Citywide Stormwater Master Plan Study
Phase 1

City of Oak Hill

Davidson County, Tennessee

Prepared for:

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EXECUTIVE SUMMARY

The purpose of this Citywide Stormwater Master Plan Study is to identify opportunities to reduce flooding and protect surface water quality throughout the limits of the City of Oak Hill, Tennessee. The City of Oak Hill is a community incorporated in 1952 that consists primarily of residential zoning. The City is home to approximately 4,700 residents and is comprised of approximately eight square miles of land located within Davidson County.

Throughout the past several years the City of Oak Hill has experienced frequent flooding in numerous areas of the City during storm events of various sizes. In February 2010, the City of Oak Hill selected Kimley-Horn and Associates, Inc. to prepare a Stormwater Master Plan Study. This phase of the study consists of the following components:

- A review of existing stormwater and drainage data, reports and plans available through the City of Oak Hill, the Metropolitan Government of Nashville and Davidson County and the Federal Emergency Management Agency (FEMA)
- Collecting information of historical drainage problems from citizens and City staff
- A partial field inventory of existing drainage structures of critical significance for modeling
- Development of a Geographic Information System (GIS) stormwater database consisting of type, size, location, material, condition and photographs of various drainage infrastructure attributes
- Basin and sub-basin delineations based on available data
- Basin and sub-basin prioritization of critical watersheds based on available data

Based on a review of the drainage areas and identified problem areas from City staff and citizens, seven drainage basins were selected as a priority for detailed analysis through hydrologic and hydraulic modeling. This study includes a review of each of the seven drainage basins that were identified for further analysis and modeling and a ranking each of the sub-basins in priority order according to the current data available.

BACKGROUND

The purpose of this Citywide Stormwater Master Plan Study is to identify opportunities to reduce flooding and protect surface water quality throughout the limits of the City of Oak Hill, Tennessee. The City of Oak Hill is a community incorporated in 1952 of approximately eight square miles of land located within Davidson County. See *Figure 1* for a map of the City of Oak Hill.

Land Use and Location

The existing land use for the City of Oak Hill is primarily residential. Lot sizes range from 10,000 square feet to over five acres in some areas. There are currently seven schools and 15 churches within the city limits that operate under conditional use permits (CUP's). The City ranges in elevation from 496 feet to 1156 feet and contains areas of extreme slopes upwards of 30%.

The City is located in the south central portion of Davidson County and is bordered by the following streets, areas and land uses:

- To the East: I- 65 and mostly residential areas Creive Hall and Trousdale to the east of I-65.
- To the West: The majority of the City is bounded to the west by Granny White Pike and General Bate Drive. West of Granny White Pike is the City of Forest Hills and west of General Bate Drive is the Green Hills neighborhood which is part of Nashville. Both of these areas immediately adjacent to Oak Hill are mostly residential.
- To the North: Woodmont Boulevard and the City of Berry Hill and the Green Hills neighborhood which is part of Nashville. The area of Berry Hill which is immediately adjacent to Oak Hill is mostly commercial and the area of Green Hills immediately adjacent to Oak Hill is mostly residential.
- To the South: Old Hickory Boulevard and the City of Brentwood, in Williamson County. The area immediately south of Old Hickory Boulevard is mostly commercial and office parks.

Project Development

This Citywide Stormwater Master Plan Study was identified as a project need by the City Manager and staff after recognizing the drainage and flooding problems encountered in various locations of the City during small rainfall events. The City made it a priority to undertake an overall comprehensive stormwater study to identify potential solutions that would alleviate flooding and poor water quality throughout the City. In February 2010, Kimley-Horn and Associates, Inc. was selected by the City of Oak Hill to perform this study.

Study Area

The study area includes the entire City of Oak Hill. As stated above this includes the area bounded roughly by Interstate 65 to the east, Woodmont Boulevard to the north, General Bate Drive and Granny White Pike to the west and Old Hickory Boulevard to the south. State and Federal routes were included in the study however private roads were not. Although our study area encompasses the entire City, every drainage area was not studied and our focus was on areas where historical drainage problems were identified by citizens and staff.

DATA COLLECTION

Public Involvement

On June 28, 2010, Kimley-Horn and Associates, Inc. (KHA) and City staff facilitated a public workshop to discuss the scope of this project and identify drainage problems within the City's watersheds for further investigation. KHA and City of Oak Hill staff conducted the meeting at the Judson Baptist Church on Franklin Road. The room was divided into six different areas, one for each previously designated neighborhood. See *Figure 2* for the Neighborhood Map. The six neighborhoods that were designated for this public meeting were strictly defined by major streets and physical features. Neighborhood boundaries had no bearing on drainage areas, watershed or patterns at this time in the study.

Each of the six neighborhoods had a station at the meeting that was facilitated by either a KHA or a City of Oak Hill staff member. Citizens were questioned about stormwater problems in the City, urged to fill out a survey form, and flag locations on aerial maps where historical flooding, erosion, obstruction or other related stormwater problems were known to exist. These problem locations were then transferred to our Geographic Information System (GIS) database and linked to the survey forms to help compile the data for the existing inventory and condition assessment portion of the study. See *Figure 3* for a blank copy of the Public Meeting Survey Form.

Please refer to *Appendix A* for all Public Meeting survey forms received.

City Involvement

Several meetings were conducted with City staff to discuss the existing drainage problems throughout the City and to review the information collected at the public meeting. City staff provided KHA with a list of the previously identified problem areas based on citizen complaints and City staff's direct knowledge of existing problems. See *Figure 4* for the listing of City staff identified problem areas. This information and the citizen survey forms were used to identify specific areas of the City where a field inventory and condition assessment of existing drainage structures should be focused.

Existing Stormwater Infrastructure Data Collection

The public meeting and City staff meetings were held to gain knowledge of historical drainage problem areas for further investigation and study. Following these meetings, KHA staff began field data collection of the existing stormwater infrastructure in the identified problem areas. Using a handheld Trimble Global Positioning System (GPS) device, an inventory and condition assessment was conducted to locate various storm water structures throughout the City. These structures were located with both horizontal and vertical data. KHA located 32 inlets/manholes, 6 outfalls, 243 culverts, and 6 BMPs (Best Management Practices, typically in the form of a retention or detention pond) by recording 530 total GPS points. Most road culverts were located and select off-road structures, culverts and outfalls were located throughout the City. Some areas with piped storm water systems were not located because these neighborhoods, churches or schools had constructions plans or as-builts available through the City records.

Each feature point collected had additional information that was gathered for that specific point. The feature point would be defined as a drainage structure, culvert, outfall or BMP.

For drainage structure types, the following information was gathered:

- Structure ID
- House Number and Street Name: Intersecting Streets were used for structures located near intersections
- Neighborhood: Based on six neighborhood used at the public meeting
- Location: Curb, Street, Lawn/Grass Area, Parking Lot, Sidewalk, Ditch, or Other
- Surface Type: Asphalt, Grass/Dirt, Concrete, Gravel, or Other
- Structure Type: Curb Inlet, Grated Inlet, Combination Inlet, Trench Drain, Pipe Inlet, Manhole, Junction Box, or Other
- Height Difference between Rim Elevation to Ground Elevation
- Drainage Condition: Sag, On Grade, or Other
- Inlet Drainage: Open, Clogged, Obstructed, Manhole or Other
- Cover Size: Measured in Length times Width in inches

- Cover Condition: Sound, Broken, Broken Frame, Tight, Loose, Rocking, Bolts Missing, or Other
- Wall Material: Precast, Brick, Block, Combination Brick and Block or Other
- Wall Condition: Surface Spalling, Cracking, Exposed Rebar, Missing Mortar, Missing Bricks, Severe, or Submerged
- Steps Type: None, Cast Iron, Plastic or Other
- Steps Conditions: Good or Poor
- Outlet Pipe Material: RCP, CMP, HDPE, PVC, Vitrified Clay, Submerged or Other
- Pipe Sediment: None, Minimal, Less than half Depth, Greater than half Depth or Pipe Covered
- Sediment Depth: Measured from invert of pipe to top of sediment level
- Submerged Depth: Measured from invert of pipe to top of water surface
- Structure Depth: Measured from invert of outlet pipe to top of structure
- Erosion: None, Minimal, Moderate, Severe
- Comment: Additional comments if necessary

For Outfall types, the following information was gathered:

- Outfall ID
- Street Name: Intersecting Streets were used for outfalls located near intersections
- Neighborhood: Based on six neighborhood used at the public meeting
- Pipe Material: RCP, CMP, HDPE, PVC, Vitrified Clay, Submerged or Other
- Diameter: Measured in inches
- Submerged: Yes or No
- End Wall: Yes or No
- Sedimentation: None, Minimal, Less than half Depth, Greater than half Depth or Pipe Covered
- Outlet Protection: None, Rip Rap or Other
- Erosion: None, Minimal, Moderate or Severe
- Comment: Additional comments if necessary

For Culvert types, the following information was gathered:

- Culvert ID
- House Number and Street Name: Intersecting Streets were used for culverts located near intersections
- Neighborhood: Based on six neighborhood used at the public meeting
- Pipe Material: RCP, CMP, HDPE, PVC, Vitrified Clay, Submerged or Other
- Diameter: Measured in inches
- Cover: Height from the top of the pipe to the road surface
- Submerged: Yes or No
- Headwall Material: Concrete, Stone, Brick, Block, Dirt or Other
- Headwall Condition: Good, Fair or Poor
- Sedimentation: None, Minimal, Less than half Depth, Greater than half Depth or Pipe Covered
- Erosion: None, Minimal, Moderate or Severe
- Comment: Additional comments if necessary

For BMP types, the following information was gathered:

- BMP ID
- Street Name: Intersecting Streets were used for BMP's located near intersections
- Neighborhood: Based on six neighborhood used at the public meeting
- Dry/Wet: Dry or Wet Pond
- Shape: Rectangle, Oval, Trapezoid, Irregular or Other
- Emergency Spillway: Yes, No or Other
- Riser: Yes, No or Other
- Number of Inlets: Number of pipes discharging into the pond
- Depth to Center: Approximate depth in the center of the pond
- Erosion: None, Minimal, Moderate or Severe
- Comment: Additional comments if necessary

Identification tags for each point were developed based on the neighborhood number and a letter. The letter was based on the amount of points collected for the specific point type in that neighborhood. For example, neighborhood 1 began with Culvert ID # 1a and continued through Culvert ID # 1ee. Each point type (Structure, Outfall, Culvert and BMP) started over with "a" in each neighborhood.

In addition to collecting the information listed above for each point type, KHA staff also photographed each point and documented field sketch data sheets as backup information. Please see *Appendix C* for a CD with all GPS data, photographs and field sketch data sheets.

Miscellaneous Information and Data Collection

Through the City of Oak Hill and other various local, state and federal sources, KHA staff researched other potential sources for previous stormwater information in this area. We obtained a drainage inventory prepared by Ragan-Smith-Murphy & Associates, Inc. in April of 1990. This inventory was only available in hard copy format and did not include mapping or physical locations associated with the structures in the inventory. Because of this, the data could not be utilized in our study.

KHA staff was also able to obtain a copy of the Flood Insurance Study and Flood Maps for the City of Oak Hill through the Federal Emergency Management Agency (FEMA). This information of flood zones and floodways was helpful in allowing us to see flood prone areas and the parcels or roads affected. This information will be important once we begin the modeling portion of this study. Please refer to *Appendix B* for copies of the FEMA Flood Maps. The FEMA Flood Insurance Study can be found in electronic format on the CD in *Appendix C*.

KHA staff met with and obtained data from the Metropolitan Government of Nashville and Davidson County, Stormwater Division. We obtained a copy of the Brown's Creek Basin Plan that was produced by ERC/EDGe Civil Engineering Division in June of 1990. While this basin plan is over 20 years old it will be beneficial once the modeling portion of this study begins.

Although this basin covers areas out of the City of Oak Hill, it includes a major portion of the City. This Basin Plan can be found in electronic format on the CD in *Appendix C*.

KHA staff obtained construction plans from various subdivisions, churches and schools throughout the City to complement our field data collection. The plans that were obtained were from the Tremont Subdivision, The Estates at Radnor Subdivision, Family of God at Woodmont Hills Church, Father Ryan School, Franklin Road Academy, Judson Baptist Church, Nashville Korean Presbyterian Church, Our Savior Lutheran Church, First Presbyterian Church and The Oak Hill School. These plans have been included in the GIS database and geo-referenced in their correct horizontal location.

Numerous photographs were taken and obtained as part of this phase of the study. KHA staff photographed various locations around the City based on identified problem areas. Oak Hill citizens were also asked following the public meeting to provide photos of their property or nearby areas during major storm events. All photos have been linked to the GIS database at the appropriate problem area or public input flag.

GIS DATABASE

Data Compilation

KHA staff created a GIS stormwater database using ArcGIS®. This database compiles all of the information that was collected throughout the life of the project, including field collected GPS data, input on drainage issues from the citizens and City staff, and existing files from the Metropolitan Government of Nashville and Davidson County. This geodatabase stores information in a series of files and folders, similar to a network drive on a personal computer. Each folder is a group containing files, called shapefiles, of similar type. The following shapefiles are included in the geodatabase:

- Boundaries
  - City Boundary
  - Neighborhood Boundary
- Drainage
  - Basins
  - BMP Polygon
  - Channel
  - Culvert Pipe
  - Storm Pipe
- Drainage Issues
  - City Input
  - Public Input
- Field Data
  - BMP
  - Culvert
  - Outfall
  - Structure
- Reference Layers
  - Soils
  - Hydrology Line
  - Hydrology Polygon
  - Flood Plain
  - Local Flood Plain
  - 2 foot contours

Each file in the geodatabase is viewed as a layer in ArcGIS ArcView® or ArcGIS Explorer®. ArcView® was used by KHA staff to view and symbolize the layers created for the geodatabase and to create the maps included in this report. Layers can be added from any single shapefile or from any existing database, and each layer can be turned on or off to show a variety of interactive or printed maps and figures. KHA staff also added aerial imagery to provide a

background for the mapping, and hardcopy plan sheets were scanned and geo-referenced using the aerial imagery to input storm piping and structure locations into the database.

The information gathered from the citizens of Oak Hill and City staff was added to the geodatabase by creating geo-located points based on the location of each area of concern. The photos taken by KHA and those provided by the citizens were linked to each point, as well as the survey forms completed during the public workshop. By selecting a point on the interactive map, the information for the selected point will appear in a dialog box, with hyperlinks to the associated photos or files. See *Figure 5* for the Public and City Input Map.

The GPS points collected in the field were imported into the geodatabase and were used to create additional line and polyline shapefiles, including the BMP Polygon, Channel, Culvert Pipe, and Storm Pipe files. As previously described, by selecting any point on the interactive map, the information for the selected point will appear in a dialog box, including all information gathered in the field, additional information added to each point type, and all associated field photos. See *Figure 6* for the Field Data Collection Map.

An alternative to ArcView® is a free GIS viewer called ArcGIS Explorer®. This viewer is available for download online and has similar capabilities as the purchased ArcView® version, with several limitations. The primary limitations to Explorer® are its inability to edit any information stored within the files of a geodatabase, inability to view hyperlinks directly, and limited options for symbolizing data layers. Explorer® is a very useful tool for GIS users interested in viewing data without the need to edit information or create new files. See *Figure 7* for the ArcGIS® Explorer – User Tutorial.

BASIN AND SUB-BASIN DELINEATION

Existing Drainage Areas

KHA staff obtained GIS data from the Metropolitan Government of Nashville and Davidson County. Included in this data were two-foot topographic contours for the entire City. Utilizing this contour information, KHA delineated seven major drainage watersheds throughout the City. To further expand on the basin delineation, 12 sub-basins were delineated within Drainage Basin "A," 7 sub-basins were delineated within Drainage Basin "B" within the City limits, 2 sub-basins were delineated within Drainage Basin "C" within the City limits, 3 sub-basins were delineated within Drainage Basin "D," 6 sub-basins were delineated within Drainage Basin "E" within the City limits, and 6 sub-basins were delineated within Drainage Basin "F" within the City limits. See *Figure 8* for the Drainage Basin Map. Sub-basin delineation included routing and connectivity of the various culverts and drainage structures throughout the watersheds. This step will be important as we move forward into the modeling phase of the project. Routing was accomplished through review of aerial ortho-photography which should be field validated.

BASIN AND SUB-BASIN PRIORITIZATION

Problem Areas

Using the data available for this study, KHA staff prioritized the drainage basins and sub-basins in order beginning with the areas of significant drainage issues. Please note that this prioritization list is based on the public and City input, KHA staff observations from field analysis and photographs, and some analysis of existing stormwater infrastructure. See *Figure 9* for the Public and City Input on the Drainage Map. Table 1 shows the prioritization of the overall Drainage Basins.

TABLE 1: Drainage Basin Prioritization

Priority Number	Drainage Basin
1	A
2	B
3	C
4	F
5	D
6	E
7	G

Some of the drainage basins fall outside of the City limits and large portions of some of the overall basins do not appear to have many documented drainage problems. A more accurate way to prioritize the problem areas is by using the sub-basins within each major drainage basin. Table 2 shows the prioritization of the overall drainage sub-basins. Some sub-basins are not included in the following list and therefore we do not recommend any further analysis or stormwater modeling at this time. These sub-basins that were not included did not receive any citizen comments or staff input that indicated historical drainage problems.

TABLE 2: Drainage Sub-Basin Prioritization

Priority Number	Drainage Sub-Basin	Priority Number	Drainage Sub-Basin
1	A12	17	C1
2	A9	18	F3
3	A8	19	F4
4	A10	20	F5
5	A11	21	F6
6	A7	22	F2
7	A1	23	F1
8	A2	24	D1
9	A3	25	D2
10	A4	26	E1
11	A5	27	E2
12	A6	28	E3
13	B7	29	E4
14	B6	30	E5
15	B4	31	E6
16	C2	32	D3

Drainage sub-basins that are grouped with similar colors in the above table are dependent upon multiple sub-basins for accurate drainage watershed analysis and modeling. These groups are recommended to be modeled and further analyzed as a group in order to provide the most accurate recommendations for proposed improvements in future phases of this study.

RECOMMENDATIONS

This section of the study discusses recommendations to the City from this point forward. These recommendations include stormwater modeling and conceptual design of stormwater facilities to improve function in these problem areas. The drainage sub-basin prioritization list is subject to change with additional information gathered from modeling, field validation and conceptual design phases of this study.

Pursuant to the letter agreement between the City of Oak Hill and Kimley-Horn and Associates, Inc. dated March 9, 2009, it is recommended to proceed with Tasks 4 and 5 of the agreement for various areas of the City. See Appendix D for a copy of the letter agreement. Per the agreement, "the selection of the basins for further study will be approved by the City before the Engineer proceeds with any of the area specific, detailed analysis." At this time KHA is requesting the City to determine which of the sub-basins in the Drainage Sub-Basin Prioritization list they wish to proceed with further analysis and modeling.

Based on the Drainage Sub-Basin Prioritization list, KHA recommends the City begin further analysis and modeling on drainage sub-basins A12, A9 and A8 as these three sub-basins are the top priority and should be analyzed together due to drainage patterns. Next on the prioritization list are sub-basins A10, A11 and A7 followed by the remaining sub-basins of watershed "A," sub-basins A1, A2, A3, A4, A5 and A6. Watershed "B" was next on the priority list but only had three sub-basins recommended for modeling and further analysis based on citizen and City staff input. These sub-basins are B7, B6 and B4. Sub-basins C2 and C1 followed the sub-basins in watershed "B" and can be modeled and analyzed independently of any other sub-basins. Although there are 15 remaining sub-basins in the priority list, the sub-basins listed above are considered to be the most critical based on the information available at this time. The remaining 15 sub-basins did include documentation of historical drainage problems per citizen comments and City staff input and are therefore considered less critical. Please note that the prioritization list is subject to change with additional information generated through the next phases of this study.