



## Spatial Risk Assessment:

# ROBBERY VULNERABILITY

A Spatial Risk Assessment was conducted to identify environmental features which make locations conducive to robberies in the City of Burlington, NC. Findings from this report explores and answers the following questions:

- Are residents of Burlington at greater risk of robberies at some areas of the City than others?
- What locations are most vulnerable to robberies?
- What makes those locations more vulnerable to robberies?
- How much riskier are those locations?



Figure 1: Location in Burlington with multiple tested environmental features.

---

### BACKGROUND 2

---

### STUDY SITE & ENVIRONMENTAL FEATURES 2

---

### DATA, SOURCES, & PARAMETERS 2

ANALYSIS PARAMETERS 2

FEATURES TESTED 3

---

### RTM APPROACH 3

---

### ROBBERY RTM RESULTS 4

FEATURE RELATIVE RISK VALUES 4

GEOGRAPHIC DISTRIBUTION OF RISK 4

RTM MAPS 5

RTM & HOT SPOTS 6

---

### RECOMMENDATIONS 7

---

## KEY TAKEAWAYS:

---

- 87% of Burlington's geography is low risk, while 13% was at above average, and < 1% is at highest risk for robberies.
- Proximity to illegal gambling operations, dollar stores, gas stations, bus stops, and restaurants increases risk of robbery victimization. In particular illegal gambling operations are 9 times more vulnerable and dollar stores are almost 6 times more vulnerable than other locations tested.
- Vulnerability is compounded when a location is in close proximity to multiple environmentally risky features.

## BACKGROUND

As the City of Burlington experienced an overall rise in violent crimes in 2017, it was noted that **robberies** in particular had **increased by 63%** when compared to the previous year. In 2015 and 2016 the number of reported robberies remained constant at 74, however in 2017 the number of reported robberies had climbed to 121. **Two thirds of those reported in 2017 involved use of a firearm**, and almost half occurred during the four month period between July and October. Due to the serious safety implications, a clear need for data-driven strategies to reduce the volume of robberies and possible victimization was identified as a priority moving forward into 2018.

In support of this effort, a spatial analysis was conducted with the purpose of identifying environmental risk factors which are conducive to robberies occurring in Burlington. A **Risk Terrain Model (RTM)** was used to diagnose spatial vulnerabilities throughout the City **to assess high risk locations** based on specific environmental features and risk factors. Results of these methods have been found to be statistically valid and may be used for effective forecasting, resource deployment, problem solving, and risk mitigation and management in these spaces.

## STUDY SITE & ENVIRONMENTAL FEATURES

The City of Burlington (study site) is a **30.75 square mile jurisdiction** located along Interstate I-40/I-85 in **Alamance County**, with a population of approximately **53,077 residents**. The jurisdiction consists of low-rise suburban landscape composed of a mix of residential and commercial properties. There are several malls, shopping, and entertainment locations along the main corridors of the jurisdiction, as well as recreational areas, and both high and low density housing of various kinds.

Due to previously observed clustering of robbery locations around main corridors and commercial settings, the following environmental features were assessed for their possible contributing risk: bus stops, illegal gambling

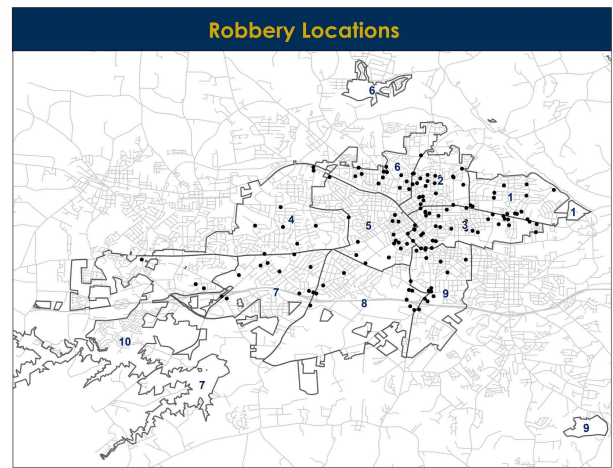


Figure 2: Robbery locations January 2017 - September of 2018.

operations, restaurants, parking lots, mobile home parks, dumpsters, ATMs, banks, bars & night clubs, convenience stores, department stores, dollar stores, fast food restaurants, gas stations, grocery stores, hotels & motels, pawn shops, pharmacies, tattoo shops, and tobacco & vape shops. While this is not an exclusive list of environmental features (potential risk factors) in the Burlington jurisdiction, these locations were identified as a sample of locations which may be expanded in future analysis.

## DATA, SOURCES, & PARAMETERS

Reported robberies in the Burlington jurisdiction were extracted from the Police Department's RMS system for the period between January of 2017 and September of 2018. The City's GIS Department provided several geographic reference data layers (shapefiles) including the Burlington city limits, bus stop locations, mobile home park locations, restaurant locations, and dumpster locations. The remaining data was collected for each entity via open-sourced research. The data was geocoded using world coordinates for inclusion in this analysis.

### ANALYSIS PARAMETERS:

- **Crime Type:** Robberies (172 reported)
- **Study Area:** The City of Burlington (divided onto a grid consisting of 57,972 sections)
- **Section Size:** 125 ft x 125 ft (half the length of a block)
- **Evaluation Extent:** 250 ft (the length of a block)

## ENVIRONMENTAL FEATURES TESTED:

Feature Type	Operationalization
Bus Stops	Proximity
Illegal Gambling Ops.	Proximity or Density
Restaurants	Proximity or Density
Parking Lots	Density
Mobile Home Parks	Proximity
Dumpsters	Proximity
ATMs	Proximity
Banks	Proximity
Bars & Night Clubs	Proximity or Density
Convenience Stores	Proximity
Department Stores	Proximity or Density
Dollar Stores	Proximity
Fast Food Rest.	Proximity
Gas Stations	Proximity
Grocery Stores	Proximity
Hotels & Motels	Proximity
Pawn Shops	Proximity
Pharmacies	Proximity
Tattoo Shops	Proximity
Tobacco & Vape Shops	Proximity

Table 1: Environmental features tested and analysis operationalization.

## RTM APPROACH

A **Risk Terrain Model (RTM)**<sup>1</sup> was used to identify locations that are most vulnerable to robberies in Burlington due to the presence and proximity or density of certain environmental features. The spatial influence of each feature type was tested and those found to have statistically significant influence on robberies (risk factors) were identified. Environmental features determined not to have an influence on robberies were disregarded from the analysis. Significant risk factors were assigned a **Relative Risk Value (RRV)**<sup>2</sup> representative of the relative vulnerability (influential weight) pertaining to robberies.

Each location was evaluated against the weighted environmental risk factors and assigned a **Relative Risk Score (RRS)**<sup>3</sup> according to presence or absence of features, concentration of features, and distance from features statistically tested to influence the presence of robberies. RRS values of 1 represent sections with the lowest relative risk while higher scores represented higher relative risk.

Resulting risk terrain maps and tabular data indicates the statistically influential environmental risk factors and the locations vulnerable to robberies within the City of Burlington. **Highly vulnerable locations are more likely to experience robberies in the future**, therefore results were further analyzed and compared with hot spot locations to provide risk mitigation recommendations.

[1] Risk Terrain Modeling is an evidence-based method for evaluating environmental features to determine how they create settings that are conducive to crime and the way people may behave in that environment. Resulting information is unique to the specific study area based on how the environmental features influence criminal behavior in that specific geographic region. Unlike hot spot mapping, RTM does not rely on past crime to indicate where future crime may occur. This type of analysis also uniformly focuses on places, not people, removing possible bias from the results and, in-turn, the actions based on those results. RTM was developed by Drs. Kennedy and Caplan at Rutgers University and is the result of over 40 years of scientific and peer reviewed research and professional experience. Additional information about this approach to understanding and mitigating crime can be found at <http://www.riskterrainmodeling.com/>.

[2] Relative Risk Values represent weights for each statistically significant risk factor input which help compare the risk of each feature type. Those features found to have a stronger spatial influence on the crime type examined have higher RRVs.

[3] Relative Risk Scores allow for easy prioritization of places in the resulting risk terrain map. For instance, a location with an RRS of 100 has an expected rate of crime (robberies for the purpose of this analysis) that is 100 times higher than a location with a score of 1.

# ROBBERY RTM RESULTS

Upon examination of RTM results it was found that only **five out of the twenty** tested environmental features have significant spatial influence, making them higher risk locations for attracting robberies. Significance of features was determined based on specified proximity rather than density of the feature type. Further examination of their influence within the Burlington jurisdiction revealed that **less than 1% of the jurisdiction geography accounts for the top 5% of locations with greatest vulnerability to robberies.** In particular **illegal gambling operations** as well as **dollar stores** were found to have substantially higher RRVs as noted below. Areas where multiple risk factors coincide were weighted accordingly, producing higher RRS values, indicating areas with the greatest risk of victimization.

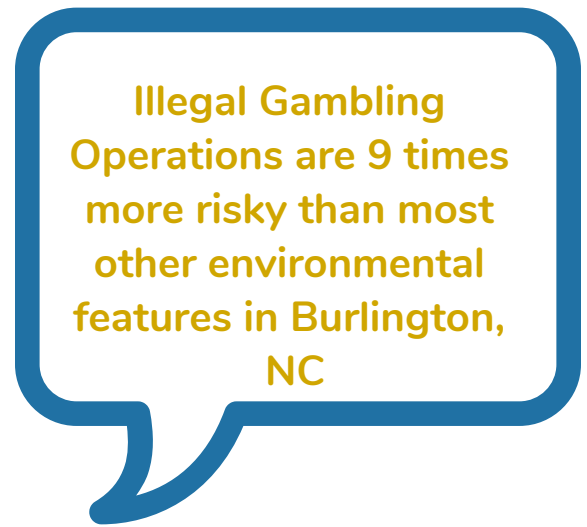
## FEATURE RELATIVE RISK VALUES:

Spatially significant environmental features scored **Relative Risk Values (RRVs)** between **2.936 and 9.065**. Features with higher RRV indicate types of locations where relative risk of being robbed is higher than those with lower RRVs. Environmental features with a risk factor of 9 are therefore three times more risky compared to those with a RRV of 3.

Risk Factor Type	Operationalization	Spatial Influence	RRV
Illegal Gambling	Proximity	250 feet	9.065
Dollar Stores	Proximity	500 feet	5.988
Gas Stations	Proximity	250 feet	3.961
Bus Stops	Proximity	500 feet	2.957
Restaurants	Proximity	500 feet	2.936

Table 2: RTM results table indicating spatially influential risk factors.

Table 2 reveals that **being within close proximity to illegal gambling operations puts individuals at greater risk of robbery** when compared to similar proximity to other types of environmental features. Though dollar stores scored a lower RRV, their spatial influence extends twice the distance of illegal gambling locations. **When high risk environmental features are located in or near other risky features, the relative risk is compounded and the robbery vulnerability becomes greater.**



## GEOGRAPHIC DISTRIBUTION OF RISK:

Relative Risk Scores for gridded sections of Burlington were calculated based on the feature RRVs and their spatial influence on each section. Resulting RRS values ranged from 1 representing the lowest risk to 311.627 representing the highest risk sections. Of the 57,972 sections, **13% were classified as above average risk locations** (RRS value above the mean), while **less than 1% were classified as highest risk locations** (RRS value +2 Standard Deviations from mean). **Locations with the highest risk (RRVs) are 17 to 311 times more vulnerable to robberies.**

- **Range:** 1 - 311.627
- **Mean:** 1.711
- **Standard Deviation:** 6.191
- **Highest Risk Locations:** 511 grid locations (0.23% of the study area)



Figure 3: An illegal gambling operation in close proximity to a gas station. When risk features are in close proximity to each other, the location's vulnerability to robberies is greater.



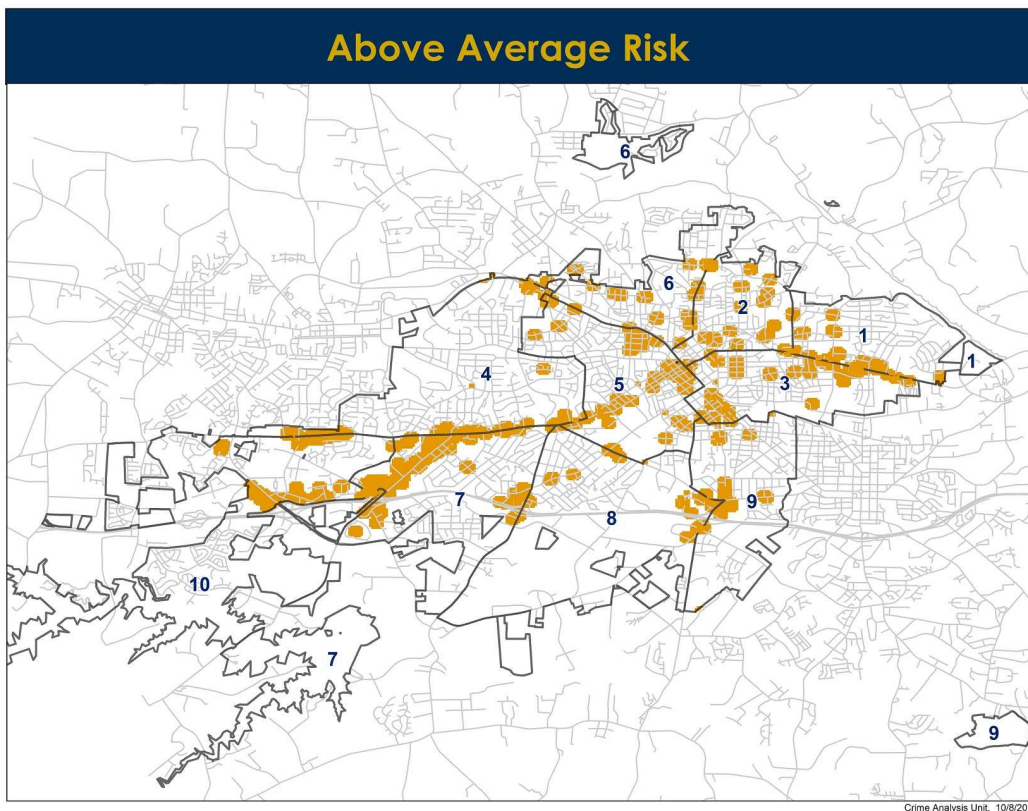


Figure 4: Locations where the RRS was greater than 1.711 indicating above average vulnerability to robberies.

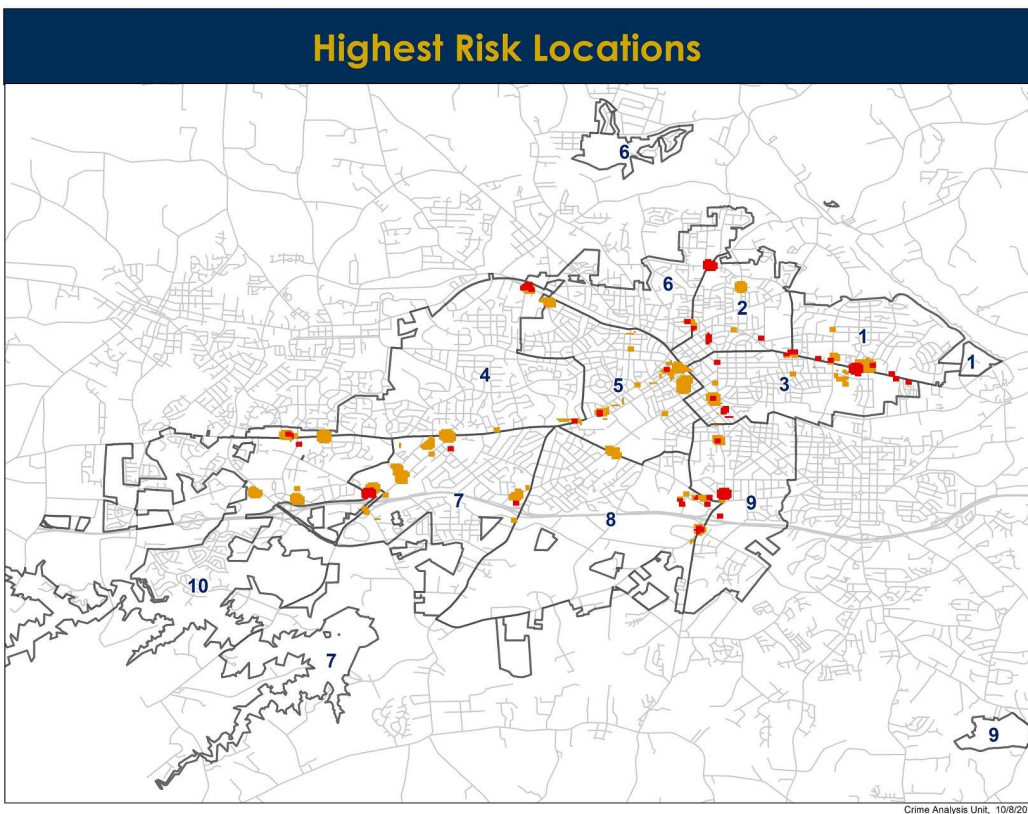


Figure 5: Locations where the RRV was one (orange) or two (red) standard deviations above the mean value indicating areas with the highest vulnerability to robberies.

## Robberies Compared to Vulnerable Locations

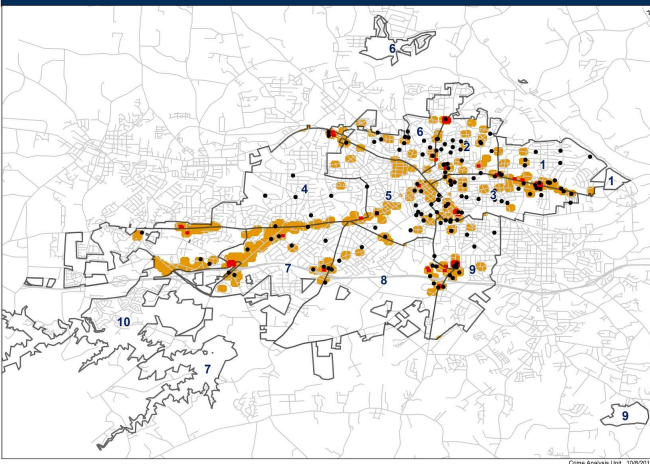


Figure 6: Locations with above average and highest risk of robberies compared to where robberies actually occurred in 2018.

**HOT SPOT ANALYSIS** tells us *where* crime is clustered without giving us context as to why crime occurs in some spaces but not others. **RISK TERRAIN MODELING** tells us *why* crime clustered there to begin with.

## RTM & HOT SPOTS:

Use of **hot spot analysis identifies areas where crime clusters** by evaluating density in order to mitigate crime in those areas (such as Focused Patrol). This form of crime suppression assumes that crime will continue to occur where it has in the past and has been found to be an effective method for allocating resources.

In contrast, **RTM focuses exclusively on environmental features which make that location conducive to criminal behavior indicating crime is likely to occur there in the future.** This form of analysis works without consideration of whether crime has occurred in these locations in the past, only that the opportunity or vulnerability exists for that specific crime. While RTM scores are independent of past crime patterns, **high-risk locations and high-density crime locations (hot spots) often intersect** due to vulnerable locations experiencing a higher volume of crime.

For comparison purposes, density analysis of all Part 1 crime data for January through September 2018 period was overlaid with the highest risk locations resulting from the RTM analysis. The intersection of hot spots with the highest risk environments (see Figure 8) supports further refinement of hot spot focused policing practices where root environmental causes of hot spots may be further addressed.

## Part 1 Crime Hot Spots

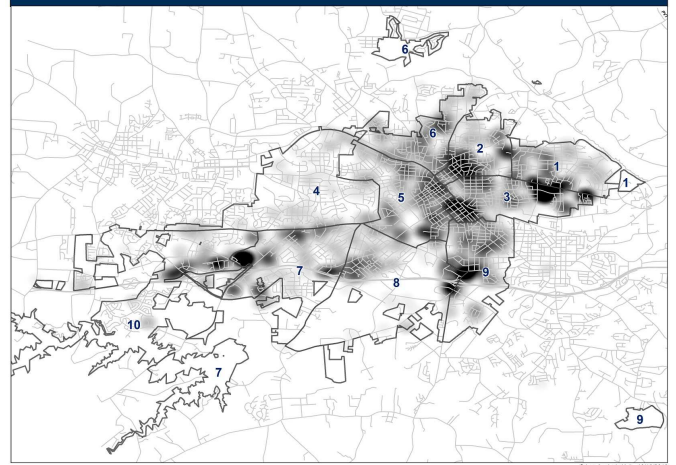


Figure 7: Combined Part 1 crime Hot Spots for January through September 2018. Dark locations indicate high density of crime as compared to light areas with lower crime density.

## Highest Risk Locations Compared to Hot Spots

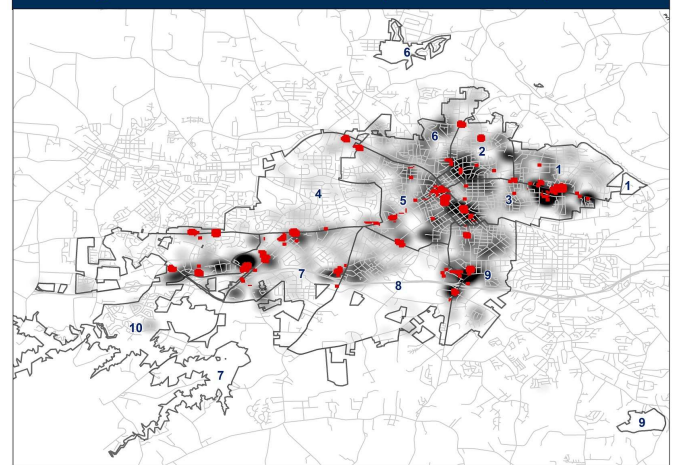


Figure 8: Crime Hot Spots compared to RTM highest risk locations (represented in red).

## RECOMMENDATIONS

Unified practices implemented with Focused Patrol and Intelligence Led Policing strategies across all divisions of the police department have already made a substantial impact on crime volume in Burlington. Robberies for the year to date in 2018 have **decreased by almost 40%** compared to 2017 and **all Part 1 crime volume is down by almost 19%**. Continuation of these practices is imperative to the vitality of positive outcomes regarding crime mitigation, with an **emphasis on collaborative efforts and interventions**.

Further, results of the discussed RTM spatial risk assessment regarding robbery vulnerability opens the door for additional opportunities to circumvent victimization.. Those recommendations are identified below:

- **FOCUS ON THE INTERSECTIONS:** Refine hot spot and focused patrol deployment efforts to smaller geographic areas identified as "highest risk" in those clustered crime or "hot" locations.
- **WRITE REPORTS IN HIGH RISK LOCATIONS:** Identify suitable places for each patrol shift to proactively interrupt crime opportunity by spending short intervals of time in those locations.
- **WORK WITH BUSINESSES:** Notify businesses of their vulnerability to robberies and suggest hanging additional interior and exterior cameras and/or lighting. Make positive contacts to build rapport and encourage communications.
- **ADDRESS ENVIRONMENTAL RISK FACTORS:** Intervention efforts should be made to improve the environmental features themselves by reducing the opportunity or appearance of opportunity for crime and illegal activities to take place in and around high risk and vulnerable locations.
- **EVALUATE OUTCOMES:** On a monthly basis measure outcomes of risk mitigation practices implemented.

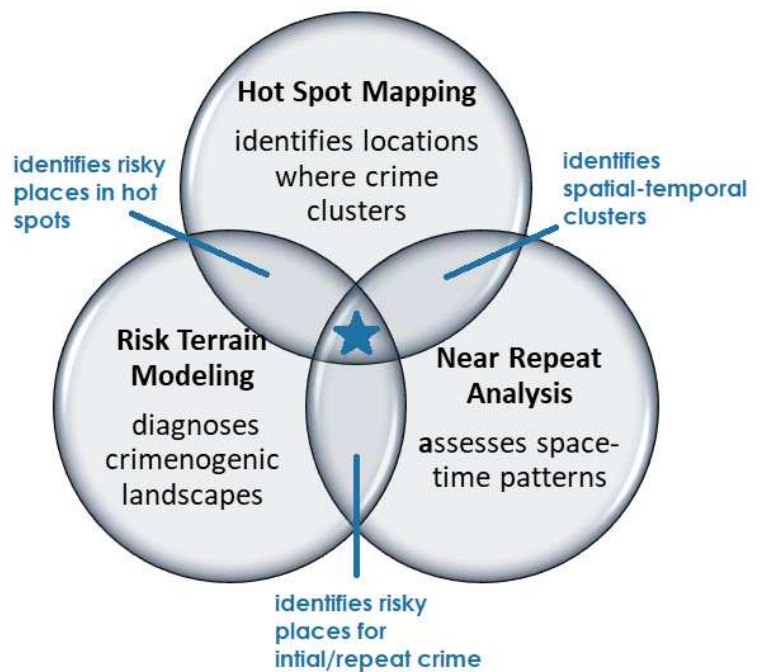


Figure 9: The intersections of Hot Spot Analysis, Risk Terrain Modeling, and Near Repeat analysis exposes vulnerability and anticipates future crime thereby reducing victimization. Image replicated from Rutgers University diagram.



## LOOKING AHEAD

In conjunction with current hot spot analysis methods, the Crime Analysis Unit is seeking to expose vulnerability and forecast crime through the supplementary use of risk terrain modeling and near repeat analysis. Joint utility of these three analysis types is supported by current, evidence-based best practices. Intelligence led efforts currently in place will continue to focus on high priority places and known offenders with the intention of providing longer-term crime reduction.

Additional collection of environmental data and spatial risk assessments are planned to identify other types of vulnerabilities to crime.

