Housing Assessment Using Geographic Information Systems (GIS): A Case Study of Community Engagement from Grand Rapids, Michigan

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ABSTRACT

After the 2008 housing loan crisis, many houses were foreclosed/abandoned in Michigan, and specifically Grand Rapids (GR). Our study provides a collaborative and scalable model for collecting parcel-level housing data, in a southeast GR neighborhood within 15 U.S. Census Blocks. Grand Valley State University Geography faculty and students partnered with the Seeds of Promise organization/residents by using GIS/sidewalk visual observation to assess housing vacancy and evaluation of physical conditions to better understand the current housing conditions.

Keywords: University-Community Collaboration, neighborhood development, technical assistance, survey housing parcels

BACKGROUND OF STUDY

Because of the collapse of the U.S. housing loan bubble in the latter part of 2008, the national recession rippled through all regions of the United States. In Grand Rapids, Michigan, this recession dramatically decreased the median value of owner-occupied housing from a 2010 high value of $122,000 down to $109,400 in 2013, a dramatic decline of -10.33% (Community Development Department, 2015). In effect, median home values fell below the value of the mortgages that homeowners owed, leading to the abandonment and foreclosure of many homes. While Michigan's real estate market has recovered in the last few years (Reindl & Tanner, 2016), the southeast section of Grand Rapids has not experienced a resurgence. This section of Grand Rapids faced a host of some of the highest poverty and crime rates. In response to these challenges, residents partnered with their local neighborhood organization, hoping to learn more about the housing and economic conditions in their own neighborhood. The following case study documents the university-community partnership that emerged from these challenges, offering a case about the value of using the tools of geographic information systems (GIS) to assess housing conditions and advocate for context-sensitive responses to neighborhood challenges.

A Geographic Information System (GIS) consists of the storage and display of various types of geographic information such as residential lot size, land use type, streets, toxic air emission sites, and zoning. GIS has been effectively used as a tool for environmental health assessment in a Maryland neighborhood. Choi, Afzal, and Sattler (2006) conducted a health survey questionnaire with 101 Maryland residents to check for risk factors such as environmental exposures and the use of pesticides, smoking, and mold/mildew. They cross-referenced roads and hydrography data from Toxic Release Inventory Information (U.S. EPA,

2005), and also air emission sites from the Aerometric Information Retrieval System (U.S. EPA, 2002). Researchers obtained the residents' addresses so they could geolocate the data, i.e., geographically matching the address location of residents who suffered from asthma and lead poisoning against the precise locations of air emission and toxic release sources (Choi et al., 2006).

Over the past two decades, there has been a recent surge in the use of Public GIS by local citizens hoping to play an active role in supporting their neighborhoods (Sieber, 2006). For example, Aronson, Wallis, O'Campo, and Schafer (2007) used neighborhood mapping to examine the quality of their local community health programs. Community residents collected data during street-by-street neighborhood walkthroughs, and they identified neighborhood features of legitimate daily usage, such as liquor stores, as well as non-daily usage, such as houses of worship. Neighborhood mapping has become a powerful tool that brings participants/residents into the research process, and empowers them to invest in their community (Aronson et al., 2007).

Accurate neighborhood mapping has also been used internationally in Pakistan. The Lahore Development Authority (LDA) collaborated with local residents to develop a GIS system for capturing local knowledge of different housing types. By using this public Geographic Information System, residents used their database information to accurately identify the variety of legal and illegal housing types within their own neighborhoods (Butt, Li, & Javed, 2016). Past studies have verified the merit of working alongside neighborhood residents, showing that community members can more accurately identify local phenomena. For instance, Brown's (2012) study evaluated the spatial accuracy of public participation GIS (PPGIS) data in southern New Zealand, and demonstrated that Otago and Southland residents who self-identified as having "good/excellent knowledge" of native plants had a 5.1% error rate in identifying native vegetation, versus a 11.5% error rate for those who self-identified as having "average/poor knowledge" of native plants. The results of this PPGIS study demonstrated that local, native knowledge of a person's neighborhood will statistically decrease the error rate of identifying local phenomenon.

Case Study of Grand Rapids Housing Assessment

This case study documents a community engagement (CE) housing assessment in the Grand Rapids, Michigan, area that partnered a university faculty and students with a neighborhood organization and its residents. As shown by Brown's (2012) study, local residents who know their neighborhood deeply, and have the proper training, can be effective in assessing phenomenon in their own neighborhood.

Grand Valley State University (GVSU) is a Midwestern regional university of 25,049 students with several campuses, located in the western Michigan region including Allendale and the City of Grand Rapids. The GVSU Department of Geography & Sustainable Planning (GSP) was selected in a competitive April 2015 Engaged Department Initiative (EDI) grant that was funded through the Grand Rapids Community Foundation, Michigan Campus Compact, and the Michigan Nonprofit Association (Lake et al., 2017). The EDI goals are to collaboratively design engaging curriculum that better supports students and community partners, in order to generate deeper, longer-term engagement opportunities likely to yield better learning outcomes (Battistoni et al., 2003). GVSU's Office of Community Engagement hosted the EDI grant. Prior to this initiative, the GSP department engaged in isolated community engagement projects led by individual faculty and conducted in singular courses ("one-off" engagement projects). The EDI provided funding, training, and project management in order for multiple faculty, students, and a strategic community partner

to collaborate more intentionally over the course of 18 months.

In December 2015, the GSP Department collaborated with Seeds of Promise (Seeds), a grass-roots neighborhood organization, via a GVSU connection. Seeds is an urban community improvement initiative located in the southeast section of Grand Rapids, Michigan (Figure 1 map). The Seeds of Promise organization consists of residents who are dedicated to their mission "to equip and empower community residents to govern and direct continuously improving, self-sustaining personal and neighborhood prosperity" (Seeds of Promise, 2016).

In order to better understand Grand Rapids and the Seeds neighborhood, a demographic analysis of the region's census data is provided. According to the U.S. Census 2013 estimate, the city of Grand Rapids is the second most populous city within the State of Michigan, having a population of 189,735 (Community Development Department, 2015). From the 2013 population estimate, 39,285 African Americans lived in Grand Rapids (GR), representing 20.7% of this GR population. Within this southeast section of Grand Rapids, where the Seeds neighborhood is located, the percentage of African Americans is significantly higher—close to 65-70% (Community Development Department, 2015).

The Seeds neighborhood organization had established the Housing Impact Team, which consisted of local residents and the Seeds of Promise staff. In the aftermath of the housing bubble, the Housing Impact Team was very interested in realizing their Team's objectives: "1) develop a team to support Host Neighbors by performing a block-based home occupancy status assessment—owned, rented, vacated; and 2) to determine home improvement needs by cosmetic, code compliance, and rehabilitation" (Housing Impact Team, 2017).

The university-community collaboration began with discussions about how to incorporate community engagement and university resources to understand the economic impact of the Great Recession on the Seeds neighborhood. During the Winter 2016 semester, three Geography students enrolled in independent study credits performed analyses of United States Census demographic/economic data by using the ArcGIS Business Analyst geography/spatial software. The data from within this software package provided the demographic/housing characteristics of the Grand Rapids region. The Business Analyst program module has a large, nationwide 40-gigabyte dataset that includes the comprehensive 2010 U.S. Census data with details down to the Census Block group level. The detailed dataset also included the locations and attributes of every single street, highway, and avenue, and retail/business establishments in the entire country. In April 2016, these three students presented their research results at a Seeds neighborhood Board meeting and discussed the specific steps necessary to help the Housing Impact Team fulfill their neighborhood objective to assess housing conditions. The students recommended using the Western Reserve Land Conservancy's housing index model (Western Reserve Land Conservancy, 2013), which was a nonprofit organization that created a parcel-level inventory of housing conditions for East Cleveland, Ohio, in 2014. The GVSU Geography and Sustainable Planning Department's (GSP) faculty and students had the hardware, geographic software, and the research expertise to conduct the type of housing conditions assessment that the Seeds community wanted. The 2016 housing index performed by the GVSU GSP Department and the Seeds residents built a collaborative model between research students, faculty members, and local residents. The GSP Department became the training agent and technical support to help Seeds residents gather information on their own neighborhoods in order to operationalize this community-based research (CBR). This pilot study directly addressed the Seeds of Promise Housing Im-

pact Team's objectives to assess their neighborhood's housing conditions (Housing Impact Team, 2017).

RESEARCH METHODS

In April 2016, Andrea Hendrick, Kin Ma, and Judith Transue formed the university research team. This research team designed the housing study assessment shaped by community-based learning (CBL) principles and in consultation with the Seeds of Promise neighborhood organization. We chose to use the Cleveland housing survey as a model (Western Reserve Land Conservancy, 2014). This survey was a detailed assessment rubric for evaluating housing quality in East Cleveland, Ohio. We collaboratively developed a detailed protocol for training observers suitable for the Seeds neighborhood by providing all training materials to the student researchers and community residents at their respective training sessions. More detailed contents will be shared below.

The Seeds of Promise neighborhood was within the southeastern section of Grand Rapids, Michigan, and consisted of 15 U.S. Census Block groups. This area covered 5,448 land parcels. In May 2016, the research team met with the Seeds staff and reviewed the Cleveland housing survey scorecard by walking the neighborhood. After collaborative discussion, we adapted the scorecard to neighborhood-specific conditions and needs. The following categories were retained for the final scorecard: "Vacant/Occupied," "For Sale/Rent Signs," "Broken Windows," and "Boarded Windows." If the housing parcels were determined to have "Broken Windows," "Boarded Windows," or "Graffiti," they were numerically weighted "2," "3," and "3," respectively (see Table 1), since the presence of these adverse house conditions would indicate significantly lower levels of house quality.

For each of the Neighborhood Block Groups, a GIS spatial software program named ArcGIS 10.1 was used to export a spatial table of parcel numbers and street addresses to Microsoft Excel. Walking routes were generated by sorting out odd-/even-numbered addresses onto separate sheets into a sizeable group of parcels, so student team members could walk sequentially down one side of the street, and complete their scorecard assessment within a two-and-a-half-hour timeframe.

Judith Transue, our housing specialist research team member, provided a training session by visiting each of the GIS summer classes and sharing her experiences about working with the community in order to provide a community-based learning (CBL) research context for the housing assessment. She helped increase the cultural awareness of the study region and emphasized the importance of the research collaboration with the Seeds neighborhood organization. Students were also provided a select set of housing and community engagement research articles to help them understand the research topic and formulate relevant research questions. Eighteen students were assigned to teams of two, and each

Table 1: Exterior Housing Survey Scorecard

	Address	Vacant/ Occupied (V/O)	For Sale/Rent Signs (Y/N)	Broken Windows (Y/N)	Boarded Windows (Y/N)	Trash/Debris (Y/N)	Graffiti (Y/N)	Roof Condition (1-4)	Missing/damaged Siding (1-4)	Peeling Paint (1-4)	Damaged Porch/ Stairs (1'4)	High Grass/ Weeds (1-4)	**Needs to be demolished**	Picture of Vacant Houses	Comments:
Minimum				0	0	0	0	1	1	1	1	1			Total=5
Maximum				2	3	2	3	4	4	4	4	4			Total= 30

team was assigned to one green-colored Census Block group (see Figure 1). Two separate field research days were scheduled for each class, and at the beginning of each of the first field research days, a Seeds of Promise staff member shared additional neighborhood knowledge and emphasized the importance of respecting the neighborhood and its residents. During the fieldwork, if residents questioned what the research teams were doing, they stated that they were partners with the Seeds of Promise neighborhood organization, and also provided to them the business card of the Seeds executive director. Each team received a packet that included 1) an overview map of their specific region, 2) a route map with addresses, 3) scorecard spreadsheets (see Table 1), 4) a grading rubric, 5) an instruction sheet with photo samples of siding and roof conditions ranging from 1 to 4 (1=excellent, and 4=bad condition) (see Figures 2, 3A, and 3B), and 6) a bright yellow "Seeds of Promise"-labeled vest. At the beginning of the initial field research sessions, the research team visually trained the student teams by asking them to observe, discuss, and assess the roof and siding conditions from the Table 1 scorecard above. This in-situ visual training enhanced the inter-observer reliability of the student research teams' housing assessments.

After the student teams returned from their fieldwork, they entered their team's observed field data and combined their data to the larger GIS land parcel shapefile. Then Andrea Hendrick and Kin Ma verified each student team's data for completeness by checking that each residential land parcel had a complete set of housing assessment graded rubrics. If there was missing data within the grading rubric of the scorecard sheets, Hendrick identified the specific addresses and followed up with additional field research to complete the data collection. In addition, Hendrick also performed stratified random sampling to validate the student research teams' collected data. Student research teams also wrote comments and observations from their field research regarding some specific vacant lots, and homes with bank foreclosure notices. The lessons learned from the student research teams' data collection helped inform and revise the instruction sheet and training session documents that were provided to the Seeds of Promise Host Neighbors. In addition to the field research, the student researcher teams formulated research questions on the U.S. Census Block section they had collected, or on any section of the Seeds neighborhood research area. At the end of the summer session, the student research teams created GIS research posters from the Seeds housing assessment research data and also orally presented their research findings to the class.

In June of 2016, Judith Transue, our housing specialist research team member, provided a two-hour housing assessment training session to a group of six Seeds Host Neighbor residents. She distributed a revised instruction sheet, photos of siding and roof examples (see Figures 2, 3A, and 3B), and a grading rubric with a list of addresses. During the month of July 2016, these residents assessed 1,000 land parcels within the blue-colored U.S. Census Blocks (see Figure 1 map).

After their field research collection was completed, Andrea Hendrick retrieved the Host Neighbors' scorecard sheets and entered their data into an Excel spreadsheet, and then aggregated their assessment data into the GIS land parcel shapefiles. All of the assessment data was then aggregated with the housing assessment GIS data files from the research student teams.

RESULTS

During four field research days in summer 2016, nine pairs of Geography GIS students, and the research team, walked the Seeds of Promise neighborhood and visually assessed 3,300 residential parcels in the green-colored U.S. Census Block groups (see Figure 1). In addition, Seeds residents assessed more than 1,000 parcels within their own neighborhood, as shown by the

blue-colored U.S. Census Block groups (see Figure 1). After aggregating all of the observations from the GIS student research teams, the Seeds residents research group, and the Geography Department research team, the scores for each of the 11 scorecard categories were summed together (see Table 1 sample) for every land parcel across the Seeds region. The final summation of all category scores yielded a range of values between 5 and 30 that represented housing conditions from "Great Condition" down to "Significant & Immediate Attention" (see Figure 4A). The four categories with their corresponding colors are 1) Green, "Great Condition (5-7)," 2) Yellow, "Minimal Work (8-12)," 3) Orange, "Moderate Work (13-17)," and 4) Red, "Significant & Immediate Attention (18-30)" (see Figure 4A).

Homes that were assigned to the "Great Condition" category had excellent roofs, good siding, and had new or well-sealed windows. For homes that were designated in the "Moderate Work" category, the roof was still structurally sound but had some peeling shingles, though the siding may have had some holes/cracks, and the window frames had peeling paint (see Figure 2). When homes were designated the "Significant & Needing Immediate Attention" category, their roofs had significant shingle damage, siding that was highly discolored and cracked, and the front door steps had cracks (see Figures 3A and 3B).

Within the entire Seeds study area, there were 5,448 land parcels (Figure 4A). Since the study focused on residential housing assessment, the land parcels that were designated "Commercial," "Industrial," and "Tax-Exempt" land use categories were separately assigned different colors, such as blue, yellow striped, and green striped parcels, respectively, in order to show the neighborhood context of local businesses/ factories. The "Tax-Exempt" category included land use for schools, churches, and a cemetery, which was located on the eastern section of Hall Street (see Figure 4A).

The number of parcel type varieties and the percentages of housing condition categories were displayed in the Figure 4A map and in the statistical summary charts in Figures 4B and 4C. Of the 4,363 residential parcels, 2,606 (60%) of these houses were assigned to the green-colored "Great Condition" category. There were 1,459 (34%) homes assigned to the yellow-colored "Minimal Work" category (see Figure 4C). Before the housing assessment, and because of the adverse effects of the housing financial crisis, the research team had assumed that there would be a larger percentage of homes that needed "Moderate Work" or "Significant Attention." To our team's surprise, a relatively small number and percentage of houses needed "Moderate Work," 219 (5.0%), and only 33 (0.8%) of all residential parcels were assigned to the "Significant & Immediate Attention" category (see Figure 4C).

One of the Housing Impact Team's objectives was to identify vacant land parcels, and the GIS program calculated 536 vacant parcels within the study area. These were designated with purple stripes (see Figure 4A). There was some clustering of vacant properties on the northeast corner of the study area map. When looking at the parcel polygons in the entire neighborhood map in Figure 4A, they were relatively small, so the enlarged Block Group 1 portrays the residential parcels more clearly (see Figure 5). The GIS summary of the Block Group 1 parcels shows 312 residential parcels; of these, 161 parcels were assigned the "Great Condition" category (51.6%). On the other hand, there were only six (1.9%) residential parcels that needed "Significant/Immediate" Repair Work (see Figure 6).

By August 2016, the university-community housing assessment collaborative research effort was completed. The Seeds of Promise neighborhood organization held a Board meeting, which included the Seeds staff, Housing Impact Team residents, Seeds Host resident research team members, and the Grand Valley Geography

research team members. The GV research team provided to Seeds a large, detailed, poster-sized map of exterior housing conditions for the 5,448 land parcels (Figure 4A), along with detailed overview maps and 15 separate detailed, close-up Census Block level maps (see Figure 5 as an example). A summary report of the findings was presented at the meeting by the GVSU Geography & Sustainable Planning (GSP) department research team (Hendrick et al., 2016). There was a discussion of the mapping results regarding the number of homes in the categories labeled "Moderate Work" and needing "Significant/Immediate Attention," and of potential grants/loans that could help fund house repairs and renovations. The results of this collaboration initiative fulfilled both of the Seeds Housing Impact Team's top two objectives. The summer GIS students also learned significantly more about the Seeds neighborhood culture and its housing, and at least two of the students expressed interest in continuing this type of collaboration with the Seeds neighborhood organization.

CONCLUSIONS

Within this university-community collaboration, six Seeds residents inventoried 1,000 land parcels during summer 2016. By having this housing inventory training, residents were empowered to use their community knowledge to effectively assess and understand the exterior housing conditions of their own neighborhood. Through this community-based learning (CBL) research approach, the Geography & Sustainable Planning (GSP) students performed valuable field and geospatial research, and increased their understanding of the neighborhood's culture and residential housing. In addition, the faculty were able to develop a collaboration with the Seeds neighborhood organization and share their knowledge and university computer resources in order to fulfill neighborhood housing objectives.

However, due to the time and resource constraints of the 18-month Engaged Department Initiative, a formal study of student assessment data was not able to be collected. Notwithstanding, there was anecdotal evidence that a handful of students expressed interest in continuing the community engagement work, and also expressed that the housing assessment project was valuable for their practical learning and future career opportunities.

Through this university-community joint collaboration, the Seeds residents were trained to identify houses that were vacant/damaged/needed repair, as well as the high percentage of homes in excellent condition. The colorful choropleth map colors (green=Great Condition, and red=Significant/Immediate Attention) can effectively showcase the spatial distribution of the rankings of exterior housing conditions, and quickly highlight land parcels with vacant lots, as well as houses in need of "Moderate Repair" work or "Significant Attention" and repair (Figures 4A and 5). The Seeds of Promise neighborhood organization has used this data to assist owner-occupied residents in the repair or replacement of roofs and siding by connecting them to local repair companies. Moreover, Seeds was provided with a parcel ownership table of names and addresses, and therefore will be able to identify landlords and reach out to them to encourage them to invest and repair old, dilapidated homes, or assist both residents and landlords to apply for Neighborhood Improvement Program (NIP) federal grants or local bank loans.

Using the valuable housing assessment information, the Seeds of Promise, in collaboration with the Federal Home Loan Bank of Indianapolis (FHLBI), have assisted 24 and 25 homeowners in 2016 and 2017, respectively, in applying for NIP grants. In the years 2016 and 2017, 13 (54.1%) and 14 (56%) of the NIP grants, respectively, were approved. These grant investments totaled $97,500 (2016) and $105,000 (2017). The Seeds of Promise worked closely with the FHLBI bank, since

they donate 10% of their earnings to the communities for housing improvement programs (Jimmerson, 2017). As a result of this collaborative comprehensive housing assessment, all of these grant and loan activities were realized, and a total of $202,500 was invested into this community over the past two years.

As a sign of the continuing partnership, the Geography & Sustainable Planning Department invited the Seeds of Promise executive director, Ronald Jimmerson, to share his perspective on this partnership at a September 2016 Open House. He passionately shared his goals and values of his Seeds of Promise community. Our Grand Valley State University community heard directly from a community leader regarding the significant impact of this collaborative community engagement project. While hearing about his Seeds community, many faculty and students appreciated more deeply the challenges of their neighborhood, and also inspired people to connect with the Seeds neighborhood organization. Jimmerson also appreciated the university's help to complete their top two Housing Impact Team goals. Moreover, with the newly formed community relationships and lessons learned from this community-based research (CBR) experience, the authors continued to support this university-community collaboration by engaging in a separate Fall 2016 Cottage Grove exterior housing assessment project funded by a local foundation.

FUTURE RESEARCH

The Geography & Sustainable Planning Department is committed to deepening their collaboration with Seeds of Promise. We are currently discussing a summer 2018 project with Seeds of Promise that can potentially help map environmental health hazards such as toxic chemical leakages and lead-based paint contamination. This case study fills a gap in the current research on engagement projects in higher education by confirming the concrete value communities' can and do yield from such partnerships (Battistoni et al., 2003; Kecskes, 2015). Universities can use their knowledge, geospatial analytical skills, and passion to purposely engage, serve, and empower the local communities that surround them as Grand Valley Geography has done.

Figure 1: Seeds of Promise Study Area within Grand Rapids, Michigan

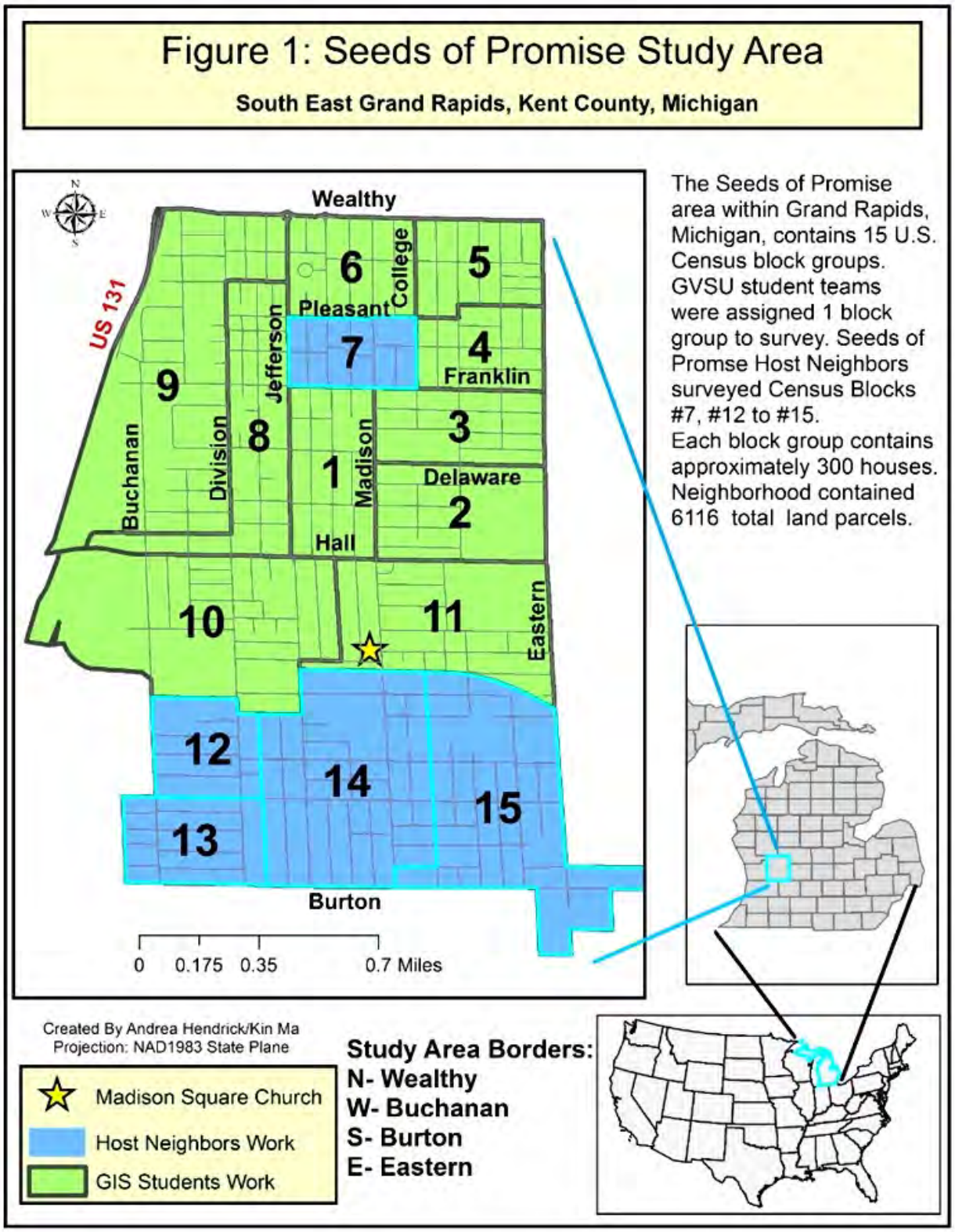


Figure 2: Photos of Siding Example Conditions

Paint/Siding Scorecard Examples

Siding should be even and complete. Paint may have very minor cracks or patches and still be ranked a 1.

Minor misplacement of siding. Small patches, discoloration, or cracks in paint.

Small gaps in siding. Moderate peeling and buckling and significant cracks in the paint.

Holes or pieces of siding breaking off. Large patches of paint falling off and wood is exposed. This is a better example for paint than for siding.

Figure 3A: Housing Sample, "Moderate Work" category

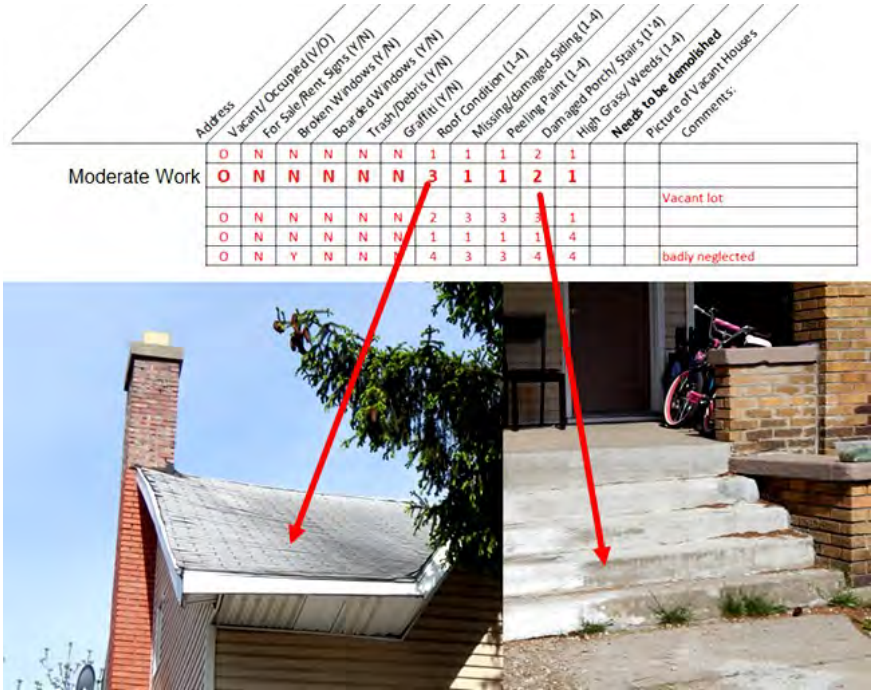


Figure 3B: Housing Sample, "Significant/Immediate Attention" category

Figure 4A: Seeds of Promise Housing Condition Map

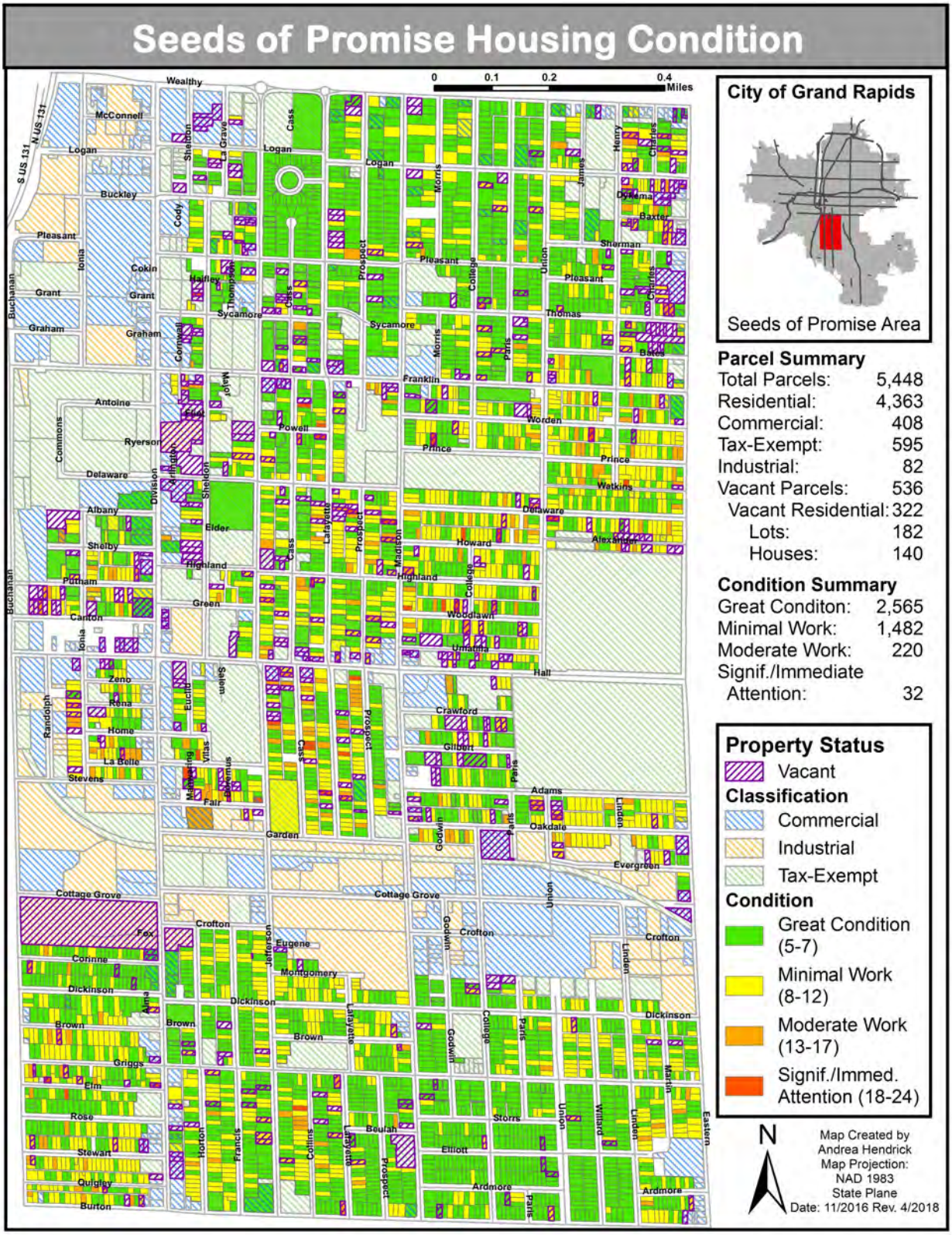


Figure 4B: Seeds of Promise Neighborhood Parcel Summary Chart

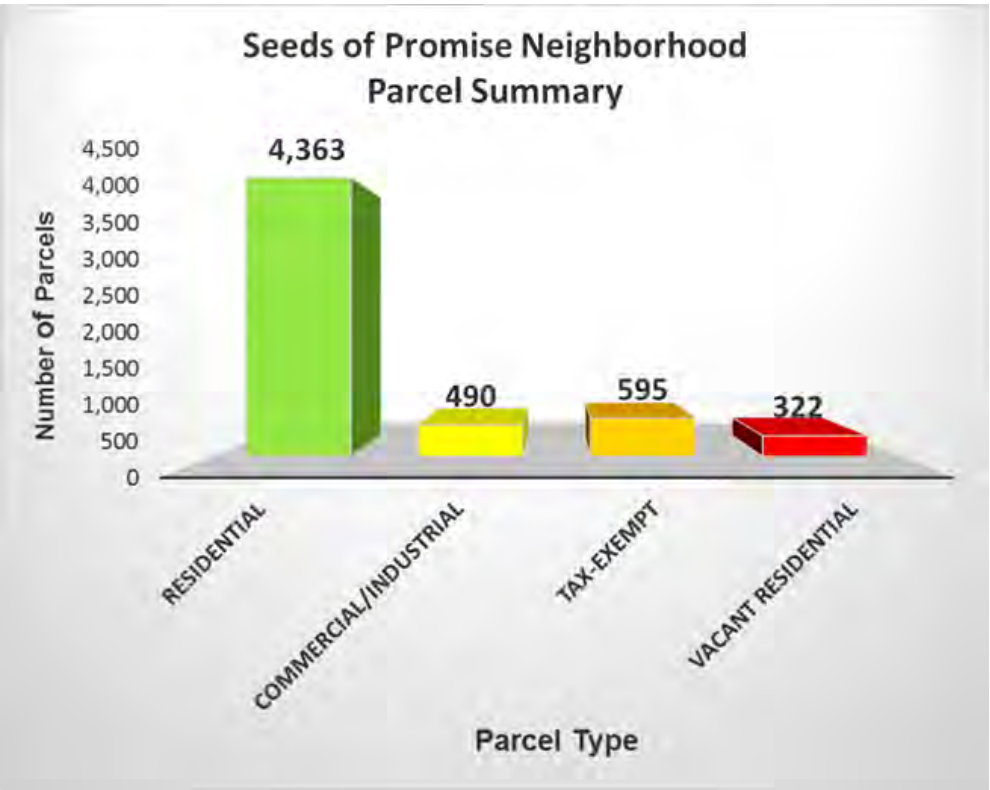


Figure 4C: Seeds of Promise Residential Housing Condition Chart

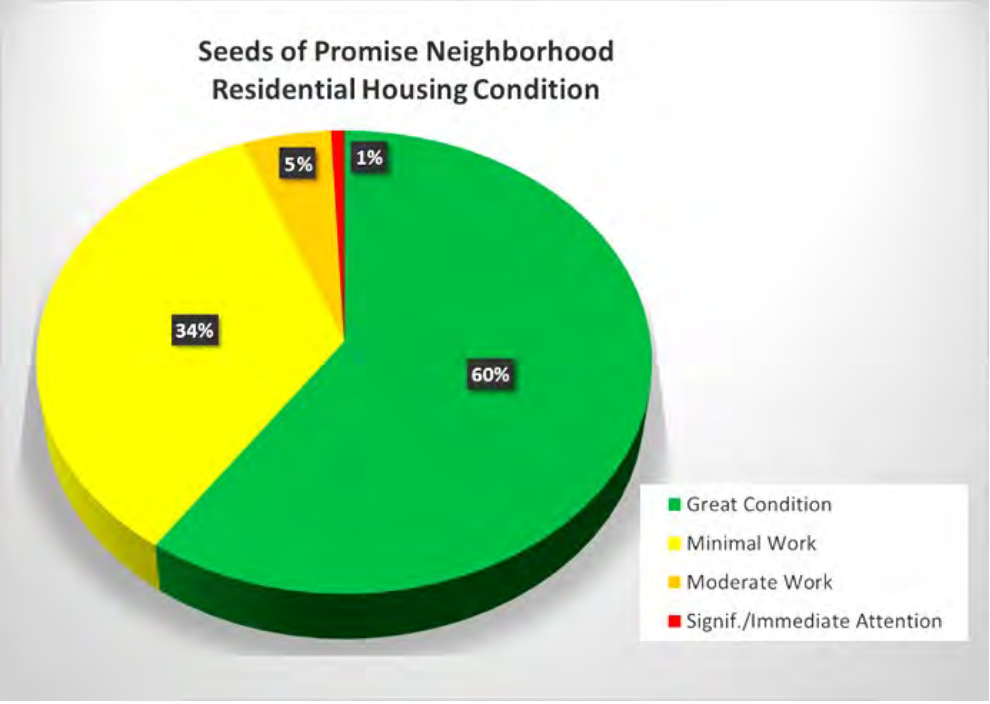


Figure 5: Seeds of Promise, Census Block 1 Housing Condition Map

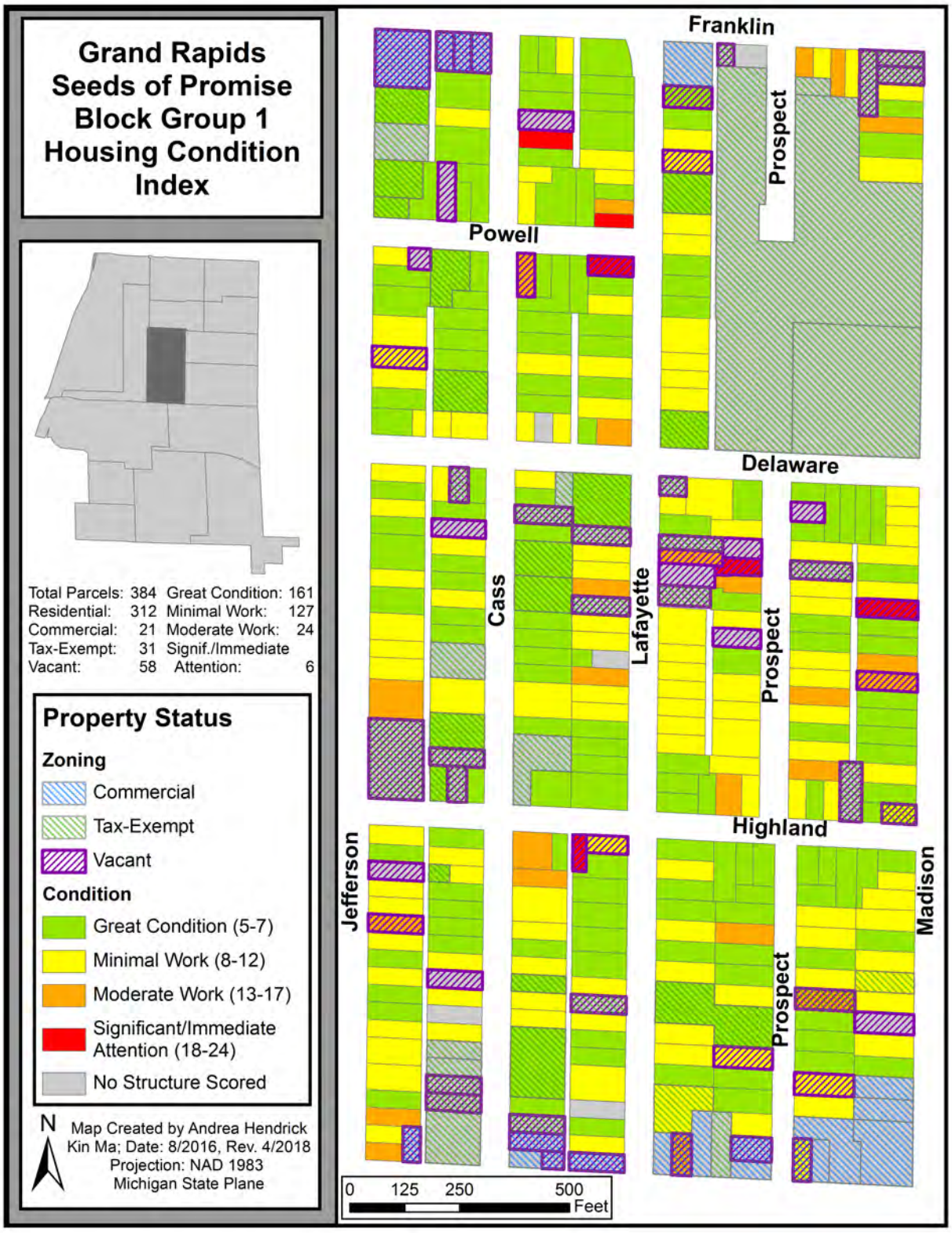
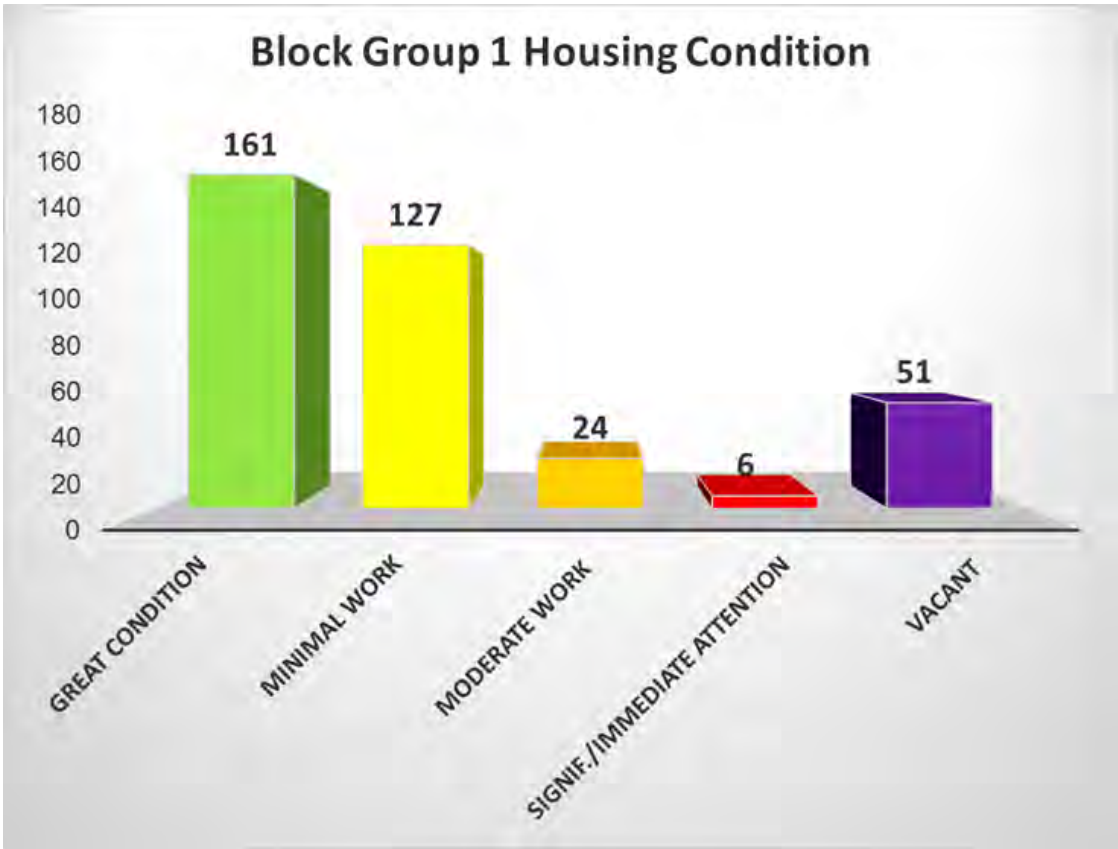


Figure 6: Census Block Group 1 Housing Condition Chart



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