HARTFORD HILL

MASTER PLAN

A Fieldhouse Development
Master Planned Community

September 2015

SMH CONSULTANTS

FIELDHOUSE DEVELOPMENT, INC.

ORDINANCE NO. 7170

AN ORDINANCE AMENDING THE CURRENT COMPREHENSIVE PLAN FOR THE DEVELOPMENT OR REDEVELOPMENT OF THE MANHATTAN URBAN AREA AND THE CITY OF MANHATTAN, KANSAS ENTITLED THE "MANHATTAN URBAN AREA COMPREHENSIVE PLAN, DATED MARCH 2015" BY THE ADOPTION, BY REFERENCE, OF THE "HARTFORD HILL MASTER PLAN, DATED SEPTEMBER 2015"

WHEREAS, following a public hearing on March 2, 2015, the publication known as the "Manhattan Urban Area Comprehensive Plan, dated March 2015" (the "MUACP") was adopted as the current comprehensive plan for the development or redevelopment of the Manhattan Urban Area and the City of Manhattan, Kansas by the Manhattan Urban Area Planning Board (the "MUAPB") with the adoption of MUAPB Resolution No. 030215-A; and

WHEREAS, the MUACP was approved and adopted pursuant to K.S.A. 12-747 by the Governing Body of the City of Manhattan, Kansas when it passed and adopted Ordinance No. 7131 on April 7, 2015; and

WHEREAS, the MUACP, as approved and adopted by the Governing Body of the City, currently consists of the base document, which is entitled the Manhattan Urban Area Comprehensive Plan, dated March 2015, and nine other separately bound documents which were incorporated into the base document that was approved and adopted by Ordinance No. 7131 and which are entitled:

1. The Poyntz Avenue Corridor District Plan, as approved and adopted by City Ordinance No. 4839, on February 1, 1994;
2. The Grand Mere Community Master Plan, as approved and adopted by City Ordinance No. 6127, on April 4, 2000;
3. Downtown Tomorrow, A Redevelopment Plan For Downtown Manhattan, Kansas, as approved and adopted by City Ordinance No. 6132, on May 2, 2000;
4. The Manhattan Area Transportation Strategy, dated March 2015, as approved and adopted by City Ordinance No. 7131, on April 7, 2015 and Riley County Resolution No. 032315-07 on March 23, 2015;
5. The Aggieville – Campus Edge District Plan, as approved and adopted by City Ordinance No. 6498, on October 11, 2005;
6. The Eureka Valley – Highway K-18 Corridor Plan, as approved and adopted by City Ordinance No. 7003, on May 21, 2013 and Riley County Resolution No. 050213-28 on May 2, 2013;
7. The Gateway to Manhattan Plan, dated April 2011, as approved and adopted by City Ordinance No. 6893, on May 17, 2011 and Riley County Resolution No. 042511-08 on April 25, 2011;
8. The US-24 Corridor Management Plan, as approved and adopted by City Ordinance No. 6792, on November 3, 2009;

9. The Wildcat Creek Floodplain Management Plan, dated November 2013, as approved and adopted by City Ordinance No. 7047, on November 5, 2013 and Riley County Resolution No. 112513-73 on November 25, 2013; and,

WHEREAS, the Hartford Hill Master Plan, dated September 2015, which was prepared by owners of the land subject to the plan and presented to City staff, provides additional guidance for development of the 320 acre site, including phasing, access, drainage and utility service, parks and trails, land use, and Fort Riley Noise Impact mitigation; and,

WHEREAS, pursuant to the provisions of K.S.A. 12-747, the Manhattan Urban Area Planning Board gave proper notice in the official City newspaper of a public hearing to be held during the August 17, 2015 meeting of the MUAPB to receive comments and remarks relating to this amendment; and,

WHEREAS, during the August 17, 2015 meeting of the MUAPB, the MUAPB tabled and continued the public hearing until the September 10, 2015 meeting of the MUAPB to allow for additional relevant information to be gathered and presented for public comment in front of the MUAPB; and,

WHEREAS, during the public hearing on Thursday, September 10, 2015, the MUAPB received comments and remarks relating to this amendment; and,

WHEREAS, following said public hearing the Manhattan Urban Area Planning Board found that the Hartford Hill Master Plan, dated September 2015 has been developed and prepared in light of the comprehensive surveys and studies of past and present conditions and trends required by K.S.A. 12-747 which were made in support of the adoption of the MUACP as well as additional information necessary to develop the Manhattan Urban Area Planning Board's recommendations for the development or redevelopment of the portion of the Manhattan Urban Area and the City of Manhattan, Kansas covered by the Hartford Hill Master Plan, dated September 2015. The Manhattan Urban Area Planning Board further found that, upon its amendment to include the Hartford Hill Master Plan, dated September 2015, the MUACP will show the Manhattan Urban Area Planning Board's recommendations for the development or redevelopment of the Manhattan Urban Area and the City of Manhattan, Kansas and, when taken in conjunction with the planning of the capital improvements programs and all other infrastructure and community planning undertaken by local governments within the Manhattan Urban Area, adequately addresses the items to be addressed in a comprehensive plan pursuant to K.S.A. 12-747; and

WHEREAS, the Governing Body of the City concurs with these findings of the Manhattan Urban Area Planning Board; and

WHEREAS, following said public hearing a majority of all members of the Manhattan Urban Area Planning Board voted to adopt MUAPB Resolution No. 091015-A amending the MUACP by the adoption, by reference, of the "Hartford Hill Master Plan, dated September 2015"; and

WHEREAS, the Governing Body of the City of Manhattan, Kansas, desires to approve and adopt by ordinance the amendment of the MUACP by the adoption, by reference, of the "Hartford Hill Master Plan, dated September 2015" in accordance with the recommendation for its approval and adoption made by the adoption of MUAPB Resolution No. 091015-A by the vote of a majority of all members of the Manhattan Urban Area Planning Board.

NOW, THEREFORE, BE IT ORDAINED BY THE GOVERNING BODY OF THE CITY OF MANHATTAN, KANSAS:

SECTION 1. The amendment of the "Manhattan Urban Area Comprehensive Plan, dated March 2015" (the "MUACP") to incorporate the Hartford Hill Master Plan, dated September 2015, as adopted by the Manhattan Urban Area Planning Board, is hereby approved and adopted. The publication known as the Hartford Hill Master Plan, dated September 2015, as adopted by the Manhattan Urban Area Planning Board, is incorporated by reference within this Ordinance in code form as that term is defined in K.S.A. 12-3301(c).

SECTION 2. The list of "Related Plans and Policy Documents" contained in Chapter 3 and Appendix B of the MUACP shall henceforth be read to include the Hartford Hill Master Plan, dated September 2015.

SECTION 3. Following this amendment, the MUACP shall consist of the base document, entitled the Manhattan Urban Area Comprehensive Plan, dated March 2015, and ten other separately bound documents, which are incorporated into the base document, and which are entitled:

1. The Poyntz Avenue Corridor District Plan, as approved and adopted by City Ordinance No. 4839, on February 1, 1994.
2. The Grand Mere Community Master Plan, as approved and adopted by City Ordinance No. 6127, on April 4, 2000.
3. Downtown Tomorrow, A Redevelopment Plan For Downtown Manhattan, Kansas, as approved and adopted by City Ordinance No. 6132, on May 2, 2000.
4. The Manhattan Area Transportation Strategy, Dated March 2015, as approved and adopted by Ordinance No. 7131, on April 7, 2015.
5. The Aggieville – Campus Edge District Plan, as approved and adopted by City Ordinance No. 6498, on October 11, 2005.
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8. The US-24 Corridor Management Plan, as approved and adopted by City Ordinance No. 6792, on November 3, 2009.
9. The Wildcat Creek Floodplain Management Plan, dated November 2013, as approved and adopted by City Ordinance No. 7047, on November 5, 2013.
10. The Hartford Hill Master Plan, dated September 2015, as approved and adopted by this Ordinance.

SECTION 4. At least one (1) copy of the MUACP containing the Hartford Hill Master Plan, dated September 2015 shall be marked or stamped "Official Copy as Incorporated by Ordinance No. 7131 and amended by Ordinance No. 7170", and shall be attached to a copy of Ordinance No. 7131 and a copy of this Ordinance and filed with the City Clerk to be open to inspection and available to the public at all reasonable business hours. All administrative departments of the City charged with enforcement of Ordinance No. 7131 and this Ordinance shall be supplied, at the cost of the City, such number of official copies of Ordinance No. 7131 and this Ordinance with copies of the MUACP containing the Hartford Hill Master Plan, dated September 2015, attached that are marked or stamped "Official Copy as Incorporated by Ordinance No. 7131 and amended by Ordinance No. 7170" as may be deemed expedient.

SECTION 5. This Ordinance shall take effect and be in force from and after its passage and publication in The Manhattan Mercury.

PASSED AND ADOPTED THIS 20TH DAY OF OCTOBER, 2015, BY THE GOVERNING BODY OF THE CITY OF MANHATTAN, KANSAS.

(SEAL)

ATTEST:

Gary S. Fees, MMC, City Clerk

Karen McCulloh, Mayor

HARTFORD HILL
MASTER PLAN

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INTRODUCTION

The purpose of this master plan submittal is to continue the planning process that began over a year ago to incorporate a tract of land into the Manhattan Urban Area Comprehensive Plan.

The intent of eventually developing this 320 acre development called Hartford Hill is to provide some of the land that the City of Manhattan needs to continue to grow and prosper. Historically, the major growth of Manhattan has been primarily to the northwest, with simultaneous expansions to the southwest and northeast. Recent years have seen the amount of land for continued development diminish along the western boundary of the City. Reasons for that include building to the edge of capabilities of the city's utility systems; building to the edge of the Ft. Riley Noise Zones; building up against large expanses of land owned by Kansas State University.

In order to continue to expand and meet the housing demands of one of the fastest growing communities in Kansas, more land has to be made available. The City of Manhattan and Counties of Riley and Pottawatomie have updated the Manhattan Urban Area Comprehensive Plan (MUACP). All three of those entities adopted the new plan in the spring of 2015. The MUACP indicates current population of the City of Manhattan is just over 56,000. Using the tools at their disposal, and the inside knowledge they have of what is happening in and around Manhattan, the professionals that developed the MUACP project the population of the city to increase to these approximate numbers:

61,000 in 2019
65,000 in 2024
69,000 in 2029
72,000 in 2034

The owners of Hartford Hill are Zac and Amber Burton, through one of their business enterprises, Fieldhouse Development, Inc. Throughout the MUACP updating efforts, the Burtons have worked with City Administration to expand the current Growth Area. Efforts have also been put forth to expand the current Urban Service Area to include Hartford Hill. Since the Manhattan Urban Area Planning Board reviews the Urban Service Area annually, City Administration indicate it is likely that boundary will move incrementally as development progresses. Hartford Hill will provide a portion of the land needed to meet the growing demand of housing in Manhattan.

As described in more detail later in this plan, the vision of the owners of Hartford Hill is to provide a quality, well planned, residential neighborhood that continues the success of other neighborhoods with similar terrain and character in northwest Manhattan. The various land uses, and their approximate acreages, throughout Hartford Hill are shown on Figure 2. As with any good master plan of any size, flexibility has to be recognized as a component. Market influences and demands will drive the ultimate, smaller development designs, but because of the physical constraints imposed upon the land, the densities of any final designs will be naturally much lower than what would otherwise be possible on flatter terrain. Likewise, the timing of the various phases will be largely driven by market demand. In a perfect developer world, with the

anticipated strength of the foreseeable Manhattan economy, the entire development could be built out in 5 to 10 years. If there are any unforeseen circumstances that substantially slow Manhattan's growth, it might take 15 to 20 years to build out the entire 320 acres.

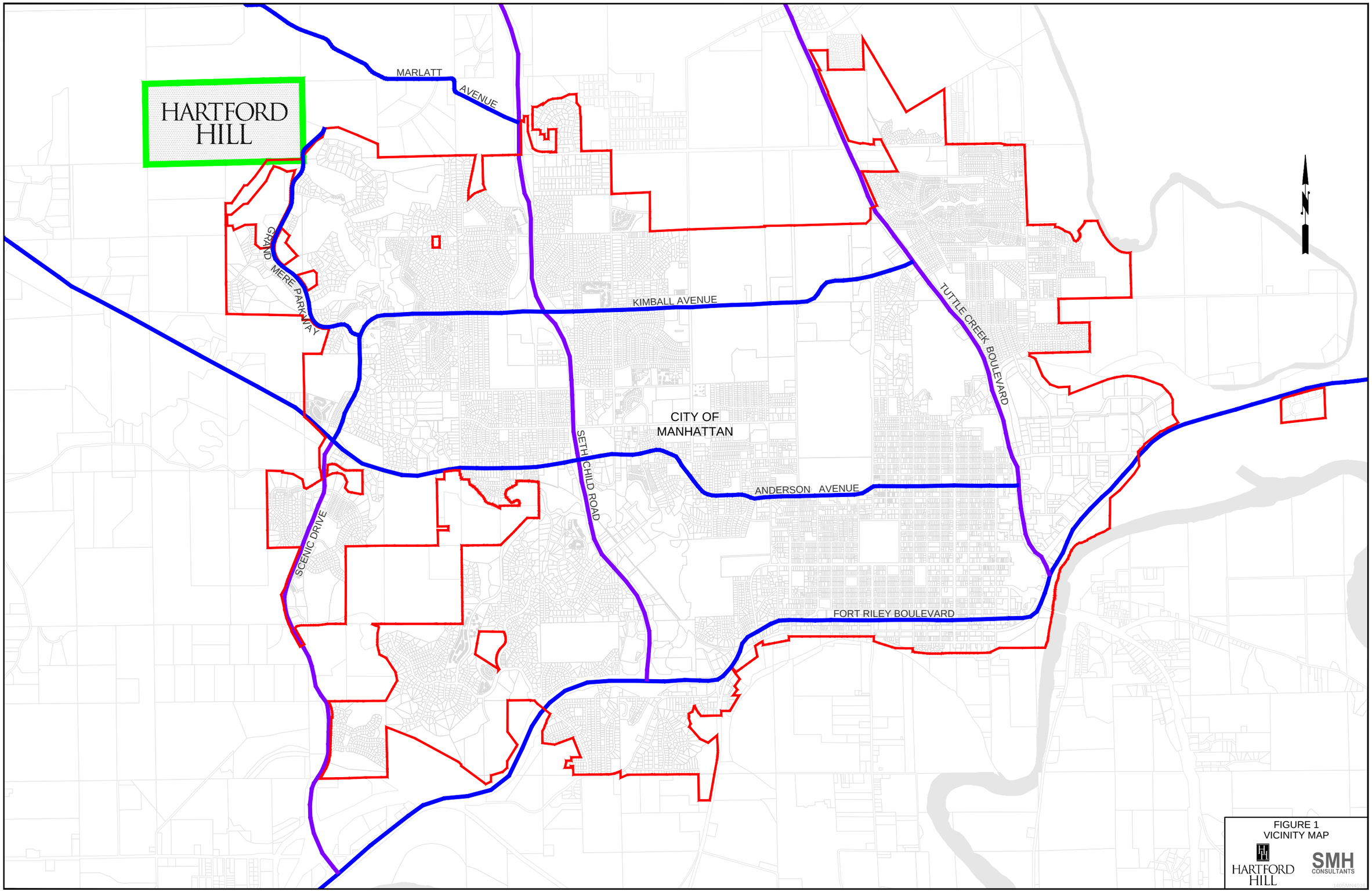

FIGURE 1
VICINITY MAP

HARTFORD HILL

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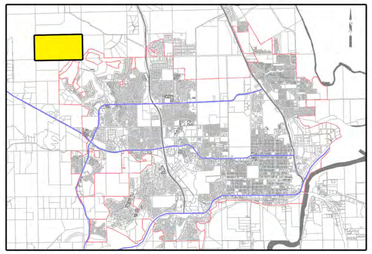
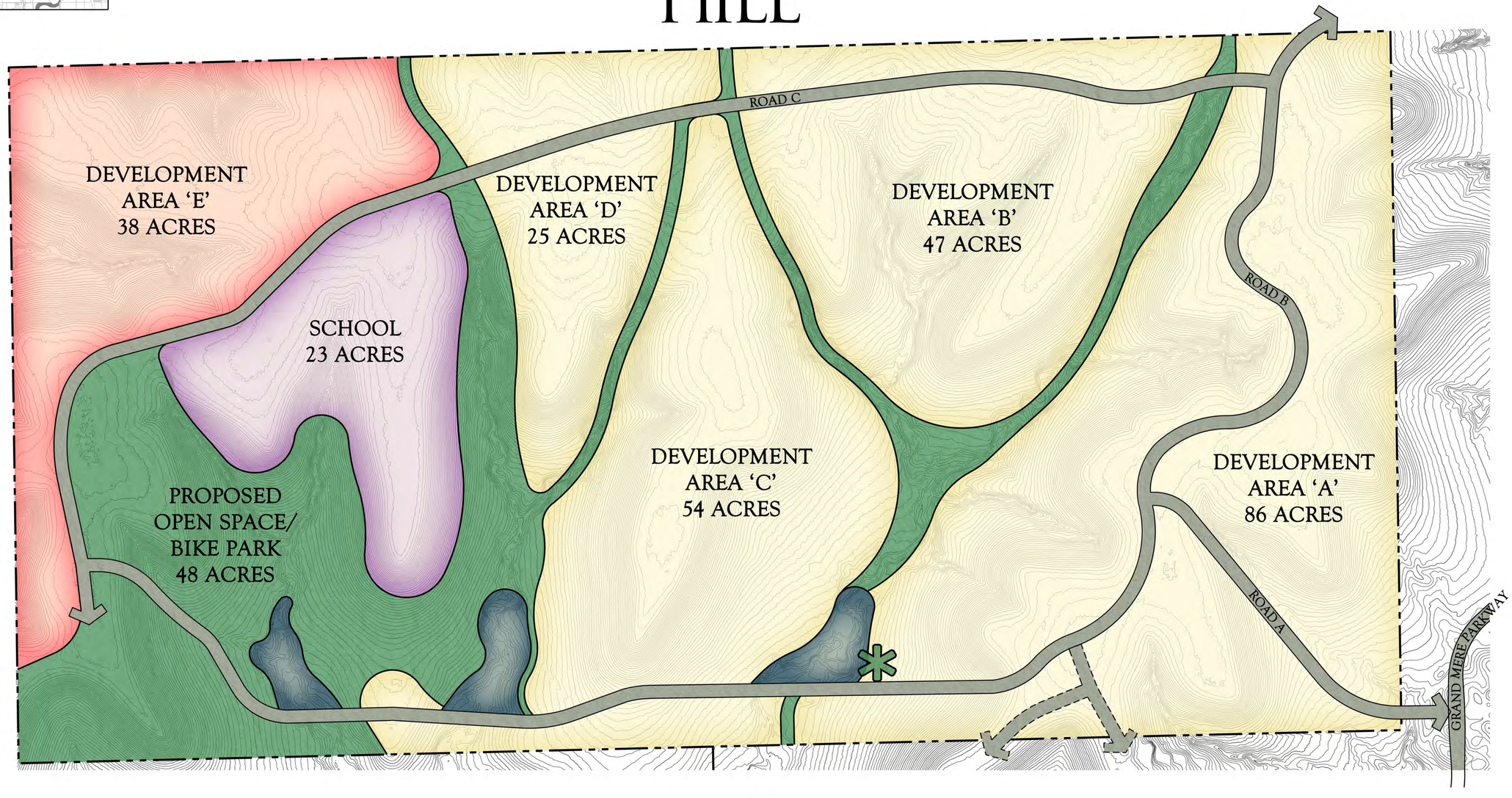


VICINITY MAP

HARTFORD HILL



LEGEND

- Low / Medium Density Residential 0 - 11 DU/AC
- Open Space
- Office / Research Park
- Public / Semi-Public
- Stormwater Management
- Proposed Neighborhood Park

DEVELOPMENT DIAGRAM

September 2015

NORTH 0' 100' 200' 400' 600'

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THE SITE

The Hartford Hill Development is located in the far northwest portion of Manhattan, Kansas, as shown on Figure 1. A conceptual Development Diagram is shown on Figure 2.

It is rectangular in shape, 1.0 by 0.5 miles, consisting of 320 acres of native range land that has been used for grazing cattle. The property lies north and west of, and adjacent to Grand Mere Development and the Colbert Hills Golf Course.

Approximately 31 acres of the southeast corner of the development drains southeast through Grand Mere and Colbert Hills, reaching Little Kitten Creek after a 0.75 mile journey, and then eventually to Wildcat Creek in another 1.5 miles. A small portion of the northwest corner of the development, about 49 acres, drains to the northwest into an unnamed tributary that after 3.2 miles joins Wildcat Creek. Runoff from the remaining 240 acres of the development traverses southwest through private rangeland, and then cropland via well-defined drainage ways and ravines, eventually reaching Wildcat Creek about 3.1 miles upstream of the bridge at Scenic Drive.

NEIGHBORING LANDS

The names of owners of land adjacent to Hartford Hill can be seen on Figure 3.

Those land parcels consist of a mix of private and public ownerships.

The land owned by Fieldhouse Development is now known as Baltustrol as recently platted through the City of Manhattan.

The land east of Hartford Hill owned by Grand Mere is master planned to be developed as an "elder care" residential area. In the event a project meeting that definition does not materialize in the foreseeable future, it is likely that area will be converted to single family residential.

The land south of Hartford Hill owned by Grand Mere is master planned to be developed as single family residential homes. It is unlikely that will change since the terrain is very difficult in that area, and not conducive to more intense development.

There is no indication as to what the owners of the Troyer land might have in mind as a long term plan for their land.

It is impossible to ascertain what Kansas State University might want to do with its land in the future. There are on-going, and continuing, studies related to KSU land nearer the main campus, but nothing related to the land in question.

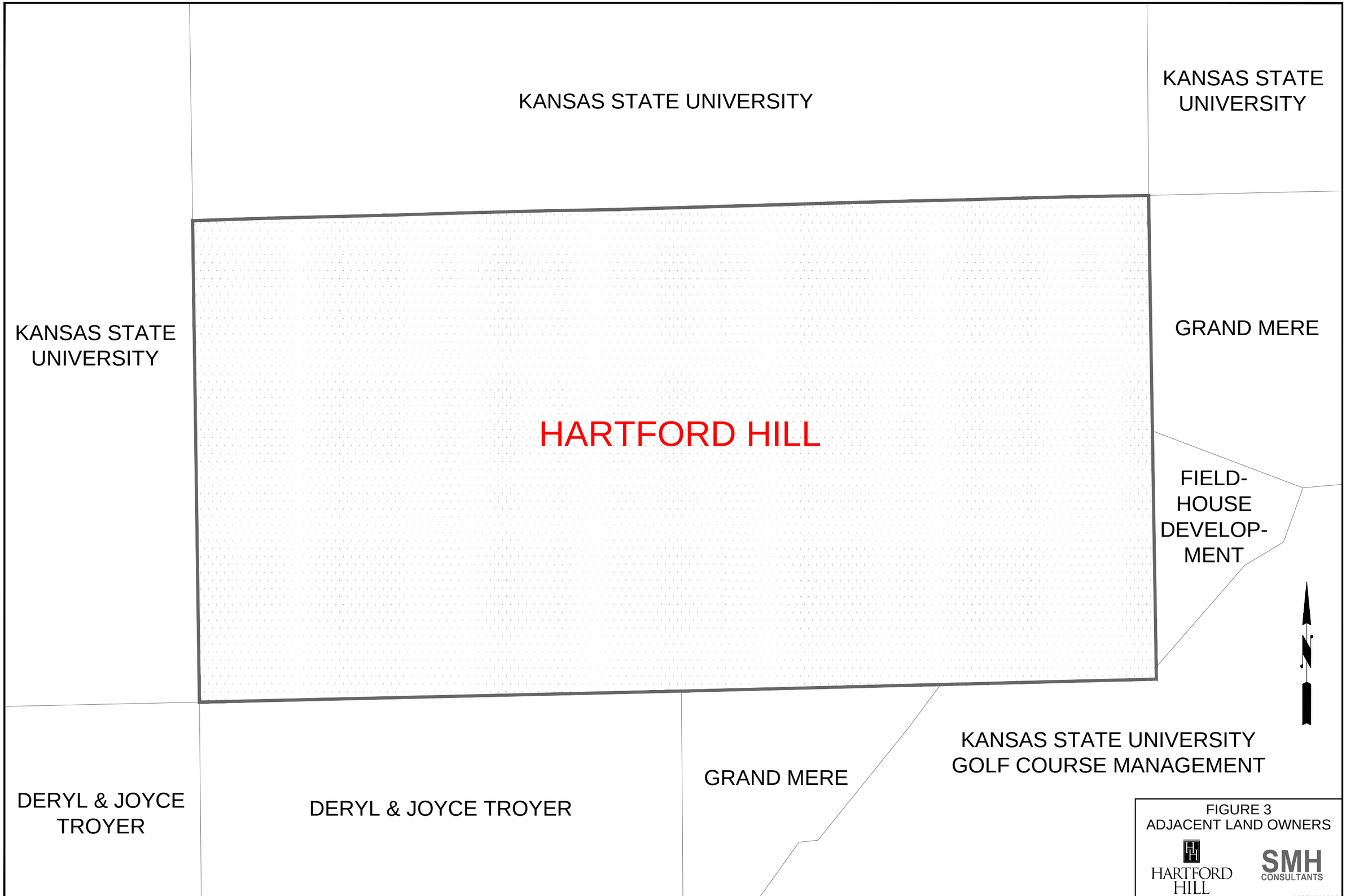


FIGURE 3
ADJACENT LAND OWNERS

SITE ANALYSIS

Existing Conditions, Land Use, and Topography

The site on which Hartford Hill sits is 100% pasture. It has always been vacant of buildings, and used to graze cattle.

The land is extremely rough in places, with elevations ranging from a low of about 1205 to a high of approximately 1350. Slopes range from almost flat to in excess of 50 %, with some exposed rock ledges showing on topographic maps at 200%. The areas that have been grazed are separated by deep ravines that contain the only trees on the site. Several varieties of native trees and brush exist along the steep slopes and bottoms of the gullies, but trees in general are few and far between. Elevations and slopes can be seen on Figures 4 and 5 respectively.

Ridgelines along the higher elevations are relatively flat, and provide commanding views in all directions.

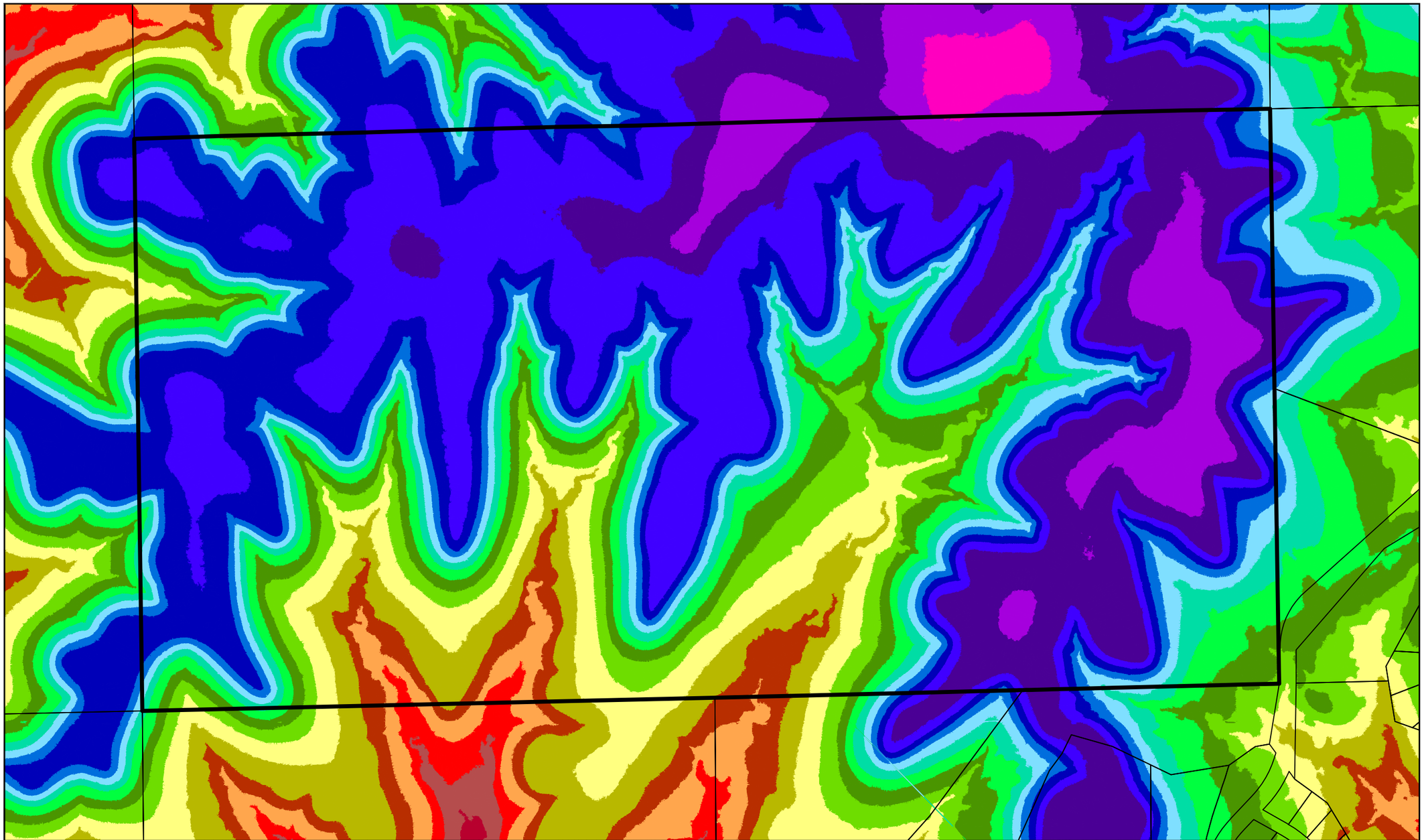
Soils within the site are shown on Figure 6. They generally include thin topsoil of just a few inches, underlain by layers of limestone and shale.

Access

The roadway network near Hartford Hill can be seen on Figure 1. Vehicular access to the site will be obtained at a minimum of two (2) locations. The first to occur will be near the southeast corner of the development, and will connect to Grand Mere Parkway. Grand Mere Parkway is functionally classified as a major collector street, and serves many modes of traffic south to where it intersects Kimball Avenue. Grand Mere Parkway carries motor vehicles, bicycles on separately marked lanes in both directions, and pedestrians on sidewalks along both sides of the street. Kimball is classified a minor arterial in the City's street network. In addition to being one of the primary east-west movers of vehicular traffic in the community, it also carries pedestrians on sidewalks, for the most part on both sides of the streets. From Grand Mere Parkway south, sidewalks do not exist yet because some land on both sides of the roadway is still undeveloped. The intent is for those sidewalks and for better bicycle facilities to be added as the City continues to grow in that direction.

The second access will be near the northeast corner of Hartford Hill. It is at that point that the subject land parcel enjoys the benefits of an easement dedicated by Kansas State University. That easement allows travel to and from Marlatt Avenue. Marlatt is functionally classified as a local road, currently under the jurisdiction of Riley County. Marlatt is a rural section, gravel roadway.

It is possible that other access points into Hartford Hill could be realized in the future. Possible connection points have been shown on Figure 2.



Elevations Table			
Number	Min. Elev.	Max. Elev.	Color
1	1170.00	1180.00	
2	1180.00	1190.00	
3	1190.00	1200.00	
4	1200.00	1210.00	
5	1210.00	1220.00	

Elevations Table			
Number	Min. Elev.	Max. Elev.	Color
6	1220.00	1230.00	
7	1230.00	1240.00	
8	1240.00	1250.00	
9	1250.00	1260.00	
10	1260.00	1270.00	

Elevations Table			
Number	Min. Elev.	Max. Elev.	Color
11	1270.00	1280.00	
12	1280.00	1290.00	
13	1290.00	1300.00	
14	1300.00	1310.00	
15	1310.00	1320.00	

Elevations Table			
Number	Min. Elev.	Max. Elev.	Color
16	1320.00	1330.00	
17	1330.00	1340.00	
18	1340.00	1350.00	
19	1350.00	1360.00	

N

FIGURE 4
ELEVATION MAP

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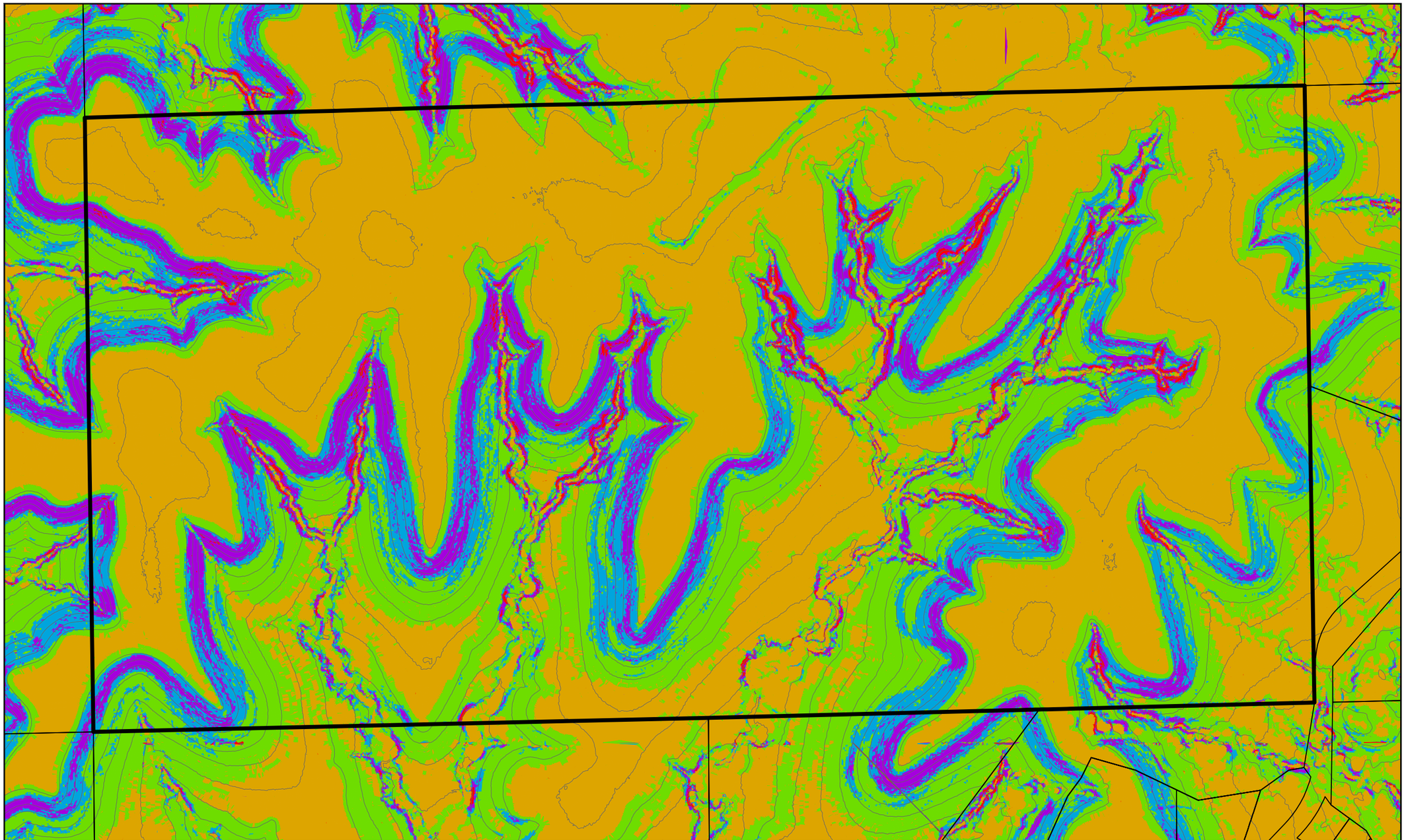

Slopes Table			
Number	Min. Slope	Max. Slope	Color
1	0.00%	10.00%	
2	10.00%	25.00%	

Slopes Table			
Number	Min. Slope	Max. Slope	Color
3	25.00%	33.00%	
4	33.00%	50.00%	

Slopes Table			
Number	Min. Slope	Max. Slope	Color
5	50.00%	200.00%	

FIGURE 5
SLOPE MAP

HARTFORD HILL

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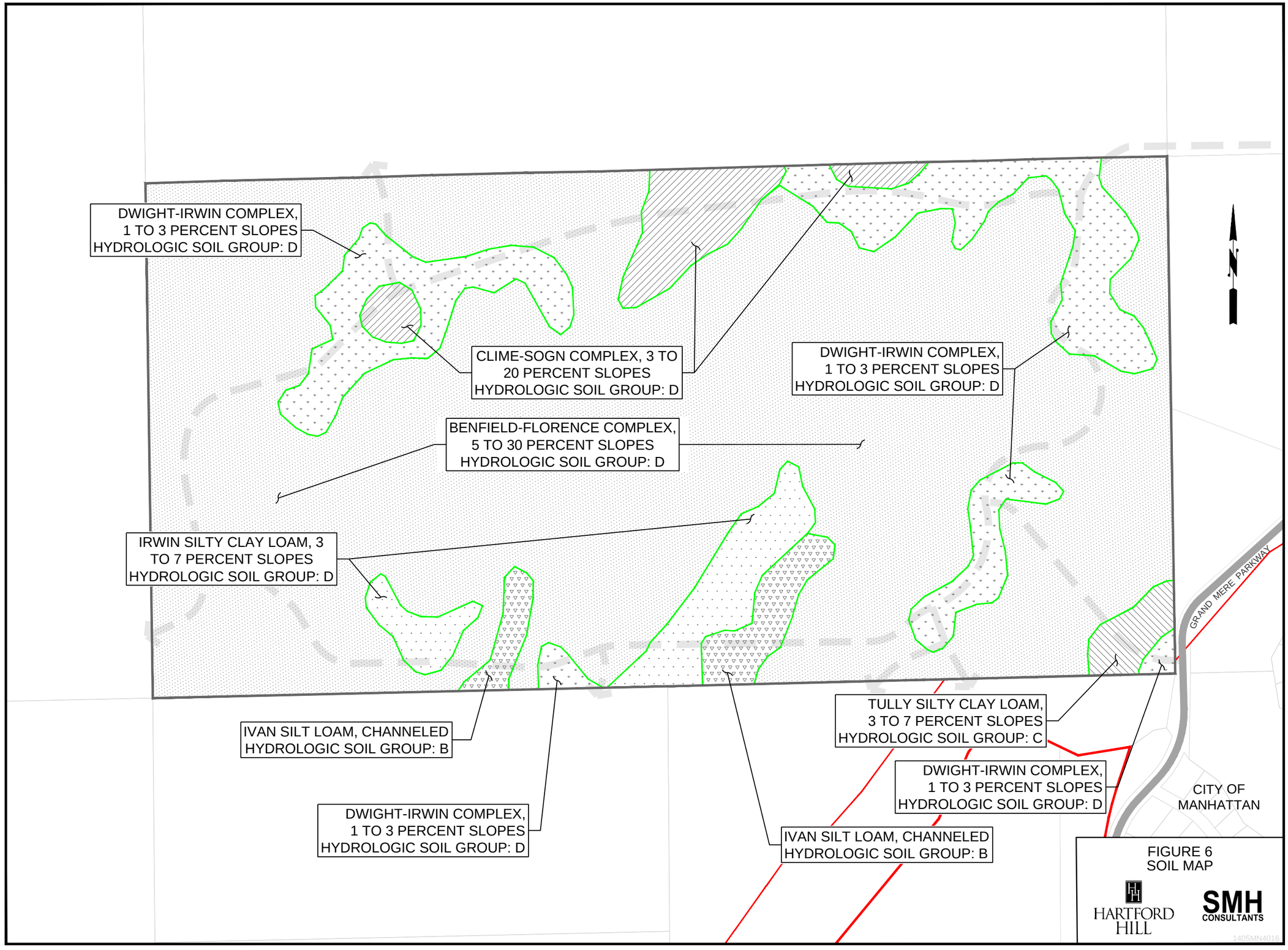


FIGURE 6
SOIL MAP

Availability of Utilities

A map of water and sanitary sewers facilities is shown on Figure 7.

Water

Water, provided by the City of Manhattan, is available in the form of a 16-inch transmission main at the east line of Hartford Hill. Water transmission runs between the Hudson Avenue Storage facility and the Northwest Storage facility. Technical Supplement No. 1, provided at the end of this master plan report explains the details regarding the water system in this portion of Manhattan. Generally, when the northwest storage tower is slightly less (4 feet) from full, the static pressure at the highest point in Hartford Hill will be in excess of 53 psi. With a combination of 16-inch and 12-inch water mains in Hartford Hill, the residual pressure (pressure under fire flow) would still remain in excess of 45 psi.

Water mains will generally follow the alignment of roadways. Therefore it is anticipated the first connection to service Hartford Hill will be near the intersection of Grand Mere Parkway and Road A. A second connection will occur near where Road B crosses the existing 16 inch water main, thus creating a looped system into Hartford Hill.

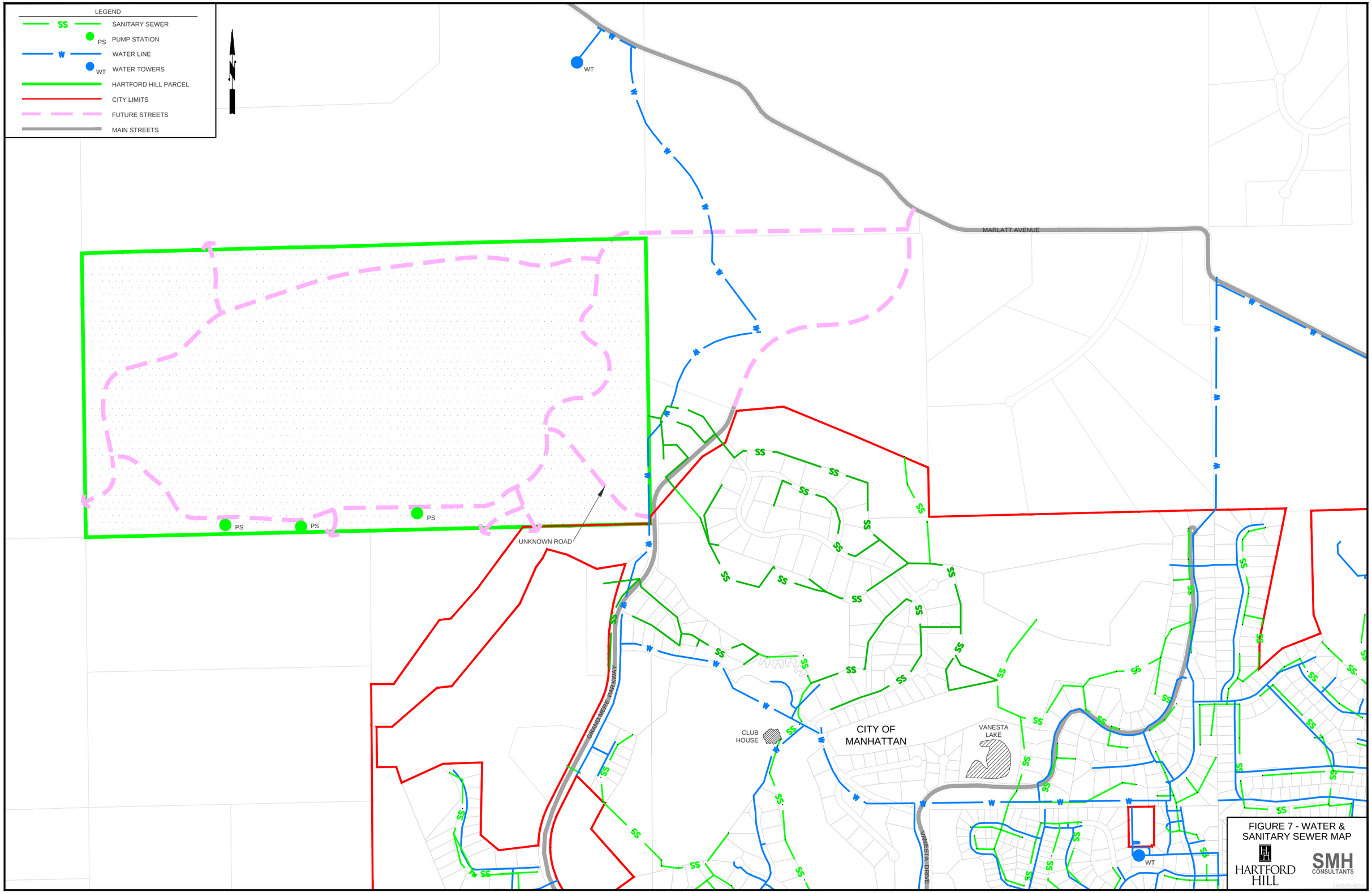
City Administration has pointed out that there are some challenges regarding the water system. On days of peak demand, it is difficult to keep the northwest storage tower full. There are at least two ways to address that issue. First, the old pump stations and transmission mains far east of the developing areas of Manhattan could be upgraded to accommodate the inevitable growth. Second, additional storage could be provided somewhere strategically located to be of best service to the entire community. The owners of Hartford Hill are willing to work with City officials to identify an appropriate site if it is determined such a site should be in Hartford Hill.

Sanitary Sewer

Sanitary sewer service by the City of Manhattan will be provided by a combination of gravity flow sewers and a series of pump stations.

The first phases of development, starting at the southeast corner of Hartford Hill, will flow by gravity to the southeast, connecting to existing sewers that run through the Grand Mere Development and the Colbert Hills Golf Course. Once the Hartford Hill development process reaches the first ridgeline west, wastewater will have to be collected in a wet well and pumped back over the hill to the previously mentioned gravity system. This general service technique will continue across the ridgelines to the west, resulting in three (3) pump stations. Eventually, if the City decides to develop westward along Anderson Avenue, gravity flow sewers could potentially be made available, and the pump stations could potentially be eliminated from service.

In Technical Supplement No. 2 details of efforts to examine the existing sewer system downstream of Hartford Hill are provided. City Administration worked with the Hartford Hill team to obtain some existing wastewater flows at strategic manholes. With the relatively low


LEGEND
SS SANITARY SEWER
PS PUMP STATION
W WATER LINE
WT WATER TOWERS
HARTFORD HILL PARCEL
CITY LIMITS
FUTURE STREETS
MAIN STREETS
N
WT
MARLATT AVENUE
PS
PS
PS
UNKNOWN ROAD
GRANDMERE PARKWAY
CLUB HOUSE
CITY OF MANHATTAN
VANESTA LAKE
VANESTA DRIVE
WT
FIGURE 7 - WATER & SANITARY SEWER MAP
HARTFORD HILL
SMH CONSULTANTS

densities which this land will develop at, the gravity system in place downstream is anticipated to accommodate this new development. In the event flows reach a point downstream that tax the system, technology of today is available to allow off-peak pumping of wastewater. A simple communication system could be implemented. A permanently mounted flow measuring device, or if necessary devices, could be installed in a strategically located manhole that is determined to be the control location in the sewer system. This device would be equipped with a transmitter that, when the flow in the sewer is at a level that more wastewater can be passed safely, a signal is given to the pump stations within Hartford Hill that they can release their flow. The pump stations will have to include slightly larger than normal wet wells in order to temporarily store the wastewater. This means the unused capacity of the existing sewer system would be used in an efficient and safe manner during off-peak periods. More details about this possibility are included in Supplement No. 2.

Electric service will be provided by Westar Energy.

Natural gas will be provided by Kansas Gas Service.

Communications will be provided by AT&T and Cox Cable, and as this industry evolves there will probably be more competitors in the future.

Stormwater Management

It is clearly recognized by the owners of Hartford Hill that Wildcat Creek is a very important focal point that must be given serious and significant attention. Because of the lay of the land within Hartford Hill, there are multiple opportunities to construct storm water management facilities, probably in the form of detention basins. City public works officials have expressed a preference that detention, rather than retention, basins be utilized. Therefore, Figure 8 shows a concept of where three (3) detention basins could be constructed as part of the roadway system.

Technical Supplement No. 3 provides details of a proposed storm water management plan. Actual engineering design will have to be part of the various phases of development. However, the intent is to plan and design the storm water facilities in a holistic manner so as to control runoff from the entire 320 acres as efficiently as possible. Separate detention ponds will not be part of every phase of development, but rather the control provided by larger, strategically placed ponds, will provide runoff management for the entire development.

Preliminary engineering analysis indicates that storm water management provided by Hartford Hill will make the flooding situation on Wildcat Creek better than it is in current conditions. In simple terms normal criteria for stormwater runoff requires that post-construction rates of runoff for 2-year, 10-year, and 100-year peak discharges be at or below pre-development levels. The owners of Hartford Hill intend for the rates of runoff values to be well below pre-development levels. The proposed approach towards storm water management in Hartford Hill generally conforms to the goals, objectives and strategies identified in the Wildcat Creek Floodplain Management Plan.

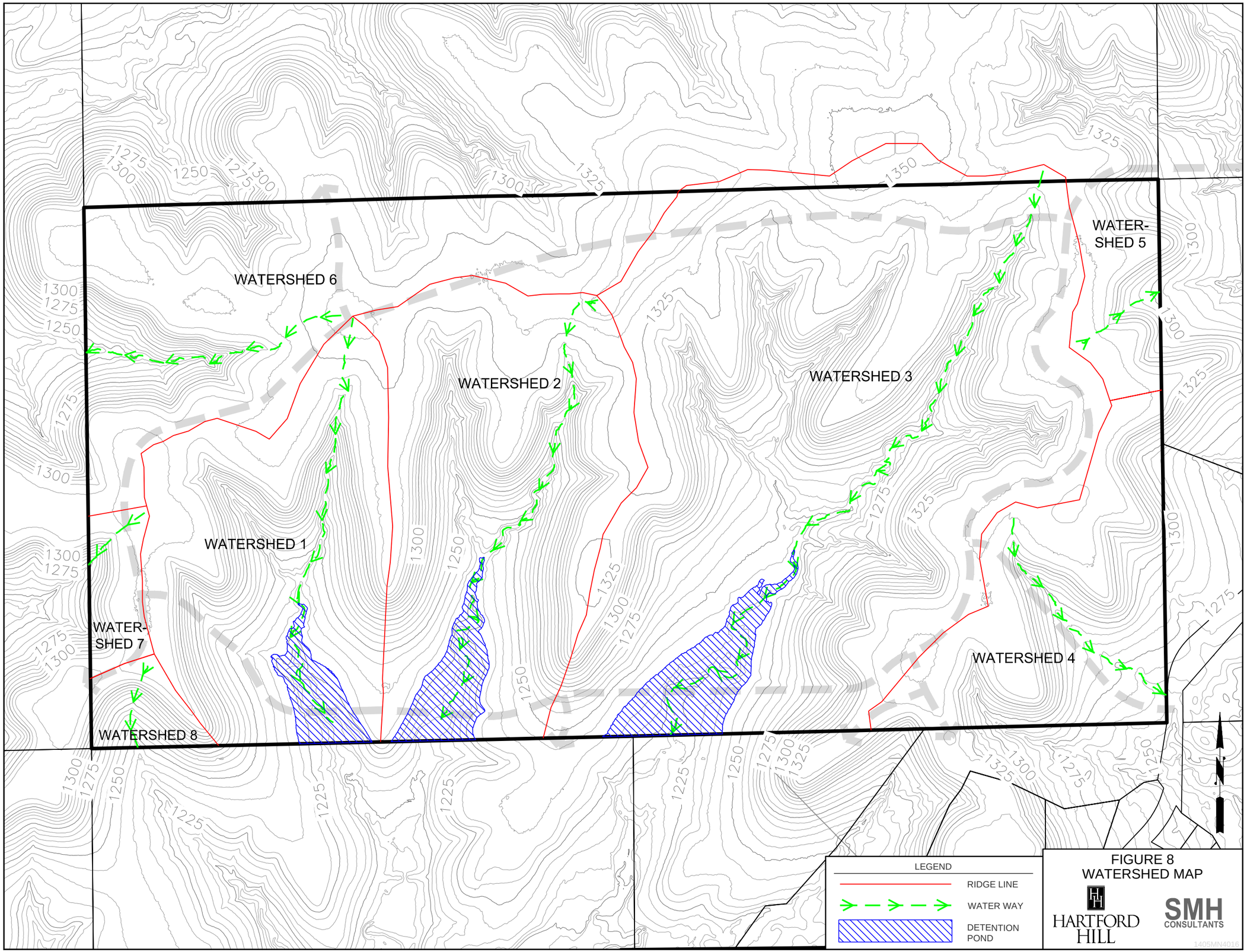


FIGURE 8
WATERSHED MAP

In addition to addressing storm water runoff rates the three (3) detention ponds will also serve as extended dry detention basins (EDDBs) for the treatment of storm water. As EDDBs, the proposed basins will fulfill the requirement for Post Construction Best Management Practices for all of Hartford Hill. There will be no requirement for each individual development project as a part of Hartford Hill to meet this requirement individually. This is discussed in further detail in Technical Supplement No. 3.

Phasing for construction of the three (3) detention basins should occur as development in each of the watersheds where detention structures are located occurs. However, it may not be necessary for one sub-development of the larger area in a watershed containing a planned detention structure to construct the entirety of the structure. Phased construction of the planned detention structure is proposed as long as phased construction accounts for ultimate build-out of the detention structure and as long as each development provides its impactful volume. It is envisioned that each developer will only be responsible for their contribution to that structure on a percentage basis. For example, if a sub-development is resulting in the development of 20% of that particular basin then that sub-development will be responsible for raising the dam structure enough to create 20% of the volume. The first development in that particular basin will be responsible for the control structure.

All storm water management regulations of the City will be followed in the design and construction of the development. In addition, attention will be given to the post-construction requirements of the city as well.

It is the intent of the developer to create a home owners association which will be responsible for the maintenance of the detention basins.

Traffic Impacts

A traffic impact study has been completed based upon the proposed land use plan for Hartford Hill. Recognized and appropriate engineering standards, using trip generation rates found in the Institute of Transportation Engineers (ITE) Trip Generation Manual, 9th Edition, have been used to estimate traffic volumes that will be produced by the development. Those volumes have been distributed from the development to the existing and proposed roadway network outside of Hartford Hill. For purposes of this study, and because it is not possible to assume with accuracy what Kansas State University might do with its land in the future, it is estimated that all the traffic from Hartford Hill will exit at either the northeast or southeast connections as shown on the roadway network. For analysis purposes, 85% of the traffic has been assigned to the southeast and 15% to the northeast.

For purposes of this study a development density of 2.5 dwelling units per gross acre was used. This should prove to be a very conservative factor given the known values that have been realized in other areas of similar terrain. For example, the current density within the adjacent Grand Mere Development is approximately 1.6 dwelling units per acre.

Intersection analyses have been performed using accepted methodologies outlined in the Highway Capacity Manual 2010 (HCM2010) as well as McTrans Highway Capacity Software (HCS) 2010.

Traffic volumes have been estimated based upon the following assumptions:

- "Existing" volumes are what they imply, actual volumes counted during the fall of 2014, while schools were in session.
- "Expected" volumes are composed of existing plus anticipated volumes to be added to the traffic network once all of the Grand Mere development is complete.
- "Development" volumes are only those estimated to be generated by the Hartford Hill project.
- "20" is a component of traffic volume added to the roadway network to represent background growth of the City. This traffic will be generated by other areas, some distant from Hartford Hill, but will use the major intersections that have been studied. This component was derived by applying a growth factor of 2% per year, over 20 years.
- Existing + Expected + Development + 20 is self-explanatory.

Existing traffic volumes for the intersection of Kimball Avenue and Vanesta Drive were provided by the City of Manhattan. Those were used to determine the peak hours for traffic in this area. Subsequently, new counts during the peak hours were taken by SMH Consultants at the intersection of Kimball Avenue and Grand Mere Parkway, as well as the intersection of Kimball Avenue and Vanesta Drive.

Google Earth was used to help approximate existing traffic volumes for Marlatt Avenue. The number of residences, businesses, and KSU facilities served by Marlatt Avenue were determined and used to estimate the trips on that roadway.

The traffic study was extended outside the boundaries of Hartford Hill to determine the impact on the intersections of Grand Mere Parkway and Kimball Avenue, Grand Mere Parkway and Marlatt Avenue, and Kimball Avenue and Vanesta Drive. At the southeast corner of Hartford Hill, the proposed intersection of Road A with Grand Mere Parkway was also analyzed. Within Hartford Hill the only intersection analyzed was the "T" where Road A meets Road B.

Results of the traffic impact study are summarized in the following paragraphs, and in the tables and drawings shown on Figures 9-16. In addition, raw data and intersection analysis sheets can be found in Technical Supplement No. 4.

Summary of Intersection Delays and LOS

Level of Service (LOS)	Signalized Intersection (seconds)	Unsignalized Intersection (seconds)
A	<10	<10
B	10-20	10-15
C	20-35	15-25
D	35-55	25-35
E	55-80	35-50
F	>80	>50

Intersection at the Southeast Corner of Hartford Hill; Road A with Grand Mere Parkway.
This future intersection was analyzed and determined under "existing + expected + development + 20" to operate satisfactorily with Road A stopped at Grand Mere Parkway. The movement with the highest delay will be the eastbound approach operating at a level of service C with a 95% queue length of approximately 115 feet.

Intersection of Road A with Road B.
This future intersection was analyzed with Road A stopping for Road B. Under "existing + expected + development + 20" the PM movement with the highest delay was determined to be the westbound approach and will operate at a level of service F when full development is reached if the approach is one lane wide. An additional analysis was performed after adding a westbound left turn lane and the levels of service for the left turn and right turn were D and B respectively.

Marlatt Avenue. Marlatt Avenue is currently a rural section, narrow, gravel road. Contacts with officials of Riley County confirm that a definite plan is not in place to improve Marlatt Avenue. There are no policies in place, either at the county or city levels of government, that provide definitive direction as to what will happen when urban development catches up with rural infrastructure. The proposed connection of Grand Mere Parkway to Marlatt Avenue has been identified in planning documents since the formal adoption of the Grand Mere Master Plan in 2000. It is recognized that the intersection configuration between Road B, Marlatt Avenue, and Grand Mere Parkway is very important. The actual design of that intersection, or intersections, will follow provisions within MATS, and will require cooperation and coordination from multiple land owners including Kansas State University. If past practice holds true in the future, improvements to public roadways such as Marlatt Avenue will occur as a matter of public/private cooperation. Marlatt Avenue is already a public roadway, and continues to become more important to the travel demands of the public in this portion of the community. Those improvements may happen because of actions by Riley County which is the governmental agency with jurisdiction over the roadway at the time of this report. Or it could occur because of actions by the City of Manhattan as urban growth continues north and west of the community.

Kimball Avenue and Vanesta Drive. The intersection of Kimball Avenue and Vanesta Drive is currently controlled by a traffic signal. Analyses as described above indicate the intersection operates during the AM and PM peak hours at level of service B under existing conditions. Under even the maximum conditions studied, the intersection will continue to operate during both peak hours at level of service C in 20 years.

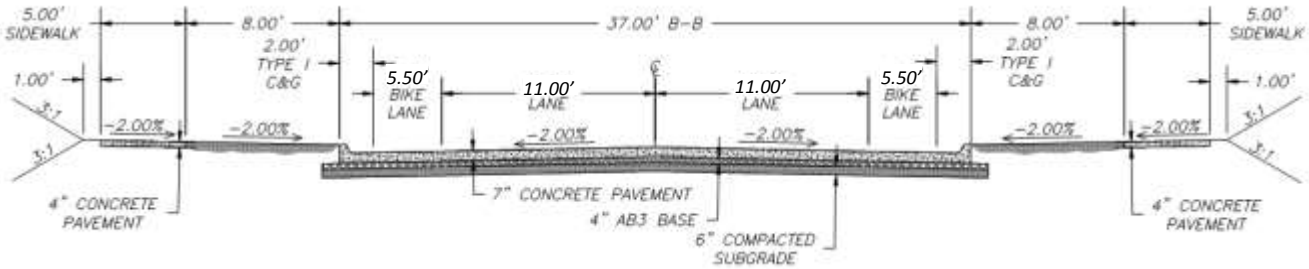
Kimball Avenue and Grand Mere Parkway. The intersection of Kimball and Grand Mere Parkway is currently controlled by a single-lane roundabout. Analyses as described above indicate the intersection operates during the AM and PM peak hours at a level of service A under existing conditions. After adding traffic volumes from the "expected" and full "development" scenarios, the level of service is C. It is not until the 20 years of the background growth factor is added that the intersection begins to reach capacity. At that time the AM peak is estimated to produce a level of service of E, and the PM peak reaches F. The City of Manhattan has recognized the future need for upgrading Kimball Avenue. The City's Capital Improvement Program includes a 2019 project to add lanes to Kimball from Hudson Avenue to Anderson

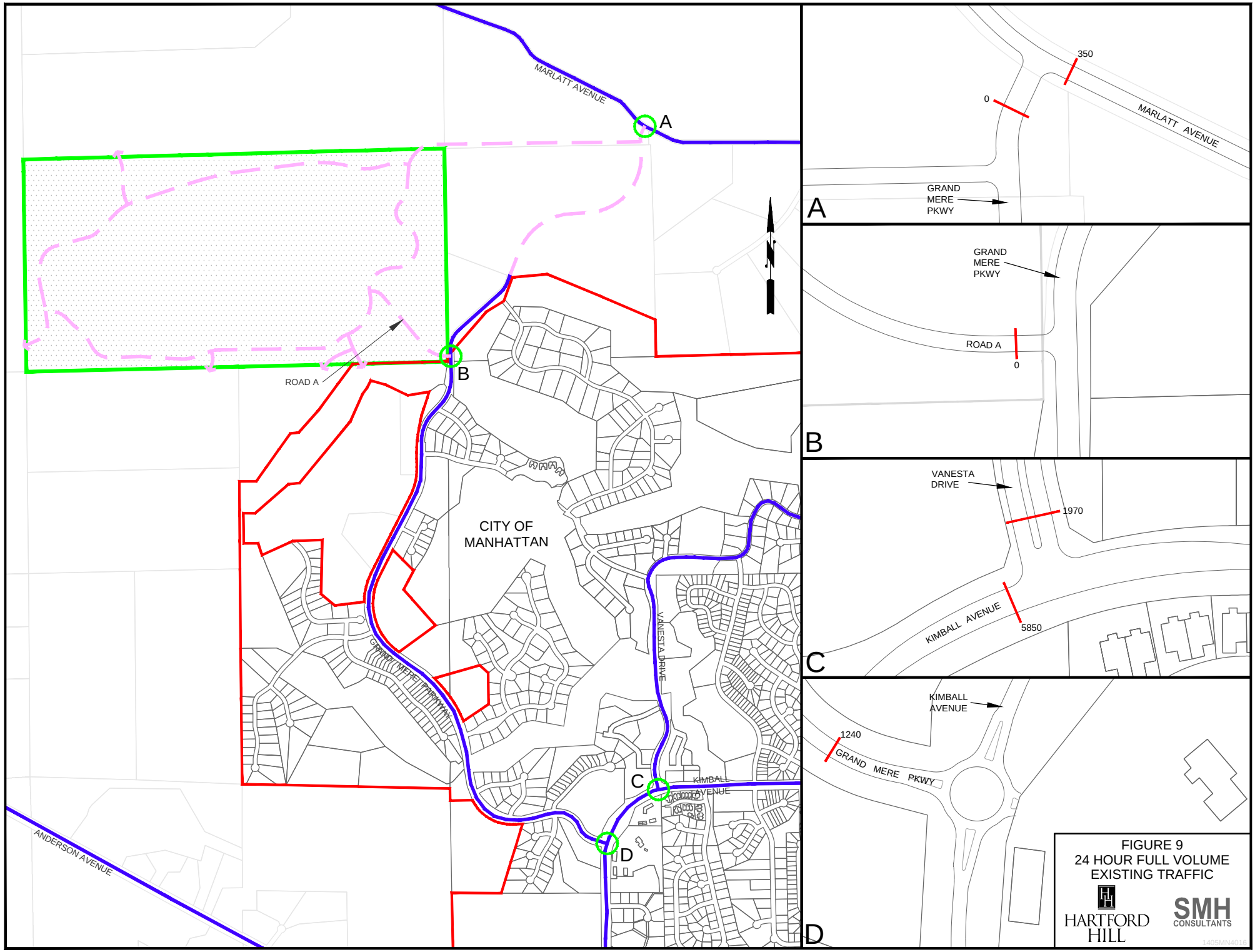
Avenue. That project will provide enhancements to this intersection as well, presumably in the form of a 2-lane roundabout, which without question will handle the future traffic volumes at this location. If the 2019 City of Manhattan CIP Project does not occur, a revaluation of the intersection of Grand Mere Parkway and Kimball Avenue may be required before development beyond Development Areas A and B occur.

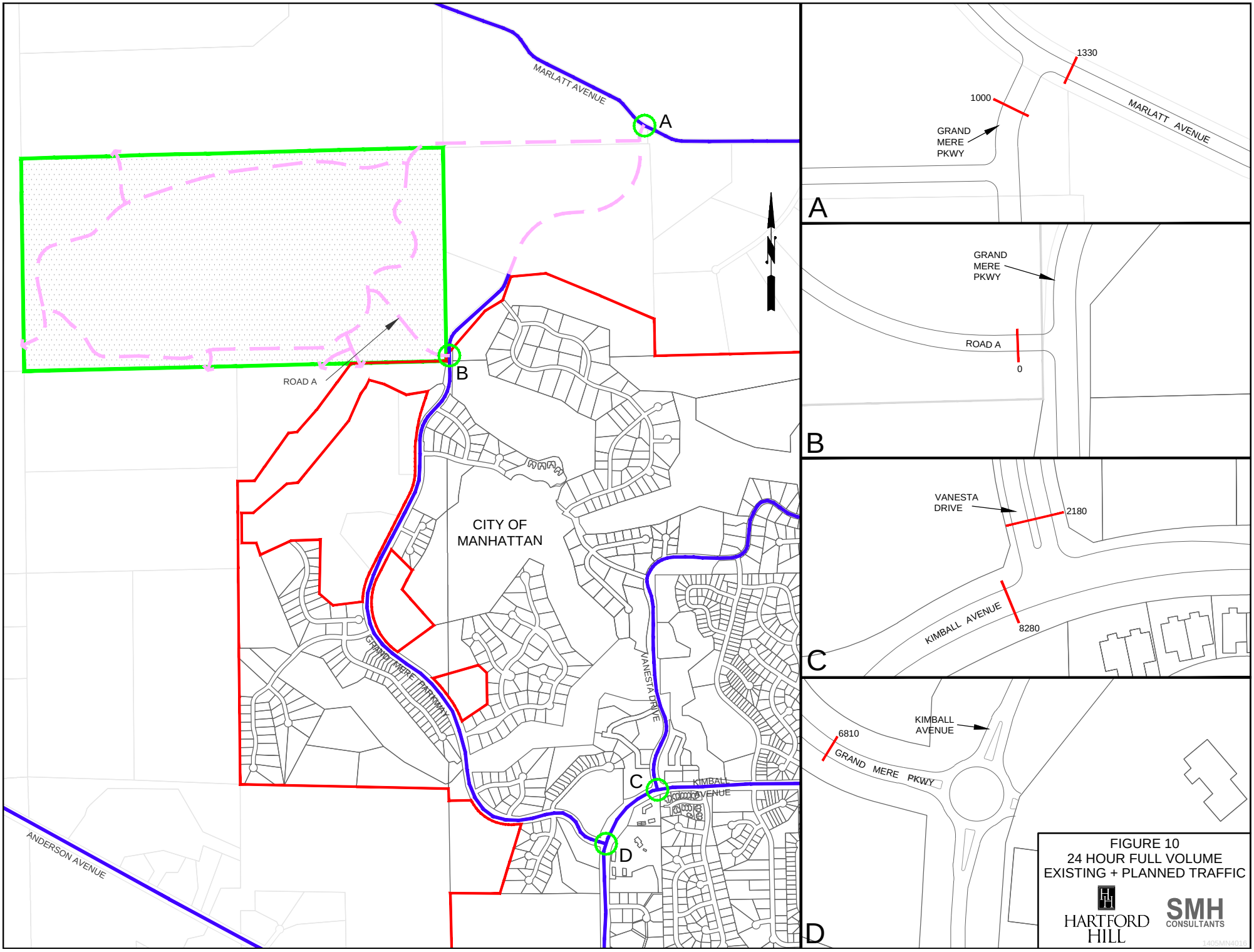
The Manhattan Department of Fire Services has indicated a desire to see the northeast roadway connection (Road B) from Hartford Hill happen as soon as possible, to provide a second access to the development. To accommodate that desire the developers of Hartford Hill have agreed that the Road B connection to Marlatt Avenue will happen after Development Area A is complete, but before Development Area B begins.

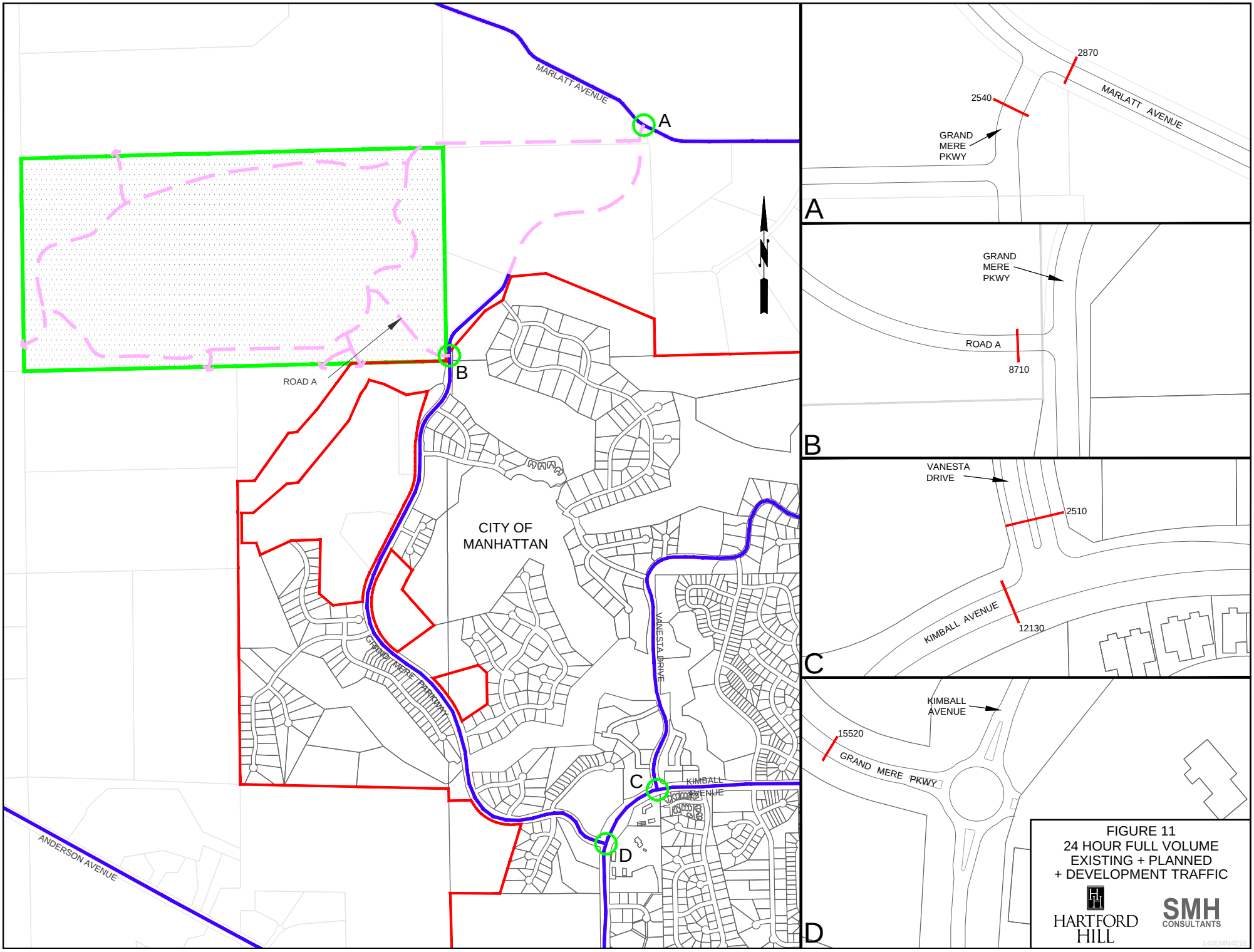
Road A will follow a path from Grand Mere Parkway to Road B by climbing the hill to reach the ridgeline. The primary interior roadways within Hartford Hill, Road B and Road C, will likely follow the ridgelines around the development. A concept for such a roadway system is shown on Figure 2. All three of these roadways will likely be functionally classified as "minor collectors". These roadways will provide direct access to adjacent properties via individual driveways, but only at locations that cannot be reasonably accommodated on local side streets because of the steep grades and narrow hilltops. Driveways onto Roads A, B, and C will be minimized as much as possible. Whenever a corner lot is created with one side on Road B or Road C and the other side on a local street, the driveway will be located on the side street. When driveways are located on Road B or Road C they will be spaced a minimum of 100 feet apart, center to center. This proposed configuration was developed in concert with the staff of the City's Public Works Department. Roads A, B, and C will also provide access to a number of culdesacs because of the terrain throughout the development. Some of those culdesacs will be longer than the recommended 200 to 400 feet length as written in the new version of MATS, because of the lay of the land. All streets will be designed to meet the standards of the City at the time in terms of widths, grades, and curvature. Recognizing the new MATS, and current subdivision standards, appropriate connections between blocks and ends of culdesacs will be provided. However, it will be impossible in some cases to provide ADAs accessible facilities, resulting in signing the paths as "non-ADA accessible".

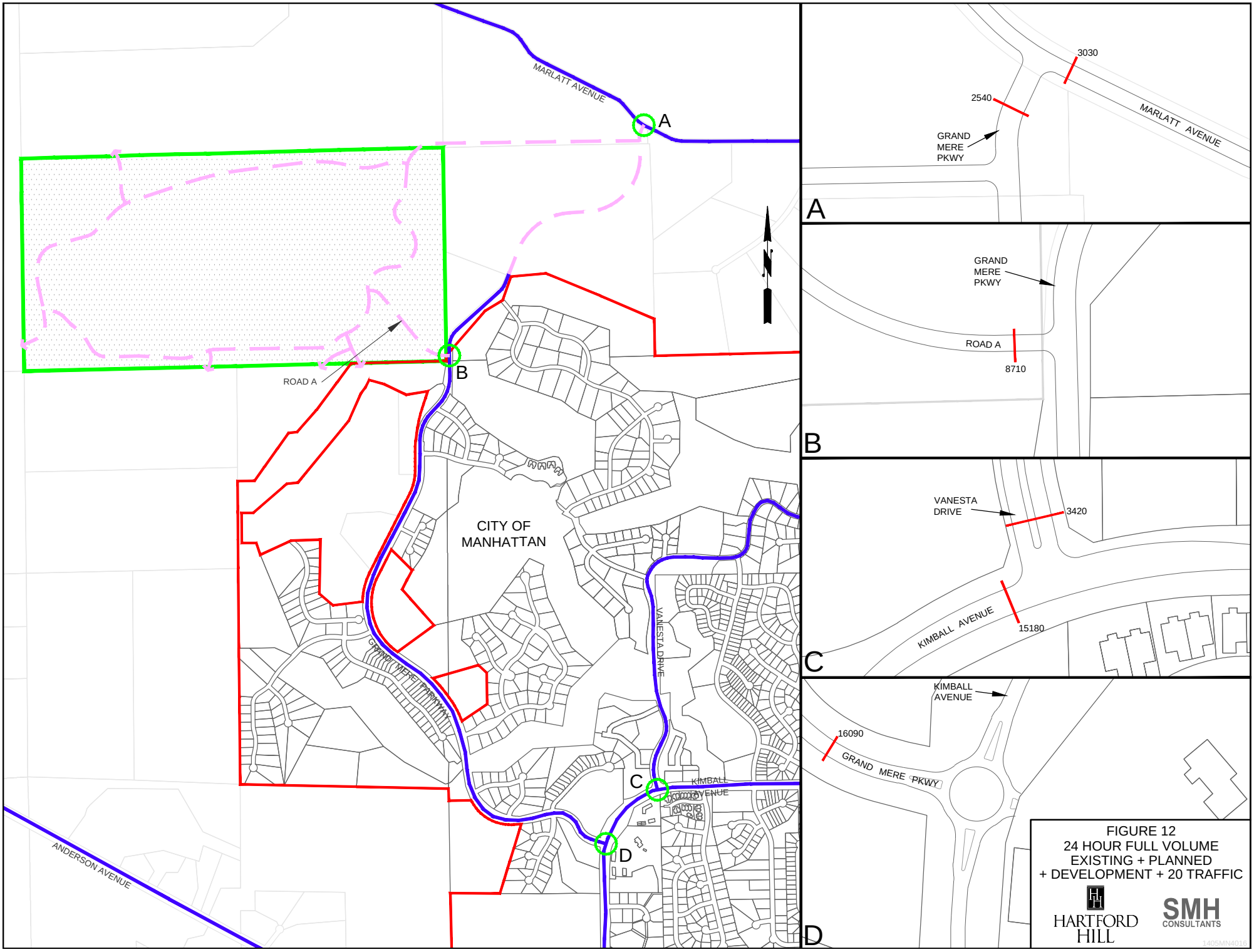
Because of the growing importance of multi-modal transportation elements, the owners of Hartford Hill plan to create a roadway typical cross section on the minor collectors that accommodates all modes of transportation. A basic sketch of the proposed cross section of such a roadway is shown below.

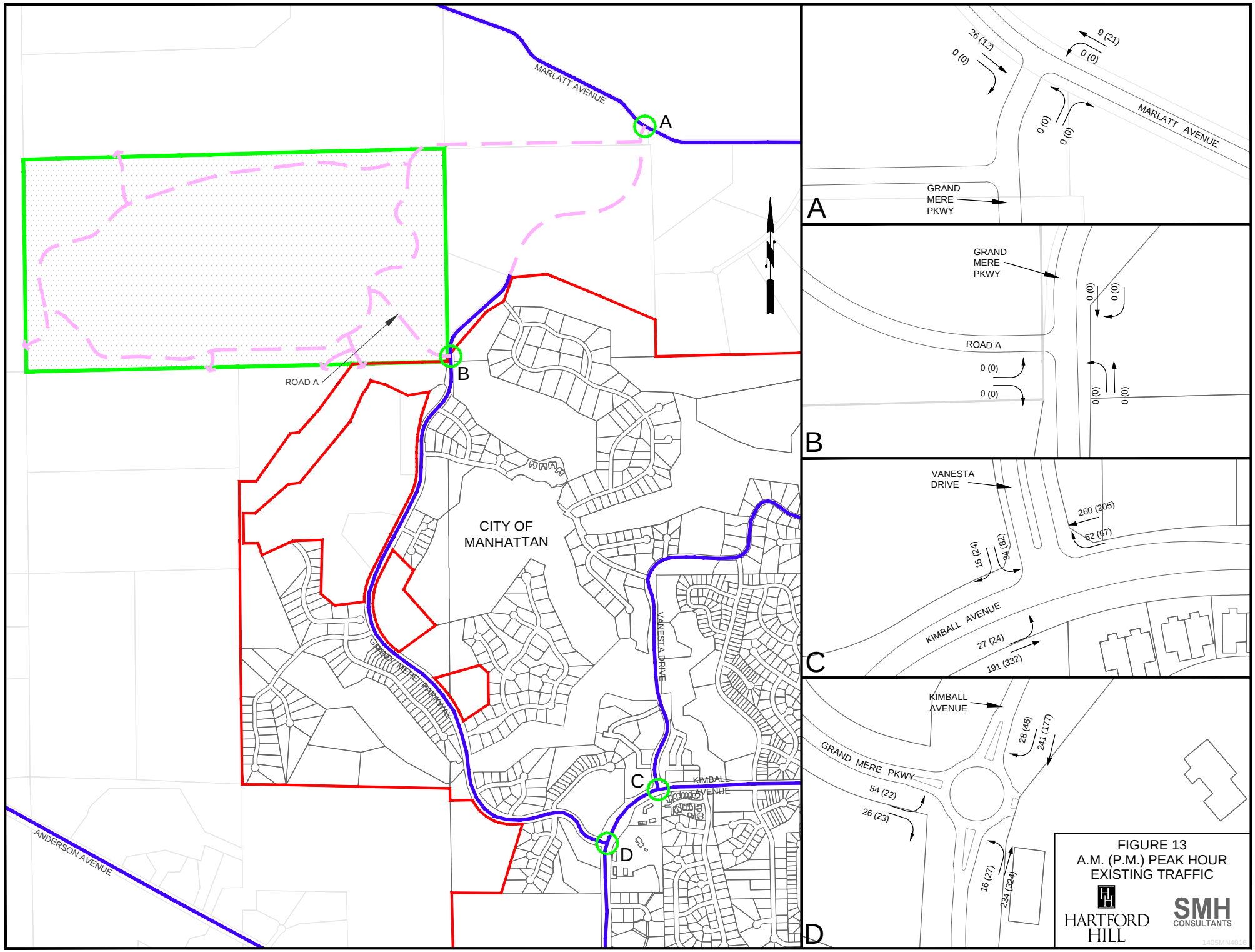


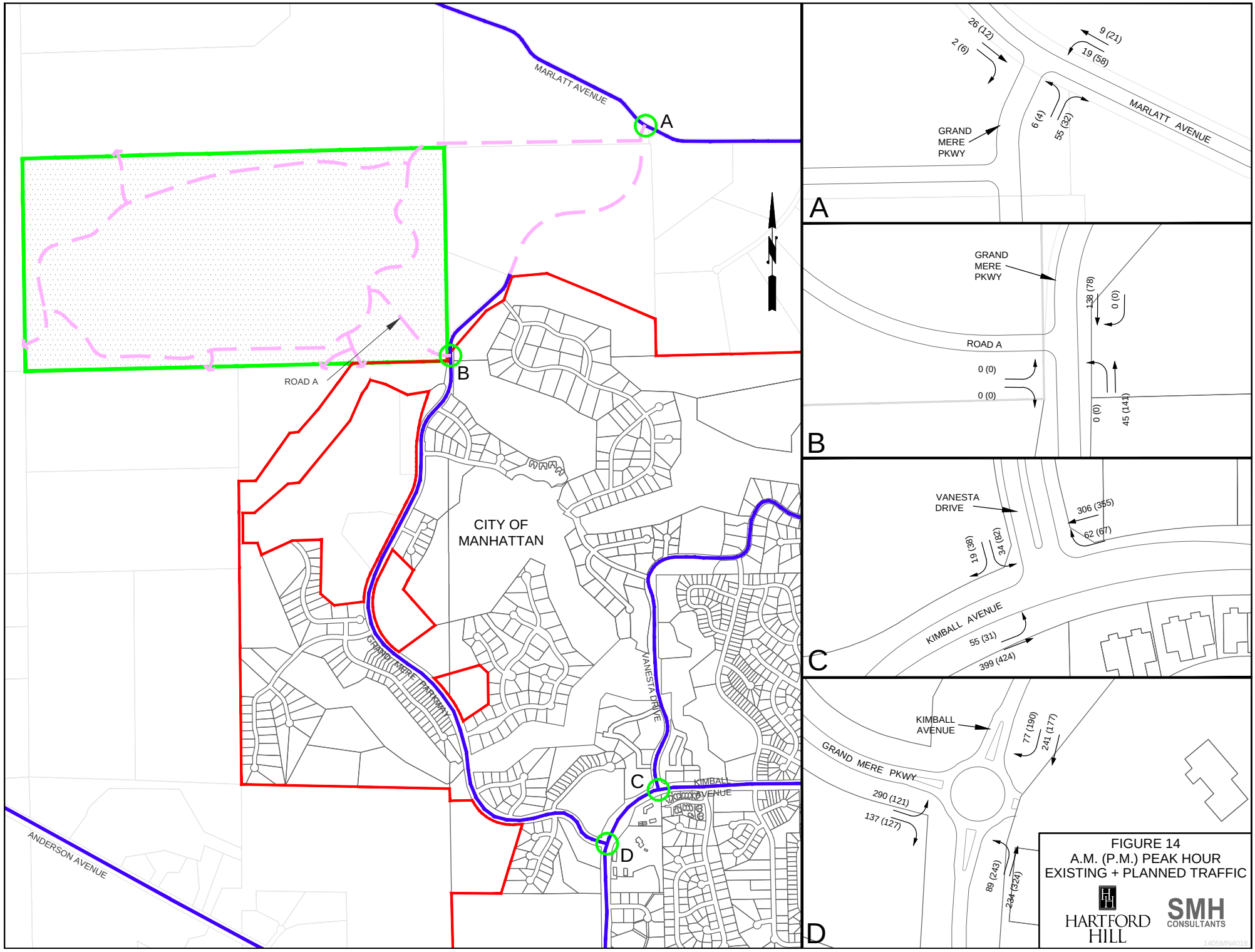

MARLATT AVENUE
A
ROAD A
B
CITY OF
MANHATTAN
GRAND MERE PARKWAY
VANESTA DRIVE
KIMBALL AVENUE
C
D
ANDERSON AVENUE
350
0
MARLATT AVENUE
GRAND
MERE
PKWY
A
GRAND
MERE
PKWY
ROAD A
0
B
VANESTA
DRIVE
1970
KIMBALL AVENUE
5850
C
KIMBALL
AVENUE
1240
GRAND MERE PKWY
D
FIGURE 9
24 HOUR FULL VOLUME
EXISTING TRAFFIC
HARTFORD
HILL
SMH
CONSULTANTS
1405MN4016


MARLATT AVENUE
A
ROAD A
B
CITY OF
MANHATTAN
GRAND MERE PKWY
VANESTA DRIVE
KIMBALL AVENUE
C
D
ANDERSON AVENUE
1330
1000
GRAND
MERE
PKWY
MARLATT AVENUE
A
GRAND
MERE
PKWY
ROAD A
0
B
VANESTA
DRIVE
2180
KIMBALL AVENUE
8280
C
KIMBALL
AVENUE
6810
GRAND MERE PKWY
D
FIGURE 10
24 HOUR FULL VOLUME
EXISTING + PLANNED TRAFFIC
HARTFORD
HILL
SMH
CONSULTANTS
1405MN4016


MARLATT AVENUE
A
ROAD A
B
CITY OF
MANHATTAN
GRAND MERE PARKWAY
VANESTA DRIVE
KIMBALL AVENUE
C
D
ANDERSON AVENUE
2870
2540
MARLATT AVENUE
GRAND
MERE
PKWY
A
GRAND
MERE
PKWY
ROAD A
8710
B
VANESTA
DRIVE
2510
KIMBALL AVENUE
12130
C
KIMBALL
AVENUE
15520
GRAND MERE PKWY
D
FIGURE 11
24 HOUR FULL VOLUME
EXISTING + PLANNED
+ DEVELOPMENT TRAFFIC
HARTFORD
HILL
SMH
CONSULTANTS
1405MN4016


MARLATT AVENUE
A
ROAD A
B
CITY OF
MANHATTAN
GRAND MERE PARKWAY
VANESTA DRIVE
KIMBALL AVENUE
C
D
ANDERSON AVENUE
3030
2540
MARLATT AVENUE
GRAND
MERE
PKWY
A
GRAND
MERE
PKWY
ROAD A
8710
B
VANESTA
DRIVE
3420
KIMBALL AVENUE
15180
C
KIMBALL
AVENUE
16090
GRAND MERE PKWY
D
FIGURE 12
24 HOUR FULL VOLUME
EXISTING + PLANNED
+ DEVELOPMENT + 20 TRAFFIC
HARTFORD
HILL
SMH
CONSULTANTS
1405MN4016


MARLATT AVENUE
A
ROAD A
B
CITY OF
MANHATTAN
GRAND MERE PARKWAY
VANESTA DRIVE
KIMBALL AVENUE
C
D
ANDERSON AVENUE
26 (12)
0 (0)
9 (21)
0 (0)
0 (0)
0 (0)
MARLATT AVENUE
GRAND
MERE
PKWY
A
GRAND
MERE
PKWY
0 (0)
0 (0)
ROAD A
0 (0)
0 (0)
0 (0)
0 (0)
B
VANESTA
DRIVE
260 (205)
62 (67)
16 (24)
34 (62)
KIMBALL AVENUE
27 (24)
191 (332)
C
KIMBALL
AVENUE
28 (46)
241 (177)
GRAND MERE PKWY
54 (22)
26 (23)
16 (27)
234 (324)
D
FIGURE 13
A.M. (P.M.) PEAK HOUR
EXISTING TRAFFIC
HARTFORD
HILL
SMH
CONSULTANTS
1405MN4016


MARLATT AVENUE
A
ROAD A
B
CITY OF
MANHATTAN
GRAND MERE PARKWAY
VANESTA DRIVE
KIMBALL AVENUE
C
D
ANDERSON AVENUE
26 (12)
2 (6)
9 (21)
19 (58)
GRAND
MERE
PKWY
6 (4)
55 (32)
MARLATT AVENUE
A
GRAND
MERE
PKWY
138 (78)
0 (0)
ROAD A
0 (0)
0 (0)
0 (0)
45 (141)
B
VANESTA
DRIVE
306 (355)
62 (67)
19 (38)
34 (82)
KIMBALL AVENUE
55 (31)
399 (424)
C
KIMBALL
AVENUE
77 (190)
241 (177)
GRAND MERE PKWY
290 (121)
137 (127)
89 (243)
234 (324)
D
FIGURE 14
A.M. (P.M.) PEAK HOUR
EXISTING + PLANNED TRAFFIC
HARTFORD
HILL
SMH
CONSULTANTS
1405MN4016

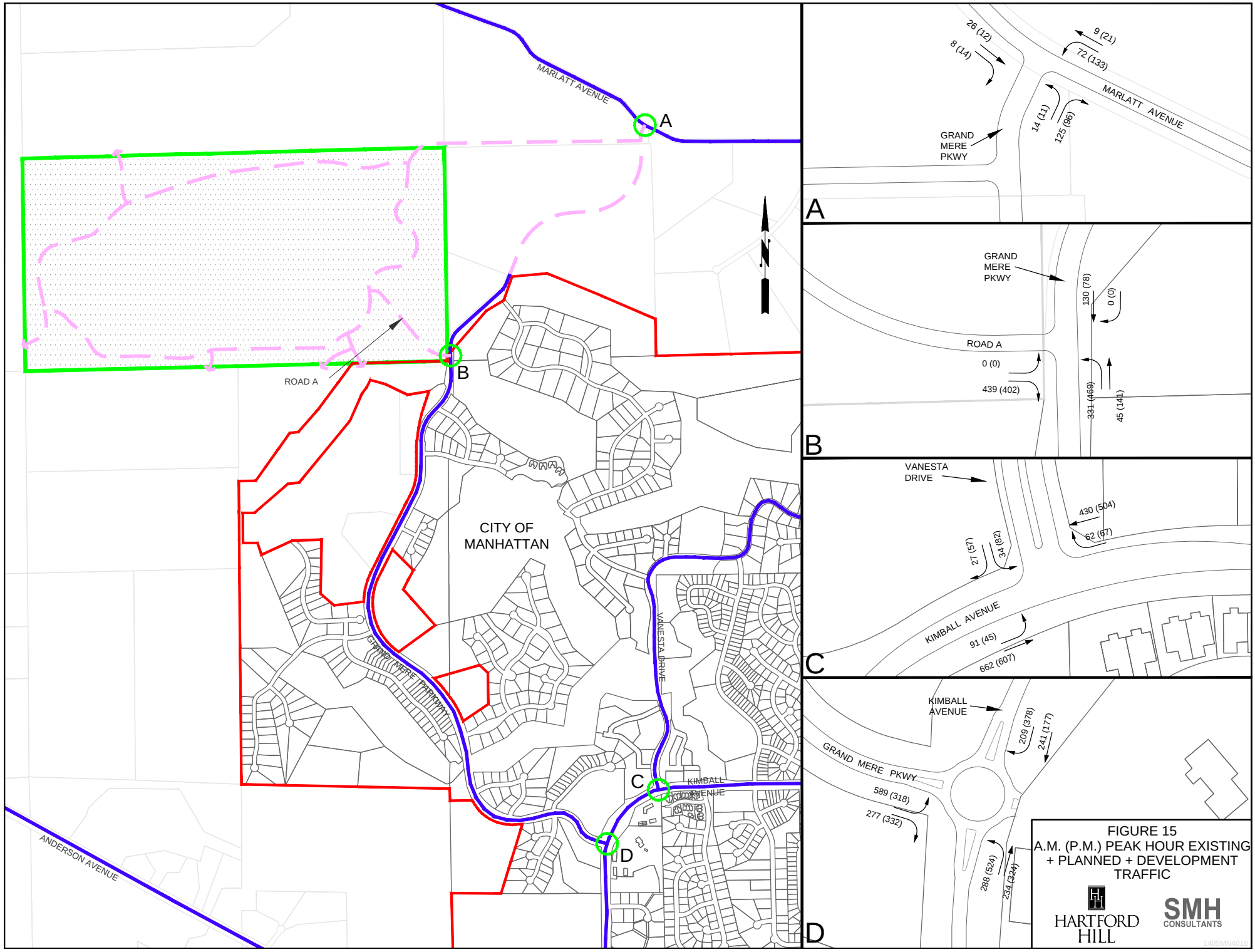


FIGURE 15
A.M. (P.M.) PEAK HOUR EXISTING
+ PLANNED + DEVELOPMENT
TRAFFIC

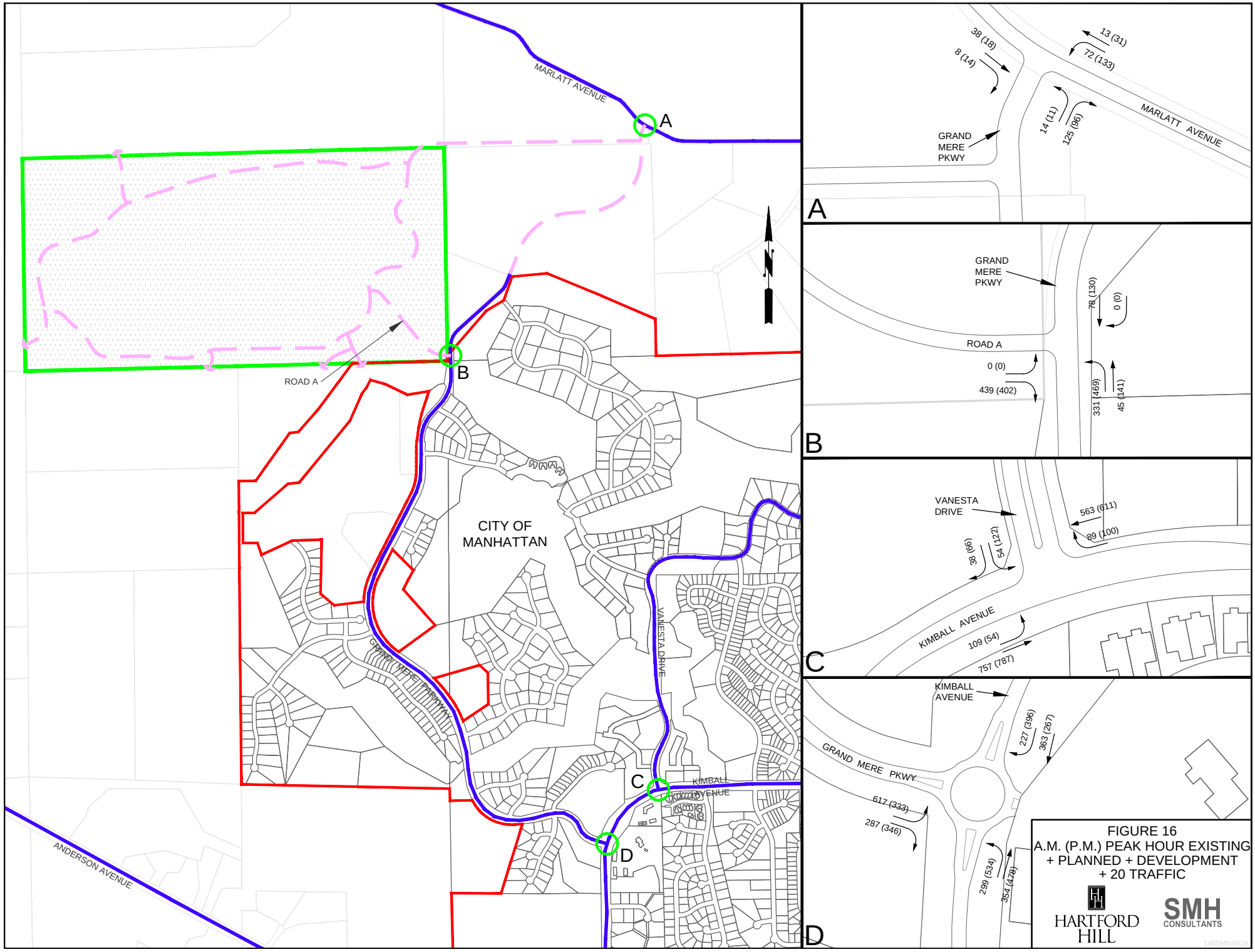


FIGURE 16
A.M. (P.M.) PEAK HOUR EXISTING
+ PLANNED + DEVELOPMENT
+ 20 TRAFFIC

Parks and Trails

In the updated 2015 edition of the Manhattan Area Transportation Strategy, the City has developed very strong statements regarding the future of pedestrian and bicycle transportation elements. Hartford Hill will complement those by meeting the Comprehensive Plan Objectives of planning appropriate sidewalks, bike facilities in some form, and connections to other similar City and County facilities adjacent to this development area. In all likelihood, bike and trail facilities will take several forms as part of actual design, and will generally follow the MUACP and MATS policies and standards. As shown above, the bikeway along the roadway that more or less circles the development will be integral with the roadway. There will be opportunities within the "bike park and open space" for both hiking and biking trails that are not paved. They could take the form of the examples demonstrated by the following photos of existing facilities that have proven to be very successful in other places.

Steamboat Springs, CO

Konza Prairie, Riley County

All of the parks and trails are intended to be open to the public, with public access appropriately provided. The site of a neighborhood park is shown on Figure 2. The developer is willing to work with the City and donate park land, but expects the City to own and maintain it.

Much work is needed northeast of Hartford Hill to connect back to the east to Washington Memorial Park, across Seth Child Road, and along Marlatt Avenue eventually to Tuttle Creek Boulevard. The same can be said of the corridor along Kimball Avenue south of Grand Mere Parkway. It is presumed that the City will see to it that those improvements are accomplished.

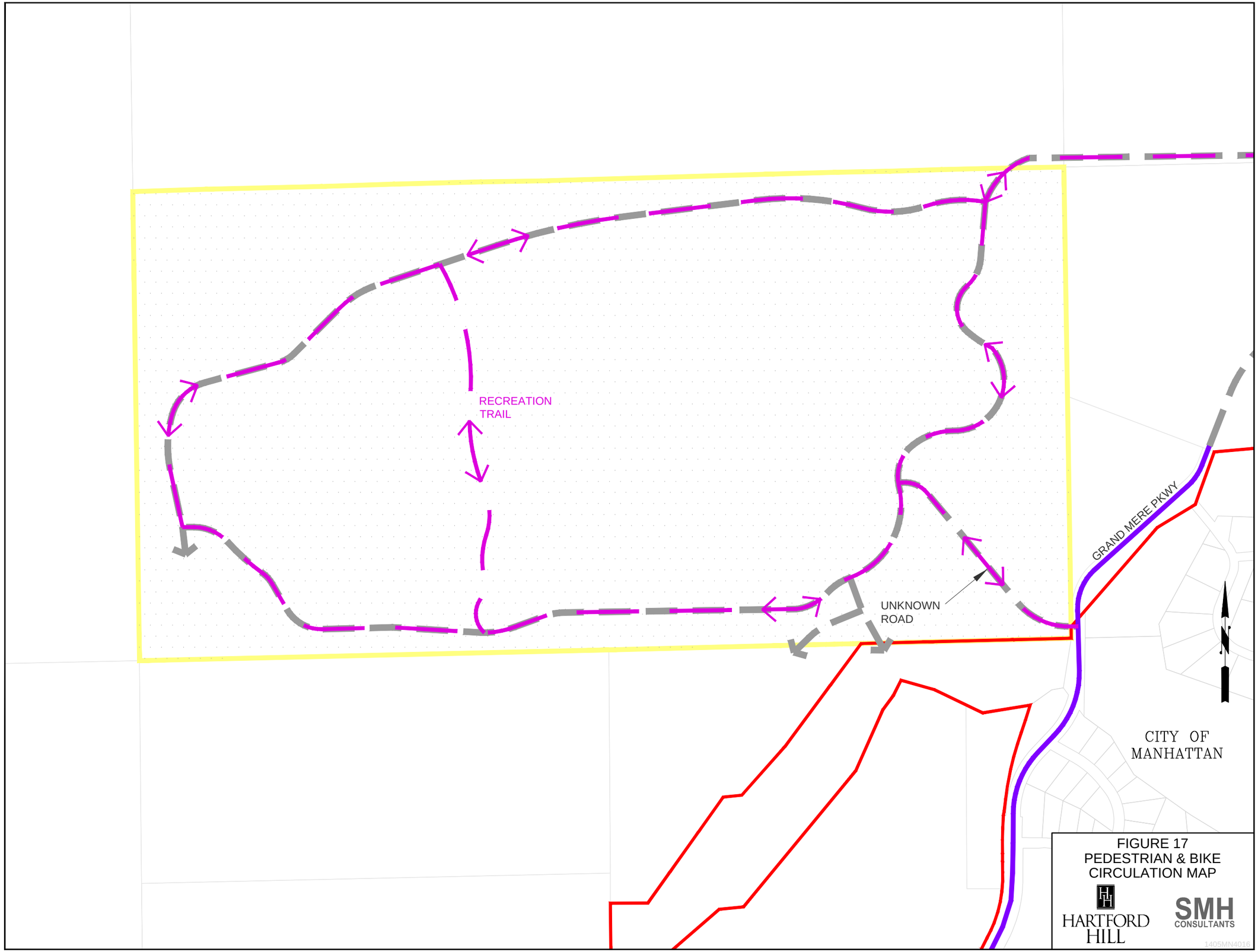


FIGURE 17
PEDESTRIAN & BIKE
CIRCULATION MAP

Ft. Riley Noise Hazard Zone

Ft. Riley has traditionally published maps showing several noise levels that are to be used for planning purposes while considering development in and around Manhattan. The current map is shown at Figure 18. All of Hartford Hill is impacted by the Ft. Riley map, being within what is called the Critical Area. More specifically Hartford Hill is within the least impacted designation of Land Use Planning Zone (LUPZ). Text from the reports indicates:

> *The noise environment at the installation varies daily and seasonally because operations are not consistent 365 days a year. To provide a planning tool that can be used to account for days of higher than average operations, a Land Use Planning Zone (LUPZ), the zone where the large caliber weapons firing noise averaged over the course of a year is less than 62 dB* (decibels) *but is greater than 57 dB, is included on this noise zone map.*

K.S.A. 12-773 created a memorandum of understanding concerning potential to expose persons to noise greater than 65 decibels. The most recent 2015 LUPZ impact line is understood to be in the range of 57-62 decibels as cited above. Property located within the LUPZ, by definition, is not exposed to noise greater than 65 db.

In other parts of Manhattan affected by the noise map, developers and builders have addressed the issue by including disclosure statements to prospective buyers. The owners of Hartford Hill intend to do that as a matter of routine for any land within the LUPZ. Builders in Hartford Hill should consider incorporating noise attenuation construction techniques to further mitigate indoor noise levels resulting from training activity at Fort Riley.

In addition, the following text will be included on any final plat of land within Hartford Hill:

> *NOTICE OF POTENTIAL IMPACT DUE TO MILITARY TRAINING*
>
> *The Lots within this subdivision are situated in an area that may be subjected to conditions resulting from military training at Fort Riley. Such conditions may include the firing of small and large caliber weapons, the over flight of both fixed-wing and rotary-wing aircraft, the movement of vehicles, the use of generators and other accepted and customary military training activities. These activities ordinarily and necessarily produce noise, dust, smoke and other conditions that may not be compatible with the permitted land uses intended to be located in this subdivision according to established federal guidelines, state guidelines or both.*

The owner of Hartford Hill understands the importance of minimizing the potential for noise complaints and will implement the following tools to address the issue:

> Noise Disclosure. Noise disclosure will be provided to prospective and future buyers, through the note on plats, disclosure statements filed on the deed of each lot that is platted, and by working with builders and realtors to provide noise disclosure through marketing and MLS documents.

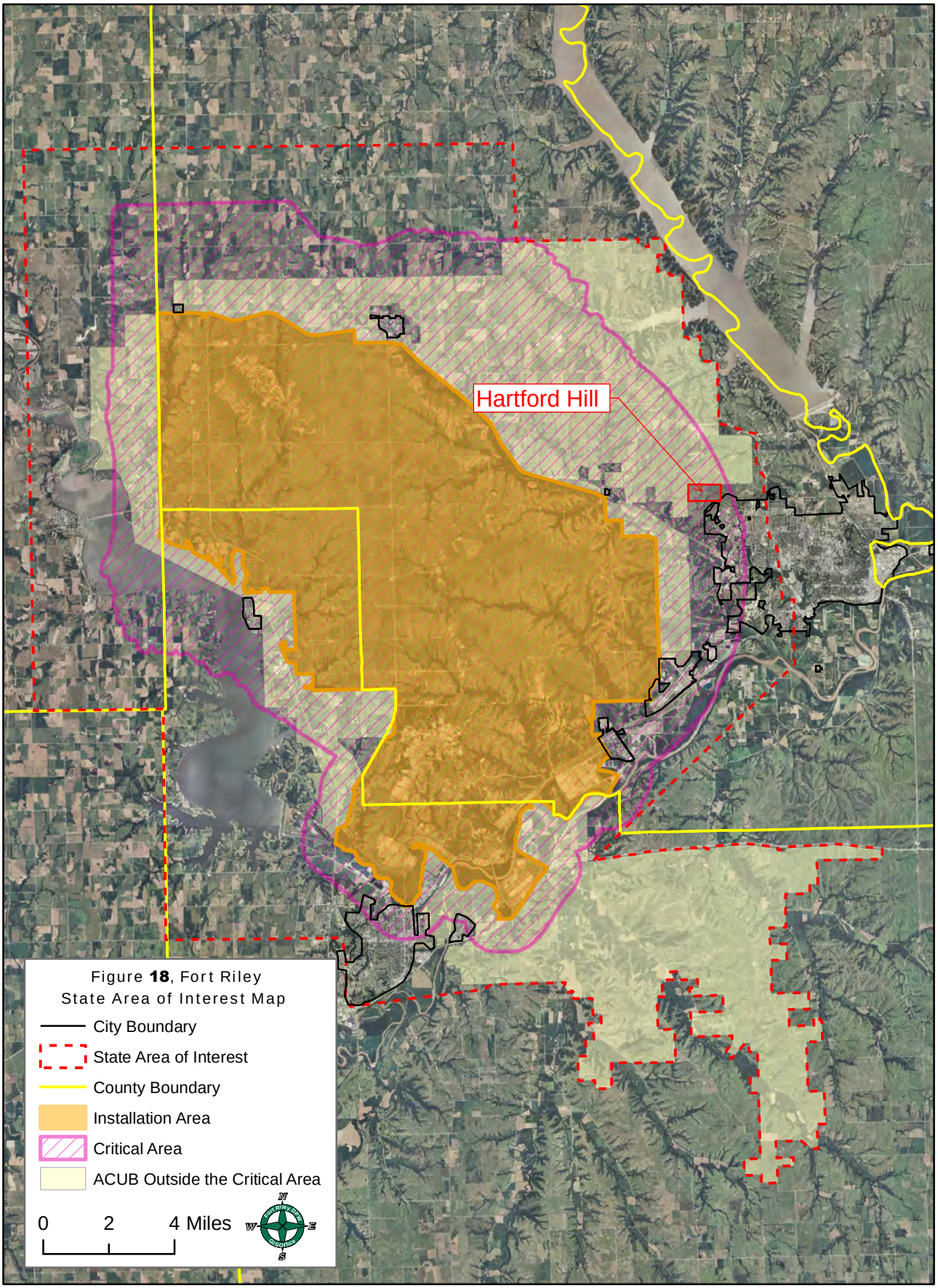
Building Siting and Orientation. In order to reduce interior noise impacts and minimize the potential for noise complaints, the developer will establish best management practices for builders including:

- Lot by lot analysis of the placement and orientation of structures.
- Minimize placement on ridge tops and western facing slopes.
- Orientation of structures so that longer exterior walls are not perpendicular to percussion waves that may be coming from the impact area on the Fort.
- Orientation of structures so that corners face the impact area.
- Incorporation of noise attenuation construction techniques.

School District Boundaries

All of Hartford Hill falls within the Riley School District. School district officials have been advised of this development and its potential impact to its attendance levels from Manhattan. Discussions have taken place between the owners of Hartford Hill and the school district regarding the possibility of identifying a site within Hartford Hill for a new elementary school. A supporting letter is included as Technical Supplement No. 5. For purposes of master planning, a site has been designated as a potential location for a school, even though no firm plans have been identified. As this development process evolves, a better site might be identified, and it must be recognized that flexibility for such modifications is necessary.

If the Riley School District develops a site in Hartford Hill, it should incorporate noise attenuation construction techniques.


Hartford Hill
Figure 18, Fort Riley
State Area of Interest Map
City Boundary
State Area of Interest
County Boundary
Installation Area
Critical Area
ACUB Outside the Critical Area
0
2
4 Miles
N
W
E
S

SITE CONCEPTS

A range of land use designations are proposed throughout the 320 acres of Hartford Hill as shown on Figure 2. Most will be associated in some fashion with "residential" uses of varying densities. However, a small component of other land uses such as "commercial" for professional offices are included. A small parcel is also shown for the inclusion of a "research park". As previously mentioned, the potential for a "school" site is also included, even though under current zoning regulations a school is a permitted use within all residential zones.

Other areas will include open spaces that are just that, open and undisturbed. Or there may also be open spaces that are developed with amenities like hiking and biking trails.

The overall development approach is to begin with Development Area A and proceed westward through Development Area E.

Areas with steep slopes, generally defined as greater than 20%, will be avoided except for the occasional crossing of a buried utility, or roadway, or nature trail.

Areas that contain steep, natural ravines will generally be maintained as riparian open spaces to help with stormwater management and quality of stormwater runoff. Most of these areas will be privately owned.

The proposed vision for development of Hartford Hill is shown in Figure 2. Flexibility is the key to any master plan that involves a 320 acre parcel that will take years to develop. As development evolves over the years, market and other conditions may change and minor adjustments to the proposed land use designations in Figure 2 may become necessary.

Residential land uses are shown on the Development Diagram in shades of yellow consistent with the color codes used in the MUACP. Densities with the yellow shading are consistent with the low to medium (0 to 11 dwelling units per acre) category.

All other potential land uses are also depicted in colors consistent with the MUACP.

If the future market conditions eliminate any of the potential uses shown on the Development Diagram that are not "residential", it is probable the back-up land use will be low to medium density residential.

It should be understood that even though the City's residential density categories include large ranges, it is highly likely the residential areas within Hartford hill will develop at much less dense coverage. The actual number will be very close to the lower end of each of the categories. History has proven that even when efforts are made to create more dense settings within residential plats in hilly terrain, the resulting density ratio is about 1.6 dwelling units per gross acre. Assuming Hartford Hill develops in a similar manner, which is the plan, a likely number of total dwelling units for the entire 320 acres will be between 500 and 600.

There is no desire on the part of the developer to incorporate a commercial, retail component in this master plan. There are two such commercial nodes within Grand Mere just east of Hartford Hill. One is less than ½ mile east, and the other is approximately 1 ½ miles south.

The developer of Hartford Hill plans to establish master homeowner's association that will be governed by private covenants. This association will include a private design review committee that will be involved in the review and approval of individual site/structure designs to be constructed within Hartford Hill.

HARTFORD HILL

Technical Supplements

SMH CONSULTANTS

FIELDHOUSE DEVELOPMENT, INC.

TECHNICAL SUPPLEMENT NO. 1

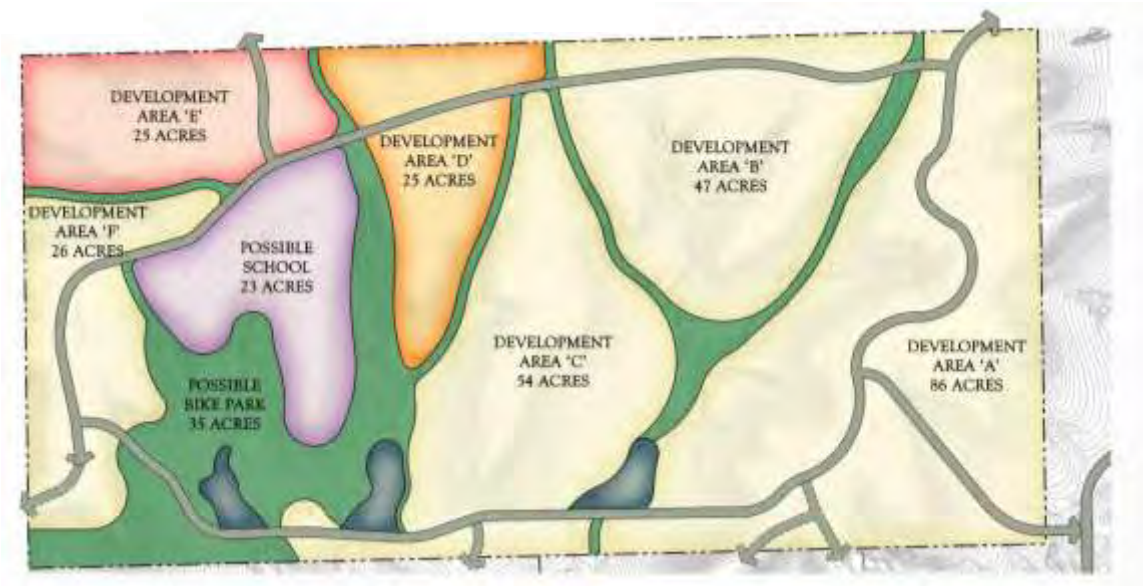
Water Supply Analysis

June 2015

Jeffrey Hancock, P.E., SMH Consultants
Todd Anderson, P.E., SMH Consultants

Water service for Hartford Hill is planned to be provided by the City of Manhattan. The entire development can be served by the Colbert Hills water tower which is less than one-half (1/2) mile north of Hartford Hill's northern boundary. It is anticipated that a water main will loop around the development generally following the "ring road" that essentially circles Hartford Hill. Figure 1 shows the development plan for Hartford Hill including the planned "ring road".

Figure 1 Hartford Hill Development Plan



The estimated daily water demand, utilizing Kansas Department of Health and Environment (KDHE) standards, is 319,200 gallons per day or 222 gallons per minute. Utilizing a peak hour factor of three (3) and then doubling the peak hour flow, the resultant approximate maximum peak water demand from Hartford Hill is 1,330 gallons per minute. These estimates include 750 living units and a school in Hartford Hill.

Reportedly, the water tower is full at elevation 1477. As part of this analysis, flow at Fire Hydrant 6353, as identified in the Riley County Community GIS system and north of Colbert Hills Drive along Grand Mere Parkway, was provided by the City of Manhattan. This fire hydrant is at approximate elevation 1270. Since static pressure was not provide by the City at

this particular hydrant, it was assumed and calculated that being approximately 203 feet below the Colbert Hill's water tower (tower 4-feet below full), pressure at the fire hydrant would be approximately 88 psi. The flow reported by the City at this hydrant when tested was 1482 gallons per minute. Friction loss over the 2,300-feet in the 16-inch water from the tower to the tested hydrant was calculated at only 4 psi when the hydrant flow is 1482 gallons per minute.

The high point in the Hartford Hill tract is approximately at elevation 1350. If the water elevation in the tower is 1473 (tower 4-feet below full) the elevation difference between the tower and the highest point in Hartford Hill is 123 feet which equates to a minimum water pressure in Hartford Hill of 53 psi. The highest point in Hartford Hill would require approximately 5,900 feet of water main from the tower. If all of the water main to the high point in Hartford Hill is 16-inch diameter, the friction loss is 3.2 psi when the water demand is 1,330 gallons per minute as discussed above (peak condition) resulting in a dynamic pressure of 50 psi. If in lieu of a 16-inch water main, 12-inch water main is utilized from the 16-inch main to the high point in Hartford Hill, the friction loss is 8.1 psi at 1,330 gallons per minute demand resulting a dynamic pressure of approximately 45 psi. The minimum water pressure for domestic water service required by the KDHE is 20 psi.

Based on the analysis presented for the critical location in Hartford Hill (the high point), adequate pressures and flows will exist in Hartford Hill utilizing the pressures and flows from the Colbert Hills water tower and the 16-inch water main from the Colbert Hills Water tower on the eastern edge of Hartford Hill.

In consultation with the City of Manhattan it is apparent that there may be, even as of the date of this technical supplement, concerns with keeping the Colbert Hills water tower full during peak demand. This could be a combination of both capacity in the water tower and capacity in the transmission main that gets water to the water tower. Full analysis of this concern should be studied by the City of Manhattan with alternatives developed to best address any capacity issues. If it is realized that additional storage capacity is required, land is available in Hartford Hill for such storage. In addition, any of the proposed water mains within Hartford Hill can be increased in size to address any transmission requirements to get water to the new storage location in Hartford Hill if desired.

TECHNICAL SUPPLEMENT NO. 2

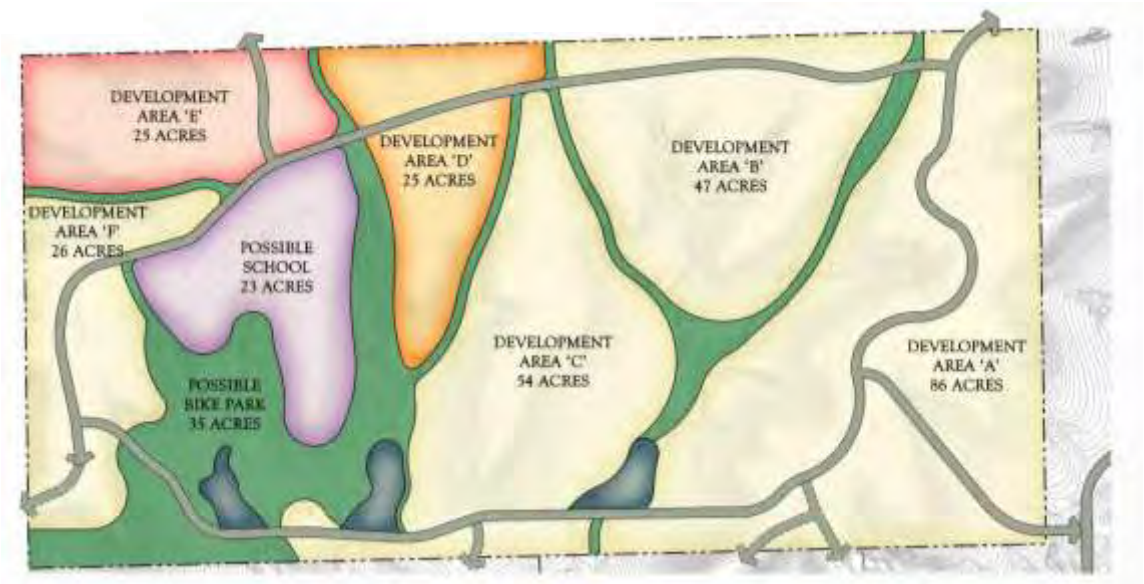
Sanitary Sewer Analysis

August 2015

Jeffrey Hancock, P.E., SMH Consultants
Todd Anderson, P.E., SMH Consultants

Sanitary sewer service for Hartford Hill is planned to be provided by the City of Manhattan. Most of the development will be served by three (3) primary lift stations that will pump waste from the three (3) primary drainage basins of the development back to the east and to the gravity system downstream. The approximately thirty (30) east acres of Hartford Hill defined by the eastern most ridgeline in the development will gravity flow eastward. Figure 1 below is the anticipated development plan for Hartford Hill

Figure 1 Hartford Hill Development Plan



In evaluating the impact of flows from Hartford Hill, three primary locations of concern were considered. All of the flows from Hartford Hill will flow via 8-inch sanitary sewer mains to manhole 3-5832-C as identified on the Riley County Community GIS Website. At this manhole several flows come together from a common basin before they go through an 8-inch sanitary sewer main through Cedar Glen Addition. In addition to the 8-inch through Cedar Glen, Bartlett and West Engineers modeled Hartford Hill's pumped flows from manhole 3-552 south of Cedar Glen to the Wildcat Creek Lift Station to determine if there were any potential issues downstream of this point.

In evaluating the flows to manhole 3-5832-C, existing development and future development were considered from all known and planned development upstream. This included lots already built on, lots platted but not yet built on, and un-platted tracts within the basin. Estimated flows from each of these development areas were utilized to derive estimated total flows at manhole 3-5832-C. Standard flow estimates and peak flows per living unit, as provided by the Kansas Department of Health and Environment (KDHE), were used to develop total flows. Table 1 below provides a summary of estimated dwelling units and flow volumes based on existing and future development within the basin at manhole 3-5832-C.

Figure 1 – Manholes 3-5832-C & 3-552 Locations

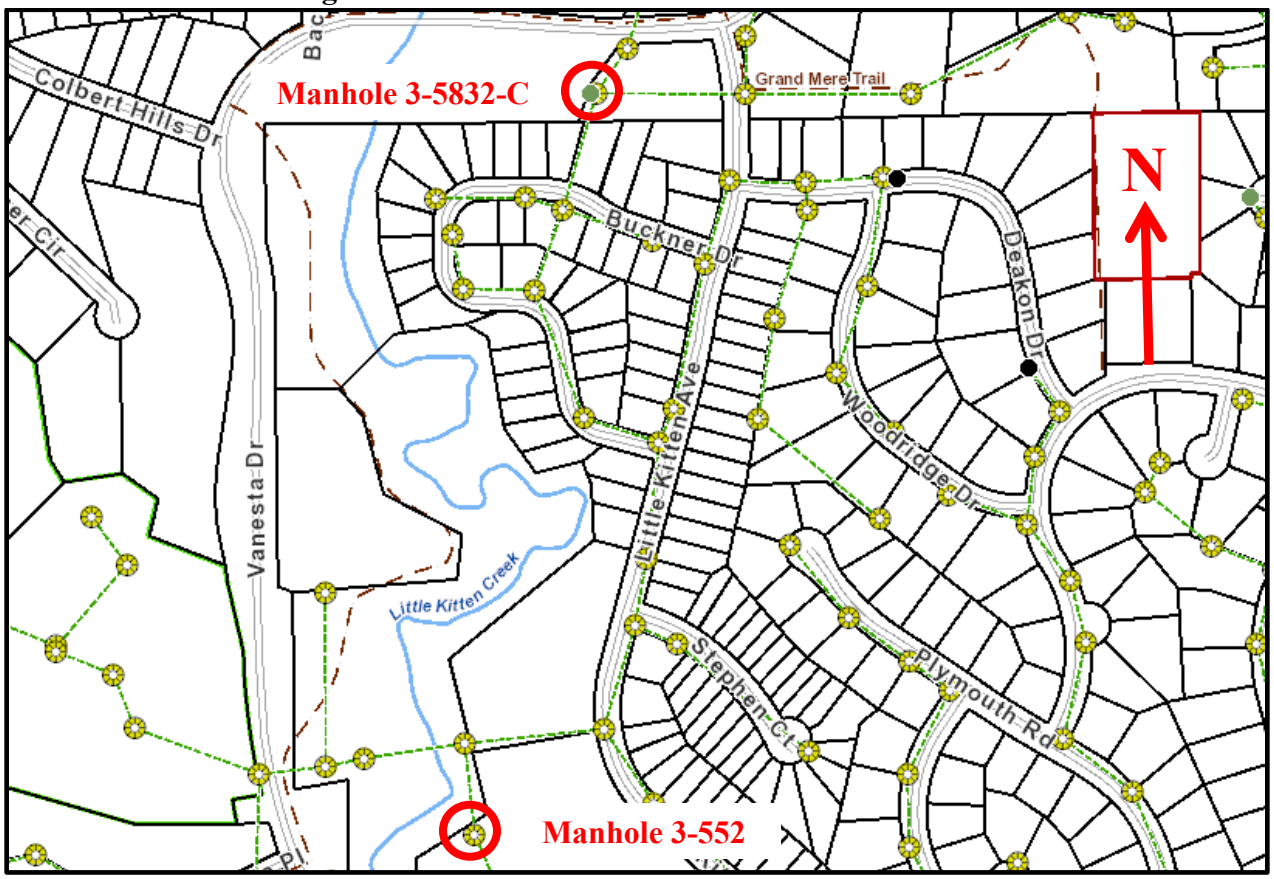


Table 1 Summary of Existing and Future Development Sanitary Sewer Flows @ MH 3-5832-C[1]

Subdivision	Units	Daily Volume (Gallons)	Average Flow (GPM)	Peak Flow (GPM)	70% Peak Flow (GPM)
Hartford Hill Gravity	44	13200	9	28	19
Pinehurst	16	4800	3	10	7
Turnberry	22	6600	5	14	10
Baltusrol	26	7800	5	16	11
Muirfield	24	7200	5	15	11
Olympic	55	16500	11	34	24
Grand Estates	12	3600	3	8	5
Interlachen Units 1 & 2	43	12900	9	27	19
Vanesta Vacant Lots	60	13500	9	28	20
100 AC GM @1.6 per Acre	160	48000	33	100	70
Founders	8	2400	2	5	4
Sub-Totals		**141000**	**98**	**294**	**206**
Hartford Hill Gravity Pumped			150	150	150
Grand Totals (Future and Existing)[3]			**248**	**444**	**356[2]**

Notes:

1. **Rounding to Whole Numbers May Result in Minor Discrepancies of Calculations**
2. **70% Design Total Does Not Include a Reduction of Pumped Flows**
3. **All Flows are Estimated, not Actual**

For design purposes KDHE requires an assumption that for each household three (3) occupants will each waste through the sanitary sewer collection system 100 gallons of water per day. Actual usage is actually closer to 70 gallons per day per occupant. Therefore, 70% design totals have also been provided in Table 1 to compare historical flows versus design flows.

South of manhole 3-5832-C, the 8-inch sanitary sewer main through Cedar Glen is constructed at the minimum grade of 0.40%. Flowing at two-thirds (2/3) full this main has a capacity of 271 gallons per minute. Flowing full the same main has a capacity of 343 gallons per minute.

Based on peak flows and development of the entire basin, the 8-inch sanitary sewer through Cedar Glen could potentially reach its capacity at some point in the future if flows from Hartford Hill are not regulated. However, as subsequently discussed later in this technical supplement, there is a means to address this issue (as it relates to Hartford Hill) through pumping from Hartford Hill during off peak flow time frames at metered rates if required.

Bartlett and West is currently under contract with the City of Manhattan to model sanitary sewer flows in the existing basin of the Wildcat Creek Lift Station. As part of that modeling effort, at the request of SMH, Bartlett and West has estimated design flows from Hartford Hill's anticipated pump stations. In turn they modeled flows at manhole 3-552 just south of Cedar Glen to the Wildcat Creek Lift Station. The sanitary sewer main is a 10-inch main downstream of manhole 3-552. Table 2 below summarizes all future and existing flows to manhole 3-552. Some of these flows are actual flows based on measurement and others are estimate flows based on KDHE criteria.

Table 2 Summary of Existing and Future Development Sanitary Sewer Flows @ MH 3-552[1]

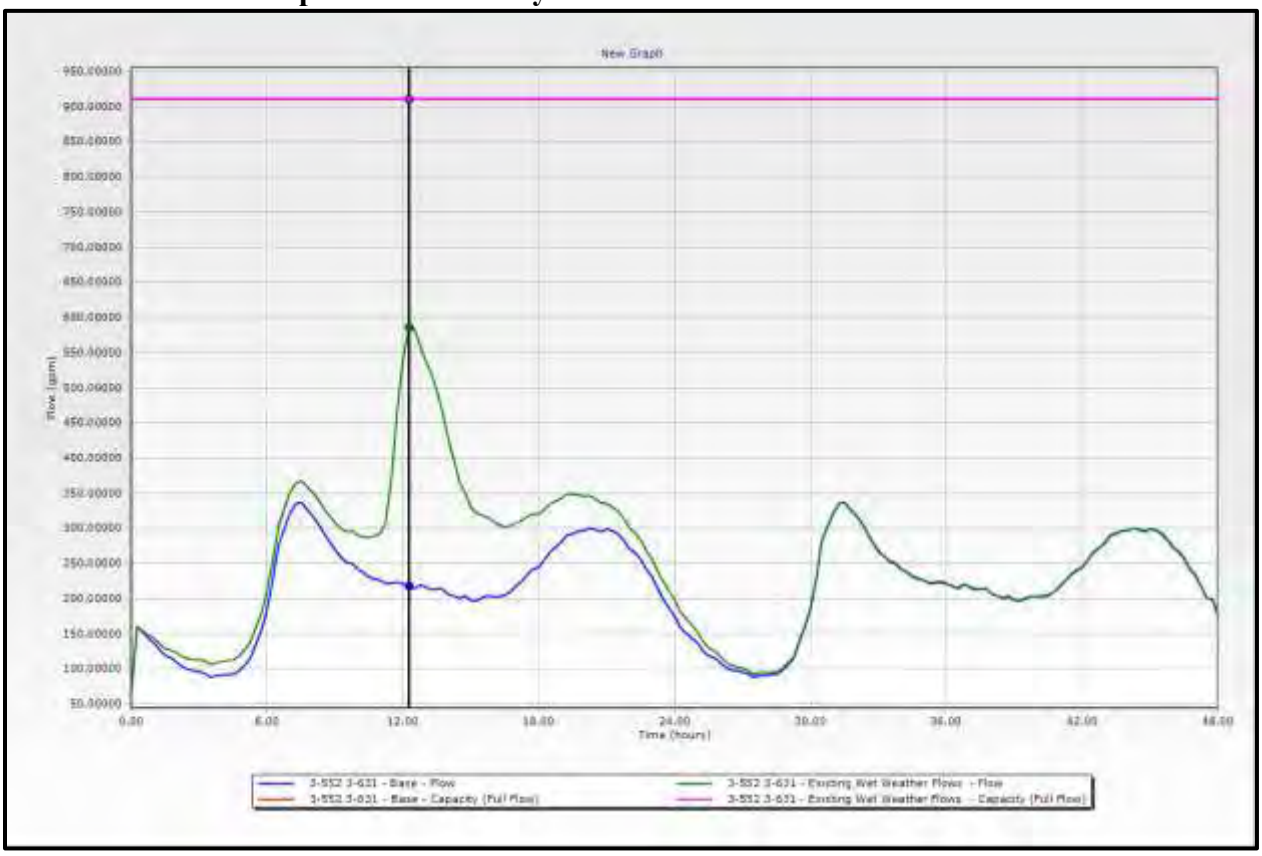
Subdivision	Units	Daily Volume (Gallons)	Average Flow (GPM)	Peak Flow (GPM)	70% Peak Flow (GPM)
Grand Luxe	18	5400	4	11	8
Enclave 1	11	3300	2	7	5
Enclave 2	12	3600	3	8	5
Grand Champions	44	13200	9	28	19
Grand Mere Townhome #3[4]	26	7800	5	16	11
Grand Mere Villa #3[4]	15	4500	3	9	7
Sub-Totals			**26**	**79**	**55**
Future Gravity Flows to US MH 3-5832-C[5]			93	279	196
Hartford Hill Pumped			150	150	150[2]
Merion Pumped			100	100	100[2]
Congressional Pumped			100	100	100[2]
Existing As-Measured Flows[3]			175	430	430
Grand Totals (Future and Existing)			**644**	**1138**	**1031[2]**

1. **Rounding to Whole Numbers May Result in Minor Discrepancies of Calculations**
2. **70% Design Total Does Not Include a Reduction of Pumped Flows or Measured Peak Flows**
3. **Existing Flows are as Reported through Flow Monitoring**
4. **Estimated at 1.6 Dwelling Units per Acre based on Grand Mere Historical Density**
5. **Future Gravity Flows do Not Include Flows from Developed Land at the time Flow Monitoring Took Place (Founders Village & 15 Lots in Vanesta)**

The graph below shows base flows and wet weather flows at manhole 3-552 (including 150 gallons per minute from Hartford Hill's anticipated pump stations). The main in this location has a full flow capacity of a little over 900 gallons per minute. The anticipated average daily and 70% peak design flow from all future flows in the basin to manhole 3-552 are 644 and 1031 gallons per minute. This includes all future gravity and pumped flows, which are a combination of estimates and existing flows. Again, if required there is a means to address this over capacity

issue (as it relates to Hartford Hill) through pumping from Hartford Hill during off peak flow time frames at metered rates if required.

Graph 1 – Flow Analysis Downstream of Manhole 3-552



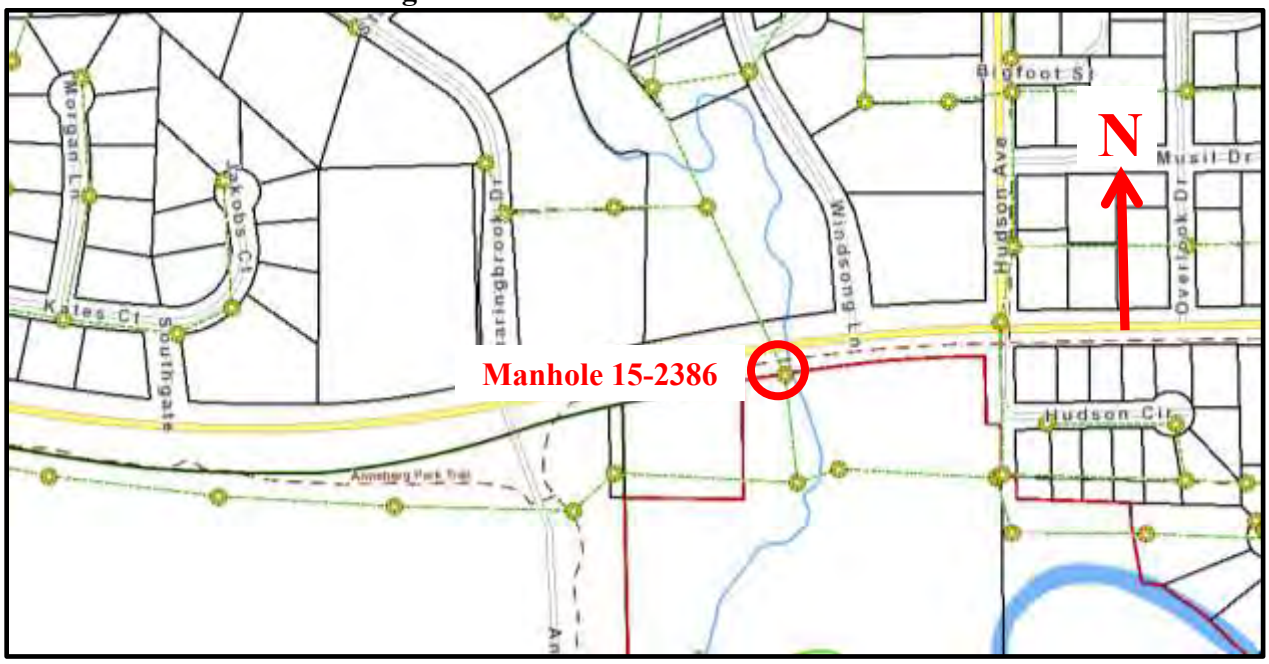
In addition to the 10-inch sanitary sewer main directly south of Cedar Glen, Bartlett and West also modeled flows at manhole 15-2386. At this manhole, flows converge into a 24-inch sanitary sewer main. Manhole 15-2386 is on the south side of Anderson Avenue near its intersection with Windsong Lane. Table 3 summarizes the existing and estimated future flows to this manhole. Graph 2 shows flows, including an estimated 150 gallons per minute from Hartford Hill's anticipated pump stations, at manhole 15-2386. Based on existing base and wet weather flows at this manhole (including an estimated 150 gallons per minute from Hartford Hill's anticipated pump stations) capacity in the downstream main to accept these flows is available. The main downstream of manhole 15-2386 has an estimated capacity as reported by Bartlett and West of 2,250 gallons per minute flowing full. Again, if required there is a means to address capacity issues (as it relates to Hartford Hill) through pumping from Hartford Hill during off peak flow time frames at metered rates if required.

Table 3 Summary of Existing and Future Development Sanitary Sewer Flows @ MH 15-2386[1]

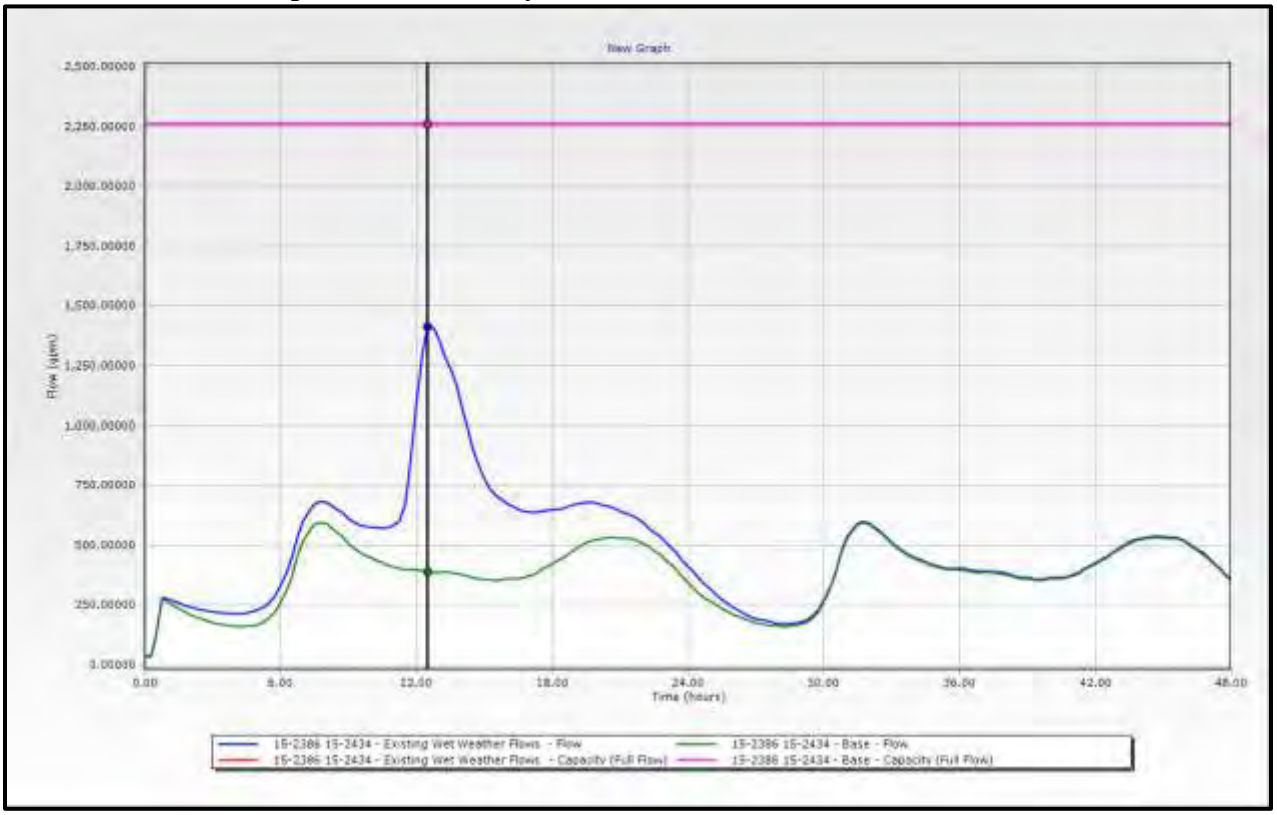
Subdivision	Units	Daily Volume (Gallons)	Average Flow (GPM)	Peak Flow (GPM)	70% Peak Flow (GPM)
Future Gravity Flows from US MH 3-552[4]			119	358	251
Hartford Hill Pumped			150	150	150[2]
Merion Pumped			100	100	100[2]
Congressional Pumped			100	100	100[2]
Existing As-Measured Flows[3]			475	1250	1250
Grand Totals (Future and Existing)			**944**	**1958**	**1851**[2]

1. **Rounding to Whole Numbers May Result in Minor Discrepancies of Calculations**
2. **70% Design Total Does Not Include a Reduction of Pumped Flows or Measured Peak Flows**
3. **Existing Flows are as Reported through Flow Monitoring**
4. **Future Gravity Flows Do Not Include Flows from Developed Land at the time Flow Monitoring Took Place (Founders Village & 15 Lots in Vanesta), nor do they Include Flows Pumped to MH 3-552, nor do they include measure flows at MH 3-552**

Figure 2 – Manhole 15-2386 Location



Graph 2 – Flow Analysis Downstream of Manhole 3-2386



With the relatively low densities which Hartford Hill and other properties in the basin are expected to develop at, and given the option to meter and discharge from Hartford Hill at off peak times, the gravity system in place downstream is anticipated to accommodate this new development.

In the event flows reach a point downstream that tax the system, technology of today is available to allow off-peak pumping of wastewater. A simple communication system can be implemented. A permanently mounted flow measuring device, or if necessary devices, can be installed in a strategically located manhole that acts as the control location in the sewer system. This device would be equipped with a transmitter that, when the flow in the sewer is at a level in which wastewater can be passed safely, a signal is given to the pump stations within Hartford Hill to release their flow. The pump stations will have to include slightly larger than normal wet wells in order to temporarily store the wastewater. This means the unused capacity of the existing sewer system would be used in an efficient and safe manner during off-peak periods.

TECHNICAL SUPPLEMENT NO. 3

Storm Water Management & Post Construction BMPs

July 2015

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Adam Wilkerson, Intern, SMH Consultants

Introduction

Existing Conditions

The following drainage analysis was conducted to determine the storm water impacts of the Hartford Hill and the proposed plan for mitigating those impacts. The analysis was completed in accordance with the most recent storm water management requirements as provided by the City of Manhattan.

Hartford Hill is located on 320 acres north and west of Grand Mere. The site rests upon a ridge and consists of 8 partial watersheds shown in Figure 8 (attached). Watershed 1 (Bike Gulch Watershed), watershed 2 (Single Track Watershed), and watershed 3 (Home Watershed) will drain to respective proposed detention ponds. Watershed 4 (Kickoff Watershed), watershed 5 (New England Watershed), watershed 6 (Washington Watershed), watershed 7 (California Watershed), and watershed 8 (Baja Watershed) drain offsite. The land is currently County AG and is used for cattle grazing. The property is dominated by native tallgrass prairie with riparian areas in the ravines. The entire 320 Acres of Hartford Hill drains into Wildcat Creek, via drainage connections at three different locations.

Study Methodology

Hydraflow Hyrdrographs software by Autodesk was used to analyze the existing and future drainage characteristics of the area. Due to the overall size of the site and the required pond routing, the Natural Resource Conservation Service (NRCS) Runoff Curve Number was utilized in all analyses to calculate peak runoff rates and total volume of runoff. According to the *City of Manhattan's Storm Water Management Criteria*, the runoff curve number of 100% pervious land is 70, which is what was utilized for all existing pasture. The runoff curve number for low to medium residential housing utilized was 80; for commercial areas 94; and for schools 90.

A combination of LiDAR data from the City of Manhattan and quadrangle maps were used to map watersheds. Upon mapping of the watersheds the areas of drainage for each watershed were determined. Maximum flow lengths and watercourse slope were calculated for each watershed. The maximum flow length is the longest possible path a drop of water could follow to reach the point of interest along the watercourse. Watercourse slope is the average slope in which this drop of water will experience. The Lag Method was used to calculate the time of concentration for each watershed.

For comparing the impacts to Wildcat Creek the Primary Point of Confluence (PPC) of all three drainages from Hartford Hill along Wildcat Creek for each of the watersheds was considered. In addition, Points of Intermediate Confluence (PIC) were also analyzed for watershed specific characteristics before and after development as they pertain to Hartford Hill. These confluence points are noted in Figure 1 below. The 2, 10 and 100 year storm events were utilized as the basis for determining flow rates for: existing, existing with no ponds, and existing with ponds.

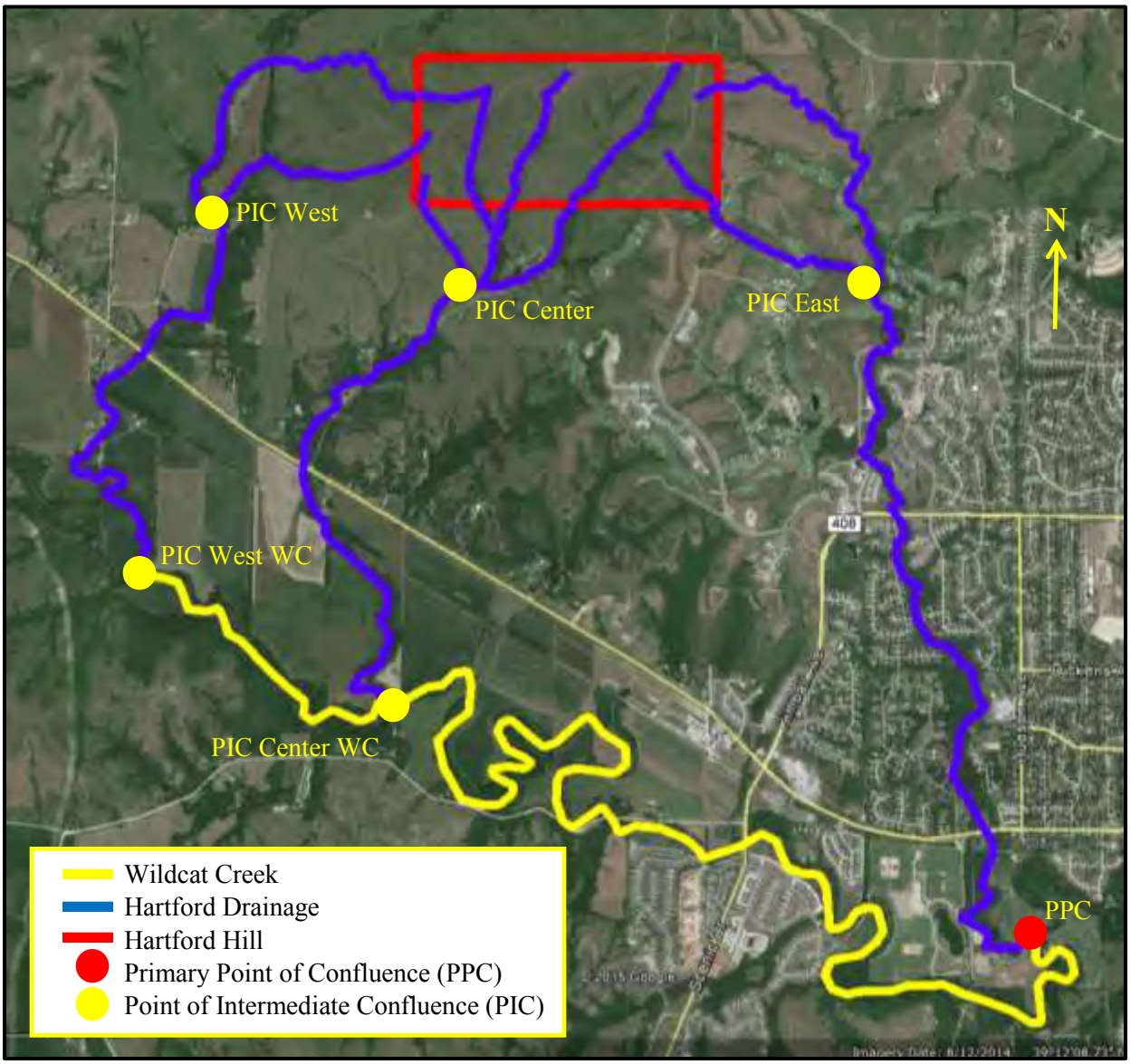

Figure 1 Points of Confluence from Hartford Hill

Analysis

Tables 1 and 2 below provide the watershed characteristics for the existing and developed conditions at Hartford Hill for each of the watersheds respectively.

Table 1 Existing Watershed Characteristics

Watershed #	Watershed Name	Area (ac)	Longest Flow Path (ft)	Hydraulic Slope (%)	Runoff Curve Number	Time of Concentration (minutes)
Watershed 1	Bike Gulch	48.6	2,165	5.08	70	34.97
Watershed 2	Single Track	54.2	2,851	4.14	70	48.28
Watershed 3	Home	124.4	3,379	3.26	70	62.33
Watershed 4	Kickoff	30.7	1,338	5.98	70	21.90
Watershed 5	New England	9.6	485	9.69	70	7.65
Watershed 6	Washington	48.7	1,320	6.97	70	20.10
Watershed 7	California	4.8	389	1.80	70	14.80
Watershed 8	Baja	4.4	516	11.43	70	7.40

Table 2 Developed Watershed Characteristics

Watershed #	Watershed Name	Area (ac)	Longest Flow Path (ft)	Hydraulic Slope (%)	Runoff Curve Number	Time of Concentration (minutes)
Watershed 1	Bike Gulch	48.6	2,165	5.08	75	30.43
Watershed 2	Single Track	54.2	2,851	4.14	79	37.32
Watershed 3	Home	124.4	3,379	3.26	80	46.71
Watershed 4	Kickoff	30.7	1,338	5.98	80	16.40
Watershed 5	New England	9.6	485	9.69	80	5.70
Watershed 6	Washington	48.7	1,320	6.97	89	11.00
Watershed 7	California	4.8	389	1.80	80	11.10
Watershed 8	Baja	4.4	516	11.43	80	5.50

Tables 3, 4 and 5 below provide the comparable flow rates for the 2, 10, and 100-year events respectively at Hartford Hill. In addition to watershed specific flow rates, the flow rates at Points of Intermediate Confluence and the Primary Point of Confluence have also been provided.

Table 3 Flow Rate Comparison – 2 Year

Watershed # Or Point of Confluence	Watershed Name or Point of Confluence	Existing (cfs)	Developed w/o Detention (cfs)	Developed w/ Detention (cfs)
Watershed 1	Bike Gulch	14.89	26.08	1.65
Watershed 2	Single Track	13.26	34.68	1.69
Watershed 3	Home	25.54	76.24	1.88
Watershed 4	Kickoff	13.05	36.12	36.12
Watershed 5	New England	6.86	15.65	15.65
Watershed 6	Washington	23.00	108.18	108.18
Watershed 7	California	2.54	6.53	6.53
Watershed 8	Baja	3.14	7.17	7.17
PIC West	PIC West	7.69	42.75	42.75
PIC Center	PIC Center	41.83	115.91	7.52
PIC East	PIC East	8.86	24.90	24.90
PIC West WC	PIC West WC	3.43	18.04	18.04
PIC Center WC	PIC Center WC	22.86	64.62	14.06
PPC	PPC	4.35	11.34	5.86

Table 4 Flow Rate Comparison – 10 Year

Watershed # Or Point of Confluence	Watershed Name or Point of Confluence	Existing (cfs)	Developed w/o Detention (cfs)	Developed w/ Detention (cfs)
Watershed 1	Bike Gulch	79.17	103.83	11.53
Watershed 2	Single Track	71.14	117.08	10.69
Watershed 3	Home	137.44	248.77	13.57
Watershed 4	Kickoff	67.85	115.36	115.36
Watershed 5	New England	32.13	47.82	47.82
Watershed 6	Washington	117.02	262.43	262.43
Watershed 7	California	12.61	20.62	20.62
Watershed 8	Baja	14.73	21.92	21.92
PIC West	PIC West	56.10	127.39	127.39
PIC Center	PIC Center	237.16	419.16	35.94
PIC East	PIC East	57.31	93.84	93.84
PIC West WC	PIC West WC	24.74	57.21	57.21
PIC Center WC	PIC Center WC	152.82	270.06	61.99
PPC	PPC	30.82	53.12	28.44

Table 5 Flow Rate Comparison – 100 Year				
Watershed # Or Point of Confluence	**Watershed Name or Point of Confluence**	**Existing (cfs)**	**Developed w/o Detention (cfs)**	**Developed w/ Detention (cfs)**
Watershed 1	Bike Gulch	151.66	186.21	16.79
Watershed 2	Single Track	136.90	200.59	16.24
Watershed 3	Home	265.39	421.78	17.34
Watershed 4	Kickoff	129.66	193.48	193.48
Watershed 5	New England	60.17	79.56	79.56
Watershed 6	Washington	223.38	403.48	403.48
Watershed 7	California	23.96	34.54	34.54
Watershed 8	Baja	27.58	36.46	36.46
PIC West	PIC West	119.51	212.04	212.04
PIC Center	PIC Center	465.86	732.94	51.09
PIC East	PIC East	117.94	167.32	167.32
PIC West WC	PIC West WC	55.63	98.59	98.59
PIC Center WC	PIC Center WC	325.67	501.91	99.73
PPC	PPC	73.56	109.76	51.12

Discussion

There are several ways to consider the impacts of Hartford Hill on downstream drainage dependent on the primary area of concern. The most comprehensive assessment, the one that takes into account all of Hartford Hill, is to consider what is happening at the PPC. For all but the 2-year event the impact is substantial and positive with the 100-year event resulting in a 22-cfs decrease in the peak flow at the PPC between the existing watershed and the fully developed watershed. The 2-year event results in a slight increase of 1.51-cfs, however his does not consider Watersheds 4 and 5 being routed through the existing Vanesta Lake facility at Grand Mere that provides additional detention before discharge into Wildcat Creek.

Another important perspective in considering the impact of Hartford Hill is to evaluate the impact at the PICs. These are where the various drainages from Hartford Hill combine. Detention is proposed to be provided for only Watersheds 1, 2, and 3; but as these watersheds are combined with watershed 8 at a common PIC the impact is huge. As these flows are carried down, the impact at PIC Center WC results in a decrease of 225-cfs for the 100-year event between the existing watershed and the fully developed watershed. PIC Center WC is where watersheds 1, 2, 3, 6, 7 and 8 join at Wildcat Creek. As a result, a reduction in flows is realized on Wildcat Creek, under the Scenic Drive bridge and to the PPC east of Anneberg Park.

Watershed 6, on its own shows a large increase in flow rate from the undeveloped to the developed condition. This increase in flow rate will need to be throttled to address any downstream erosion issues if

it develops as modeled. There are opportunities for storm water detention in Watershed 6 that would be fairly simple to accomplish, but they have purposely been initially not proposed in the master plan. Watershed 6 is proposed for a research/office park to be marketed to KSU and could ultimately be something related to agriculture given it abuts KSU agricultural land on two sides. If it stays predominantly agricultural there may be little need to do anything to address downstream erosion concerns. Regardless, it is proposed that when Watershed 6 develops and how it develops will drive the need for detention or other means for slowing storm water down coming from the watershed.

Detention

To realize the positive impacts noted that Hartford Hill has on Wildcat Creek, detention facilities are required. The facilities proposed are to be a result of the grading required for crossing the large ravines with streets where the detention facilities will be located. Embankment for roadway fills will provide the necessary dams. Outlet structures will be final designed as part of the roadway design process to yield the reduction in outflows noted. Table 6 below summarizes the required hydraulic volume that each structure will be required to detain for a 100-year event.

Table 6 100 Year Required Hydraulic Storage Volume

Watershed #	Detention Structure	Required Hydraulic Storage Volume (Acre-Feet)
Watershed 1	Bike Gulch Pond	10.41
Watershed 2	Single Track Pond	13.55
Watershed 3	Home Pond	37.25

Post Construction Best Management Practices (BMPs)

Hartford hill is dominated by soils of hydrologic soils group D. Based on an estimate of the impervious to pervious ratio, Post Construction BMPs will be required at Hartford Hill as stipulated in the City of Manhattan's most recently adopted Post Construction Storm Water BMP Manual. This analysis is presented below.

1. Total Approximate Acres = 320
2. Soil Group D
3. Impervious
    a. Assumed Approximate Structures and Associated Paving = 73 Acres (800 Structures with an estimated 4,000 SF of impermeable area each)(Assumed 2.5 Dwelling Units Per Acre as Estimated in Master Plan)
    b. Assumed Approximate Streets and Sidewalks = 10 Acres
4. Pervious
    a. Native Areas, Yard, Etc. = 237

5. Impervious/Pervious Ratio = 0.35
6. Within Shaded Area of Appendix H of Post Construction Manual - 90% Event Chart

Since Post Construction BMPs are required in Hartford Hill the next step is to determine the water quality volume (WQ_v). For Manhattan the 90% Water Quality Rainfall Event, based on Section 4 of the Post Construction BMP Manual is 1.10-inches. Utilizing equations 4.1 and 4.4 of the Post Construction BMP Manual, the WQ_v is calculated to be 10.71 acre-feet.

The WQ_v is the volume of water that is required to be treated for water quality. This will be accomplished utilizing the proposed detention basins as Extended Dry Detention Basins (EDDBs). EDDBs are designed to detain the WQ_v for 40 hours to allow particles and associated pollutants to settle. According to the City's Post Construction BMP Manual, EDDBs that store water for 24 hours or more will remove 90% of the pollutants.

By over detaining in the proposed detention basins to capitalize on decreasing flows to Wildcat Creek, the proposed detention basins can store and treat the WQ_v for a minimum of 40 hours. The smallest storm analyzed as part of the hydrologic analysis, the 2-year event, results in the storage of approximately 12.20 acre-feet of water and the three ponds release this volume over a time period in excess of 90 hours. The design volume for the WQ_v, as required by the City's Post Construction BMP Manual, is $1.2(WQ_v)$. For Hartford Hill this equates to 12.85 acre-feet of water that is to be released over a minimum of 40 hours. The proposed ponds at Hartford Hill have a combined estimated total storage capacity of 84 acre-feet, of which 73% is actually utilized for the 100-year event leaving ample additional capacity to insure treatment of the WQ_v if final design of the detention ponds reveals such need.

Storm Water Analysis
Watershed Map &
Hydraflow Output

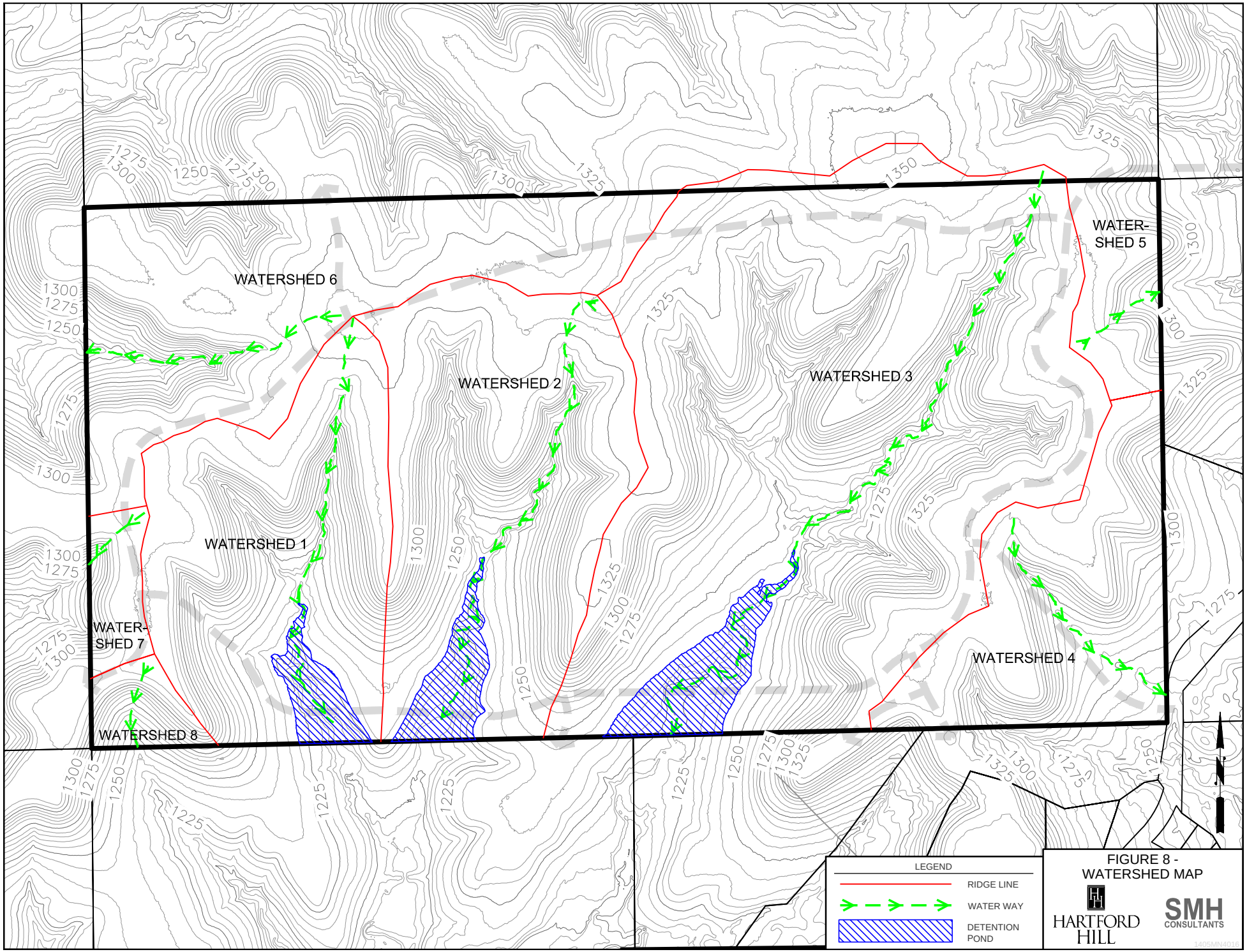

FIGURE 8 -
WATERSHED MAP

Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.02

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph description
1	SCS Runoff	14.89	2	738	87,869	----	------	------	Watershed 1-Bike Gulch (Existing)
2	SCS Runoff	13.26	2	746	99,120	----	------	------	Watershed 2-Single Track (Existing)
3	SCS Runoff	25.54	2	756	228,998	----	------	------	Watershed 3-Home (Existing)
4	SCS Runoff	13.05	2	728	57,146	----	------	------	Watershed 4-Kickoff (Existing)
5	SCS Runoff	6.855	2	720	17,556	----	------	------	Watershed 5-New England (Existing)
6	SCS Runoff	23.00	2	726	89,062	----	------	------	Watershed 6-Washington (Existing)
7	SCS Runoff	2.542	2	724	8,559	----	------	------	Watershed 7-California (Existing)
8	SCS Runoff	3.142	2	720	8,047	----	------	------	Watershed 8-Baja (Existing)
9	Reach	11.45	2	752	82,257	1	------	------	HH 1 Outfall to Inter Con
10	Reach	11.43	2	762	95,511	2	------	------	HH2 Outfall to Inter Con
11	Reach	21.76	2	778	225,306	3	------	------	HH 3 Outfall to Inter Con
12	Reach	6.843	2	748	89,028	6	------	------	HH 6 Outfall to Inter Con
13	Reach	0.884	2	740	8,536	7	------	------	HH 7 Outfall to Inter Con
14	Combine	7.687	2	746	97,564	12, 13	------	------	PIC West
15	Reach	3.425	2	862	97,486	14	------	------	PIC West to WC
16	Reach	1.640	2	728	8,039	8	------	------	HH 8 Outfall to Inter Con
17	Combine	41.83	2	764	411,113	9, 10, 11, 16	------	------	PIC Center
18	Reach	22.34	2	816	411,068	17	------	------	PIC Center to WC
19	Reach	7.730	2	744	57,133	4	------	------	HH 4 Outfall to Inter Con
20	Reach	1.129	2	746	17,512	5	------	------	HH 5 Outfall to Inter Con
21	Combine	8.859	2	744	74,646	19, 20	------	------	PIC East
22	Reach	2.044	2	864	74,514	21	------	------	PIC East to WC
23	Reach	1.888	2	1122	97,308	15	------	------	PIC West @ WC to PIC Center @ W
24	Combine	22.86	2	818	508,376	18, 23	------	------	3.06 Miles Upstream of Scenic Bridge
25	Reach	3.484	2	1530	476,613	24	------	------	3.06 Up to PPC
26	Combine	4.345	2	1198	551,128	22, 25	------	------	PPC

Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.02

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph description
1	SCS Runoff	79.17	2	736	368,146	----	------	------	Watershed 1-Bike Gulch (Existing)
2	SCS Runoff	71.14	2	744	415,285	----	------	------	Watershed 2-Single Track (Existing)
3	SCS Runoff	137.44	2	752	959,434	----	------	------	Watershed 3-Home (Existing)
4	SCS Runoff	67.85	2	728	239,426	----	------	------	Watershed 4-Kickoff (Existing)
5	SCS Runoff	32.13	2	720	73,556	----	------	------	Watershed 5-New England (Existing)
6	SCS Runoff	117.02	2	724	373,144	----	------	------	Watershed 6-Washington (Existing)
7	SCS Runoff	12.61	2	722	35,859	----	------	------	Watershed 7-California (Existing)
8	SCS Runoff	14.73	2	720	33,713	----	------	------	Watershed 8-Baja (Existing)
9	Reach	66.17	2	744	344,658	1	------	------	HH 1 Outfall to Inter Con
10	Reach	64.15	2	752	400,187	2	------	------	HH2 Outfall to Inter Con
11	Reach	122.77	2	766	944,002	3	------	------	HH 3 Outfall to Inter Con
12	Reach	50.27	2	740	373,122	6	------	------	HH 6 Outfall to Inter Con
13	Reach	6.193	2	734	35,844	7	------	------	HH 7 Outfall to Inter Con
14	Combine	56.10	2	740	408,966	12, 13	------	------	PIC West
15	Reach	24.74	2	794	408,919	14	------	------	PIC West to WC
16	Reach	10.20	2	724	33,708	8	------	------	HH 8 Outfall to Inter Con
17	Combine	237.16	2	756	1,722,554	9, 10, 11, 16	------	------	PIC Center
18	Reach	146.52	2	790	1,722,526	17	------	------	PIC Center to WC
19	Reach	48.74	2	738	239,418	4	------	------	HH 4 Outfall to Inter Con
20	Reach	9.099	2	730	73,529	5	------	------	HH 5 Outfall to Inter Con
21	Combine	57.31	2	738	312,948	19, 20	------	------	PIC East
22	Reach	14.77	2	790	312,866	21	------	------	PIC East to WC
23	Reach	13.39	2	922	408,823	15	------	------	PIC West @ WC to PIC Center @ W
24	Combine	152.82	2	792	2,131,348	18, 23	------	------	3.06 Miles Upstream of Scenic Bridge
25	Reach	24.28	2	1156	2,123,014	24	------	------	3.06 Up to PPC
26	Combine	30.82	2	940	2,435,887	22, 25	------	------	PPC

Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.02

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph description
1	SCS Runoff	151.66	2	734	689,514	----	------	------	Watershed 1-Bike Gulch (Existing)
2	SCS Runoff	136.90	2	744	777,803	----	------	------	Watershed 2-Single Track (Existing)
3	SCS Runoff	265.39	2	752	1,796,961	----	------	------	Watershed 3-Home (Existing)
4	SCS Runoff	129.66	2	726	448,431	----	------	------	Watershed 4-Kickoff (Existing)
5	SCS Runoff	60.17	2	718	137,766	----	------	------	Watershed 5-New England (Existing)
6	SCS Runoff	223.38	2	724	698,875	----	------	------	Watershed 6-Washington (Existing)
7	SCS Runoff	23.96	2	722	67,161	----	------	------	Watershed 7-California (Existing)
8	SCS Runoff	27.58	2	718	63,143	----	------	------	Watershed 8-Baja (Existing)
9	Reach	130.46	2	742	645,528	1	------	------	HH 1 Outfall to Inter Con
10	Reach	125.61	2	750	749,529	2	------	------	HH2 Outfall to Inter Con
11	Reach	241.96	2	762	1,768,066	3	------	------	HH 3 Outfall to Inter Con
12	Reach	107.18	2	738	698,856	6	------	------	HH 6 Outfall to Inter Con
13	Reach	13.01	2	732	67,149	7	------	------	HH 7 Outfall to Inter Con
14	Combine	119.51	2	738	766,004	12, 13	------	------	PIC West
15	Reach	55.63	2	780	765,966	14	------	------	PIC West to WC
16	Reach	20.66	2	724	63,138	8	------	------	HH 8 Outfall to Inter Con
17	Combine	465.86	2	752	3,226,260	9, 10, 11, 16	------	------	PIC Center
18	Reach	307.87	2	782	3,226,234	17	------	------	PIC Center to WC
19	Reach	98.91	2	736	448,424	4	------	------	HH 4 Outfall to Inter Con
20	Reach	20.60	2	728	137,744	5	------	------	HH 5 Outfall to Inter Con
21	Combine	117.94	2	736	586,168	19, 20	------	------	PIC East
22	Reach	34.28	2	776	586,102	21	------	------	PIC East to WC
23	Reach	31.08	2	878	765,891	15	------	------	PIC West @ WC to PIC Center @ W
24	Combine	325.67	2	784	3,992,128	18, 23	------	------	3.06 Miles Upstream of Scenic Bridge
25	Reach	58.16	2	1028	3,989,873	24	------	------	3.06 Up to PPC
26	Combine	73.56	2	896	4,575,980	22, 25	------	------	PPC

Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.02

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph description
1	SCS Runoff	26.08	2	734	126,769	----	------	------	Watershed 1-Bike Gulch (Developed)
2	SCS Runoff	34.68	2	738	178,077	----	------	------	Watershed 2-Single Track (Develope
3	SCS Runoff	76.24	2	742	429,055	----	------	------	Watershed 3-Home (Developed)
4	SCS Runoff	36.12	2	722	104,167	----	------	------	Watershed 4-Kickoff (Developed)
5	SCS Runoff	15.65	2	718	31,321	----	------	------	Watershed 5-New England (Develope
6	SCS Runoff	108.18	2	720	281,208	----	------	------	Watershed 6-Washington (Developed
7	SCS Runoff	6.529	2	722	17,226	----	------	------	Watershed 7-California (Developed)
8	SCS Runoff	7.175	2	718	14,355	----	------	------	Watershed 8-Baja (Developed)
9	Reach	21.75	2	746	126,763	1	------	------	HH 1 Outfall to Inter Con
10	Reach	30.99	2	748	178,072	2	------	------	HH2 Outfall to Inter Con
11	Reach	64.46	2	756	429,047	3	------	------	HH 3 Outfall to Inter Con
12	Reach	40.06	2	732	281,185	6	------	------	HH 6 Outfall to Inter Con
13	Reach	2.697	2	732	17,209	7	------	------	HH 7 Outfall to Inter Con
14	Combine	42.75	2	732	298,394	12, 13	------	------	PIC West
15	Reach	18.04	2	790	298,343	14	------	------	PIC West to WC
16	Reach	4.283	2	722	14,349	8	------	------	HH 8 Outfall to Inter Con
17	Combine	115.91	2	750	748,232	9, 10, 11, 16	------	------	PIC Center
18	Reach	60.03	2	784	748,196	17	------	------	PIC Center to WC
19	Reach	21.89	2	732	104,157	4	------	------	HH 4 Outfall to Inter Con
20	Reach	3.054	2	726	31,285	5	------	------	HH 5 Outfall to Inter Con
21	Combine	24.90	2	732	135,443	19, 20	------	------	PIC East
22	Reach	5.006	2	808	135,335	21	------	------	PIC East to WC
23	Reach	9.508	2	922	298,237	15	------	------	PIC West @ WC to PIC Center @ W
24	Combine	64.62	2	786	1,046,434	18, 23	------	------	3.06 Miles Upstream of Scenic Bridge
25	Reach	9.324	2	1306	1,026,476	24	------	------	3.06 Up to PPC
26	Combine	11.34	2	1060	1,161,812	22, 25	------	------	PPC

Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.02

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph description
1	SCS Runoff	103.83	2	734	452,027	----	------	------	Watershed 1-Bike Gulch (Developed)
2	SCS Runoff	117.08	2	736	568,189	----	------	------	Watershed 2-Single Track (Develope
3	SCS Runoff	248.77	2	740	1,333,795	----	------	------	Watershed 3-Home (Developed)
4	SCS Runoff	115.36	2	722	323,822	----	------	------	Watershed 4-Kickoff (Developed)
5	SCS Runoff	47.82	2	716	97,366	----	------	------	Watershed 5-New England (Develope
6	SCS Runoff	262.43	2	720	705,110	----	------	------	Watershed 6-Washington (Developed
7	SCS Runoff	20.62	2	720	53,551	----	------	------	Watershed 7-California (Developed)
8	SCS Runoff	21.92	2	716	44,626	----	------	------	Watershed 8-Baja (Developed)
9	Reach	93.37	2	740	452,023	1	------	------	HH 1 Outfall to Inter Con
10	Reach	109.68	2	744	568,185	2	------	------	HH2 Outfall to Inter Con
11	Reach	223.09	2	750	1,333,790	3	------	------	HH 3 Outfall to Inter Con
12	Reach	116.91	2	732	705,092	6	------	------	HH 6 Outfall to Inter Con
13	Reach	10.54	2	730	53,538	7	------	------	HH 7 Outfall to Inter Con
14	Combine	127.39	2	730	758,630	12, 13	------	------	PIC West
15	Reach	57.21	2	770	758,592	14	------	------	PIC West to WC
16	Reach	15.44	2	722	44,620	8	------	------	HH 8 Outfall to Inter Con
17	Combine	419.16	2	746	2,398,617	9, 10, 11, 16	------	------	PIC Center
18	Reach	251.06	2	772	2,398,592	17	------	------	PIC Center to WC
19	Reach	80.60	2	730	323,815	4	------	------	HH 4 Outfall to Inter Con
20	Reach	13.88	2	724	97,341	5	------	------	HH 5 Outfall to Inter Con
21	Combine	93.84	2	730	421,156	19, 20	------	------	PIC East
22	Reach	22.96	2	772	421,082	21	------	------	PIC East to WC
23	Reach	31.84	2	862	758,518	15	------	------	PIC West @ WC to PIC Center @ W
24	Combine	270.06	2	774	3,157,112	18, 23	------	------	3.06 Miles Upstream of Scenic Bridge
25	Reach	42.73	2	1044	3,153,321	24	------	------	3.06 Up to PPC
26	Combine	53.12	2	904	3,574,404	22, 25	------	------	PPC

Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.02

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph description
1	SCS Runoff	186.21	2	732	804,475	----	------	------	Watershed 1-Bike Gulch (Developed)
2	SCS Runoff	200.59	2	736	974,258	----	------	------	Watershed 2-Single Track (Develope
3	SCS Runoff	421.78	2	740	2,266,743	----	------	------	Watershed 3-Home (Developed)
4	SCS Runoff	193.48	2	722	550,326	----	------	------	Watershed 4-Kickoff (Developed)
5	SCS Runoff	79.56	2	716	165,470	----	------	------	Watershed 5-New England (Develope
6	SCS Runoff	403.48	2	720	1,111,872	----	------	------	Watershed 6-Washington (Developed
7	SCS Runoff	34.54	2	720	91,009	----	------	------	Watershed 7-California (Developed)
8	SCS Runoff	36.46	2	716	75,840	----	------	------	Watershed 8-Baja (Developed)
9	Reach	171.23	2	740	804,471	1	------	------	HH 1 Outfall to Inter Con
10	Reach	190.38	2	742	974,254	2	------	------	HH2 Outfall to Inter Con
11	Reach	385.62	2	750	2,266,739	3	------	------	HH 3 Outfall to Inter Con
12	Reach	192.94	2	730	1,111,856	6	------	------	HH 6 Outfall to Inter Con
13	Reach	19.10	2	730	90,997	7	------	------	HH 7 Outfall to Inter Con
14	Combine	212.04	2	730	1,202,853	12, 13	------	------	PIC West
15	Reach	98.59	2	764	1,202,819	14	------	------	PIC West to WC
16	Reach	26.92	2	722	75,837	8	------	------	HH 8 Outfall to Inter Con
17	Combine	732.94	2	744	4,121,301	9, 10, 11, 16	------	------	PIC Center
18	Reach	465.30	2	768	4,121,278	17	------	------	PIC Center to WC
19	Reach	142.39	2	730	550,320	4	------	------	HH 4 Outfall to Inter Con
20	Reach	26.86	2	724	165,450	5	------	------	HH 5 Outfall to Inter Con
21	Combine	167.32	2	730	715,769	19, 20	------	------	PIC East
22	Reach	45.52	2	764	715,707	21	------	------	PIC East to WC
23	Reach	56.54	2	842	1,202,759	15	------	------	PIC West @ WC to PIC Center @ W
24	Combine	501.91	2	770	5,324,032	18, 23	------	------	3.06 Miles Upstream of Scenic Bridge
25	Reach	88.44	2	968	5,323,059	24	------	------	3.06 Up to PPC
26	Combine	109.76	2	868	6,038,765	22, 25	------	------	PPC

Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.02

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph description
1	SCS Runoff	26.08	2	734	126,769	----	------	------	Watershed 1-Bike Gulch (Developed)
2	SCS Runoff	34.68	2	738	178,077	----	------	------	Watershed 2-Single Track (Develope
3	SCS Runoff	76.24	2	742	429,055	----	------	------	Watershed 3-Home (Developed)
4	SCS Runoff	36.12	2	722	104,167	----	------	------	Watershed 4-Kickoff (Developed)
5	SCS Runoff	15.65	2	718	31,321	----	------	------	Watershed 5-New England (Develope
6	SCS Runoff	108.18	2	720	281,208	----	------	------	Watershed 6-Washington (Developed
7	SCS Runoff	6.529	2	722	17,226	----	------	------	Watershed 7-California (Developed)
8	SCS Runoff	7.175	2	718	14,355	----	------	------	Watershed 8-Baja (Developed)
9	Reach	40.06	2	732	281,185	6	------	------	HH 6 Outfall to Inter Con
10	Reach	2.697	2	732	17,209	7	------	------	HH 7 Outfall to Inter Con
11	Combine	42.75	2	732	298,394	9, 10	------	------	PIC West
12	Reach	18.04	2	790	298,343	11	------	------	PIC West to WC
13	Reach	4.283	2	722	14,349	8	------	------	HH 8 Outfall to Inter Con
14	Reach	21.89	2	732	104,157	4	------	------	HH 4 Outfall to Inter Con
15	Reach	3.054	2	726	31,285	5	------	------	HH 5 Outfall to Inter Con
16	Combine	24.90	2	732	135,443	14, 15	------	------	PIC East
17	Reach	5.006	2	808	135,335	16	------	------	PIC East to WC
18	Reach	9.508	2	922	298,237	12	------	------	PIC West @ WC to PIC Center @ W
19	Reservoir	1.649	2	984	126,766	1	1213.08	69,072	Bike Gulch Pond
20	Reservoir	1.690	2	1104	178,072	2	1213.09	111,938	Single Track Pond
21	Reservoir	1.881	2	1462	427,808	3	1230.06	350,235	Home Pond
22	Combine	7.524	2	724	746,996	13, 19, 20, 21	------	------	PIC Center
23	Reach	5.169	2	1454	745,331	22	------	------	PIC Center to WC
24	Combine	14.06	2	940	1,043,568	18, 23	------	------	3.06 Miles Upstream of Scenic Bridge
25	Reach	5.181	2	1872	948,579	24	------	------	3.06 Up to PPC
26	Combine	5.858	2	1456	1,083,914	17, 25	------	------	PPC

Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.02

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph description
1	SCS Runoff	103.83	2	734	452,027	----	------	------	Watershed 1-Bike Gulch (Developed)
2	SCS Runoff	117.08	2	736	568,189	----	------	------	Watershed 2-Single Track (Develope
3	SCS Runoff	248.77	2	740	1,333,795	----	------	------	Watershed 3-Home (Developed)
4	SCS Runoff	115.36	2	722	323,822	----	------	------	Watershed 4-Kickoff (Developed)
5	SCS Runoff	47.82	2	716	97,366	----	------	------	Watershed 5-New England (Develope
6	SCS Runoff	262.43	2	720	705,110	----	------	------	Watershed 6-Washington (Developed
7	SCS Runoff	20.62	2	720	53,551	----	------	------	Watershed 7-California (Developed)
8	SCS Runoff	21.92	2	716	44,626	----	------	------	Watershed 8-Baja (Developed)
9	Reach	116.91	2	732	705,092	6	------	------	HH 6 Outfall to Inter Con
10	Reach	10.54	2	730	53,538	7	------	------	HH 7 Outfall to Inter Con
11	Combine	127.39	2	730	758,630	9, 10	------	------	PIC West
12	Reach	57.21	2	770	758,592	11	------	------	PIC West to WC
13	Reach	15.44	2	722	44,620	8	------	------	HH 8 Outfall to Inter Con
14	Reach	80.60	2	730	323,815	4	------	------	HH 4 Outfall to Inter Con
15	Reach	13.88	2	724	97,341	5	------	------	HH 5 Outfall to Inter Con
16	Combine	93.84	2	730	421,156	14, 15	------	------	PIC East
17	Reach	22.96	2	772	421,082	16	------	------	PIC East to WC
18	Reach	31.84	2	862	758,518	12	------	------	PIC West @ WC to PIC Center @ W
19	Reservoir	11.53	2	806	452,024	1	1218.22	237,493	Bike Gulch Pond
20	Reservoir	10.69	2	840	568,182	2	1217.78	330,144	Single Track Pond
21	Reservoir	13.57	2	974	1,269,987	3	1234.46	894,209	Home Pond
22	Combine	35.94	2	832	2,334,810	13, 19, 20, 21	------	------	PIC Center
23	Reach	33.25	2	984	2,328,470	22	------	------	PIC Center to WC
24	Combine	61.99	2	892	3,086,988	18, 23	------	------	3.06 Miles Upstream of Scenic Bridge
25	Reach	25.88	2	1440	3,015,919	24	------	------	3.06 Up to PPC
26	Combine	28.44	2	1342	3,437,002	17, 25	------	------	PPC

Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.02

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph description
1	SCS Runoff	186.21	2	732	804,475	----	------	------	Watershed 1-Bike Gulch (Developed)
2	SCS Runoff	200.59	2	736	974,258	----	------	------	Watershed 2-Single Track (Develope
3	SCS Runoff	421.78	2	740	2,266,743	----	------	------	Watershed 3-Home (Developed)
4	SCS Runoff	193.48	2	722	550,326	----	------	------	Watershed 4-Kickoff (Developed)
5	SCS Runoff	79.56	2	716	165,470	----	------	------	Watershed 5-New England (Develope
6	SCS Runoff	403.48	2	720	1,111,872	----	------	------	Watershed 6-Washington (Developed
7	SCS Runoff	34.54	2	720	91,009	----	------	------	Watershed 7-California (Developed)
8	SCS Runoff	36.46	2	716	75,840	----	------	------	Watershed 8-Baja (Developed)
9	Reach	192.94	2	730	1,111,856	6	------	------	HH 6 Outfall to Inter Con
10	Reach	19.10	2	730	90,997	7	------	------	HH 7 Outfall to Inter Con
11	Combine	212.04	2	730	1,202,853	9, 10	------	------	PIC West
12	Reach	98.59	2	764	1,202,819	11	------	------	PIC West to WC
13	Reach	26.92	2	722	75,837	8	------	------	HH 8 Outfall to Inter Con
14	Reach	142.39	2	730	550,320	4	------	------	HH 4 Outfall to Inter Con
15	Reach	26.86	2	724	165,450	5	------	------	HH 5 Outfall to Inter Con
16	Combine	167.32	2	730	715,769	14, 15	------	------	PIC East
17	Reach	45.52	2	764	715,707	16	------	------	PIC East to WC
18	Reach	56.54	2	842	1,202,759	12	------	------	PIC West @ WC to PIC Center @ W
19	Reservoir	16.79	2	818	804,471	1	1221.94	453,542	Bike Gulch Pond
20	Reservoir	16.24	2	846	974,254	2	1221.24	590,281	Single Track Pond
21	Reservoir	17.34	2	1052	2,133,743	3	1238.13	1,622,820	Home Pond
22	Combine	51.09	2	822	3,988,306	13, 19, 20, 21	------	------	PIC Center
23	Reach	49.34	2	1016	3,982,002	22	------	------	PIC Center to WC
24	Combine	99.73	2	862	5,184,750	18, 23	------	------	3.06 Miles Upstream of Scenic Bridge
25	Reach	46.23	2	1410	5,126,093	24	------	------	3.06 Up to PPC
26	Combine	51.12	2	774	5,841,807	17, 25	------	------	PPC

TECHNICAL SUPPLEMENT NO. 4

Traffic Impact

July, 2015

Jeffrey Hancock, P.E., SMH Consultants
Brett Louk, P.E. SMH Consultants

A traffic impact study has been completed based upon the proposed land use plan for Hartford Hill. Recognized and appropriate engineering standards, using trip generation rates found in the Institute of Transportation Engineers (ITE) Trip Generation Manual, 9th Edition, have been used to estimate traffic volumes that will be produced by the development. Those volumes have been distributed from the development to the existing and proposed roadway network outside of Hartford Hill. For purposes of this study, and because it is not possible to assume with accuracy what Kansas State University might do with its land in the future, it is estimated that all the traffic from Hartford Hill will exit at either the northeast or southeast connections as shown on the roadway network. For analysis purposes, 85% of the traffic has been assigned to the southeast and 15% to the northeast.

For purposes of this study a development density of 2.5 dwelling units per gross acre was used. This should prove to be a very conservative factor given the known values that have been realized in other areas of similar terrain. For example, the current density within the adjacent Grand Mere Development is approximately 1.6 dwelling units per acre.

Intersection analyses have been performed using accepted methodologies outlined in the Highway Capacity Manual 2010 (HCM2010) as well as McTrans Highway Capacity Software (HCS) 2010.

Traffic volumes have been estimated based upon the following assumptions:

- "Existing" volumes are what they imply, actual volumes counted during the fall of 2014, while schools were in session.
- "Expected" volumes are composed of existing plus anticipated volumes to be added to the traffic network once all of the Grand Mere development is complete.
- "Development" volumes are only those estimated to be generated by the Hartford Hill project.
- "20" is a component of traffic volume added to the roadway network to represent background growth of the City. This traffic will be generated by other areas, some distant from Hartford Hill, but will use the major intersections that have been studied. This component was derived by applying a growth factor of 2% per year, over 20 years.
- Existing + Expected + Development + 20 is self-explanatory.

The pages that follow are the summaries of the intersection analyses for each of the intersections that were studied, and for each of the conditions described above.

TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst:	*Brett Louk*
Agency/Co.:	*SMH Consultants*
Date Performed:	*1/13/2015*
Analysis Time Period:	*7:00-8:00 am*

Site Information

Intersection:	*Grand Mere Parkway & Marlatt*
Jurisdiction:	
Analysis Year:	*2014*
Peak Hour Factor:	

Project Description: *Existing + Planned A.M.*

East/West Street: *Marlatt Ave* | North/South Street: *Grand Mere Parkway*

Intersection Orientation: *East-West* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Eastbound				Westbound			
Movement	1U	1	2	3	4U	4	5	6
	U	L	T	R	U	L	T	R
Volume (veh/h)			*26*	*2*		*19*	*9*	
Percent Heavy Vehicles		*0*	*0*	*0*		*0*	*0*	*0*
Median Type	*Undivided*							
Storage	*1*							
RT Channelized				*0*				*0*
Lanes	*0*		*1*	*0*	*0*		*1*	*0*
Configuration				*TR*	*LT*			
Proportion Time Blocked								

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*6*	*0*	*55*			
Percent Heavy Vehicles	*0*	*0*	*0*	*0*	*0*	*0*
Left-Turn Lane Storage						
Percent Grade (%)	*0*			*0*		
Flared Approach			*N*			*N*
Storage			*0*			*0*
Lanes	*0*	*1*	*0*	*0*	*0*	*0*
Configuration		*LTR*				
Proportion Time Blocked						

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*LT*		*LTR*				
v (veh/h)		*19*		*61*				
C (m) (veh/h)		*1599*		*1040*				
v/c Ratio		*0.01*		*0.06*				
95% Queue Length		*0.04*		*0.19*				
Control Delay (s/veh)		*7.3*		*8.7*				
Movement LOS		*A*		*A*				
Approach Delay (s/veh)			*8.7*					
Approach LOS			*A*					

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst:	*Brett Louk*
Agency/Co.:	*SMH Consultants*
Date Performed:	*1/13/2015*
Analysis Time Period:	*7:00-8:00 am*

Site Information

Intersection:	*Grand Mere Parkway & Marlatt*
Jurisdiction:	
Analysis Year:	*2014*
Peak Hour Factor:	

Project Description: *Existing + Planned + Development AM*

East/West Street: *Marlatt Ave* | North/South Street: *Grand Mere Parkway*

Intersection Orientation: *East-West* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Eastbound				Westbound			
Movement	1U	1	2	3	4U	4	5	6
	U	L	T	R	U	L	T	R
Volume (veh/h)			*26*	*8*		*72*	*9*	
Percent Heavy Vehicles		*0*	*0*	*0*		*0*	*0*	*0*
Median Type	*Undivided*							
Storage	*1*							
RT Channelized				*0*				*0*
Lanes	*0*		*1*	*0*	*0*		*1*	*0*
Configuration				*TR*	*LT*			
Proportion Time Blocked								

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*14*		*125*			
Percent Heavy Vehicles	*0*	*0*	*0*	*0*	*0*	*0*
Left-Turn Lane Storage						
Percent Grade (%)	*0*			*0*		
Flared Approach			*N*			*N*
Storage			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*0*	*0*
Configuration		*LR*				
Proportion Time Blocked						

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*LT*		*LR*				
v (veh/h)		*78*		*150*				
C (m) (veh/h)		*1588*		*1009*				
v/c Ratio		*0.05*		*0.15*				
95% Queue Length		*0.15*		*0.52*				
Control Delay (s/veh)		*7.4*		*9.2*				
Movement LOS		*A*		*A*				
Approach Delay (s/veh)			*9.2*					
Approach LOS			*A*					

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst:	*Brett Louk*
Agency/Co.:	*SMH Consultants*
Date Performed:	*1/13/2015*
Analysis Time Period:	*7:00-8:00 am*

Site Information

Intersection:	*Grand Mere Parkway & Marlatt*
Jurisdiction:	
Analysis Year:	*2014*
Peak Hour Factor:	

Project Description: *Existing + Planned + Development + 20 yrs AM*

East/West Street: *Marlatt Ave* | North/South Street: *Grand Mere Parkway*

Intersection Orientation: *East-West* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Eastbound				Westbound			
Movement	1U	1	2	3	4U	4	5	6
	U	L	T	R	U	L	T	R
Volume (veh/h)			*38*	*8*		*72*	*13*	
Percent Heavy Vehicles		*0*	*0*	*0*		*0*	*0*	*0*
Median Type	*Undivided*							
Storage	*1*							
RT Channelized				*0*				*0*
Lanes	*0*		*1*	*0*	*0*		*1*	*0*
Configuration				*TR*	*LT*			
Proportion Time Blocked								

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*14*		*125*			
Percent Heavy Vehicles	*0*	*0*	*0*	*0*	*0*	*0*
Left-Turn Lane Storage						
Percent Grade (%)	*0*			*0*		
Flared Approach			*N*			*N*
Storage			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*0*	*0*
Configuration		*LR*				
Proportion Time Blocked						

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*LT*		*LR*				
v (veh/h)		*78*		*150*				
C (m) (veh/h)		*1571*		*992*				
v/c Ratio		*0.05*		*0.15*				
95% Queue Length		*0.16*		*0.53*				
Control Delay (s/veh)		*7.4*		*9.3*				
Movement LOS		*A*		*A*				
Approach Delay (s/veh)			*9.3*					
Approach LOS			*A*					

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst:	*Brett Louk*
Agency/Co.:	*SMH Consultants*
Date Performed:	*1/13/2015*
Analysis Time Period:	*5:00-6:00 pm*

Site Information

Intersection:	*Grand Mere Parkway & Marlatt*
Jurisdiction:	
Analysis Year:	*2014*
Peak Hour Factor:	

Project Description: *Existing + Planned PM*

East/West Street: *Marlatt Ave* | North/South Street: *Grand Mere Parkway*

Intersection Orientation: *East-West* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Eastbound				Westbound			
Movement	1U	1	2	3	4U	4	5	6
	U	L	T	R	U	L	T	R
Volume (veh/h)			*12*	*6*		*58*	*21*	
Percent Heavy Vehicles		*0*	*0*	*0*		*0*	*0*	*0*
Median Type	*Undivided*							
Storage	*1*							
RT Channelized				*0*				*0*
Lanes	*0*		*1*	*0*	*0*		*1*	*0*
Configuration				*TR*	*LT*			
Proportion Time Blocked								

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*4*		*32*			
Percent Heavy Vehicles	*0*	*0*	*0*	*0*	*0*	*0*
Left-Turn Lane Storage						
Percent Grade (%)	*0*			*0*		
Flared Approach			*N*			*N*
Storage			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*0*	*0*
Configuration		*LR*				
Proportion Time Blocked						

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*LT*		*LR*				
v (veh/h)		*58*		*36*				
C (m) (veh/h)		*1612*		*1034*				
v/c Ratio		*0.04*		*0.03*				
95% Queue Length		*0.11*		*0.11*				
Control Delay (s/veh)		*7.3*		*8.6*				
Movement LOS		*A*		*A*				
Approach Delay (s/veh)			*8.6*					
Approach LOS			*A*					

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst:	*Brett Louk*
Agency/Co.:	*SMH Consultants*
Date Performed:	*1/13/2015*
Analysis Time Period:	*5:00-6:00 pm*

Site Information

Intersection:	*Grand Mere Parkway & Marlatt*
Jurisdiction:	
Analysis Year:	*2014*
Peak Hour Factor:	

Project Description: *Existing + Planned + Development PM*

East/West Street: *Marlatt Ave* | North/South Street: *Grand Mere Parkway*

Intersection Orientation: *East-West* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Eastbound				Westbound			
Movement	1U	1	2	3	4U	4	5	6
	U	L	T	R	U	L	T	R
Volume (veh/h)			*12*	*14*		*133*	*21*	
Percent Heavy Vehicles		*0*	*0*	*0*		*0*	*0*	*0*
Median Type	*Undivided*							
Storage	*1*							
RT Channelized				*0*				*0*
Lanes	*0*		*1*	*0*	*0*		*1*	*0*
Configuration				*TR*	*LT*			
Proportion Time Blocked								

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*11*		*96*			
Percent Heavy Vehicles	*0*	*0*	*0*	*0*	*0*	*0*
Left-Turn Lane Storage						
Percent Grade (%)	*0*			*0*		
Flared Approach			*N*			*N*
Storage			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*0*	*0*
Configuration		*LR*				
Proportion Time Blocked						

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*LT*		*LR*				
v (veh/h)		*144*		*115*				
C (m) (veh/h)		*1599*		*993*				
v/c Ratio		*0.09*		*0.12*				
95% Queue Length		*0.30*		*0.39*				
Control Delay (s/veh)		*7.5*		*9.1*				
Movement LOS		*A*		*A*				
Approach Delay (s/veh)			*9.1*					
Approach LOS			*A*					

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst:	*Brett Louk*
Agency/Co.:	*SMH Consultants*
Date Performed:	*1/13/2015*
Analysis Time Period:	*5:00-6:00 pm*

Site Information

Intersection:	*Grand Mere Parkway & Marlatt*
Jurisdiction:	
Analysis Year:	*2014*
Peak Hour Factor:	

Project Description: *Existing + Planned + Development + 20 yrs PM*

East/West Street: *Marlatt Ave* | North/South Street: *Grand Mere Parkway*

Intersection Orientation: *East-West* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Eastbound				Westbound			
Movement	1U	1	2	3	4U	4	5	6
	U	L	T	R	U	L	T	R
Volume (veh/h)			*18*	*14*		*133*	*31*	
Percent Heavy Vehicles		*0*	*0*	*0*		*0*	*0*	*0*
Median Type	*Undivided*							
Storage	*1*							
RT Channelized				*0*				*0*
Lanes	*0*		*1*	*0*	*0*		*1*	*0*
Configuration				*TR*	*LT*			
Proportion Time Blocked								

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*11*		*96*			
Percent Heavy Vehicles	*0*	*0*	*0*	*0*	*0*	*0*
Left-Turn Lane Storage						
Percent Grade (%)	*0*			*0*		
Flared Approach			*N*			*N*
Storage			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*0*	*0*
Configuration		*LR*				
Proportion Time Blocked						

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*LT*		*LR*				
v (veh/h)		*144*		*115*				
C (m) (veh/h)		*1591*		*983*				
v/c Ratio		*0.09*		*0.12*				
95% Queue Length		*0.30*		*0.40*				
Control Delay (s/veh)		*7.5*		*9.1*				
Movement LOS		*A*		*A*				
Approach Delay (s/veh)			*9.1*					
Approach LOS			*A*					

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst:	*Brett Louk, P.E.*
Agency/Co.:	*SMH Consultants*
Date Performed:	*2/16/2015*
Analysis Time Period:	*7:00-8:00 am*

Site Information

Intersection:	*Grand Mere Parkway & Road A*
Jurisdiction:	
Analysis Year:	*2014*
Peak Hour Factor:	

Project Description: *Existing + Planned AM*

East/West Street: *Road A* | North/South Street: *Grand Mere Parkway*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound				Southbound			
Movement	1U	1	2	3	4U	4	5	6
	U	L	T	R	U	L	T	R
Volume (veh/h)		*19*	*45*				*130*	*3*
Percent Heavy Vehicles		*0*	*0*	*0*		*0*	*0*	*0*
Median Type	*Undivided*							
Storage	*1*							
RT Channelized				*0*				*0*
Lanes	*1*		*1*	*0*	*0*		*1*	*0*
Configuration	*L*		*T*					*TR*
Proportion Time Blocked								

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*7*		*43*			
Percent Heavy Vehicles	*0*			*0*	*0*	*0*
Left-Turn Lane Storage						
Percent Grade (%)	*0*			*0*		
Flared Approach			*N*			*N*
Storage			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*0*	*0*
Configuration		*LR*				
Proportion Time Blocked						

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*L*						*LR*	
v (veh/h)	*20*						*53*	
C (m) (veh/h)	*1464*						*852*	
v/c Ratio	*0.01*						*0.06*	
95% Queue Length	*0.04*						*0.20*	
Control Delay (s/veh)	*7.5*						*9.5*	
Movement LOS	*A*						*A*	
Approach Delay (s/veh)						*9.5*		
Approach LOS						*A*		

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst:	*Brett Louk, P.E.*
Agency/Co.:	*SMH Consultants*
Date Performed:	*2/16/2015*
Analysis Time Period:	*7:00-8:00 am*

Site Information

Intersection:	*Grand Mere Parkway & Road A*
Jurisdiction:	
Analysis Year:	*2014*
Peak Hour Factor:	

Project Description: *Existing + Planned + Development AM*

East/West Street: *Road A* | North/South Street: *Grand Mere Parkway*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound				Southbound			
Movement	1U	1	2	3	4U	4	5	6
	U	L	T	R	U	L	T	R
Volume (veh/h)		*350*	*45*				*130*	*3*
Percent Heavy Vehicles		*0*	*0*	*0*		*0*	*0*	*0*
Median Type	*Undivided*							
Storage	*1*							
RT Channelized				*0*				*0*
Lanes	*1*		*1*	*0*	*0*		*1*	*0*
Configuration	*L*		*T*					*TR*
Proportion Time Blocked								

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*7*		*482*			
Percent Heavy Vehicles	*0*			*0*	*0*	*0*
Left-Turn Lane Storage						
Percent Grade (%)	*0*			*0*		
Flared Approach			*N*			*N*
Storage			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*0*	*0*
Configuration		*LR*				
Proportion Time Blocked						

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*L*						*LR*	
v (veh/h)	*380*						*530*	
C (m) (veh/h)	*1464*						*834*	
v/c Ratio	*0.26*						*0.64*	
95% Queue Length	*1.04*						*4.66*	
Control Delay (s/veh)	*8.3*						*16.5*	
Movement LOS	*A*						*C*	
Approach Delay (s/veh)						*16.5*		
Approach LOS						*C*		

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst:	*Brett Louk, P.E.*
Agency/Co.:	*SMH Consultants*
Date Performed:	*2/16/2015*
Analysis Time Period:	*7:00-8:00 am*

Site Information

Intersection:	*Grand Mere Parkway & Road A*
Jurisdiction:	
Analysis Year:	*2014*
Peak Hour Factor:	

Project Description: *Existing + Planned + Development + 20 yrs AM*

East/West Street: *Road A* | North/South Street: *Grand Mere Parkway*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound				Southbound			
Movement	1U	1	2	3	4U	4	5	6
	U	L	T	R	U	L	T	R
Volume (veh/h)		*350*	*45*				*130*	*3*
Percent Heavy Vehicles		*0*	*0*	*0*		*0*	*0*	*0*
Median Type	*Undivided*							
Storage	*1*							
RT Channelized				*0*				*0*
Lanes	*1*		*1*	*0*	*0*		*1*	*0*
Configuration	*L*		*T*					*TR*
Proportion Time Blocked								

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*7*		*482*			
Percent Heavy Vehicles	*0*			*0*	*0*	*0*
Left-Turn Lane Storage						
Percent Grade (%)	*0*			*0*		
Flared Approach			*N*			*N*
Storage			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*0*	*0*
Configuration		*LR*				
Proportion Time Blocked						

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*L*						*LR*	
v (veh/h)	*380*						*530*	
C (m) (veh/h)	*1464*						*834*	
v/c Ratio	*0.26*						*0.64*	
95% Queue Length	*1.04*						*4.66*	
Control Delay (s/veh)	*8.3*						*16.5*	
Movement LOS	*A*						*C*	
Approach Delay (s/veh)						*16.5*		
Approach LOS						*C*		

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst:	*Brett Louk, P.E.*
Agency/Co.:	*SMH Consultants*
Date Performed:	*2/16/2015*
Analysis Time Period:	*5:00-6:00 pm*

Site Information

Intersection:	*Grand Mere Parkway & Road A*
Jurisdiction:	
Analysis Year:	*2014*
Peak Hour Factor:	

Project Description: *Existing + Planned PM*

East/West Street: *Road A* | North/South Street: *Grand Mere Parkway*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound				Southbound			
Movement	1U	1	2	3	4U	4	5	6
	U	L	T	R	U	L	T	R
Volume (veh/h)		*60*	*141*				*78*	*11*
Percent Heavy Vehicles		*0*	*0*	*0*		*0*	*0*	*0*
Median Type	*Undivided*							
Storage	*1*							
RT Channelized				*0*				*0*
Lanes	*1*		*1*	*0*	*0*		*1*	*0*
Configuration	*L*		*T*					*TR*
Proportion Time Blocked								

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*5*		*27*			
Percent Heavy Vehicles	*0*			*0*	*0*	*0*
Left-Turn Lane Storage						
Percent Grade (%)	*0*			*0*		
Flared Approach			*N*			*N*
Storage			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*0*	*0*
Configuration		*LR*				
Proportion Time Blocked						

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*L*						*LR*	
v (veh/h)	*65*						*34*	
C (m) (veh/h)	*1519*						*861*	
v/c Ratio	*0.04*						*0.04*	
95% Queue Length	*0.13*						*0.12*	
Control Delay (s/veh)	*7.5*						*9.4*	
Movement LOS	*A*						*A*	
Approach Delay (s/veh)						*9.4*		
Approach LOS						*A*		

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst:	*Brett Louk, P.E.*
Agency/Co.:	*SMH Consultants*
Date Performed:	*2/16/2015*
Analysis Time Period:	*5:00-6:00 pm*

Site Information

Intersection:	*Grand Mere Parkway & Road A*
Jurisdiction:	
Analysis Year:	*2014*
Peak Hour Factor:	

Project Description: *Existing + Planned + Development PM*

East/West Street: *Road A* | North/South Street: *Grand Mere Parkway*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound				Southbound			
Movement	1U	1	2	3	4U	4	5	6
	U	L	T	R	U	L	T	R
Volume (veh/h)		*529*	*141*				*78*	*11*
Percent Heavy Vehicles		*0*	*0*	*0*		*0*	*0*	*0*
Median Type	*Undivided*							
Storage	*1*							
RT Channelized				*0*				*0*
Lanes	*1*		*1*	*0*	*0*		*1*	*0*
Configuration	*L*		*T*					*TR*
Proportion Time Blocked								

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*5*		*429*			
Percent Heavy Vehicles	*0*			*0*	*0*	*0*
Left-Turn Lane Storage						
Percent Grade (%)	*0*			*0*		
Flared Approach			*N*			*N*
Storage			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*0*	*0*
Configuration		*LR*				
Proportion Time Blocked						

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*L*						*LR*	
v (veh/h)	*574*						*471*	
C (m) (veh/h)	*1519*						*850*	
v/c Ratio	*0.38*						*0.55*	
95% Queue Length	*1.79*						*3.47*	
Control Delay (s/veh)	*8.8*						*14.4*	
Movement LOS	*A*						*B*	
Approach Delay (s/veh)						*14.4*		
Approach LOS						*B*		

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst:	*Brett Louk, P.E.*
Agency/Co.:	*SMH Consultants*
Date Performed:	*2/16/2015*
Analysis Time Period:	*5:00-6:00 pm*

Site Information

Intersection:	*Grand Mere Parkway & Road A*
Jurisdiction:	
Analysis Year:	*2014*
Peak Hour Factor:	

Project Description: *Existing + Planned + Development + 20 yrs PM*

East/West Street: *Road A* | North/South Street: *Grand Mere Parkway*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound				Southbound			
Movement	1U	1	2	3	4U	4	5	6
	U	L	T	R	U	L	T	R
Volume (veh/h)		*529*	*141*				*78*	*11*
Percent Heavy Vehicles		*0*	*0*	*0*		*0*	*0*	*0*
Median Type	*Undivided*							
Storage	*1*							
RT Channelized				*0*				*0*
Lanes	*1*		*1*	*0*	*0*		*1*	*0*
Configuration	*L*		*T*					*TR*
Proportion Time Blocked								

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*5*		*429*			
Percent Heavy Vehicles	*0*			*0*	*0*	*0*
Left-Turn Lane Storage						
Percent Grade (%)	*0*			*0*		
Flared Approach			*N*			*N*
Storage			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*0*	*0*
Configuration		*LR*				
Proportion Time Blocked						

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*L*						*LR*	
v (veh/h)	*574*						*471*	
C (m) (veh/h)	*1519*						*850*	
v/c Ratio	*0.38*						*0.55*	
95% Queue Length	*1.79*						*3.47*	
Control Delay (s/veh)	*8.8*						*14.4*	
Movement LOS	*A*						*B*	
Approach Delay (s/veh)						*14.4*		
Approach LOS						*B*		

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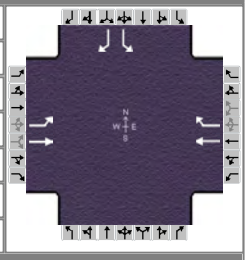
HCS 2010 Signalized Intersection Results Summary

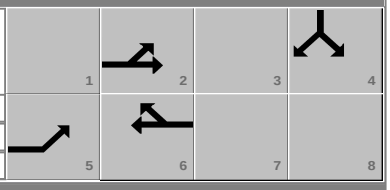
General Information				Intersection Information	
Agency	SMH Consultants			Duration, h	0.25
Analyst	Brett Louk	Analysis Date	Jan 13, 2015	Area Type	Other
Jurisdiction		Time Period	7:45-8:45 am	PHF	0.92
Intersection	Kimball & Vanesta	Analysis Year	2014	Analysis Period	1> 7:00
File Name	Kimball & Vanesta - Existing AM.xus				
Project Description	Existing AM				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	27	191			260	62				34		16

Signal Information			
Cycle, s	112.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	20.0	45.0	30.0	0.0	0.0	0.0
Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Red	1.0	2.0	2.0	0.0	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2		6				4
Case Number	1.0	4.0		7.3				9.0
Phase Duration, s	25.0	76.0		51.0				36.0
Change Period, ($Y+R_c$), s	5.0	6.0		6.0				6.0
Max Allow Headway (*MAH*), s	3.1	3.0		3.0				3.3
Queue Clearance Time (g_s), s	2.7	7.2		13.7				3.7
Green Extension Time (g_e), s	0.0	1.0		1.0				0.1
Phase Call Probability	1.00	1.00		1.00				1.00
Max Out Probability	0.00	0.00		0.00				0.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2			6	16				7		14
Adjusted Flow Rate (*v*), veh/h	29	208			283	67				37		17
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1810	1900			1900	1610				1810		1610
Queue Service Time (g_s), s	0.7	5.2			11.7	2.9				1.7		0.9
Cycle Queue Clearance Time (g_c), s	0.7	5.2			11.7	2.9				1.7		0.9
Green Ratio (*g/C*)	0.60	0.62			0.40	0.40				0.27		0.27
Capacity (*c*), veh/h	718	1187			763	647				485		431
Volume-to-Capacity Ratio (*X*)	0.041	0.175			0.370	0.104				0.076		0.040
Available Capacity (c_a), veh/h	718	1187			763	647				485		431
Back of Queue (*Q*), veh/ln (50th percentile)	0.3	2.0			5.1	1.1				0.8		0.4
Queue Storage Ratio (*RQ*) (50th percentile)	0.06	0.00			0.00	0.13				0.00		0.00
Uniform Delay (d_1), s/veh	10.1	8.8			23.5	20.9				30.6		30.3
Incremental Delay (d_2), s/veh	0.0	0.0			0.1	0.0				0.0		0.0
Initial Queue Delay (d_3), s/veh	0.0	0.0			0.0	0.0				0.0		0.0
Control Delay (*d*), s/veh	10.1	8.9			23.7	20.9				30.7		30.4
Level of Service (LOS)	B	A			C	C				C		C
Approach Delay, s/veh / LOS	9.0	A		23.1	C		0.0			30.6	C	
Intersection Delay, s/veh / LOS	18.5						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	0.7	A	2.3	B	2.3	B	2.3	B
Bicycle LOS Score / LOS	0.9	A	1.1	A				F

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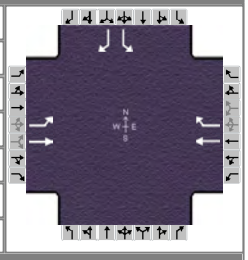
HCS 2010 Signalized Intersection Results Summary

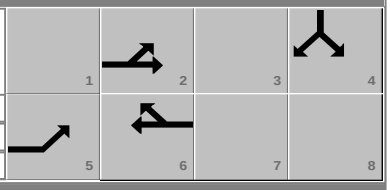
General Information				Intersection Information	
Agency	SMH Consultants			Duration, h	0.25
Analyst	Brett Louk	Analysis Date	Jan 13, 2015	Area Type	Other
Jurisdiction		Time Period	7:45-8:45 am	PHF	0.92
Intersection	Kimball & Vanesta	Analysis Year	2014	Analysis Period	1> 7:00
File Name	Kimball & Vanesta - Existing + Planned AM.xus				
Project Description	Existing + Planned AM				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	55	399			306	62				34		19

Signal Information			
Cycle, s	112.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	20.0	45.0	30.0	0.0	0.0	0.0
Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Red	1.0	2.0	2.0	0.0	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2		6				4
Case Number	1.0	4.0		7.3				9.0
Phase Duration, s	25.0	76.0		51.0				36.0
Change Period, ($Y+R_c$), s	5.0	6.0		6.0				6.0
Max Allow Headway (*MAH*), s	3.1	3.0		3.0				3.3
Queue Clearance Time (g_s), s	3.5	14.4		16.2				3.7
Green Extension Time (g_e), s	0.1	1.5		1.5				0.1
Phase Call Probability	1.00	1.00		1.00				1.00
Max Out Probability	0.00	0.00		0.00				0.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2			6	16				7		14
Adjusted Flow Rate (*v*), veh/h	60	434			333	67				37		21
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1810	1900			1900	1610				1810		1610
Queue Service Time (g_s), s	1.5	12.4			14.2	2.9				1.7		1.1
Cycle Queue Clearance Time (g_c), s	1.5	12.4			14.2	2.9				1.7		1.1
Green Ratio (*g/C*)	0.60	0.62			0.40	0.40				0.27		0.27
Capacity (*c*), veh/h	680	1187			763	647				485		431
Volume-to-Capacity Ratio (*X*)	0.088	0.365			0.436	0.104				0.076		0.048
Available Capacity (c_a), veh/h	680	1187			763	647				485		431
Back of Queue (*Q*), veh/ln (50th percentile)	0.6	4.7			6.2	1.1				0.8		0.4
Queue Storage Ratio (*RQ*) (50th percentile)	0.12	0.00			0.00	0.13				0.00		0.00
Uniform Delay (d_1), s/veh	10.6	10.2			24.3	20.9				30.6		30.4
Incremental Delay (d_2), s/veh	0.0	0.1			0.1	0.0				0.0		0.0
Initial Queue Delay (d_3), s/veh	0.0	0.0			0.0	0.0				0.0		0.0
Control Delay (*d*), s/veh	10.6	10.3			24.4	20.9				30.7		30.4
Level of Service (LOS)	B	B			C	C				C		C
Approach Delay, s/veh / LOS	10.3	B		23.8	C		0.0			30.6	C	
Intersection Delay, s/veh / LOS	17.2						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	0.7	A	2.3	B	2.3	B	2.3	B
Bicycle LOS Score / LOS	1.3	A	1.1	A				F

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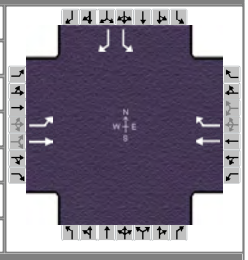
HCS 2010 Signalized Intersection Results Summary

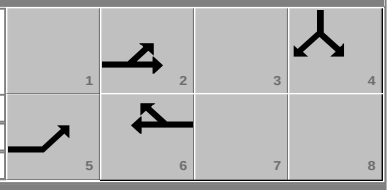
General Information				Intersection Information	
Agency	SMH Consultants			Duration, h	0.25
Analyst	Brett Louk	Analysis Date	Jan 13, 2015	Area Type	Other
Jurisdiction		Time Period	7:45-8:45 am	PHF	0.92
Intersection	Kimball & Vanesta	Analysis Year	2014	Analysis Period	1> 7:00
File Name	Kimball & Vanesta - Existing + Planned + Development AM.xus				
Project Description	Existing + Planned + Development AM				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	91	662			430	62				34		27

Signal Information			
Cycle, s	112.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	20.0	45.0	30.0	0.0	0.0	0.0
Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Red	1.0	2.0	2.0	0.0	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2		6				4
Case Number	1.0	4.0		7.3				9.0
Phase Duration, s	25.0	76.0		51.0				36.0
Change Period, ($Y+R_c$), s	5.0	6.0		6.0				6.0
Max Allow Headway (*MAH*), s	3.1	3.0		3.0				3.3
Queue Clearance Time (g_s), s	4.6	27.6		23.9				3.7
Green Extension Time (g_e), s	0.1	2.4		2.5				0.1
Phase Call Probability	1.00	1.00		1.00				1.00
Max Out Probability	0.00	0.02		0.01				0.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2			6	16				7		14
Adjusted Flow Rate (*v*), veh/h	99	720			467	67				37		29
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1810	1900			1900	1610				1810		1610
Queue Service Time (g_s), s	2.6	25.6			21.9	2.9				1.7		1.5
Cycle Queue Clearance Time (g_c), s	2.6	25.6			21.9	2.9				1.7		1.5
Green Ratio (*g/C*)	0.60	0.62			0.40	0.40				0.27		0.27
Capacity (*c*), veh/h	582	1187			763	647				485		431
Volume-to-Capacity Ratio (*X*)	0.170	0.606			0.612	0.104				0.076		0.068
Available Capacity (c_a), veh/h	582	1187			763	647				485		431
Back of Queue (*Q*), veh/ln (50th percentile)	1.0	9.9			9.7	1.1				0.8		0.6
Queue Storage Ratio (*RQ*) (50th percentile)	0.20	0.00			0.00	0.13				0.00		0.00
Uniform Delay (d_1), s/veh	12.4	12.7			26.6	20.9				30.6		30.6
Incremental Delay (d_2), s/veh	0.1	0.6			1.1	0.0				0.0		0.0
Initial Queue Delay (d_3), s/veh	0.0	0.0			0.0	0.0				0.0		0.0
Control Delay (*d*), s/veh	12.5	13.3			27.6	20.9				30.7		30.6
Level of Service (LOS)	B	B			C	C				C		C
Approach Delay, s/veh / LOS	13.2	B		26.8	C		0.0			30.6	C	
Intersection Delay, s/veh / LOS	19.1						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	0.7	A	2.3	B	2.3	B	2.3	B
Bicycle LOS Score / LOS	1.8	A	1.4	A				F

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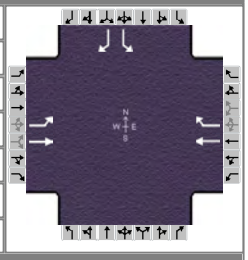
HCS 2010 Signalized Intersection Results Summary

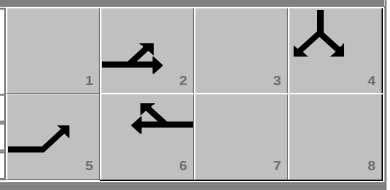
General Information				Intersection Information	
Agency	SMH Consultants			Duration, h	0.25
Analyst	Brett Louk	Analysis Date	Jan 13, 2015	Area Type	Other
Jurisdiction		Time Period	7:45-8:45 am	PHF	0.92
Intersection	Kimball & Vanesta	Analysis Year	2014	Analysis Period	1> 7:00
File Name	Kimball & Vanesta - Existing + Planned + Development + 20 AM.xus				
Project Description	Existing + Planned + Development + 20 yrs AM				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	109	757			563	89				54		38

Signal Information			
Cycle, s	112.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	20.0	45.0	30.0	0.0	0.0	0.0
Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Red	1.0	2.0	2.0	0.0	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2		6				4
Case Number	1.0	4.0		7.3				9.0
Phase Duration, s	25.0	76.0		51.0				36.0
Change Period, ($Y+R_c$), s	5.0	6.0		6.0				6.0
Max Allow Headway (*MAH*), s	3.1	3.0		3.0				3.3
Queue Clearance Time (g_s), s	5.2	34.1		33.8				4.7
Green Extension Time (g_e), s	0.1	2.8		2.8				0.2
Phase Call Probability	1.00	1.00		1.00				1.00
Max Out Probability	0.00	0.19		0.18				0.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2			6	16				7		14
Adjusted Flow Rate (*v*), veh/h	118	823			612	97				59		41
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1810	1900			1900	1610				1810		1610
Queue Service Time (g_s), s	3.2	32.1			31.8	4.3				2.7		2.2
Cycle Queue Clearance Time (g_c), s	3.2	32.1			31.8	4.3				2.7		2.2
Green Ratio (*g/C*)	0.60	0.62			0.40	0.40				0.27		0.27
Capacity (*c*), veh/h	484	1187			763	647				485		431
Volume-to-Capacity Ratio (*X*)	0.245	0.693			0.802	0.150				0.121		0.096
Available Capacity (c_a), veh/h	484	1187			763	647				485		431
Back of Queue (*Q*), veh/ln (50th percentile)	1.2	12.6			15.0	1.6				1.2		0.8
Queue Storage Ratio (*RQ*) (50th percentile)	0.24	0.00			0.00	0.18				0.00		0.00
Uniform Delay (d_1), s/veh	15.6	13.9			29.6	21.3				31.0		30.8
Incremental Delay (d_2), s/veh	0.1	1.5			5.7	0.0				0.0		0.0
Initial Queue Delay (d_3), s/veh	0.0	0.0			0.0	0.0				0.0		0.0
Control Delay (*d*), s/veh	15.7	15.4			35.3	21.4				31.1		30.8
Level of Service (LOS)	B	B			D	C				C		C
Approach Delay, s/veh / LOS	15.4	B		33.4	C		0.0			31.0	C	
Intersection Delay, s/veh / LOS	23.6						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	0.7	A	2.3	B	2.3	B	2.3	B
Bicycle LOS Score / LOS	2.0	B	1.7	A				F

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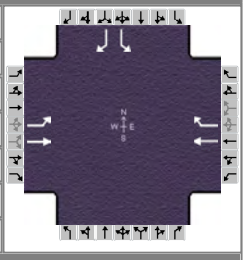
HCS 2010 Signalized Intersection Results Summary

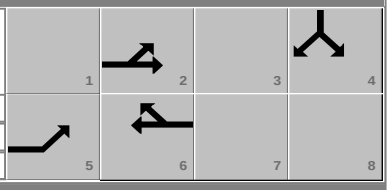
General Information				Intersection Information	
Agency	SMH Consultants			Duration, h	0.25
Analyst	Brett Louk	Analysis Date	Jan 13, 2015	Area Type	Other
Jurisdiction		Time Period	5:00-6:00 pm	PHF	0.92
Intersection	Kimball & Vanesta	Analysis Year	2014	Analysis Period	1> 7:00
File Name	Kimball & Vanesta - Existing PM.xus				
Project Description	Existing PM				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	24	332			205	67				82		24

Signal Information			
Cycle, s	112.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	20.0	45.0	30.0	0.0	0.0	0.0
Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Red	1.0	2.0	2.0	0.0	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2		6				4
Case Number	1.0	4.0		7.3				9.0
Phase Duration, s	25.0	76.0		51.0				36.0
Change Period, ($Y+R_c$), s	5.0	6.0		6.0				6.0
Max Allow Headway (*MAH*), s	3.1	3.0		3.0				3.2
Queue Clearance Time (g_s), s	2.7	11.8		10.9				6.2
Green Extension Time (g_e), s	0.0	1.2		1.2				0.2
Phase Call Probability	1.00	1.00		1.00				1.00
Max Out Probability	0.00	0.00		0.00				0.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2			6	16				7		14
Adjusted Flow Rate (*v*), veh/h	26	361			223	73				89		26
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1810	1900			1900	1610				1810		1610
Queue Service Time (g_s), s	0.7	9.8			8.9	3.2				4.2		1.4
Cycle Queue Clearance Time (g_c), s	0.7	9.8			8.9	3.2				4.2		1.4
Green Ratio (*g/C*)	0.60	0.62			0.40	0.40				0.27		0.27
Capacity (*c*), veh/h	766	1187			763	647				485		431
Volume-to-Capacity Ratio (*X*)	0.034	0.304			0.292	0.113				0.184		0.060
Available Capacity (c_a), veh/h	766	1187			763	647				485		431
Back of Queue (*Q*), veh/ln (50th percentile)	0.2	3.7			3.9	1.2				1.9		0.5
Queue Storage Ratio (*RQ*) (50th percentile)	0.05	0.00			0.00	0.14				0.00		0.00
Uniform Delay (d_1), s/veh	9.7	9.7			22.7	21.0				31.6		30.5
Incremental Delay (d_2), s/veh	0.0	0.1			0.1	0.0				0.1		0.0
Initial Queue Delay (d_3), s/veh	0.0	0.0			0.0	0.0				0.0		0.0
Control Delay (*d*), s/veh	9.7	9.8			22.8	21.0				31.6		30.5
Level of Service (LOS)	A	A			C	C				C		C
Approach Delay, s/veh / LOS	9.8	A		22.3	C		0.0			31.4	C	
Intersection Delay, s/veh / LOS	17.6						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	0.7	A	2.3	B	2.3	B	2.3	B
Bicycle LOS Score / LOS	1.1	A	1.0	A				F

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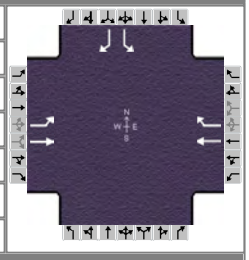
HCS 2010 Signalized Intersection Results Summary

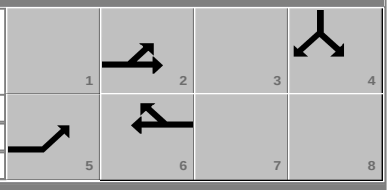
General Information				Intersection Information	
Agency	SMH Consultants			Duration, h	0.25
Analyst	Brett Louk	Analysis Date	Jan 13, 2015	Area Type	Other
Jurisdiction		Time Period	5:00-6:00 pm	PHF	0.92
Intersection	Kimball & Vanesta	Analysis Year	2014	Analysis Period	1> 7:00
File Name	Kimball & Vanesta - Existing + Planned PM.xus				
Project Description	Existing + Planned PM				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	31	424			335	67				82		38

Signal Information			
Cycle, s	112.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	20.0	45.0	30.0	0.0	0.0	0.0
Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Red	1.0	2.0	2.0	0.0	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2		6				4
Case Number	1.0	4.0		7.3				9.0
Phase Duration, s	25.0	76.0		51.0				36.0
Change Period, ($Y+R_c$), s	5.0	6.0		6.0				6.0
Max Allow Headway (*MAH*), s	3.1	3.0		3.0				3.3
Queue Clearance Time (g_s), s	2.9	15.5		17.9				6.2
Green Extension Time (g_e), s	0.0	1.6		1.6				0.2
Phase Call Probability	1.00	1.00		1.00				1.00
Max Out Probability	0.00	0.00		0.00				0.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2			6	16				7		14
Adjusted Flow Rate (*v*), veh/h	34	461			364	73				89		41
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1810	1900			1900	1610				1810		1610
Queue Service Time (g_s), s	0.9	13.5			15.9	3.2				4.2		2.2
Cycle Queue Clearance Time (g_c), s	0.9	13.5			15.9	3.2				4.2		2.2
Green Ratio (*g/C*)	0.60	0.62			0.40	0.40				0.27		0.27
Capacity (*c*), veh/h	656	1187			763	647				485		431
Volume-to-Capacity Ratio (*X*)	0.051	0.388			0.477	0.113				0.184		0.096
Available Capacity (c_a), veh/h	656	1187			763	647				485		431
Back of Queue (*Q*), veh/ln (50th percentile)	0.3	5.1			6.9	1.2				1.9		0.8
Queue Storage Ratio (*RQ*) (50th percentile)	0.07	0.00			0.00	0.14				0.00		0.00
Uniform Delay (d_1), s/veh	10.7	10.4			24.8	21.0				31.6		30.8
Incremental Delay (d_2), s/veh	0.0	0.1			0.2	0.0				0.1		0.0
Initial Queue Delay (d_3), s/veh	0.0	0.0			0.0	0.0				0.0		0.0
Control Delay (*d*), s/veh	10.7	10.5			25.0	21.0				31.6		30.8
Level of Service (LOS)	B	B			C	C				C		C
Approach Delay, s/veh / LOS	10.5	B		24.3	C		0.0			31.4	C	
Intersection Delay, s/veh / LOS	18.7						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	0.7	A	2.3	B	2.3	B	2.3	B
Bicycle LOS Score / LOS	1.3	A	1.2	A				F

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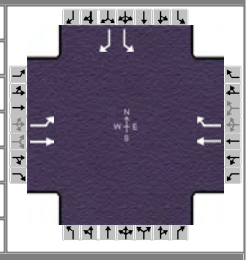
HCS 2010 Signalized Intersection Results Summary

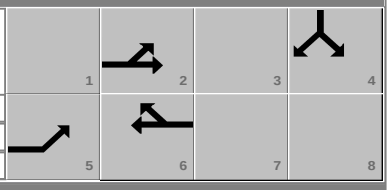
General Information				Intersection Information	
Agency	SMH Consultants			Duration, h	0.25
Analyst	Brett Louk	Analysis Date	Jan 13, 2015	Area Type	Other
Jurisdiction		Time Period	5:00-6:00 pm	PHF	0.92
Intersection	Kimball & Vanesta	Analysis Year	2014	Analysis Period	1> 7:00
File Name	Kimball & Vanesta - Existing + Planned + Development PM.xus				
Project Description	Existing + Planned + Development PM				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	45	607			504	67				82		57

Signal Information			
Cycle, s	112.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	20.0	45.0	30.0	0.0	0.0	0.0
Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Red	1.0	2.0	2.0	0.0	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2		6				4
Case Number	1.0	4.0		7.3				9.0
Phase Duration, s	25.0	76.0		51.0				36.0
Change Period, ($Y+R_c$), s	5.0	6.0		6.0				6.0
Max Allow Headway (*MAH*), s	3.1	3.0		3.0				3.3
Queue Clearance Time (g_s), s	3.3	24.3		29.1				6.2
Green Extension Time (g_e), s	0.0	2.5		2.4				0.3
Phase Call Probability	1.00	1.00		1.00				1.00
Max Out Probability	0.00	0.01		0.03				0.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2			6	16				7		14
Adjusted Flow Rate (*v*), veh/h	49	660			548	73				89		62
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1810	1900			1900	1610				1810		1610
Queue Service Time (g_s), s	1.3	22.3			27.1	3.2				4.2		3.3
Cycle Queue Clearance Time (g_c), s	1.3	22.3			27.1	3.2				4.2		3.3
Green Ratio (*g/C*)	0.60	0.62			0.40	0.40				0.27		0.27
Capacity (*c*), veh/h	526	1187			763	647				485		431
Volume-to-Capacity Ratio (*X*)	0.093	0.556			0.718	0.113				0.184		0.144
Available Capacity (c_a), veh/h	526	1187			763	647				485		431
Back of Queue (*Q*), veh/ln (50th percentile)	0.5	8.5			12.3	1.2				1.9		1.3
Queue Storage Ratio (*RQ*) (50th percentile)	0.10	0.00			0.00	0.14				0.00		0.00
Uniform Delay (d_1), s/veh	13.3	12.1			28.2	21.0				31.6		31.2
Incremental Delay (d_2), s/veh	0.0	0.3			2.8	0.0				0.1		0.1
Initial Queue Delay (d_3), s/veh	0.0	0.0			0.0	0.0				0.0		0.0
Control Delay (*d*), s/veh	13.3	12.4			31.0	21.0				31.6		31.3
Level of Service (LOS)	B	B			C	C				C		C
Approach Delay, s/veh / LOS	12.5	B		29.8	C		0.0			31.5	C	
Intersection Delay, s/veh / LOS	21.7						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	0.7	A	2.3	B	2.3	B	2.3	B
Bicycle LOS Score / LOS	1.7	A	1.5	A				F

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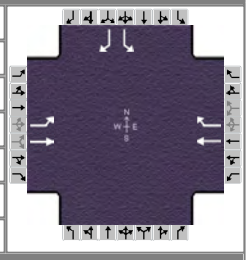
HCS 2010 Signalized Intersection Results Summary

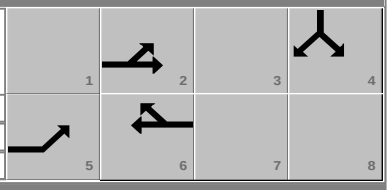
General Information				Intersection Information	
Agency	SMH Consultants			Duration, h	0.25
Analyst	Brett Louk	Analysis Date	Jan 13, 2015	Area Type	Other
Jurisdiction		Time Period	5:00-6:00 pm	PHF	0.92
Intersection	Kimball & Vanesta	Analysis Year	2014	Analysis Period	1> 7:00
File Name	Kimball & Vanesta - Existing + Planned + Development + 20 PM.xus				
Project Description	Existing + Planned + Development + 20 yrs PM				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	54	787			611	100				122		66

Signal Information			
Cycle, s	112.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	20.0	45.0	30.0	0.0	0.0	0.0
Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Red	1.0	2.0	2.0	0.0	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2		6				4
Case Number	1.0	4.0		7.3				9.0
Phase Duration, s	25.0	76.0		51.0				36.0
Change Period, ($Y+R_c$), s	5.0	6.0		6.0				6.0
Max Allow Headway (*MAH*), s	3.1	3.0		3.0				3.3
Queue Clearance Time (g_s), s	3.5	36.4		38.0				8.5
Green Extension Time (g_e), s	0.1	2.8		2.5				0.4
Phase Call Probability	1.00	1.00		1.00				1.00
Max Out Probability	0.00	0.34		0.47				0.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2			6	16				7		14
Adjusted Flow Rate (*v*), veh/h	59	855			664	109				133		72
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1810	1900			1900	1610				1810		1610
Queue Service Time (g_s), s	1.5	34.4			36.0	4.9				6.5		3.8
Cycle Queue Clearance Time (g_c), s	1.5	34.4			36.0	4.9				6.5		3.8
Green Ratio (*g/C*)	0.60	0.62			0.40	0.40				0.27		0.27
Capacity (*c*), veh/h	450	1187			763	647				485		431
Volume-to-Capacity Ratio (*X*)	0.130	0.720			0.870	0.168				0.274		0.166
Available Capacity (c_a), veh/h	450	1187			763	647				485		431
Back of Queue (*Q*), veh/ln (50th percentile)	0.6	13.6			17.7	1.8				2.9		1.5
Queue Storage Ratio (*RQ*) (50th percentile)	0.12	0.00			0.00	0.21				0.00		0.00
Uniform Delay (d_1), s/veh	16.3	14.3			30.8	21.5				32.4		31.4
Incremental Delay (d_2), s/veh	0.0	1.9			10.2	0.0				0.1		0.1
Initial Queue Delay (d_3), s/veh	0.0	0.0			0.0	0.0				0.0		0.0
Control Delay (*d*), s/veh	16.4	16.2			41.0	21.5				32.5		31.5
Level of Service (LOS)	B	B			D	C				C		C
Approach Delay, s/veh / LOS	16.2	B		38.3	D		0.0			32.1	C	
Intersection Delay, s/veh / LOS	27.0						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	0.7	A	2.3	B	2.3	B	2.3	B
Bicycle LOS Score / LOS	2.0	A	1.8	A				F

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ROUNDABOUT REPORT

General Information		Site Information	
Analyst	*Brett Louk*	Intersection	*Grand Mere Parkway & Kimball*
Agency or Co.	*SMH Consultants*	E/W Street Name	*Grand Mere Parkway*
Date Performed	*1/13/2015*	N/S Street Name	*Kimball Avenue*
Time Period	*7:30-8:30 am*	Analysis Year	*2014*
Peak Hour Factor	*0.92*	Project ID	*Existing A.M.*

Project Description:

Volume Adjustment and Site Characteristics

	EB				WB				NB				SB			
	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R	U
Number of Lanes (N)	*0*	*1*	*0*		*0*	*0*	*0*		*0*	*1*	*0*		*0*	*1*	*0*	
Lane Assignment			*LTR*								*LT*				*TR*	
Right-Turn Bypass	*None*				None				None				None			
Conflicting Lanes	*1*				1				1				1			
Volume (V), veh/h	*54*	*0*	*26*	*0*	*0*	*0*	*0*	*0*	*16*	*234*	*0*	*0*	*0*	*241*	*28*	*0*
Heavy Veh. Adj. (f_{HV}), %	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Pedestrians Crossing	*0*				0				0				0			

Critical and Follow-Up Headway Adjustment

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (sec)	*5.1929*	*4.8000*	*5.1929*	*5.1929*	*4.8000*	*5.1929*	*5.1929*	*4.8000*	*5.1929*	*5.1929*	*4.8000*	*5.1929*
Follow-Up Headway (sec)	*3.1858*	*2.5000*	*3.1858*	*3.1858*	*2.5000*	*3.1858*	*3.1858*	*2.5000*	*3.1858*	*3.1858*	*2.5000*	*3.1858*

Flow Computations

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Circulating Flow (V_c), pc/h	*262*			*330*			*59*			*17*		
Exiting Flow (V_{ex}), pc/h	*0*			*48*			*313*			*290*		
Entry Flow (V_e), pc/h		*87*			*0*			*272*			*292*	
Entry Volume veh/h		*87*						*272*			*292*	

Capacity and v/c Ratios

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Capacity (c_{PCE}), pc/h		*1112*			*0*			*1359*			*1416*	
Capacity (*c*), veh/h		*1112*			*0*			*1359*			*1416*	
v/c Ratio (X)		*0.08*						*0.20*			*0.21*	

Delay and Level of Service

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		*3.9*						*4.3*			*4.2*	
Lane LOS		*A*			*F*			*A*			*A*	
Lane 95% Queue		*0.3*						*0.7*			*0.8*	
Approach Delay, s/veh	*3.90*						*4.31*			*4.23*		
Approach LOS, s/veh	*A*						*A*			*A*		
Intersection Delay, s/veh	*4.22*											
Intersection LOS	*A*											

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ROUNDABOUT REPORT

General Information		Site Information	
Analyst	*Brett Louk*	Intersection	*Grand Mere Parkway & Kimball*
Agency or Co.	*SMH Consultants*	E/W Street Name	*Grand Mere Parkway*
Date Performed	*1/13/2015*	N/S Street Name	*Kimball Avenue*
Time Period	*7:30-8:30 am*	Analysis Year	*2014*
Peak Hour Factor	*0.92*	Project ID	*Existing + Planned A.M.*

Project Description:

Volume Adjustment and Site Characteristics

	EB				WB				NB				SB			
	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R	U
Number of Lanes (N)	*0*	*1*	*0*		*0*	*0*	*0*		*0*	*1*	*0*		*0*	*1*	*0*	
Lane Assignment			*LTR*								*LT*				*TR*	
Right-Turn Bypass	*None*				None				None				None			
Conflicting Lanes	*1*				1				1				1			
Volume (V), veh/h	*290*	*0*	*137*	*0*	*0*	*0*	*0*	*0*	*89*	*234*	*0*	*0*	*0*	*241*	*77*	*0*
Heavy Veh. Adj. (f_{HV}), %	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Pedestrians Crossing	*0*				0				0				0			

Critical and Follow-Up Headway Adjustment

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (sec)	*5.1929*	*4.8000*	*5.1929*	*5.1929*	*4.8000*	*5.1929*	*5.1929*	*4.8000*	*5.1929*	*5.1929*	*4.8000*	*5.1929*
Follow-Up Headway (sec)	*3.1858*	*2.5000*	*3.1858*	*3.1858*	*2.5000*	*3.1858*	*3.1858*	*2.5000*	*3.1858*	*3.1858*	*2.5000*	*3.1858*

Flow Computations

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Circulating Flow (V_c), pc/h	*262*			*666*			*315*			*97*		
Exiting Flow (V_{ex}), pc/h	*0*			*180*			*570*			*411*		
Entry Flow (V_e), pc/h		*464*			*0*			*351*			*346*	
Entry Volume veh/h		*464*						*351*			*346*	

Capacity and v/c Ratios

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Capacity (c_{PCE}), pc/h		*1112*			*0*			*1055*			*1309*	
Capacity (*c*), veh/h		*1112*			*0*			*1055*			*1309*	
v/c Ratio (X)		*0.42*						*0.33*			*0.26*	

Delay and Level of Service

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		*7.6*						*6.8*			*5.1*	
Lane LOS		*A*			*F*			*A*			*A*	
Lane 95% Queue		*2.1*						*1.5*			*1.1*	
Approach Delay, s/veh	*7.62*						*6.77*			*5.06*		
Approach LOS, s/veh	*A*						*A*			*A*		
Intersection Delay, s/veh	*6.60*											
Intersection LOS	*A*											

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ROUNDABOUT REPORT

General Information		Site Information	
Analyst	*Brett Louk*	Intersection	*Grand Mere Parkway & Kimball*
Agency or Co.	*SMH Consultants*	E/W Street Name	*Grand Mere Parkway*
Date Performed	*1/13/2015*	N/S Street Name	*Kimball Avenue*
Time Period	*7:30-8:30 am*	Analysis Year	*2014*
Peak Hour Factor	*0.92*	Project ID	*Existing + Planned + Development AM*

Project Description:

Volume Adjustment and Site Characteristics

	EB				WB				NB				SB			
	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R	U
Number of Lanes (N)	*0*	*1*	*0*		*0*	*0*	*0*		*0*	*1*	*0*		*0*	*1*	*0*	
Lane Assignment			*LTR*								*LT*				*TR*	
Right-Turn Bypass	*None*				None				None				None			
Conflicting Lanes	*1*				1				1				1			
Volume (V), veh/h	*589*	*0*	*277*	*0*	*0*	*0*	*0*	*0*	*288*	*234*	*0*	*0*	*0*	*241*	*209*	*0*
Heavy Veh. Adj. (f_{HV}), %	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Pedestrians Crossing	*0*				0				0				0			

Critical and Follow-Up Headway Adjustment

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (sec)	*5.1929*	*4.8000*	*5.1929*	*5.1929*	*4.8000*	*5.1929*	*5.1929*	*4.8000*	*5.1929*	*5.1929*	*4.8000*	*5.1929*
Follow-Up Headway (sec)	*3.1858*	*2.5000*	*3.1858*	*3.1858*	*2.5000*	*3.1858*	*3.1858*	*2.5000*	*3.1858*	*3.1858*	*2.5000*	*3.1858*

Flow Computations

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Circulating Flow (V_c), pc/h	*262*			*1207*			*640*			*313*		
Exiting Flow (V_{ex}), pc/h	*0*			*540*			*895*			*563*		
Entry Flow (V_e), pc/h		*941*			*489*			*567*			*489*	
Entry Volume veh/h		*941*						*567*			*489*	

Capacity and v/c Ratios

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Capacity (c_{PCE}), pc/h		*1112*			*0*			*766*			*1058*	
Capacity (*c*), veh/h		*1112*			*0*			*766*			*1058*	
v/c Ratio (X)		*0.85*						*0.74*			*0.46*	

Delay and Level of Service

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		*22.2*						*20.5*			*8.6*	
Lane LOS		*C*			*F*			*C*			*A*	
Lane 95% Queue		*10.9*						*6.7*			*2.5*	
Approach Delay, s/veh	*22.16*						*20.53*			*8.60*		
Approach LOS, s/veh	*C*						*C*			*A*		
Intersection Delay, s/veh	*18.38*											
Intersection LOS	*C*											

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ROUNDABOUT REPORT

General Information		Site Information	
Analyst	*Brett Louk*	Intersection	*Grand Mere Parkway & Kimball*
Agency or Co.	*SMH Consultants*	E/W Street Name	*Grand Mere Parkway*
Date Performed	*1/13/2015*	N/S Street Name	
Time Period	*7:30-8:30 am*	Analysis Year	*2014*
Peak Hour Factor	*0.92*	Project ID	*Exist + Planned + Dev + 20 yrs AM*

Project Description:

Volume Adjustment and Site Characteristics

	EB				WB				NB				SB			
	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R	U
Number of Lanes (N)	0	1	0		0	0	0		0	1	0		0	1	0	
Lane Assignment			LTR								LT				TR	
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1				1			
Volume (V), veh/h	617	0	287	0	0	0	0	0	299	354	0	0	0	363	227	0
Heavy Veh. Adj. (f_{HV}), %	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pedestrians Crossing	0				0				0				0			

Critical and Follow-Up Headway Adjustment

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (sec)	5.1929	4.8000	5.1929	5.1929	4.8000	5.1929	5.1929	4.8000	5.1929	5.1929	4.8000	5.1929
Follow-Up Headway (sec)	3.1858	2.5000	3.1858	3.1858	2.5000	3.1858	3.1858	2.5000	3.1858	3.1858	2.5000	3.1858

Flow Computations

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Circulating Flow (V_c), pc/h	395			1381			671			325		
Exiting Flow (V_{ex}), pc/h	0			572			1055			707		
Entry Flow (V_e), pc/h		983			641			710			641	
Entry Volume veh/h		983						710			641	

Capacity and v/c Ratios

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Capacity (c_{PCE}), pc/h		976			0			743			1045	
Capacity (c), veh/h		976			0			743			1045	
v/c Ratio (X)		1.01						0.96			0.61	

Delay and Level of Service

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		51.2						46.4			11.8	
Lane LOS		F			F			E			B	
Lane 95% Queue		19.6						14.4			4.4	
Approach Delay, s/veh	51.22						46.36			11.82		
Approach LOS, s/veh	F						E			B		
Intersection Delay, s/veh	38.92											
Intersection LOS	E											

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ROUNDABOUT REPORT

General Information		Site Information	
Analyst	*Brett Louk*	Intersection	*Grand Mere Parkway & Kimball*
Agency or Co.	*SMH Consultants*	E/W Street Name	*Grand Mere Parkway*
Date Performed	*1/13/2015*	N/S Street Name	*Kimball*
Time Period	*4:45-5:45 pm*	Analysis Year	*2014*
Peak Hour Factor	*0.89*	Project ID	*Existing PM*

Project Description:

Volume Adjustment and Site Characteristics

	EB				WB				NB				SB			
	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R	U
Number of Lanes (N)	0	1	0		0	0	0		0	1	0		0	1	0	
Lane Assignment			LTR								LT				TR	
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1				1			
Volume (V), veh/h	22	0	23	0	0	0	0	0	27	324	0	0	0	177	46	0
Heavy Veh. Adj. (f_{HV}), %	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pedestrians Crossing	0				0				0				0			

Critical and Follow-Up Headway Adjustment

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (sec)	5.1929	4.8000	5.1929	5.1929	4.8000	5.1929	5.1929	4.8000	5.1929	5.1929	4.8000	5.1929
Follow-Up Headway (sec)	3.1858	2.5000	3.1858	3.1858	2.5000	3.1858	3.1858	2.5000	3.1858	3.1858	2.5000	3.1858

Flow Computations

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Circulating Flow (V_c), pc/h	199			419			25			30		
Exiting Flow (V_{ex}), pc/h	0			82			389			225		
Entry Flow (V_e), pc/h		51			0			394			251	
Entry Volume veh/h		51						394			251	

Capacity and v/c Ratios

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Capacity (c_{PCE}), pc/h		1184			0			1405			1398	
Capacity (c), veh/h		1184			0			1405			1398	
v/c Ratio (X)		0.04						0.28			0.18	

Delay and Level of Service

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		3.4						5.0			4.0	
Lane LOS		A			F			A			A	
Lane 95% Queue		0.1						1.2			0.7	
Approach Delay, s/veh	3.39						4.96			4.04		
Approach LOS, s/veh	A						A			A		
Intersection Delay, s/veh	4.51											
Intersection LOS	A											

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ROUNDABOUT REPORT

General Information		Site Information	
Analyst	*Brett Louk*	Intersection	*Grand Mere Parkway & Kimball*
Agency or Co.	*SMH Consultants*	E/W Street Name	*Grand Mere Parkway*
Date Performed	*1/13/2015*	N/S Street Name	*Kimball*
Time Period	*4:45-5:45 pm*	Analysis Year	*2014*
Peak Hour Factor	*0.89*	Project ID	*Existing + Planned PM*

Project Description:

Volume Adjustment and Site Characteristics

	EB				WB				NB				SB			
	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R	U
Number of Lanes (N)	*0*	*1*	*0*		*0*	*0*	*0*		*0*	*1*	*0*		*0*	*1*	*0*	
Lane Assignment			*LTR*								*LT*				*TR*	
Right-Turn Bypass	*None*				None				None				None			
Conflicting Lanes	*1*				1				1				1			
Volume (V), veh/h	*121*	*0*	*127*	*0*	*0*	*0*	*0*	*0*	*243*	*324*	*0*	*0*	*0*	*177*	*190*	*0*
Heavy Veh. Adj. (f_{HV}), %	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Pedestrians Crossing	*0*				0				0				0			

Critical and Follow-Up Headway Adjustment

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (sec)	*5.1929*	*4.8000*	*5.1929*	*5.1929*	*4.8000*	*5.1929*	*5.1929*	*4.8000*	*5.1929*	*5.1929*	*4.8000*	*5.1929*
Follow-Up Headway (sec)	*3.1858*	*2.5000*	*3.1858*	*3.1858*	*2.5000*	*3.1858*	*3.1858*	*2.5000*	*3.1858*	*3.1858*	*2.5000*	*3.1858*

Flow Computations

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Circulating Flow (V_c), pc/h	*199*			*773*			*136*			*273*		
Exiting Flow (V_{ex}), pc/h	*0*			*487*			*500*			*342*		
Entry Flow (V_e), pc/h		*279*			*0*			*637*			*412*	
Entry Volume veh/h		*279*						*637*			*412*	

Capacity and v/c Ratios

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Capacity (c_{PCE}), pc/h		*1184*			*0*			*1259*			*1100*	
Capacity (*c*), veh/h		*1184*			*0*			*1259*			*1100*	
v/c Ratio (X)		*0.24*						*0.51*			*0.37*	

Delay and Level of Service

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		*5.2*						*8.3*			*7.1*	
Lane LOS		*A*			*F*			*A*			*A*	
Lane 95% Queue		*0.9*						*3.0*			*1.8*	
Approach Delay, s/veh	*5.15*						*8.28*			*7.09*		
Approach LOS, s/veh	*A*						*A*			*A*		
Intersection Delay, s/veh	*7.25*											
Intersection LOS	*A*											

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ROUNDABOUT REPORT

General Information		Site Information	
Analyst	*Brett Louk*	Intersection	*Grand Mere Parkway & Kimball*
Agency or Co.	*SMH Consultants*	E/W Street Name	*Grand Mere Parkway*
Date Performed	*1/13/2015*	N/S Street Name	*Kimball*
Time Period	*4:45-5:45 pm*	Analysis Year	*2014*
Peak Hour Factor	*0.89*	Project ID	*Existing + Planned + Development PM*

Project Description:

Volume Adjustment and Site Characteristics

	EB				WB				NB				SB			
	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R	U
Number of Lanes (N)	*0*	*1*	*0*		*0*	*0*	*0*		*0*	*1*	*0*		*0*	*1*	*0*	
Lane Assignment			*LTR*								*LT*				*TR*	
Right-Turn Bypass	*None*				None				None				None			
Conflicting Lanes	*1*				1				1				1			
Volume (V), veh/h	*318*	*0*	*332*	*0*	*0*	*0*	*0*	*0*	*524*	*324*	*0*	*0*	*0*	*177*	*378*	*0*
Heavy Veh. Adj. (f_{HV}), %	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Pedestrians Crossing	*0*				0				0				0			

Critical and Follow-Up Headway Adjustment

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (sec)	*5.1929*	*4.8000*	*5.1929*	*5.1929*	*4.8000*	*5.1929*	*5.1929*	*4.8000*	*5.1929*	*5.1929*	*4.8000*	*5.1929*
Follow-Up Headway (sec)	*3.1858*	*2.5000*	*3.1858*	*3.1858*	*2.5000*	*3.1858*	*3.1858*	*2.5000*	*3.1858*	*3.1858*	*2.5000*	*3.1858*

Flow Computations

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Circulating Flow (V_c), pc/h	*199*			*1310*			*357*			*589*		
Exiting Flow (V_{ex}), pc/h	*0*			*1013*			*721*			*572*		
Entry Flow (V_e), pc/h		*730*			*0*			*953*			*624*	
Entry Volume veh/h		*730*						*953*			*624*	

Capacity and v/c Ratios

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Capacity (c_{PCE}), pc/h		*1184*			*0*			*1012*			*806*	
Capacity (*c*), veh/h		*1184*			*0*			*1012*			*806*	
v/c Ratio (X)		*0.62*						*0.94*			*0.77*	

Delay and Level of Service

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		*10.9*						*36.1*			*21.9*	
Lane LOS		*B*			*F*			*E*			*C*	
Lane 95% Queue		*4.5*						*15.6*			*7.7*	
Approach Delay, s/veh	*10.88*						*36.13*			*21.85*		
Approach LOS, s/veh	*B*						*E*			*C*		
Intersection Delay, s/veh	*24.28*											
Intersection LOS	*C*											

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ROUNDABOUT REPORT

General Information		Site Information	
Analyst	*Brett Louk*	Intersection	*Grand Mere Parkway & Kimball*
Agency or Co.	*SMH Consultants*	E/W Street Name	*Grand Mere Parkway*
Date Performed	*1/13/2015*	N/S Street Name	*Kimball Ave*
Time Period	*4:45-5:45 pm*	Analysis Year	*2014*
Peak Hour Factor	*0.89*	Project ID	*Exist + Planned + Dev + 20 yrs PM*

Project Description:

Volume Adjustment and Site Characteristics

	EB				WB				NB				SB			
	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R	U
Number of Lanes (N)	*0*	*1*	*0*		*0*	*0*	*0*		*0*	*1*	*0*		*0*	*1*	*0*	
Lane Assignment			*LTR*								*LT*				*TR*	
Right-Turn Bypass	*None*				None				None				None			
Conflicting Lanes	*1*				1				1				1			
Volume (V), veh/h	*333*	*0*	*346*	*0*	*0*	*0*	*0*	*0*	*534*	*478*	*0*	*0*	*0*	*267*	*396*	*0*
Heavy Veh. Adj. (f_{HV}), %	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Pedestrians Crossing	*0*				0				0				0			

Critical and Follow-Up Headway Adjustment

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (sec)	*5.1929*	*4.8000*	*5.1929*	*5.1929*	*4.8000*	*5.1929*	*5.1929*	*4.8000*	*5.1929*	*5.1929*	*4.8000*	*5.1929*
Follow-Up Headway (sec)	*3.1858*	*2.5000*	*3.1858*	*3.1858*	*2.5000*	*3.1858*	*3.1858*	*2.5000*	*3.1858*	*3.1858*	*2.5000*	*3.1858*

Flow Computations

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Circulating Flow (V_c), pc/h	*300*			*1511*			*374*			*600*		
Exiting Flow (V_{ex}), pc/h	*0*			*1045*			*911*			*689*		
Entry Flow (V_e), pc/h		*763*			*745*			*1137*			*745*	
Entry Volume veh/h		*763*						*1137*			*745*	

Capacity and v/c Ratios

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Capacity (c_{PCE}), pc/h		*1071*			*0*			*996*			*797*	
Capacity (*c*), veh/h		*1071*			*0*			*996*			*797*	
v/c Ratio (X)		*0.71*						*1.14*			*0.93*	

Delay and Level of Service

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		*14.8*						*94.1*			*40.5*	
Lane LOS		*B*			*F*			*F*			*E*	
Lane 95% Queue		*6.4*						*31.3*			*13.8*	
Approach Delay, s/veh	*14.77*						*94.05*			*40.51*		
Approach LOS, s/veh	*B*						*F*			*E*		
Intersection Delay, s/veh	*56.10*											
Intersection LOS	*F*											

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst:	*Brett Louk, P.E.*	Intersection:	*Road A & Road B*
Agency/Co.:	*SMH Consultants*	Jurisdiction:	
Date Performed:	*6/03/2015*	Analysis Year:	*2015*
Analysis Time Period:	*7:00-8:00 am*	Peak Hour Factor:	

Project Description: *Existing + Planned AM*

East/West Street: *Road A*	North/South Street: *Road B*
Intersection Orientation: *North-South*	Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound				Southbound			
Movement	1U	1	2	3	4U	4	5	6
	U	L	T	R	U	L	T	R
Volume (veh/h)			*13*	*50*		*0*	*0*	
Percent Heavy Vehicles		*0*	*0*	*0*		*0*	*0*	*0*
Median Type	*Undivided*							
Storage	*1*							
RT Channelized				*0*				*0*
Lanes	*0*		*1*	*0*	*0*		*1*	*0*
Configuration				*TR*	*LT*			
Proportion Time Blocked								

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*9*		*13*
Percent Heavy Vehicles	*0*			*0*	*0*	*0*
Left-Turn Lane Storage						
Percent Grade (%)	*0*			*0*		
Flared Approach			*N*			*N*
Storage			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*0*	*0*
Configuration					*LR*	
Proportion Time Blocked						

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*LT*		*LR*				
v (veh/h)		*0*		*23*				
C (m) (veh/h)		*1546*		*1011*				
v/c Ratio		*0.00*		*0.02*				
95% Queue Length		*0.00*		*0.07*				
Control Delay (s/veh)		*7.3*		*8.6*				
Movement LOS		*A*		*A*				
Approach Delay (s/veh)			*8.6*					
Approach LOS			*A*					

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst:	*Brett Louk, P.E.*
Agency/Co.:	*SMH Consultants*
Date Performed:	*6/03/2015*
Analysis Time Period:	*7:00-8:00 am*

Site Information

Intersection:	*Road A & Road B*
Jurisdiction:	
Analysis Year:	*2015*
Peak Hour Factor:	

Project Description: *Existing + Planned + Development AM*

East/West Street: *Road A* | North/South Street: *Road B*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound				Southbound			
Movement	1U	1	2	3	4U	4	5	6
	U	L	T	R	U	L	T	R
Volume (veh/h)			*13*	*226*		*263*	*9*	
Percent Heavy Vehicles		*0*	*0*	*0*		*0*	*0*	*0*
Median Type	*Undivided*							
Storage	*1*							
RT Channelized				*0*				*0*
Lanes	*0*		*1*	*0*	*0*		*1*	*0*
Configuration				*TR*	*LT*			
Proportion Time Blocked								

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*141*		*212*
Percent Heavy Vehicles	*0*			*0*	*0*	*0*
Left-Turn Lane Storage						
Percent Grade (%)	*0*			*0*		
Flared Approach			*N*			*N*
Storage			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*0*	*0*
Configuration					*LR*	
Proportion Time Blocked						

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*LT*		*LR*				
v (veh/h)		*285*		*383*				
C (m) (veh/h)		*1317*		*518*				
v/c Ratio		*0.22*		*0.74*				
95% Queue Length		*0.82*		*6.22*				
Control Delay (s/veh)		*8.5*		*29.1*				
Movement LOS		*A*		*D*				
Approach Delay (s/veh)			*29.1*					
Approach LOS			*D*					

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst:	*Brett Louk, P.E.*	Intersection:	*Road A & Road B*
Agency/Co.:	*SMH Consultants*	Jurisdiction:	
Date Performed:	*6/03/2015*	Analysis Year:	*2015*
Analysis Time Period:	*7:00-8:00 am*	Peak Hour Factor:	

Project Description: *Existing + Planned + Development + 20 yrs AM*

East/West Street: *Road A* | North/South Street: *Road B*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound				Southbound			
Movement	1U	1	2	3	4U	4	5	6
	U	L	T	R	U	L	T	R
Volume (veh/h)			*13*	*226*		*263*	*9*	
Percent Heavy Vehicles		*0*	*0*	*0*		*0*	*0*	*0*
Median Type	*Undivided*							
Storage	*1*							
RT Channelized				*0*				*0*
Lanes	*0*		*1*	*0*	*0*		*1*	*0*
Configuration				*TR*	*LT*			
Proportion Time Blocked								

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*141*		*212*
Percent Heavy Vehicles	*0*			*0*	*0*	*0*
Left-Turn Lane Storage						
Percent Grade (%)	*0*			*0*		
Flared Approach			*N*			*N*
Storage			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*0*	*0*
Configuration					*LR*	
Proportion Time Blocked						

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*LT*		*LR*				
v (veh/h)		*285*		*383*				
C (m) (veh/h)		*1317*		*518*				
v/c Ratio		*0.22*		*0.74*				
95% Queue Length		*0.82*		*6.22*				
Control Delay (s/veh)		*8.5*		*29.1*				
Movement LOS		*A*		*D*				
Approach Delay (s/veh)			*29.1*					
Approach LOS			*D*					

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst:	*Brett Louk, P.E.*
Agency/Co.:	*SMH Consultants*
Date Performed:	*6/03/2015*
Analysis Time Period:	*7:00-8:00 am*

Site Information

Intersection:	*Road A & Road B*
Jurisdiction:	
Analysis Year:	*2015*
Peak Hour Factor:	

Project Description: *Existing + Planned + Development AM - WB Left Turn*

East/West Street: *Road A* | North/South Street: *Road B*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound				Southbound			
Movement	1U	1	2	3	4U	4	5	6
	U	L	T	R	U	L	T	R
Volume (veh/h)			*13*	*226*		*263*	*9*	
Percent Heavy Vehicles		*0*	*0*	*0*		*0*	*0*	*0*
Median Type	*Undivided*							
Storage	*1*							
RT Channelized				*0*				*0*
Lanes	*0*		*1*	*0*	*0*		*1*	*0*
Configuration				*TR*	*LT*			
Proportion Time Blocked								

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*141*		*212*
Percent Heavy Vehicles	*0*			*0*	*0*	*0*
Left-Turn Lane Storage						
Percent Grade (%)	*0*			*0*		
Flared Approach			*N*			*N*
Storage			*0*			*0*
Lanes	*0*	*0*	*0*	*1*	*0*	*1*
Configuration				*L*		*R*
Proportion Time Blocked						

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*LT*	*L*		*R*			
v (veh/h)		*285*	*153*		*230*			
C (m) (veh/h)		*1317*	*313*		*918*			
v/c Ratio		*0.22*	*0.49*		*0.25*			
95% Queue Length		*0.82*	*2.54*		*0.99*			
Control Delay (s/veh)		*8.5*	*27.0*		*10.2*			
Movement LOS		*A*	*D*		*B*			
Approach Delay (s/veh)			*16.9*					
Approach LOS			*C*					

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst:	*Brett Louk, P.E.*
Agency/Co.:	*SMH Consultants*
Date Performed:	*6/03/2015*
Analysis Time Period:	*7:00-8:00 am*

Site Information

Intersection:	*Road A & Road B*
Jurisdiction:	
Analysis Year:	*2015*
Peak Hour Factor:	

Project Description: *Existing + Planned + Development + 20 yrs AM - WB Left Turn*

East/West Street: *Road A* | North/South Street: *Road B*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound				Southbound			
Movement	1U	1	2	3	4U	4	5	6
	U	L	T	R	U	L	T	R
Volume (veh/h)			*13*	*226*		*263*	*9*	
Percent Heavy Vehicles		*0*	*0*	*0*		*0*	*0*	*0*
Median Type	*Undivided*							
Storage	*1*							
RT Channelized				*0*				*0*
Lanes	*0*		*1*	*0*	*0*		*1*	*0*
Configuration				*TR*	*LT*			
Proportion Time Blocked								

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*141*		*212*
Percent Heavy Vehicles	*0*			*0*	*0*	*0*
Left-Turn Lane Storage						
Percent Grade (%)	*0*			*0*		
Flared Approach			*N*			*N*
Storage			*0*			*0*
Lanes	*0*	*0*	*0*	*1*	*0*	*1*
Configuration				*L*		*R*
Proportion Time Blocked						

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*LT*	*L*		*R*			
v (veh/h)		*285*	*153*		*230*			
C (m) (veh/h)		*1317*	*313*		*918*			
v/c Ratio		*0.22*	*0.49*		*0.25*			
95% Queue Length		*0.82*	*2.54*		*0.99*			
Control Delay (s/veh)		*8.5*	*27.0*		*10.2*			
Movement LOS		*A*	*D*		*B*			
Approach Delay (s/veh)			*16.9*					
Approach LOS			*C*					

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst:	*Brett Louk, P.E.*
Agency/Co.:	*SMH Consultants*
Date Performed:	*6/03/2015*
Analysis Time Period:	*5:00-6:00 pm*

Site Information

Intersection:	*Road A & Road B*
Jurisdiction:	
Analysis Year:	*2015*
Peak Hour Factor:	

Project Description: *Existing + Planned PM*

East/West Street: *Road A* | North/South Street: *Road B*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound				Southbound			
Movement	1U	1	2	3	4U	4	5	6
	U	L	T	R	U	L	T	R
Volume (veh/h)			*8*	*32*		*0*	*0*	
Percent Heavy Vehicles		*0*	*0*	*0*		*0*	*0*	*0*
Median Type	*Undivided*							
Storage	*1*							
RT Channelized				*0*				*0*
Lanes	*0*		*1*	*0*	*0*		*1*	*0*
Configuration				*TR*	*LT*			
Proportion Time Blocked								

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*28*		*43*
Percent Heavy Vehicles	*0*			*0*	*0*	*0*
Left-Turn Lane Storage						
Percent Grade (%)	*0*			*0*		
Flared Approach			*N*			*N*
Storage			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*0*	*0*
Configuration					*LR*	
Proportion Time Blocked						

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*LT*		*LR*				
v (veh/h)		*0*		*76*				
C (m) (veh/h)		*1580*		*1032*				
v/c Ratio		*0.00*		*0.07*				
95% Queue Length		*0.00*		*0.24*				
Control Delay (s/veh)		*7.3*		*8.8*				
Movement LOS		*A*		*A*				
Approach Delay (s/veh)			*8.8*					
Approach LOS			*A*					

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst:	*Brett Louk, P.E.*
Agency/Co.:	*SMH Consultants*
Date Performed:	*6/03/2015*
Analysis Time Period:	*5:00-6:00 pm*

Site Information

Intersection:	*Road A & Road B*
Jurisdiction:	
Analysis Year:	*2015*
Peak Hour Factor:	

Project Description: *Existing + Planned + Development PM*

East/West Street: *Road A* | North/South Street: *Road B*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound				Southbound			
Movement	1U	1	2	3	4U	4	5	6
	U	L	T	R	U	L	T	R
Volume (veh/h)			*8*	*193*		*241*	*12*	
Percent Heavy Vehicles		*0*	*0*	*0*		*0*	*0*	*0*
Median Type	*Undivided*							
Storage	*1*							
RT Channelized				*0*				*0*
Lanes	*0*		*1*	*0*	*0*		*1*	*0*
Configuration				*TR*	*LT*			
Proportion Time Blocked								

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*216*		*324*
Percent Heavy Vehicles	*0*			*0*	*0*	*0*
Left-Turn Lane Storage						
Percent Grade (%)	*0*			*0*		
Flared Approach			*N*			*N*
Storage			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*0*	*0*
Configuration					*LR*	
Proportion Time Blocked						

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*LT*		*LR*				
v (veh/h)		*261*		*586*				
C (m) (veh/h)		*1365*		*568*				
v/c Ratio		*0.19*		*1.03*				
95% Queue Length		*0.71*		*15.99*				
Control Delay (s/veh)		*8.3*		*73.2*				
Movement LOS		*A*		*F*				
Approach Delay (s/veh)			*73.2*					
Approach LOS			*F*					

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst:	*Brett Louk, P.E.*	Intersection:	*Road A & Road B*
Agency/Co.:	*SMH Consultants*	Jurisdiction:	
Date Performed:	*6/03/2015*	Analysis Year:	*2015*
Analysis Time Period:	*5:00-6:00 pm*	Peak Hour Factor:	

Project Description: *Existing + Planned + Development + 20 yrs PM*

East/West Street: *Road A*	North/South Street: *Road B*
Intersection Orientation: *North-South*	Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound				Southbound			
Movement	1U	1	2	3	4U	4	5	6
	U	L	T	R	U	L	T	R
Volume (veh/h)			*8*	*193*		*241*	*12*	
Percent Heavy Vehicles		*0*	*0*	*0*		*0*	*0*	*0*
Median Type	*Undivided*							
Storage	*1*							
RT Channelized				*0*				*0*
Lanes	*0*		*1*	*0*	*0*		*1*	*0*
Configuration				*TR*	*LT*			
Proportion Time Blocked								

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*216*		*324*
Percent Heavy Vehicles	*0*			*0*	*0*	*0*
Left-Turn Lane Storage						
Percent Grade (%)	*0*			*0*		
Flared Approach			*N*			*N*
Storage			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*0*	*0*
Configuration					*LR*	
Proportion Time Blocked						

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*LT*		*LR*				
v (veh/h)		*261*		*586*				
C (m) (veh/h)		*1365*		*568*				
v/c Ratio		*0.19*		*1.03*				
95% Queue Length		*0.71*		*15.99*				
Control Delay (s/veh)		*8.3*		*73.2*				
Movement LOS		*A*		*F*				
Approach Delay (s/veh)			*73.2*					
Approach LOS			*F*					

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst:	*Brett Louk, P.E.*
Agency/Co.:	*SMH Consultants*
Date Performed:	*6/03/2015*
Analysis Time Period:	*5:00-6:00 pm*

Site Information

Intersection:	*Road A & Road B*
Jurisdiction:	
Analysis Year:	*2015*
Peak Hour Factor:	

Project Description: *Existing + Planned + Development PM - WB Left Turn*

East/West Street: *Road A* | North/South Street: *Road B*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound				Southbound			
Movement	1U	1	2	3	4U	4	5	6
	U	L	T	R	U	L	T	R
Volume (veh/h)			*8*	*193*		*241*	*12*	
Percent Heavy Vehicles		*0*	*0*	*0*		*0*	*0*	*0*
Median Type	*Undivided*							
Storage	*1*							
RT Channelized				*0*				*0*
Lanes	*0*		*1*	*0*	*0*		*1*	*0*
Configuration				*TR*	*LT*			
Proportion Time Blocked								

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*216*		*324*
Percent Heavy Vehicles	*0*			*0*	*0*	*0*
Left-Turn Lane Storage						
Percent Grade (%)	*0*			*0*		
Flared Approach			*N*			*N*
Storage			*0*			*0*
Lanes	*0*	*0*	*0*	*1*	*0*	*1*
Configuration				*L*		*R*
Proportion Time Blocked						

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*LT*	*L*		*R*			
v (veh/h)		*261*	*234*		*352*			
C (m) (veh/h)		*1365*	*355*		*947*			
v/c Ratio		*0.19*	*0.66*		*0.37*			
95% Queue Length		*0.71*	*4.48*		*1.73*			
Control Delay (s/veh)		*8.3*	*32.7*		*11.0*			
Movement LOS		*A*	*D*		*B*			
Approach Delay (s/veh)			*19.7*					
Approach LOS			*C*					

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst:	*Brett Louk, P.E.*
Agency/Co.:	*SMH Consultants*
Date Performed:	*6/03/2015*
Analysis Time Period:	*5:00-6:00 pm*

Site Information

Intersection:	*Road A & Road B*
Jurisdiction:	
Analysis Year:	*2015*
Peak Hour Factor:	

Project Description: *Existing + Planned + Development + 20 yrs PM - WB Left Turn*

East/West Street: *Road A* | North/South Street: *Road B*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound				Southbound			
Movement	1U	1	2	3	4U	4	5	6
	U	L	T	R	U	L	T	R
Volume (veh/h)			*8*	*193*		*241*	*12*	
Percent Heavy Vehicles		*0*	*0*	*0*		*0*	*0*	*0*
Median Type	*Undivided*							
Storage	*1*							
RT Channelized				*0*				*0*
Lanes	*0*		*1*	*0*	*0*		*1*	*0*
Configuration				*TR*	*LT*			
Proportion Time Blocked								

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*216*		*324*
Percent Heavy Vehicles	*0*			*0*	*0*	*0*
Left-Turn Lane Storage						
Percent Grade (%)	*0*			*0*		
Flared Approach			*N*			*N*
Storage			*0*			*0*
Lanes	*0*	*0*	*0*	*1*	*0*	*1*
Configuration				*L*		*R*
Proportion Time Blocked						

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*LT*	*L*		*R*			
v (veh/h)		*261*	*234*		*352*			
C (m) (veh/h)		*1365*	*355*		*947*			
v/c Ratio		*0.19*	*0.66*		*0.37*			
95% Queue Length		*0.71*	*4.48*		*1.73*			
Control Delay (s/veh)		*8.3*	*32.7*		*11.0*			
Movement LOS		*A*	*D*		*B*			
Approach Delay (s/veh)			*19.7*					
Approach LOS			*C*					

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TECHNICAL SUPPLEMENT NO. 5

USD 378 School Site

May 2015

Zachary J. Burton

I received a phone call from Riley County School Board member David Higgins on February 12, 2015, inviting me to their upcoming school board meeting on February 16th. He said the school board was considering future plans for a new school somewhere near Manhattan, and wanted me to be available to comment on future growth projections within the Riley County school district in the City of Manhattan. He specifically wanted me to be present to answer any questions about Hartford Hill. He said he was aware of the large amount of development I'd already done in Grand Mere that fell within the Riley County school boundary.

I received a call from Riley County School Board member Tom Richard on February 16, 2015, encouraging me to attend the board meeting that evening. Tom verified that he'd received the copy of the Hartford Hill master plan map that I'd sent him a couple weeks earlier. Tom had requested the Hartford Hill master plan so he could share it with fellow school board members as they considered future growth possibilities into the Manhattan area.

I attended the Riley County School Board meeting the evening of February 16, 2015, at the Riley County High School library. Eric Cattell, with the City of Manhattan Community Development Department, spoke to the board regarding new housing developments on the west side of Manhattan. He gave estimates of the number of dwelling units predicted to fall within the USD 378 boundary line: short term (1-7 years) is 768 dwelling units; long term (20+ years) is 1,268-1,368 dwelling units. Mr. Cattell specifically mentioned the Hartford Hill master plan at this meeting and indicated to the board that a school site was included. I was not asked by the board for further comment after Mr. Cattell's presentation.

I had an in-person conversation with Riley County School Board member-elect Randy O'Boyle on May 1, 2015. We spoke about the need for Riley County to expand into the Manhattan area. Randy indicated he believed an elementary school would be a likely fit. He mentioned that Hartford Hill was a possible site that was under consideration, but that others were being explored as well. He said he would know much more after he began his service on the board July 1, 2015.

Sincerely,

Zachary J. Burton
President