

GIS Method for Characterizing Fire Flow Capacity

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Outline

- Introduction
- Research Design
- Methods
- Results
- Discussion
- Conclusions



Introduction

- Past studies have:
 - Investigated linkages between socioeconomic characteristics with fire risk and specific types of incidents
 - Assessed fire station location and response
 - Combined with spatial statistics as analytic tools to investigate fire incidence

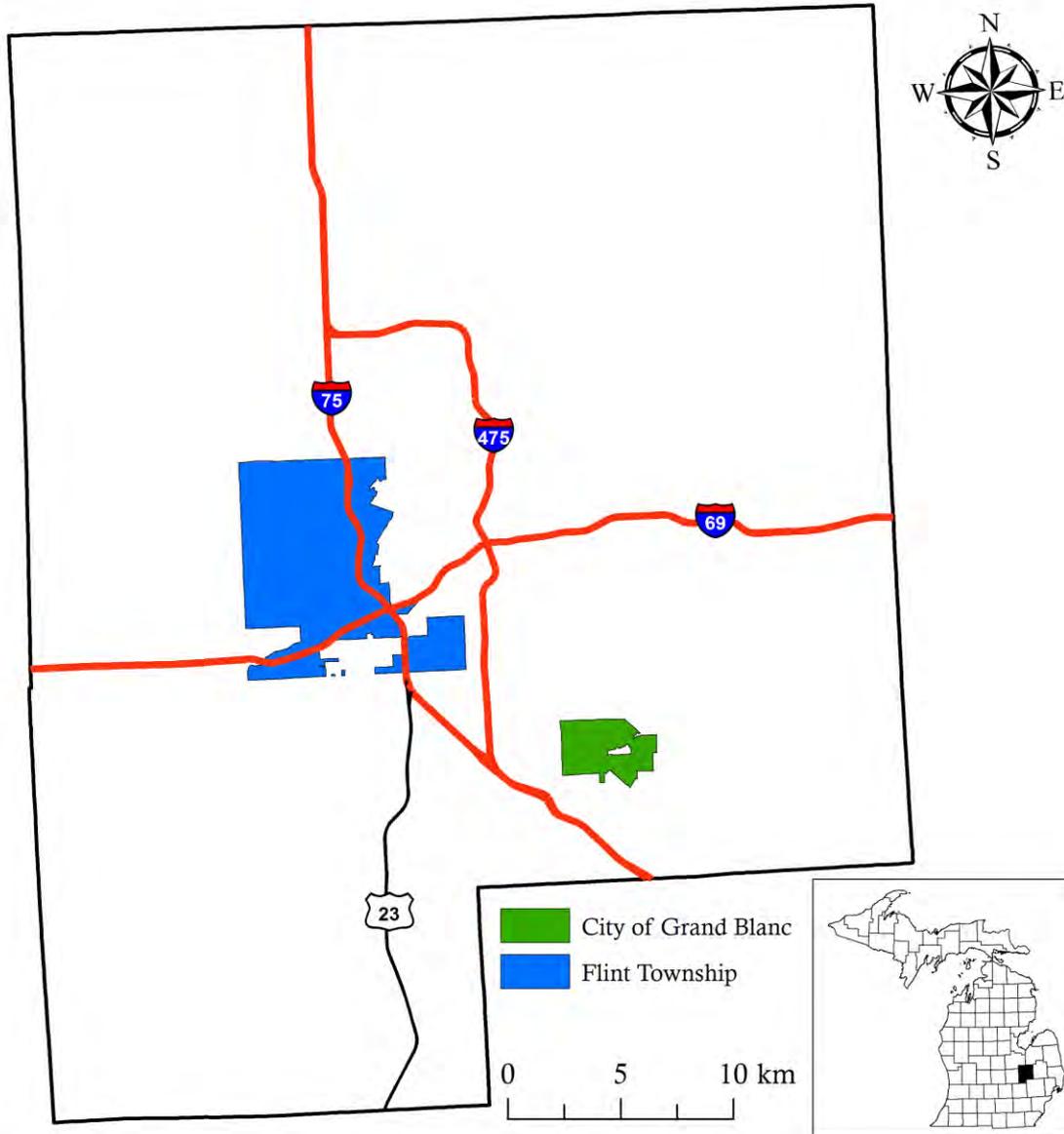
Introduction

- Current research need:
 - Lack of studies
 - Thus, an *a priori* risk assessment can be made by fire departments to identify locations within their coverage area that may lack adequate fire flow.
 - This research is designed to provide fire personnel the ability to make a risk assessment about fire flow capacity at specific locations.

Research Design

- Hypothesis:
 - Fire-fighting capacity is not sufficient in all cases.
- Experimental Groups:
 - Two communities with different characteristics
- Data Collection:
 - Fire hydrant locations and flow rates
 - 3-year fire history
 - Parcels

Study Area



Methods

- Geocode locations of all fire hydrants with flow data, 3-year fire history with International Fire Codes and overlay with parcel data
- Develop GIS model to compute fire flow capacity within specified radii
- Compare the existing fire-flow capacities to the required standards by International Fire Code (1,500 gal/min)
 - Using fire history and parcels
 - Examined potential areas with excessive fire-flow by doubling the minimum as an arbitrary baseline.
- Field verification

Fire-flow calculation area (square feet)

Type 1A and 1B	Type IIA and IIIA	Type IV and V-A	Type IIB and IIIB	Type V-B	Fire-flow (gal/min)	Flow duration (h)
0-22,700	0-12,700	0-8200	0-5900	0-3600	1500	2
22,701-30,200	12,701-17,000	8201-10,900	5901-7900	3601-4,800	1750	
30,201-38,700	17,001-21,800	10,901-12,900	7901-9800	4801-6200	2000	
38,701-48,300	21,801-24,200	12,901-17,400	9801-12,600	6201-7700	2250	3
48,301-59,000	24,201-33,200	17,401-21,300	12,601-15,400	7701-9400	2500	
59,001-70,900	33,201-39,700	21,301-25,500	15,401-18,400	9401-11,300	2750	
70,901-83,700	39,701-47,100	25,501-30,100	18,401-21,800	11,301-13,400	3000	4
83,701-97,700	47,101-54,900	30,101-35,200	21,801-25,900	13,401-15,600	3250	
97,701-112,700	54,901-63,400	35,201-40,600	25,901-29,300	15,601-18,000	3500	
112,701-128,700	63,401-72,400	40,601-46,400	29,301-33,500	18,001-20,600	3750	4
128,701-145,900	72,401-82,100	46,401-52,500	33,501-37,900	20,601-23,300	4000	
145,901-164,200	82,101-92,400	52,501-59,100	37,901-42,700	23,301-26,300	4250	
164,201-183,400	92,401-103,100	59,101-66,000	42,701-47,700	26,301-29,300	4500	4
183,401-203,700	103,101-114,600	66,001-73,300	47,701-53,000	29,301-32,600	4750	
203,701-225,200	114,601-126,700	73,301-81,100	53,001-58,600	32,601-36,000	5000	
225,201-247,700	126,701-139,400	81,101-89,200	58,601-65,400	36,001-39,600	5250	4
247,701-271,200	139,401-152,600	89,201-97,700	65,401-70,600	39,601-43,400	5500	
271,201-295,900	152,601-166,500	97,701-106,500	70,601-77,000	43,401-47,400	5750	
295,901-Greater	166,501-Greater	106,501-115,800	77,001-83,700	47,401-51,500	6000	4
-	-	115,801-125,500	83,701-90,600	51,501-55,700	6250	
-	-	125,501-135,500	90,601-97,900	55,701-60,200	6500	
-	-	135,501-145,800	97,901-106,800	60,201-64,800	6750	4
-	-	145,801-156,700	106,801-113,200	64,801-69,600	7000	
-	-	156,701-167,900	113,201-121,300	69,601-74,600	7250	
-	-	167,901-179,400	121,301-129,600	74,601-79,800	7500	4
-	-	179,401-191,400	129,601-138,300	79,801-85,100	7750	
-	-	191,401-Greater	138,301-Greater	85,101-Greater	8000	

2012, International Fire Code, International Code Council, Washington, DC.

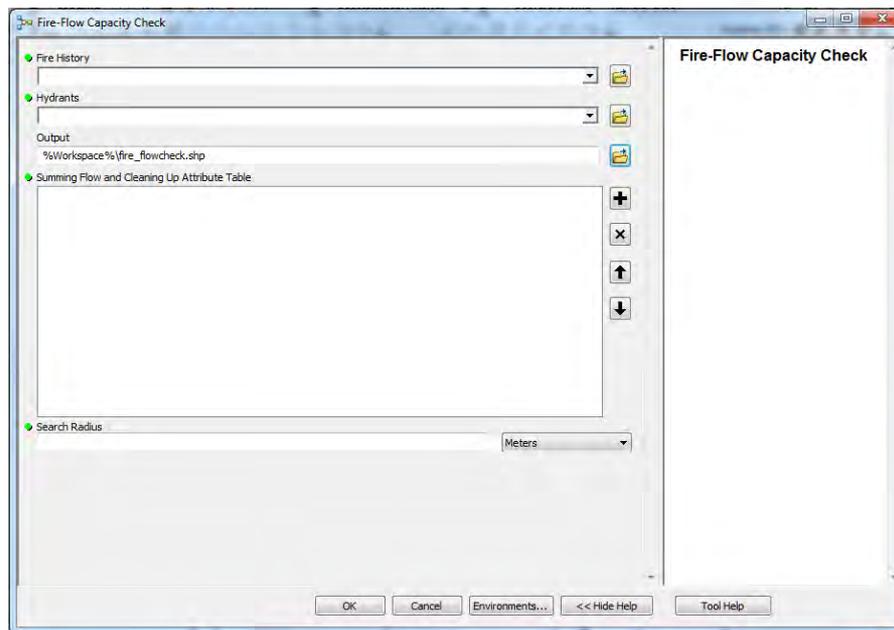
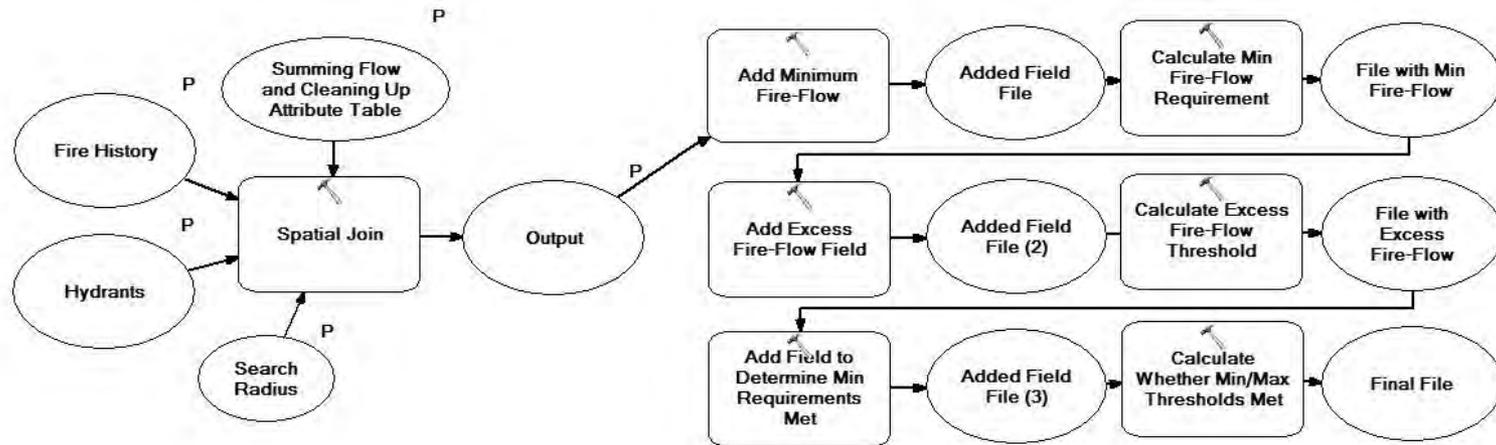


TABLE C105.1 NUMBER AND DISTRIBUTION OF FIRE HYDRANTS

FIRE-FLOW REQUIREMENT (gpm)	MINIMUM NUMBER OF HYDRANTS	AVERAGE SPACING BETWEEN HYDRANTS^{a, b, c} (feet)	MAXIMUM DISTANCE FROM ANY POINT ON STREET OR ROAD FRONTAGE TO A HYDRANT^d
1,750 or less	1	500	250
2,000-2,250	2	450	225
2,500	3	450	225
3,000	3	400	225
3,500-4,000	4	350	210
4,500-5,000	5	300	180
5,500	6	300	180
6,000	6	250	150
6,500-7,000	7	250	150
7,500 or more	8 or more ^e	200	120

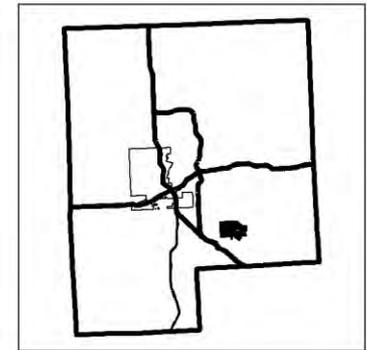
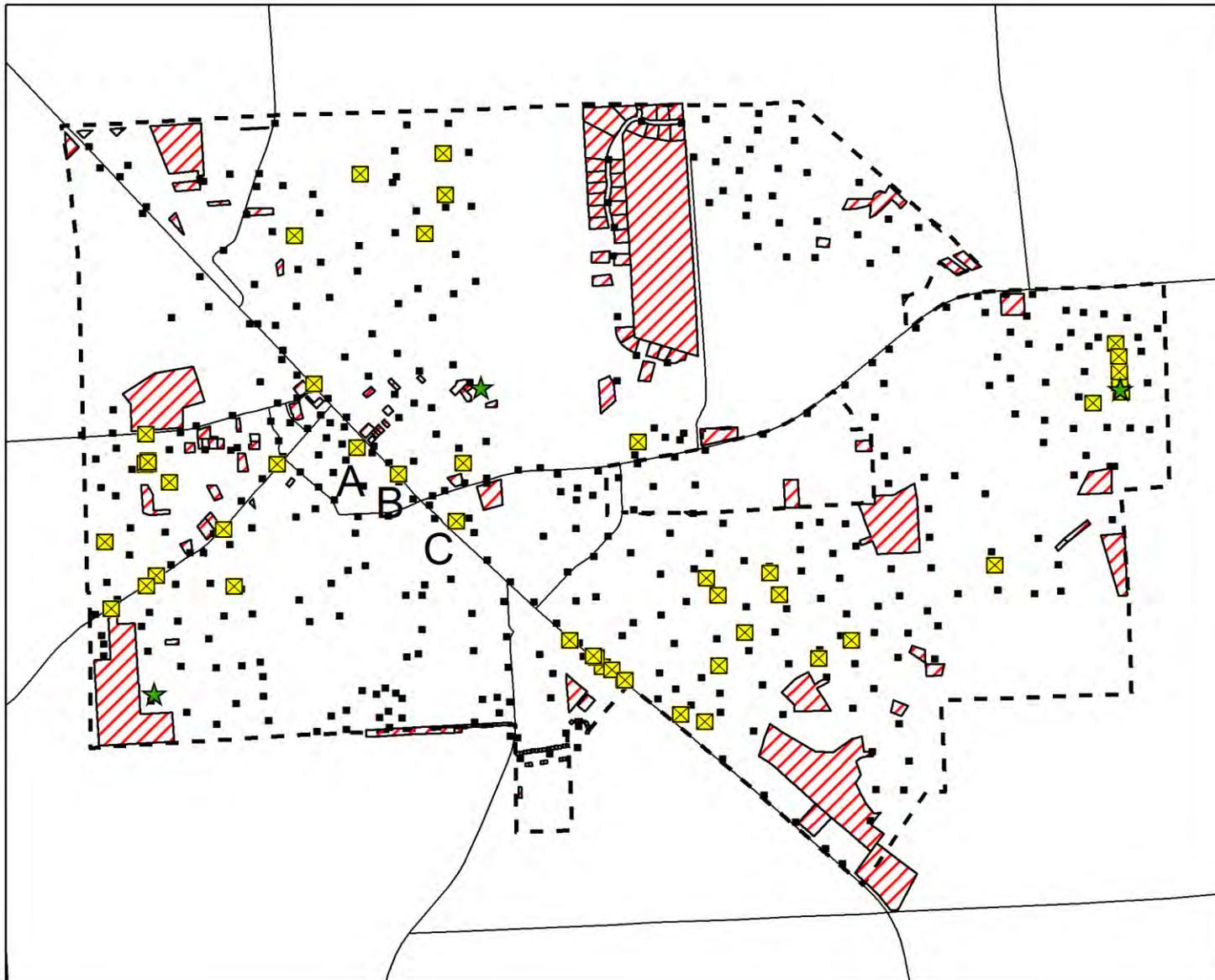
2012, International Fire Code, International Code Council, Washington, DC.

ModelBuilder Flow Chart



Results

- Ran the created model in Grand Blanc and Flint Township using fire history and parcels
- Highlighted areas for future investigation
- Grand Blanc had no potentially deficient areas
 - Though, there were areas that showed potentially excessive fire-flow capability
- Flint Township had areas with potentially deficient fire-flow
 - Also, had areas of potentially excessive areas



■ Hydrants

Potential Fire-Flow Capacity

- Potential Deficient Fire-Flow
- ★ Sufficient Fire-Flow
- ⊠ Potential Excessive Fire-Flow

▨ Vacant Properties

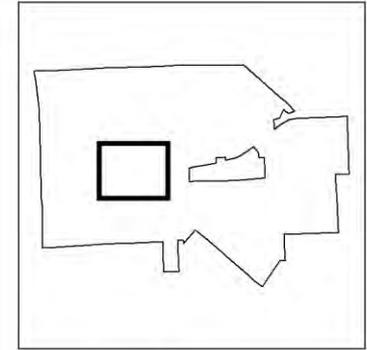
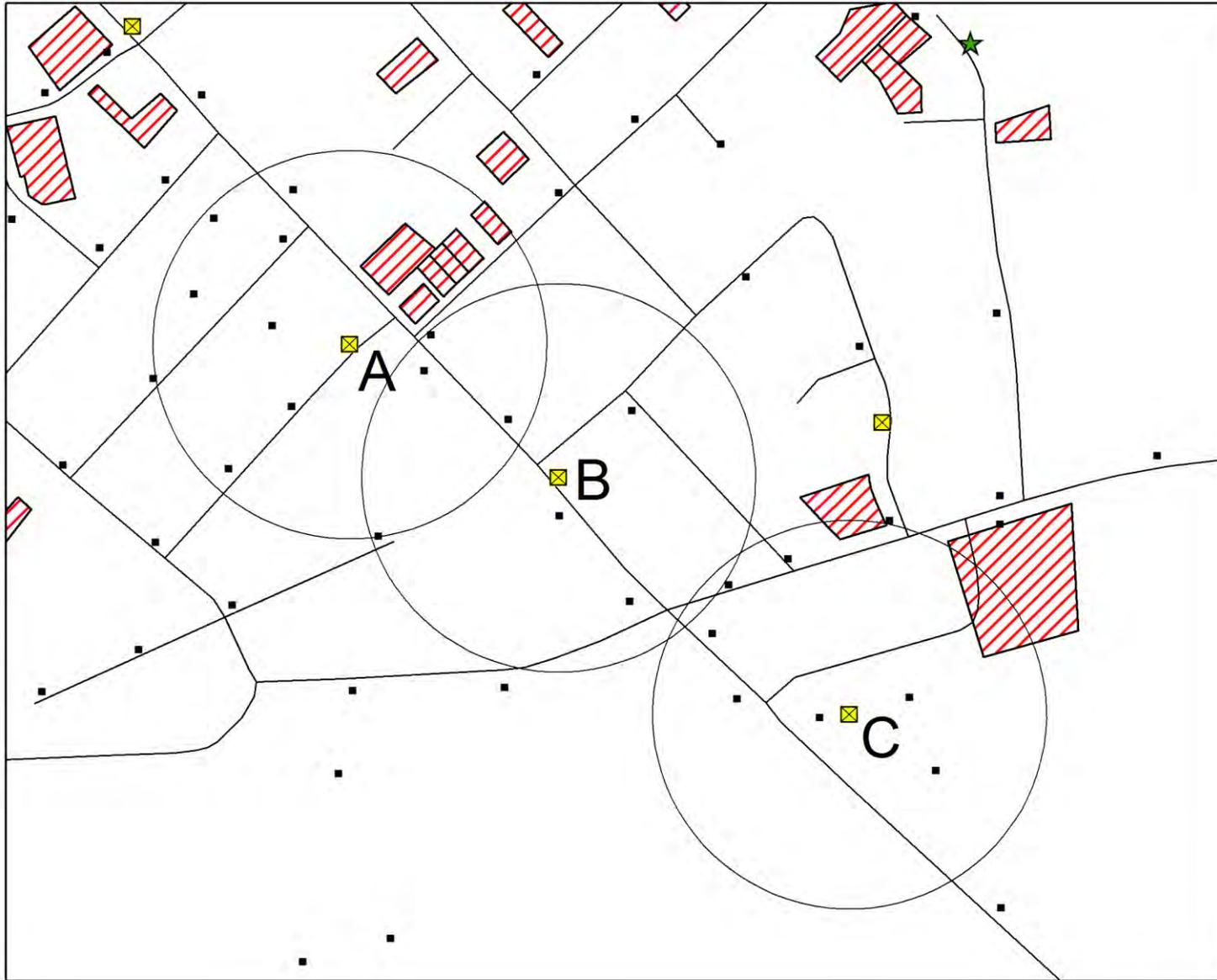
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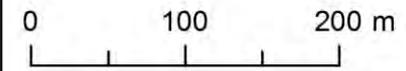
0 500 1,000 m

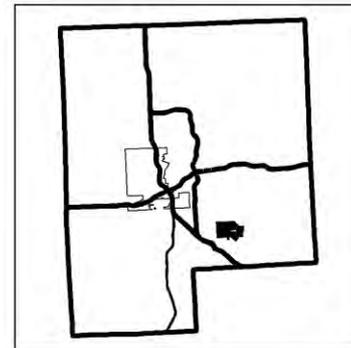
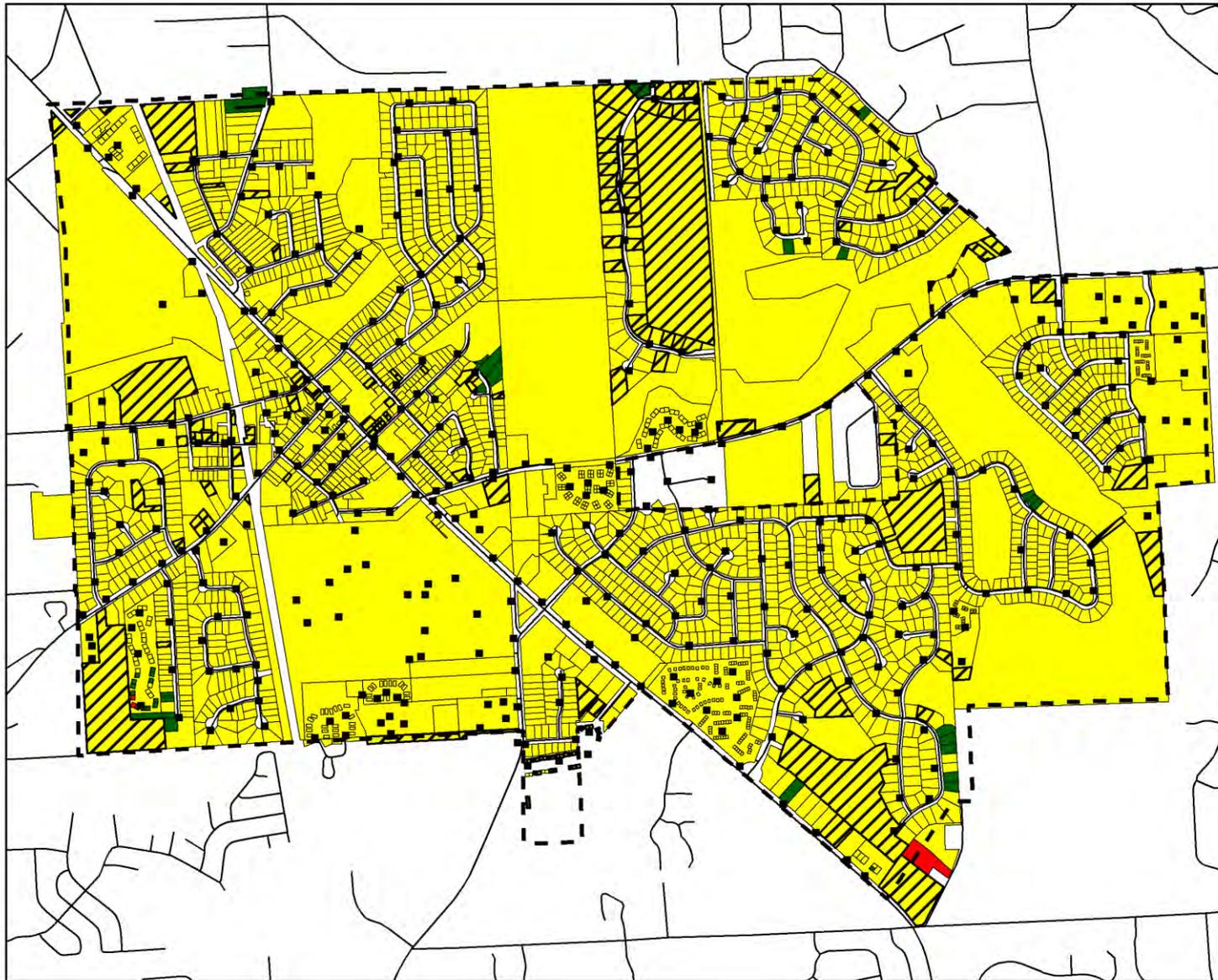
A horizontal scale bar with tick marks at 0, 500, and 1,000 meters.





- Hydrants
- Potential Fire-Flow Capacity**
- Potential Deficient Fire-Flow
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■ Hydrants

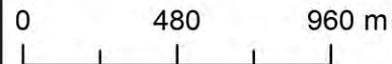
Potential Fire-Flow Capacity

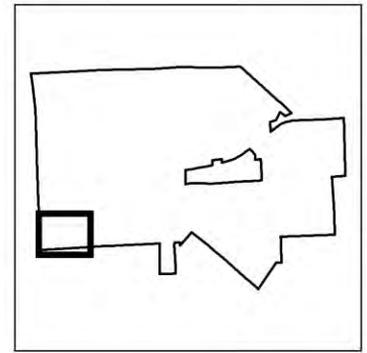
- Potentially Deficient Fire-Flow
- Sufficient Fire-Flow
- Potentially Excessive Fire-Flow

Vacant Properties

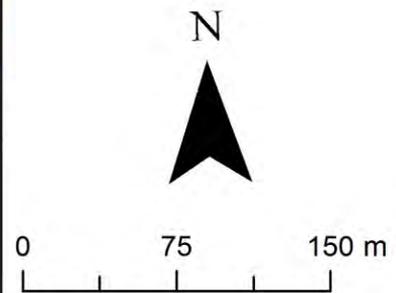
City of Grand Blanc

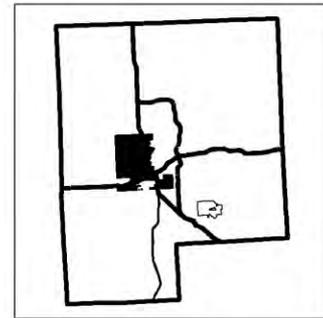
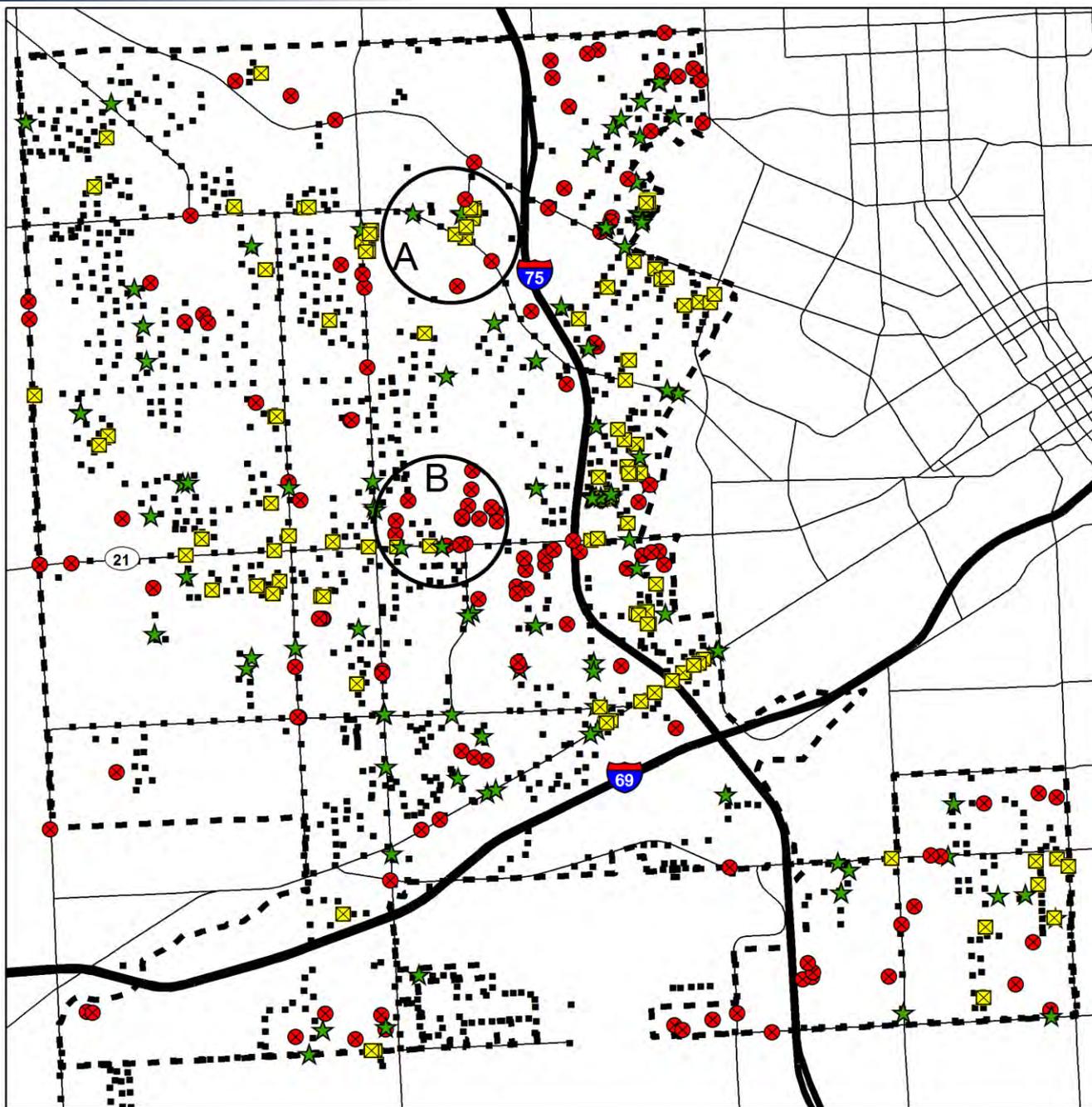
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- Hydrants
- Potential Fire-Flow Capacity**
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- ▨ Vacant Properties
- - - City of Grand Blanc

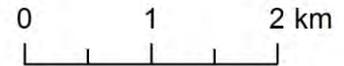


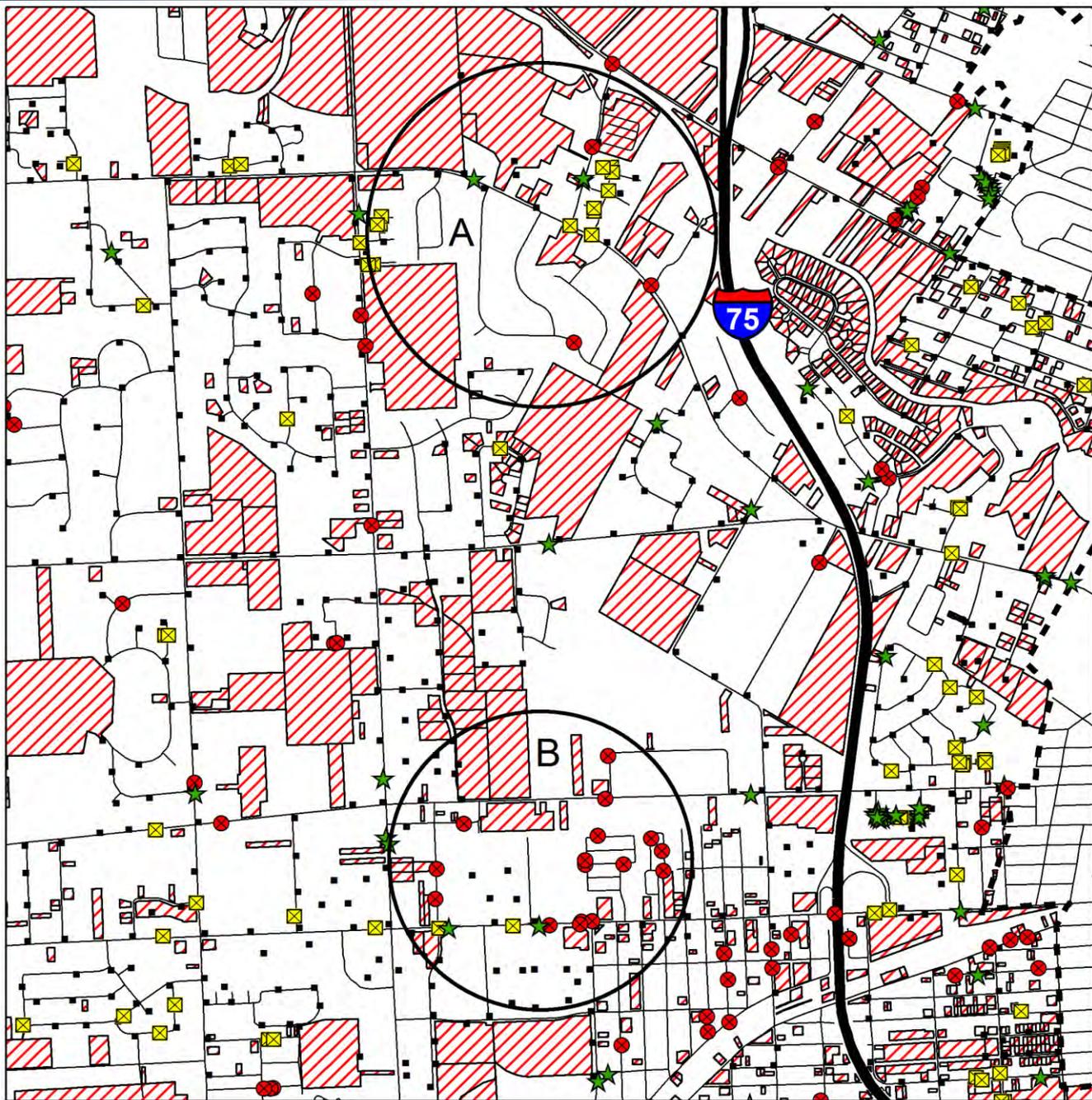


■ Hydrants

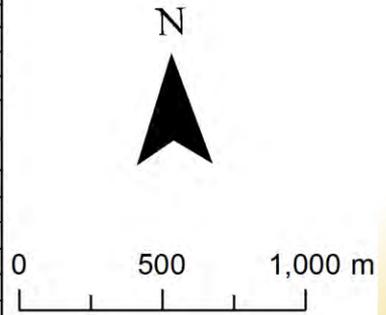
Potential Fire-Flow Capacity

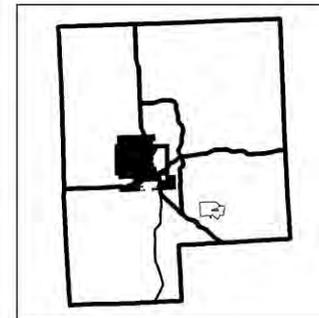
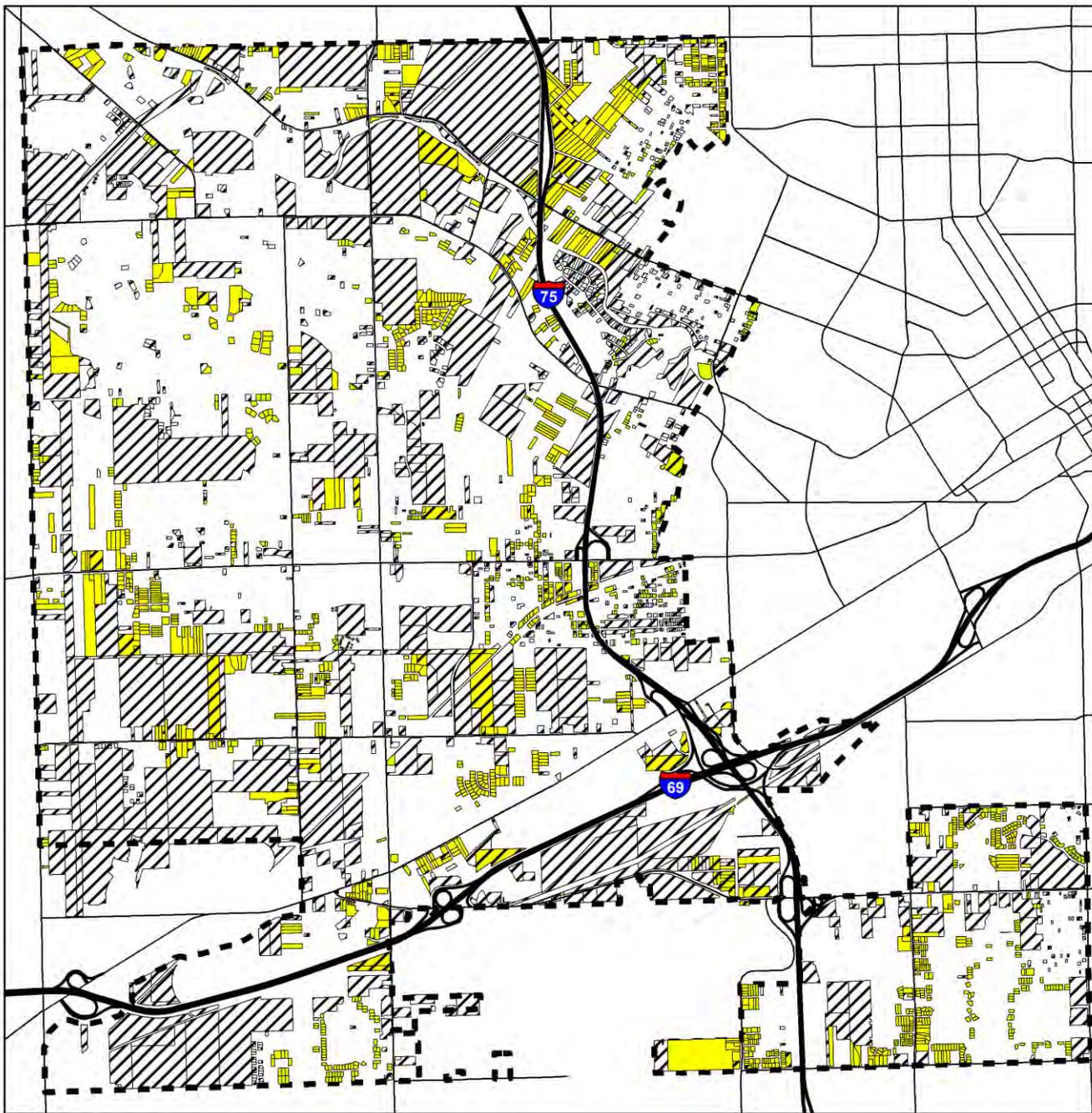
- Potential Deficient Fire-Flow
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- Hydrants
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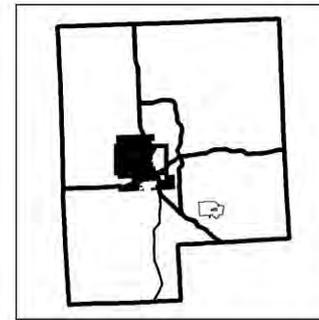


 Vacant Parcels

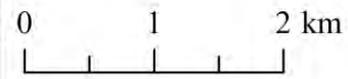
 Parcels with Potential Deficient Fire-Flow

 Flint Township





-  Vacant Parcels
-  Parcels with Potential Deficient Fire-Flow
-  Parcels with Potential Deficient Fire-Flow (no historical fires)
-  Flint Township



Discussion

- Differences between the two developments can be seen
 - Grand Blanc: smaller, mix of old residential zones and new subdivision development types
 - Flint Township: industrial/commercial, larger, more sparse residential zones
- From the basis of the given GIS model application, additional GIS analyses can be performed
 - Future hydrant locations
 - Temporal fire-flow availability analysis
 - In conjunction with SCADA systems
 - Hazardous materials

Conclusions

- Our hypothesis was confirmed by the model
 - Fire-flow not sufficient in all cases
 - Converse is also true: Fire-flow may be excessive in some cases
- Efficacy of the model increases using land parcels, especially when vacant land is prevalent
- If fire incidences had building type included in reports, model has added value
- Provides added value to fire departments and emergency management

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GIS method for characterizing fire flow capacity



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ABSTRACT

There are numerous methods currently used to calculate required water flow rates for sprinklered and non-sprinklered buildings. The aim of this study is provide a flexible automated procedure for indentifying locations lacking adequate fire flow. To accomplish this objective, this research uses a GIS procedure to determine the spatial relationships between fire hydrants and historical fire incidences, and integrates the recommended hydrant spacing and building type specifications from the International Fire Code. This method was tested in two communities in eastcentral Michigan, USA. The results indicate an ability to define clusters of fires, determine the availability of hydrants, and assess the suitability of the available fire flow, including areas of potential extra capacity. Using these same data, additional GIS analyses can optimize hydrant location, ascertain the frequencies of different categories of fires, and identify the patterns of building types prone to fires.

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Questions?

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