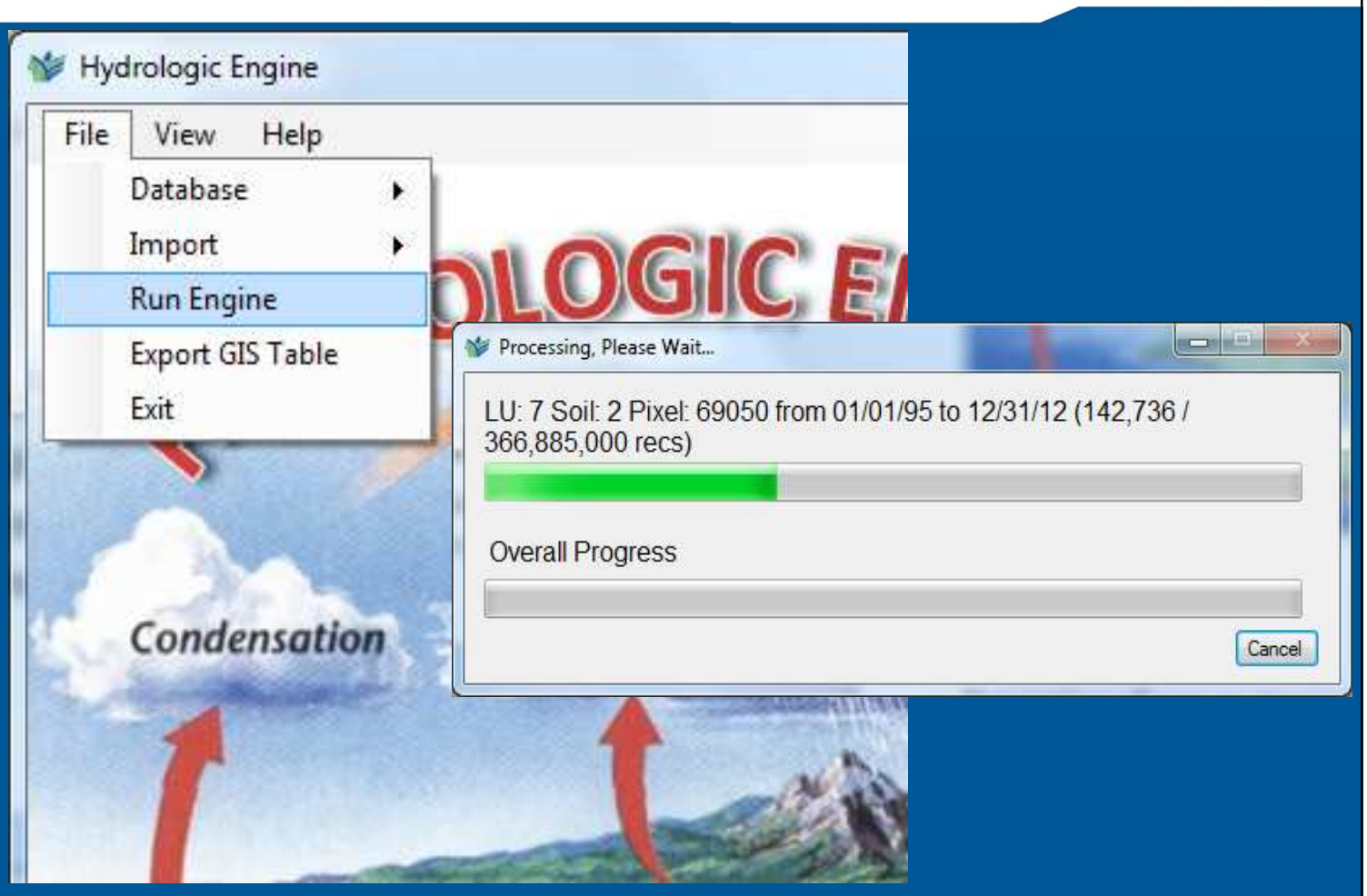


Data Entry

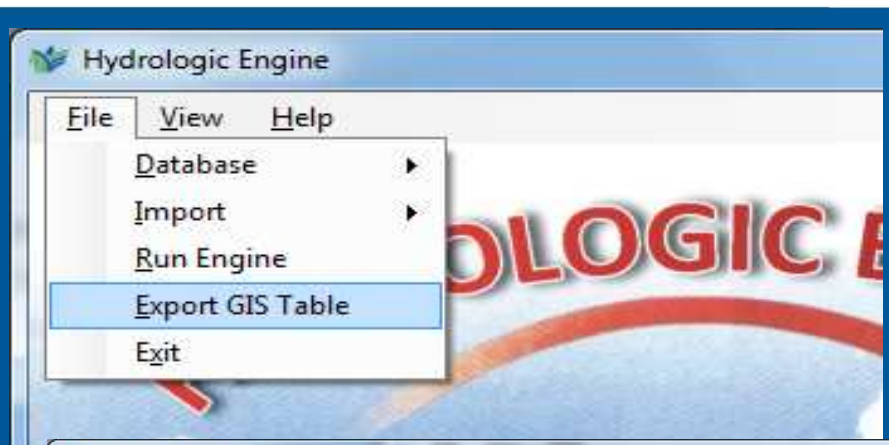


Data Check

Calculations



Output



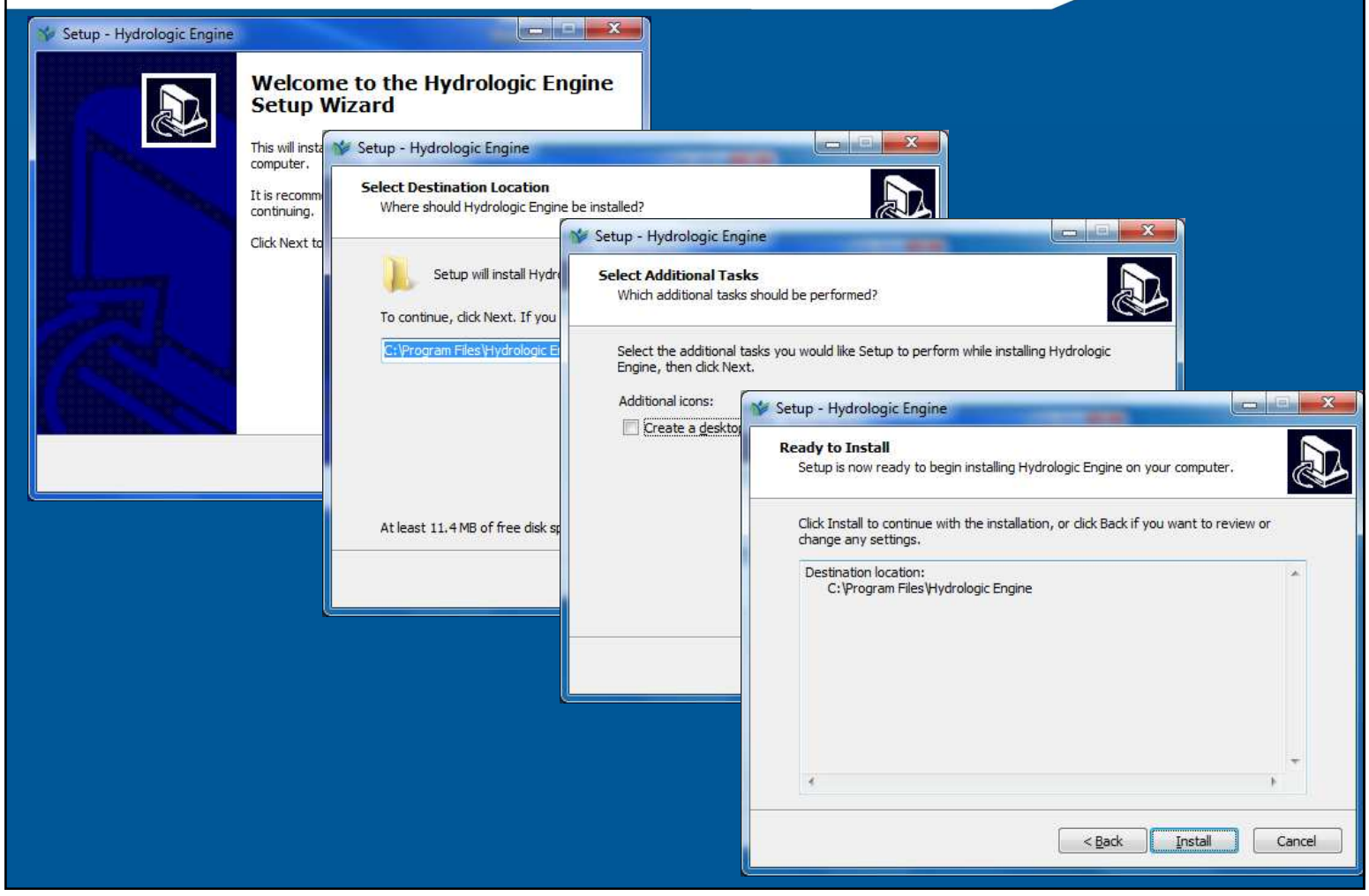
Hydrology Time Series

OBJECTID	date_	Pixel	Rainfall	Runoff	Baseflow	LU	Soil	LU_Soil	Pixel_LU_Soil
0	1/1/1995 12:00:00 AM	69050	3.561	0.357603	0.579288	1	1	1_1	69050_1_1
1	2/1/1995 12:00:00 AM	69050	2.576	0.066853	0.542484	1	1	1_1	69050_1_1
2	3/1/1995 12:00:00 AM	69050	1.024	0.000000	0.547109	1	1	1_1	69050_1_1
3	4/1/1995 12:00:00 AM	69050	3.136	0.000000	0.443171	1	1	1_1	69050_1_1
4	5/1/1995 12:00:00 AM	69050	0.141	0.000000	0.386499	1	1	1_1	69050_1_1
5	6/1/1995 12:00:00 AM	69050	23.151	10.115083	1.119389	1	1	1_1	69050_1_1
6	7/1/1995 12:00:00 AM	69050	13.161	3.001292	1.909116	1	1	1_1	69050_1_1
7	8/1/1995 12:00:00 AM	69050	8.314	2.672183	2.130510	1	1	1_1	69050_1_1
8	9/1/1995 12:00:00 AM	69050	7.124	1.657315	1.934782	1	1	1_1	69050_1_1
9	10/1/1995 12:00:00 AM	69050	10.223	2.116009	2.009770	1	1	1_1	69050_1_1
10	11/1/1995 12:00:00 AM	69050	0.853	0.000126	1.481262	1	1	1_1	69050_1_1
11	12/1/1995 12:00:00 AM	69050	0.969	0.000000	1.177996	1	1	1_1	69050_1_1
12	1/1/1996 12:00:00 AM	69050	0.540	0.000000	0.933254	1	1	1_1	69050_1_1
13	2/1/1996 12:00:00 AM	69050	0.611	0.000000	0.711716	1	1	1_1	69050_1_1
14	3/1/1996 12:00:00 AM	69050	4.275	0.009182	0.628445	1	1	1_1	69050_1_1

Setup File

- Prerequisites
  - Microsoft .Net version 4.0
  - Microsoft .Net version 4.5
  - Microsoft SQL Server Express LocalDB
  - Visual Basic Powerpack
- Professional Installer

Installer



Pollutant Loading Model

- Modules
  - Direct runoff
  - Base flow
  - Wet/dryfall
  - Irrigation
  - Point-source
  - Septic tank

$$EMC = \frac{\sum_{i=1}^{n} V_i C_i}{\sum_{i=1}^{n} V_i}$$

where:

EMC = event mean concentration

V_i = discharge amount corresponding to sample i

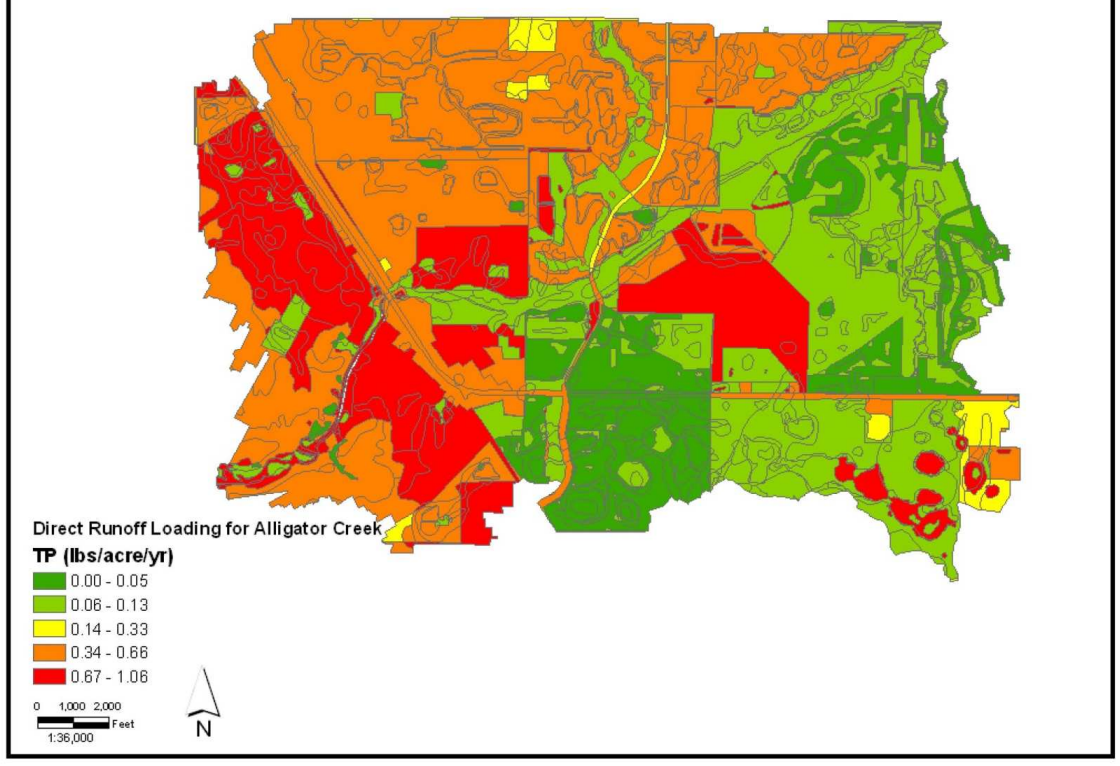
C_i = pollutant concentration in sample i

i = sample number

n = total number of samples collected

- Derived From Sampling
- Varies by Constituent and Land Cover (FLUCCS)
- BMPs Included

SIMPLE Output: Hot Spot Mapping



Source: Sarasota County (2007)

Questions

Derek E. Huston, P.E.
dhuston@hsweng.com
(407) 872-6893