RESOLUTION 326

A RESOLUTION BY THE CITY COUNCIL OF THE CITY OF CHESTERFIELD TO ADOPT THE CHESTERFIELD VALLEY STORMWATER MASTER PLAN DATED DECEMBER 2005

WHEREAS, in 1985 a Stormwater Master Plan was developed for the Chesterfield Valley last updated in 1998; and

WHEREAS, in 2003 an effort was undertaken to update the Master Plan to reflect the current level of development within Chesterfield Valley, to reflect those improvements associated with the 500-year levee project, to re-create the stormwater model to validate and eliminate any structural errors, and to create a "Point-in-Time" Master Plan; and

WHEREAS, the Department of Public Works is responsible for regular and routine maintenance of the Chesterfield Valley Stormwater Master Plan and related Hydrologic model, and

WHEREAS, the Department of Public Works has sought to incorporate changes and new developments into the Hydrologic model,

WHEREAS, this work has been completed.

NOW, THEREFORE, BE IT RESOLVED that the Mayor and City Council of the City of Chesterfield, Missouri do hereby adopt the Chesterfield Valley Stormwater Master Plan dated December 2005, as its current effective plan.

PASSED AND APPROVED this 18th day of January, 2006.

By: [signature]
Mayor

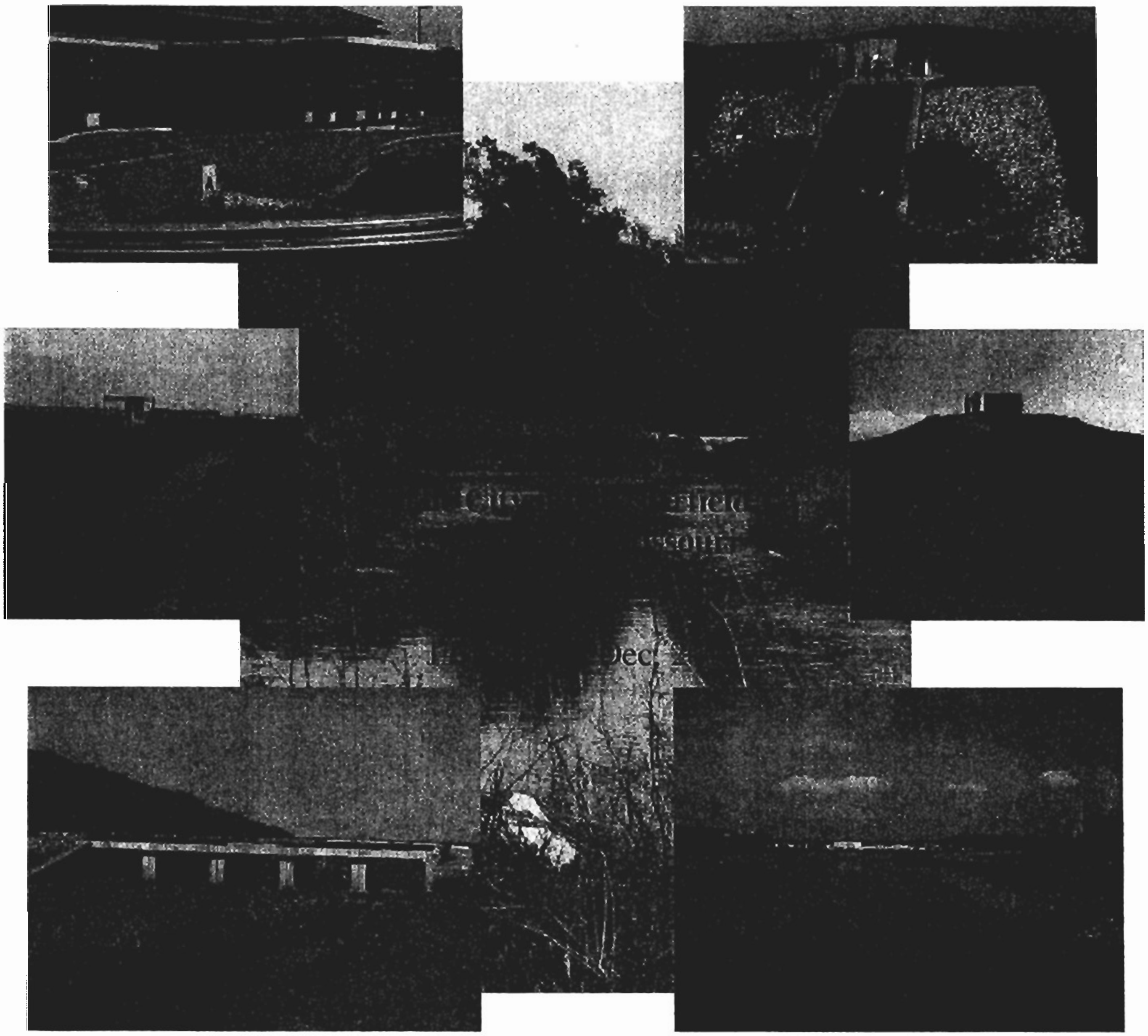
ATTEST:

[signature]
City Clerk

CHESTERFIELD VALLEY

FINAL CONDITIONS

STORMWATER ANALYSIS



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Savannah, Georgia

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The Final Model–Chesterfield Valley Storm Water Master Plan-should be a planning tool to guide future storm drainage designs to be properly interconnected and work efficiently as a complete watershed storm drainage system. It is recommended to implement the results as part of the City's adopted Comprehensive Plan.

INTRODUCTION

Flooding in Missouri between 1989 and 1998 caused $3.5 billion in property damages and tragically killed 64 people. St. Louis County was declared a federal disaster area 5 times during this same time period. It is possible for the City of Chesterfield to experience flooding by rising water from the Mississippi and Missouri Rivers, or from falling water (rainfall). This study focuses on flooding which occurs from rainfall and not the Missouri River. The objective of this report is to determine the flood elevations throughout Chesterfield Valley for a 100 year rainfall event for existing conditions and to prepare a drainage master plan to accommodate fully developed, future conditions according to the City's adopted Comprehensive Plan. This report presents and recommends a stormwater master plan for Chesterfield Valley – Chesterfield, Missouri.. The Chesterfield Valley Storm Water Master Plan, once adopted will serve as a tool to reduce future flood risks safely and with sound floodplain management, a requirement of the National Flood Insurance Program. The report summarizes the work performed, findings, and recommendations for managing the quantity of stormwater in the valley.

A. BACKGROUND

The City of Chesterfield is located twenty-two miles west of St. Louis, Missouri, along the western edge of the St. Louis County metropolitan area. Incorporated in 1988 and covering approximately 32 square miles, the City of Chesterfield is a thriving community with a population of 46,802 (US Census 2000). Development within the city is guided by a comprehensive plan adopted by the city in 1990 and updated through the years when deemed appropriate. The area of focus for this project is Chesterfield Valley.

The western corridor of the City of Chesterfield is known as Chesterfield Valley. The Chesterfield Valley watershed is approximately 4,500 acres surrounded by a levee system that keeps the Valley dry when the Missouri and Mississippi Rivers flood. Elevations within the valley range from 432 feet (next to the Missouri River) to 470 feet at the levee. The internal storm water master plan will act as a guide to ensure that the storm drainage system design for future developments will comply with the City's adopted comprehensive master plan. An annual rainfall of 56 inches and the rapid development within Chesterfield Valley are two factors that weigh heavily in the storm water master plan. Exhibit A presents a location map showing the Chesterfield Valley boundaries, major watersheds, upland areas, and roads.

Since the City of Chesterfield has been incorporated, it has been proactive in preparing and maintaining storm drainage master plans. The history of the long list of storm drainage computer models prepared for the City follow:

1985 study – by Booker Associates.
The plan divided the Valley into seven watersheds and proposed wide flat bottom ditches (25' – 700' with 4:1 side slopes). The model had a total of 7 gravity outfalls, the discharge from the gravity pipes would be reduced when the Bonhomme Creek and/or the Missouri Rivers were high.

1996 study –
This model was performed to certify the existing 100 year levee following its breach of 1993, and also to satisfy the Federal Emergency Management Agency (FEMA) requirements.

Original – PB Booker – Chesterfield Valley Ponding Study – Dated March 1998
This study's purpose was to update an existing 1996 study which determined the water elevations of the 100 year interior design storm within the levee protected portion of Chesterfield Valley. The update was to determine the impact of pump stations, and other site development being considered in 1997.

Chesterfield Valley Master Plan – September 1998 –
This model was to propose an updated model that would piece together existing channels within the Valley to create a proposed master storm water plan. Up to this point developers were building drainage systems to drain their individual site, which left fragmented section of channels strewn throughout the Chesterfield Valley area. This model was also used to update the flood insurance rate map to include the effects of the storm water pump stations.

City of Chesterfield – Chesterfield Valley Master Plan – January 10, 2002
This model was done by the City of Chesterfield in an attempt to update the model with the changing conditions in the Valley. The model, which was designed using AdICPR in the DOS based application, was continuously updated with functional equivalencies to keep up with the development in the Valley.

Thomas & Hutton Engineering Co. – Chesterfield Valley Storm water Master Plan – June 1, 2005
This model was prepared to update and validate the existing storm drainage computer model, incorporate existing functional equivalency studies and any new developments during the time in which the model was being updated. The previous model inputs were completely recalculated for consistency and to avoid any bugs that might have formed due to the constant updating. Available construction plans were reviewed to avoid any false details that could not be validated by appropriate plans. This model will continue to evolve as the Valley is developed through functional equivalencies, and to reflect as-developed conditions.

B. PURPOSE

The City of Chesterfield may flood by rising waters from the Missouri or Mississippi Rivers; or from localized rainfall. Chesterfield Valley is a levee protected area of approximately 4,500 acres. Portions of the Valley are considered 'Special Flood Hazard Areas' by the federal government. A Special Flood Hazard Area (SFHA) is defined as an area of land that would be inundated by a flood as a result of a 100-year rain event (or a flood having a 1% chance of occurring in any given year). A SFHA realizes the need for building restrictions to minimize potential loss of life/property and the economic benefits to be derived from floodplain development. Development may take place within the SFHA, provided that development complies with local floodplain management ordinances, which must meet the minimum Federal requirements. The levee has both negative and positive impacts on the Chesterfield Valley. The purpose of the levee is to keep rising waters from the Missouri River from inundating the Valley. To the contrary, the levee also dams water on the inside and doesn't allow gravity flow of storm water into the Missouri River when the river is low. Therefore, it is an obligation of the City of Chesterfield to establish a master storm drainage system that can be adopted and enforced to protect the property owners from the possibility of rising waters inside the levee when a storm of 7.0 inches of rainfall occurs in 24-hours (interior 100-yr design storm event). To participate in the federal flood insurance program FEMA requires an adopted and enforced floodplain management ordinance that reduces future flood risks to new construction in special flood hazard areas. The final storm drainage computer model – Chesterfield Valley Storm Water Master Plan, will be one of the planning tools to assist the City of Chesterfield for continued participation in the National Flood Insurance Program. This project focuses on the analysis of localized rainfall flooding and <u>not</u> flooding caused by the Missouri and Mississippi Rivers.

This report has been prepared to serve as a planning tool for the management of water courses and surface water runoff. The study has considered aesthetics, hydrology, hydraulics and regulatory requirements. Sound flood plain management, efficiency and safety are all major considerations for the future potential growth of the Chesterfield Valley. To assist in preparing this report, Thomas & Hutton Engineering Co. created maps of the existing drainage inventory within the City of Chesterfield. Information pertaining to the utilities was compiled from the most reliable sources of information available. Archives, record drawings or City provided information was used as the source of information. The drainage inventory consists of a map and a data base. The map shows the storm drainage facility locations and respective node number. The data base lists all pertinent information such as elevation, size, length, etc. for each node number.

The ultimate reasons for the Valley's Drainage Study were:

1. Guide future developments' drainage system designs to comply with the City's adopted Comprehensive Plan.

2. Inventory the Valley's existing storm drainage facilities.

3. Determine the major drainage paths.

4. Identify storm drainage bottlenecks.

5. Recommend drainage improvement alternatives to alleviate identified drainage problems.

6. Estimate the cost of implementing the improvements (Phase II).

This storm water master plan should be used in its entirety to establish the appropriate channel and pipe dimensions and location of drainage easements. This will provide that future development will have the proper means of alleviating increased runoff and prevent unnecessary flooding. The master plan recognizes that although runoff is a valuable resource, it may lead to flooding, property damage, destruction of roads and utilities, and personal harm when excess runoff conflicts with human activities.

The primary goal of this report is to present a storm water master plan for Chesterfield Valley - City of Chesterfield, Missouri which will incorporate the future land use changes, show proposed drainage easements, sizes and dimensions for channels and culverts for the entire Chesterfield Valley, a portion of which is actually situated within the City of Wildwood. A comprehensive approach has been taken to insure that no "bottlenecking" or restrictions occur in the main tributaries or arteries due to increased runoff from future development. The final storm drainage computer model has been developed based on projected development that reflects the existing development trends. As additional sites develop, the model will require updating to reflect record drawings and functional equivalency studies.

C. PROCEDURES

The general procedure used in the preparation of this report is outlined below:

1. Obtain an existing Geographical Information System data base from the City of Chesterfield.

2. Research City's archive files to obtain information about piping, grate inlet elevations, flap gates, ditching, pump stations and other control structures. Assimilate this existing as-built information into the City's existing GIS database.

3. Inventory the existing drainage facilities (water courses, wetlands, detention and retention areas).

4. Combine the archive "as-built" information and City's GIS data base into one data base.

5. Field reconnaissance to confirm watershed characteristics (geology, climate, flood problems, and land uses).

6. Delineate watersheds for major pipes, channels and individual lagoons by utilizing the City's Geographic Information System, topographic map and site investigation.

7. Delineate different soil classifications on the watershed map.

8. Determine the hydrologic variable (SCS Curve number, watershed area, time of concentration, etc.).

9. Create detailed hydraulic and hydrologic computer models for the entire Valley. The hydrographs are generated by the Soil Conservation Services' Method; the routing process utilized a reservoir in series routing, flood routing, channel routing, pump routing and a combination thereof.

10. Meet with City to gather input.

11. Model the 100 year flood frequency storm to determine any drainage problem areas. Tabulate each of the drainage problems in order of their severity.

12. Meet with City to review drainage models input.

13. Prepare a study report which will summarize and incorporate all of the information stated above.

14. Phase II. Prepare prioritization schedule and preliminary design drawings to solve problems for the 100 year storm frequency. On the plans show reservoir areas, piping, and ditching improvements and any potential pump station sizes and location.

D. HYDRAULICS & HYDROLOGY

1. Description

Ideally, the measurement of flood flows should be based on long-term stream flow gauging. Unfortunately, stream flow gauging information is not available in the Chesterfield Valley watershed, so the magnitudes and frequencies of peak rates of runoff are estimated by modeling the measurable watershed characteristics.

Runoff is affected by many variables such as area of influence (surface area), infiltration, characteristics related to soil type, antecedent rainfall conditions, type of vegetative cover, surface storage, season, and precipitation. Due to all of these variables, peak rates of runoff will vary substantially.

There have been many methods developed to synthesize floods. Many of these methods use different parameters to synthesize the storm. They differ in accordance with the region of the country, size of watershed, and variables of the watershed.

The peak flow rates for all sub-watersheds in Chesterfield Valley have been determined by use of ICPR v3.0 computer model developed by Streamline Technologies. The computer program generates unit hydrographs for each designated sub-watershed for full utilization in the hydraulic computer counterpart. The specific hydrology theory is described in the Soils Conservation Services National Engineering Handbook, Section 4, "Hydrology".

ICPR v3.0, by Streamline Technologies, is the computer program used to model the hydraulics. Parameters of this computer model include channel and pipe dimensions, storm water pump station sizes, inverts, and Manning's n values for the complete drainage network. In addition all stage-storage information and the respective outfall information is assimilated for each required location and entered into the computer model.

The unit hydrographs are merged into the hydraulic model and the computer output reflects the interaction of the system as a whole. It shows maximum water elevations at each node. The model is dynamic in that it calculates the water elevation for each time increment at each point of interest.

The final model consists of the creation of a storm water master plan showing proposed water levels, control structures, connecting pipes, channels and pump stations which will be sized to accommodate future development. Different alternatives will be calculated and the best of these alternatives will be stated.

2. Use of the Computer Model

The peak rates of stormwater runoff (cubic feet per second) for the watersheds of the Chesterfield Valley were calculated by means of SCS Unit Hydrograph Package with the following assumptions:

a. The 24 hour, 100 year frequency storm (an average of 7.0 inches of rainfall in a 24 hour time period) was used for all hydrology. This information is from technical paper no. 40, "Rainfall Frequency Atlas of the United States" by the Soil Conservation Service which was published in May 1961. The model was used to determine peak runoff rates for existing conditions and the corresponding water elevations at each node. The delineation of all watersheds and the associated impervious coverage were determined from the City's archive drawings, site investigation and from the City's Geographical Information System.

b. A Type II Antecedent Moisture Condition (AMC II) was used. This describes the degree of wetness of the watershed at the beginning of the storm. AMC II is the standard used in watershed studies and it reflects an average condition (the soil is not dry nor is it saturated).

c. A Type II Rainfall Distribution was used. This distribution pattern has been determined by the Soil Conservation Service comparing regional rain-gauge data. The City of Chesterfield area falls in the area having a Type II rainfall distribution pattern.

d. A 256 Unit Hydrograph Peaking Factor was used for the Valley's hydrology due to the areas flat terrain and surface storage potential. This peaking factor was also rightly utilized in the past storm drainage computer models for the Chesterfield Valley. The SCS method allows for different peaking factors to be used. They range in values from 100 to 600. A 100 value correlates to swamps and a value of 600 correlates to mountains. The lower value implies water accumulates very slowly whereas, the higher values imply flash flood. Typically, a peaking factor of 256 would be applied to flat regions with mild slopes of 0.5% or less having significant surface storage (causing lower peak flows). The "Peaking Factor" is one factor that controls the watershed peak runoff rate and the way in which the volume of runoff occurs during a 24-hour storm. Essentially, the peaking factor controls the distribution of the volume of runoff during the period of the storm. The dimensionless unit hydrograph combined with the appropriate peaking factor affect the shape of the runoff hydrograph which is assigned to each node location on the channel.

e. The SCS Hydrograph Package was used to form hydrologic models of the existing conditions.

f. The hydrographs for each sub-watershed were merged into the computer model which models the hydraulic interactions of the contiguous drainage facility.

The computer model was used to predict runoff rates and maximum water elevations for the 24 hour, 100 year storm frequency design. This equates to a total rainfall of 7.0 inches over a time period of 24 hours.

3. Design Criteria

The 100 year 24 hour storm frequency was used to design all channels, pipes, and their respective control structures. The goal of the storm water master plan is to provide a design which would not increase the 100 year flood elevation with full build out conditions above the existing FEMA 100 year flood elevation; and in areas not in a flood hazard area, the water elevation may not exceed the existing ground level or the level of any surrounding structures. This issue could be resolved by importing a reasonable amount of fill material. Thus, the criterion is based upon collective engineering judgments.

Some modifications which will be considered in the design are to modify reservoir water levels, enlarging/replacing non-existent or under sized channels and pipes, installing regional reservoirs, installing/enlarging storm water pumping stations and filling the site to an appropriate elevation.

4. Background Information to Determine Watershed Characteristics

Drainage basins were determined for major watersheds. For existing sites, pervious and impervious coverage of each basin was projected from the current zoning, from the site design drawings or record information. For parcels to be developed in the future, pervious and impervious coverage's were projected assuming maximum development conditions allowed in accordance with the City's latest comprehensive plan, zoning ordinances and future land use maps. The composite curve number was based upon a ratio of pervious and impervious coverage to the total basin area. Existing soil conditions were determined from field reconnaissance and the Soil Survey of St. Louis County, Mo.

Existing time of concentrations were determined by calculating the time it takes for runoff to travel from the hydraulically most distant part of the watershed to the point of reference. Flow velocities within the channel sections were calculated using the channel geometry. Sheet flows, shallow concentrated flows and channel velocities were calculated using the TR-55 method (see Appendix A). Pipe flow velocities were determined by Manning's Equation. The ultimate time of concentration for each watershed was determined by summing the times of sheet flow, shallow concentrated flow and travel times through pipes and channels. The time of concentration calculations are shown in Appendix A.

The peak discharge for each basin was computed using the SCS Unit Hydrograph Method Computer Program by Advanced Engineering Technologies, Inc. Runoff was calculated for the 100 year, 24 hour storm (7.0 inches of rainfall in 24 hours) event with a 256 peaking factor.

E. TIME OF CONCENTRATION PROCEDURE

Time of concentration for the Chesterfield Valley area has been calculated using the SCS method. This method was the chosen method because of the ability to break the travel time into specified segments of travel for each development. All commercial and industrial basins have been assumed to have developed future conditions. Therefore all sheet flow was calculated based on an assumed graded parking lots with minimal shallow concentrated flow and the majority of flow concentrated in channels or pipes. Because of these assumtions, in undeveloped areas the travel time was dramaticly decreased from previous studies. For undeveloped areas a sheet flow slope was assumed to be between 0.01ft/ft to 2 ft/ft depending on the existing contours of the site. Sheet flow has been calculated using a maximum length of 300 ft in extremely large watersheds, but typically a 100 ft distance has been used. Overland flow has been calculated using the distance from the end of the proposed sheet flow to a point down hill where the flow becomes concentrated. Pipe flow has been calculated where the a proposed pipe is anticipated or when an existing constructon plan shows a pipe. Lastly, channel flow has been calculated using the proposed channel width, side slopes, and longitudinal slope as shown in the computer model. The depth of flow has been estimated based on past models average depth of flow for the area in question. Below are basic calculations used for the time of concentration in the Computer Model.

Sheet Flow

-flow over plane surfaces.

$$T_t = \frac{0.007\,(nL)^{0.8}}{(P)^{0.5}\,s^{0.4}} * 60$$

Where:

T_t = Travel time (min)
n = Manning's roughness coefficient (table 3-1)
L = flow length (ft)
P_2 = 2-year, 24-hour rainfall (in)
s = slope of hydraulic grade line (land slope, ft/ft)

Table 3-1 Roughness coefficients (Manning's n) for sheet flow

Surface description	n [1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses [2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods: [3]	
Light underbrush	0.40
Dense underbrush	0.80

1 The n values are a composite of information compiled by Engman (1986).
2 Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
3 When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

The simplified form of Manning's kinematic solution is based on:

(1) shallow steady uniform flow
(2) constant intensity of rainfall excess
(3) rainfall duration of 24 hours
(4) minor effect of infiltration on travel time
(5) maximum of 300 feet sheet flow

Shallow Concentrated Flow

-flow over plane surfaces

$$T_t = \frac{L}{V \times 60}$$

Where:

L = Length of Water Course

V = $a \times s^{0.5}$

s = slope of hydraulic grade line (land slope, ft/ft)

a = Coefficent A for equation

Coefficient a	
Shallow concentrated flow	
Alluvial fans	10.1
Grassed waterways	16.1
Small upland gullies	20.3
Paved	20.3

Pipe Flow

$$T_t = \frac{L}{V \times 60}$$

$$V = \frac{1.49\, r^{2/3}\, s^{1/5}}{n}$$

$$r = A/P$$

Where:

L = pipe length

s = slope of hydraulic grade line (pipe slope, ft/ft)

n = Manning's roughness coefficient

V = average pipe velocity (ft/s)

r = hydraulic radius (ft)

A = Pipe Area

P = Wetted Pipe Perimeter

Open Channel Flow

$$T_t = \frac{L}{V \times 60}$$

$$V = \frac{1.49\, r^{2/3}\, s^{1/5}}{n}$$

$$r = A/P$$

Where:

L	= channel length
s	= slope of hydraulic grade line (channel slope, ft/ft)
n	= Manning's roughness coefficient for open channel flow
V	= average velocity (ft/s)
R	= hydraulic radius (ft)
A	= Cross sectional flow area (ft^2)
P	= Wetted Channel Perimeter (ft)

Total Time of Concentration

Total Time of Concentration (min) = Sheet Flow (min) +
Shallow Concentrated Flow (min) +
Pipe Flow (min) +
Open Channel Flow (min)

Time of Concentration Assumptions

- Neglect Elevation difference due to levee.
- Direct runoff into channels
- Mimimal assumed slopes for overland flow
- 2-yr percipitation of 3.5 inches

F. CURVE NUMBER PROCEDURE

Curve Numbers were derived using Soil Conservation Surveys, land use plans (obtained from the City of Chesterfield) and field observation . The Soil Conservation Surveys have been classified into Types A, B, C, and D soils using soil descriptions. The Future Land Use Plan provided by the City of Chesterfield depicts a basic layout concept of future development and zoning. These zones have been classified into hydrological soil groups with assosiated curve numbers based on engineering judgement and experience. Below is the list utilized for the City of Chesterfield.

Land Use Curve Numbers

Zoning Abbrev.	Zoning Title	Hydrological Soil Group A	B	C	D	Assumptions
FP	Flood District Regulations					
PS	Park and Scenic Regulations	68	79	86	89	Open Space - Poor Condition
AG	Agricultural	57	73	82	86	Woods-Grass Combination (Orchard or Tree Farm) - Poor Condition
LLR	Large Lot Residence	51	68	79	84	20% Impervious Area
E-1	Residence District	51	68	79	84	20% Impervious Area
E-2	Residence District	51	68	79	84	20% Impervious Area
E-3	Residence District	54	70	80	85	25% Impervious Area
R-2	Residence	57	72	81	86	30% Impervious Area
R-3	Residence	61	75	83	87	34% Impervious Area
R-4	Residence	69	80	86	89	38% Impervious Area
R-5	Residence	77	85	90	92	65% Impervious Area
R-6	Residence	77	85	90	92	65% Impervious Area
R-6A	Residence	77	85	90	92	65% Impervious Area
R-6AA	Residence	77	85	90	92	65% Impervious Area
R-7	Residence	77	85	90	92	65% Impervious Area
R-8	Residence	77	85	90	92	65% Impervious Area
PC	Planned Commercial	89	92	94	95	85% Impervious Area
PI	Planned Industrial	81	88	91	93	72% Impervious Area

Revised June 3rd, 2003
[1]Curve number source - Urban Hydrology for Small Watersheds, SCS Technical Release 55, June 1986

The Future Land Use Plan was then overlayed with the soils map to derive a percent of soil per type of development in each basin. These percentages were then multiplied by the curve number and added to all other areas in the basin to find the composite curve number.

BASIN NAME	AREA (AC)	SOIL TYPE AREA (AC)				LAND USE DESCRIPTION	RUNOFF CURVE #				% OF LAND USED				COMPOSITE CURVE #
		A	B	C	D		A	B	C	D	A	B	C	D	
B4-04P	4.27	0	3.1	0	0	PLANNED COMMERCIAL (85% IMPERVIOUS) (PC)	89	92	94	95	0	72	0	0	[redacted]
[redacted]		0	1.2	0	0	STREETS AND ROADS: PAVED WITH CURBS AND STORM SEWERS	98	98	98	98	0	28	0	0	**94**

Curve numbers have been derived in accordance with the SCS TR-55 Method.

G. HYDROLOGIC SOIL CLASSES

This section of the report presents information on the various soil types encountered within the Chesterfield Valley and a general discussion of their impact on surface drainage.

The soil associations used in this study are described in a publication entitled "*Soil Survey of St. Louis County, Missouri*", prepared by the U.S. Department of Agriculture Soil Conservation Service.

The primary factors considered in rating the impact of soils on surface runoff are:

1. Texture of soil.
2. Degree of natural drainage or moisture content.
3. Presence or absence of bedrock, fragipan, or underlying layers of silty and clayey materials.

The ratings are based on the ability of the soils to absorb additional water from a long duration storm, assuming that the soils have been previously wetted and are at average (normal) saturation. It is also assumed that the soil surface is bare of vegetation. Length and gradient of slopes are not considered when rating the soils.

Four hydrologic classes of potential surface runoff are utilized, as discussed below.

<u>Class A – Low Runoff Potential</u>

Soils having low runoff of surface water. They have formed on deep deposits of sand and gravel material. The soils are coarse textured and draughty. Precipitation infiltrates into the soils rapidly and little surface runoff occurs. Sand and gravel materials also have the ability to store groundwater and reduce peak rates of runoff. These soils generally consist of course sand and gravel deposits of stratified drift. Sands and gravels are examples of Class A – low runoff potential soils.

Class B – Moderate Runoff Potential

Soils having moderate runoff of surface water. The soils are well-drained or moderately well-drained and do not contain layers which could restrict downward movement of water. They have finer textures in the surface and underlying soils than the soils placed in the above class. Therefore, less water infiltrates into them and more surface runoff occurs.

Class C – Moderate to High Runoff Potential

Soils having high runoff of surface water. The soils are well drained or moderately well-drained in the upper stratus but contain fragipan (hard pan) or silty and clayey materials within about 2 feet of the surface. These layers inhibit downward movement of water and the soil material above it is quickly saturated. These soils cannot absorb large quantities of water, leading to moderate to high runoff rates.

Class D – High Runoff Potential

Soils having very high runoff of surface water and consisting of soils with high water tables or shallow bedrock. Many of these soils are very poorly drained and are saturated practically all year. They occur in low lying areas and are usually directly connected to the surface drainage pattern. Infiltration rates are very slow due to the soils water logged state. Although the topography on which these soils occur may permit temporary ponding or a delayed contribution of stream flow, the total volume of runoff is very high.

The different soil associates of the valley are: Menfro, Gasconade, Goss, Crider, Fishpot, Elsah, Wilbur, Eudoro, Booker, Blake, Waldron, Sarpy, Parkville, Blake, Freeburg, and Gumbo. The hydrologic soil classifications ranged over the entire spectrum (A, B, C, & D) however, the majority of the soils fell in the B and D classifications. See the attached Soils Map Exhibit for Chesterfield Valley. With these classifications, the impact of soils on surface runoff is known. The composite curve number calculations can be viewed in Appendix A.

H. CHANNEL AND PIPE SIZING ANALYSIS

The initial channel and pipe sizing has been calculated to accommodate storm water drainage resulting from a 100 year rainfall event. This process consisted of delineating the total contributing watershed to said channel or pipe. Then the time of concentration and appropriate curve numbers for each watershed was then calculated. Using this information, the hydrology for the basin was calculated using the ICPR program to determine the basin flow through the channel or pipe section. The best section was then determined using the equations and procedures listed below. Once all proposed channel and pipe sizes were determined, the existing model was updated to include the new channel and pipe sizes. The model is executed and the output data studied in order to reduce or increase sizes where needed to prevent flooding while maintaining a buildable product. The steps are listed below:

1. Calculate CN, Tc, and area for the drainage basin at most upstream point in the analysis.

2. Calculate the max basin flow for each node using the ICPR program. (100-year, 24-hour storm)

3. After the flow for each node has been determined, channel and pipe sizing is calculated.

   A. Channel Sizing – has been calculated using two methods.
      i. Best Hydraulic Section – the cross section which simultaneously minimizes cross-sectional area and wetted perimeter.
      ii. Depth-Limited Procedure – in many situations, channel depth is restricted due to topography, existing building finished floor elevation, roadway elevations, etc. Under this condition, the channel bottom width is calculated. This analysis does not take into consideration the back flow from downstream nodes.

   B. Pipe Sizing – Using Manning's equation.

4. After the first link has been sized the process continues, but this time the flow is calculated for the next node in line. This basin will incorporate the area, soil types, and time of concentration from the previous basin/basins.

5. Once the channels have been sized according to upstream basin flows, the sizes and basin are entered into the ICPR program along with basins attached to their respective nodes. The computer model is executed, the results reviewed, the channel and pipe sizes are reviewed to identify inappropriately sized pipes and channels. The sizing inputs to the computer model are modified and the program is executed. This process is repeated until the optimum solution is achieved. This trial and error process is necessitated by the dynamics of the Chesterfield Valley's drainage network which consists of pipes, channels, reservoirs, pump stations and a fluctuating Missouri River water level.

I. PEAK RATES OF RUNOFF AND PUMP STATION SIZING

Peak Rates of Runoff

Ideally, the measurement of flood flows should be based on long-term stream flow gauging records for the area being studied. However, measurements for all watersheds is not feasible, therefore, the magnitudes and frequencies of peak rates of runoff are estimated by modeling the measurable watershed characteristics.

Runoff is affected by many variables such as infiltration, characteristics related to soil type, antecedent rainfall conditions, and type of vegetation cover, surface storage, season, and precipitation. Thus, obtaining the peak rates of runoff, one will find that the variance is substantial.

There have been many methods developed to synthesize storms. Many of these methods use different parameters to synthesize the storm. They differ in accordance with region, size of watershed and variables of the watershed.

For this investigation, the City of Chesterfield generated all hydrologic information with the aid of the ICPR v3.0 computer model. This model was formed by dividing sub-watersheds into basin areas at a node. Hydrographs were generated for the 100-year, 24-hour storm (7.0 inches of rain fall in 24 hours) for each of the basins.

Water Surface Profile

The Chesterfield Valley's proposed storm water model was used to estimate the water surface elevations for the 100-year, 24 hour storm. The hydraulic model was established by utilizing detailed GIS information. With this information input into the model, flow profiles were generated which considered unsteady flow, flow reversals, pumping cycles and flood routing throughout the entire 100 year, 24 hour storm event.

For a rough approximation of the pump sizes a constant pump efficiency was assumed. Note that this is not the case when head varies as in a pumped reservoir. For final sizing the pumps operation curve must be used for routing the inflow hydrograph. Here the stage-discharge expression will solve for fluid power, as a basis for pump sizing. The resulting Fluid Power Equation is as follows:

$$P_f = \frac{(Q)}{8.81N}(Z_2 - Z_1 + \frac{522\,(Q/N)^2}{D^4}\ _2\ \frac{(12\,fl+Ke)}{D}$$

$$TDH = Z_2 - Z_1 + \frac{522(Q/N)^2}{D^4}\ \frac{(12\,fl+Ke)}{D}$$

Where	P_f	=	Fluid Power (HP @ 100% efficiency)
	TDH	=	Total Dynamic Head (ft)
	Q	=	Discharge (CFS)
	N	=	No. of parallel, identical pipes/pumps
	Z_2	=	Downstream water surface elevation
	Z_1	=	Upstream water surface elevation
	D	=	Pipe Diameter (in)
	f	=	Darcy - Weisbach friction factor

l	=	Pipe Length (ft)
Ke	=	Aggregate minor loss coefficient

Selections of the number and size of pipes were made, and power per pump was computed. With these results, search data was searched to determine the best combination based on economics and operating criteria. After preliminary sizing, the sizes were input into the computer model and fine tuned using a trial and error routine.

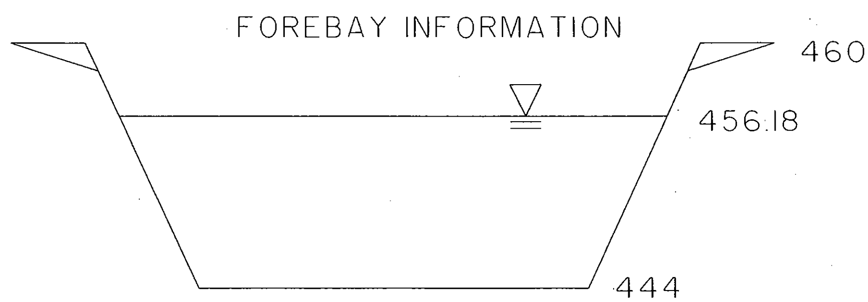
<u>Chesterfield Pump Station Size</u>

Watershed # 7

Objective: To size the storage basin for the Valley's West End, given the maximum pump station (size is 300 CFS).

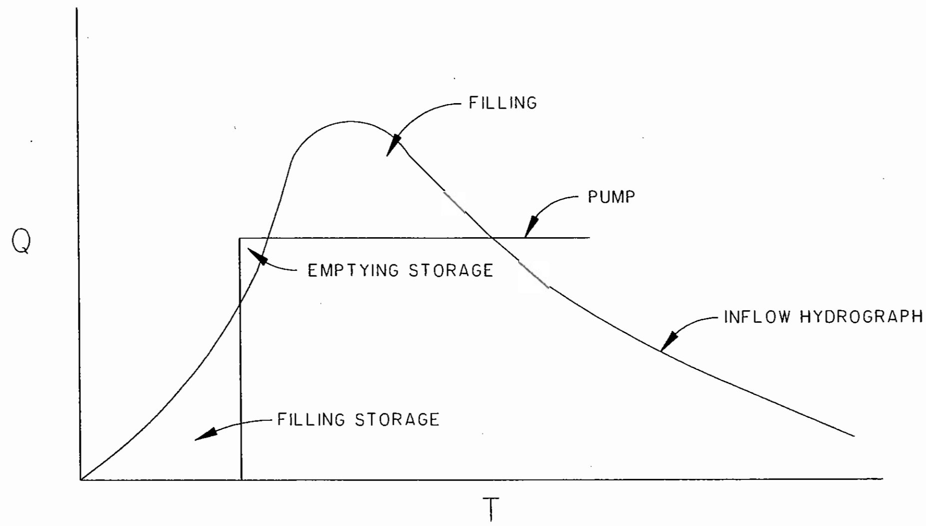
Given:

Qp	=	1,360 CFS (100 Year)
CN	=	90
Tc	=	130 Minutes
Area	=	1,397 Acres. Change to 1,850 acres due to North Air Field added to acreage.
Pump Size	=	300 CFS
Tail Water	=	Assume no tailwater – as directed by City of Chesterfield. At elevation 443.



Box Culvert = 444.44

Tailwater (2 yr) 453.8 → Drop it to 443.



Calculation: Storage $= \frac{100}{CN} - 10$

$= \frac{1{,}000}{90} - 10 = 1.11$ inches of infiltration

$$\text{Runoff } Q^* = \frac{(P - 0.2\underline{S})^2}{P + 0.8\underline{S}} = \frac{\left(7 - 0.2X1.11)^2\right)}{7 + 0.8 \text{x} 1.11} = 5.8 \text{inches}$$

Time to Peak =

$$\frac{Vol.}{1.37\,Qp} = \left[\frac{(1{,}397\,ac)(5.8\,in.)}{(1.37)\left(1{,}361\frac{Ft^3}{Sec}\right)}\right]\left[\left(\frac{1\,ft}{12\,in.}\right)\left(43{,}560\frac{ft.}{ac}\right)\right]\left(\frac{1\text{ min.}}{60\text{ sec.}}\right) =$$

Tp = 262 minutes

Knowing Qp = 1,361 Ft^3/sec and Qo = 300 Ft^3/sec

$$\frac{Qo}{Qp} = \frac{300}{1{,}361} = 0.22 \Rightarrow$$

From Estimating Aid $\frac{S\,Req}{Qp\,Tp} = 0.7740$

$$S\ Req. = 0.7740 \times 1{,}361 \times 262 \times 60\ \frac{Sec}{Min} = 16{,}560{,}000\ Ft^3 = 380\ Ac\text{-}Ft.$$

Box Culvert Outfall = (3) each 7' X 7' @ 0.04%

Chesterfield Study

Original Feasibility Report

Watershed			Total DA sq miles	pump size cfs	Storage ac-ft
1	1.154				
2	0.758				
3	0.208				
4	1.507	3 & 4	1.715	222.5	293.1
5	0.385		0.385	44.5	9.3
6	0.739		0.739	133.5	47
7	3.069	1,2 & 7	4.981	273.5	800.8

New analysis

Watershed				Total DA sq miles	pump size cfs	Storage ac-ft
1	1.154					
2	0.758					
3	0.208	new	2,3,.2(7)	1.5798	285.3901	300
4	1.507	Same		1.507	195.5146	257.552
5	0.385	Same		0.385	44.5	9.3
6	0.739	Same		0.739	133.5	47
7	3.069	Modified	1 & .8(7)	3.6092	198.1763	580.2544

J. FINDINGS AND PROPOSED IMPROVEMENTS

The City of Chesterfield's approach to their storm water master plan will well serve the complete development of the Chesterfield Valley. Most community drainage systems are installed as a hodge-podge of individual drainage systems-designed without attention to comprehensive planning. These types of evolved drainage network results in systems with non-uniform sizes, locations, elevations and longitudinal slopes. These hodge-podge systems directly result in flooding, erosion, expensive drainage retrofit projects and management nightmares. The City of Chesterfield's master planned system will safely accommodate drainage for interior storms up to the 100-year, 24-hour frequency. Interior flooding has been identified as the basis of design, since it's the City's responsibility to properly manage the drainage which they have control over. Flooding caused by the Missouri River is well outside the control of Chesterfield and therefore was not included in the analysis. The 100-year, 24-hour storm frequency is used as the basis of design to be in line with Federal Emergency Management Agency standards which where established by Congress in 1973. (Many communities utilize a smaller storm and suffer the consequences). Ultimately, this master plan will save the tax payers of the City of Chesterfield significant cost and aggravations, and may likely, save developers land and cost as well.

The storm water master plan has been calculated through the use of a valley wide drainage computer model. The computer model mimics the drainage interactions of the system as a whole. Thus, the interconnections of the system are reflected in the drainage system. The resulting master plan is optimized by taking advantage of the drainage interconnects and strategically located reservoirs to minimize channel, pipe, and pump station sizes.

Sizing of the drainage network has been performed to accommodate maintenance. For example, to minimize erosion along the channel banks, a 4:1 side slope is recommended and is depicted on the plan. The slope is due to the poor soils conditions. In addition, box culverts longer than 200 feet have been sized to be 7 feet tall to allow mechanical cleaning of the culverts. Also, it must be pointed out, where possible, a single large pipe is recommended in lieu of multiple smaller pipes due to the maintenance issue. This approach has attempted to minimize potential drainage installation costs, without sacrificing maintenance issues. The thought process is, cost doesn't matter if the outcome does not work. Also as with all systems, drainage systems require routine maintenance.

Within this report, the best tools are the maps which identify the master planned pipe and channel sizes, locations and elevations.

Each watershed is affected by not only changes made in the hydrologic characteristics of that watershed, but also by the changes made to other interconnected watersheds. Below is a list of the changes made to the model to either help the hydrologic situation or to more accurately depict the "real life" characteristics of the area. The attached 100-year flood elevation map gives a graphical summary of the maximum water elevations at the nodes. Detailed findings of the Final Model per watershed are listed below.

Watershed 1: This 184 Acre watershed has been added to the model so that proposed improvements in the stormwater master plan are sized to serve overflow from Watershed 1. Watershed 1 flows include runoff from the mainly vegetated bluff with elevations ranging from 677 feet to 463 feet and soils primarily of the Type B classification. This runoff is caught in a low area between the bottom of the bluff and the existing rail road track embankment. The main outfall for the bluff drainage is through an existing closure structure with a 24" opening installed as part of the railroad system.

The main drainage outfall follows a variety of channels to Centaur Chute. The closure structure must be manually operated to close or open. Typically, the structure remains open, but may be manually closed in the event that Centaur Chute is anticipated to backflow and flood the Valley. Currently, there are six (6) separate pipe locations under the railroad tracks to drain Watershed 1 into the Valley area. The 6 locations and respective pipe sizes follows:

1-18" – R2-13C
1-20" – R2-10P
2-24" – R2-11C, R2-11P
1-30" – R2-11CA
1-RR BOX – R2-13PA

The drainage from Watershed 1 is collected by the master planned channel in Watershed 2 and routed to the proposed pump station (R237-PUMP). The 6 separate railroad pipe crossings are located at node N1-02P, then routed through the 6 parallel pipes and added to the appropriate node. These pipes are considered silt free for model purposes. From site observations, the pipes are not currently clear of silt as the model assumes. Thus, as with all systems, it is imperative each segment of all drainage networks have a perpetual maintenance program implemented.

The proposed build-out of Watershed 1 is designated as single family future development. Therefore in order to calculate the drainage characteristics of Watershed 1 at complete build-out, the curve numbers and hydrologic parameters were calculated for full development with single family units. These assumptions will produce a higher curve number and a smaller time of concentration than the current conditions of the area. It is important to recognize that the proposed flows are based on fully maintained pipes under the existing railroad tracks and a full build-out scenario upstream of the pipe crossings. The calculated drainage flows are intended to estimate the future flows for Watershed 1, and accommodate full build-out drainage of the Valley area.

Watershed 2: Watershed 2 is currently relatively undeveloped with mainly farmland and open space. Currently only a natural drainage network exists in the watershed. The future land use for the property is identified as Planned Industrial. The watershed is approximately 540 acres. Elevations range from 464 to 453 feet with existing soil types spanning the entire range from sandy to fine silty clays according to the soil survey. A site visit showed mostly gumbo soil types in this watershed. Therefore, the curve numbers have been calculated using this site visit observation of C and D type soils.

The storm water master plan within Watershed 2 differs from past recommendations. As shown on the proposed master plan map, the drainage within this area is interconnected with other watersheds and is linked to a regional storm water pumping station within Watershed 7. This optimizes the drainage network by allowing drainage to flow in multiple directions and take advantage of the complete drainage network as a whole. Previous models had the drainage within this watershed flowing exclusively through the airport to Bonhomme Creek which results in spot flooding throughout the watershed.

The proposed channel locations in this storm drainage master plan have been designed to follow property lines where possible. This has been done to minimize impact on property as much as possible. The curve numbers for this area have been calculated based on a future land use of planned industrial with a 72% impervious cover. Time of Concentration has been calculated with the assumption of lots graded to create a perpendicular flow path directly into the channels. A series of pipe crossings from Watershed 1 have been added to the most south channel in the watershed to account for additional drainage from the bluff. No recommendations have been made to convey bluff runoff across Eatherton Road and into the proposed channels. The channel network has been graded to flow in the north and east directions in Watershed 2.

The watershed consists of the area located between the existing levee to the west, the bluff to the south and Eatherton Road to the west. This basin flows north and/or east into Watershed 7 with a final outfall through reservoir N237-RES and out of the Valley using either the gravity pipe R237-BNDY and/or the pump station R237-PUMP. The watershed has a natural high point located in the middle of the watershed. Channels must cut through this high point and will appear deep. The channels must maintain a slight down hill slope in order to drain upstream areas. As proposed developments are submitted for approval, individual revisions to the channel top width will need to be reviewed for possible adjustment. A cut-off wall of some sort is recommended for all channels 10' deep or more that are within 400' of the levee. This wall will minimize the effects of piping that may occur under the levee due to hydrostatic pressure differences. A reservoir has been proposed at node N2-18P to reduce flooding in this area due to low ground elevations. A series of pipe crossing have been added to the channels to account for future road crossings. These crossings have been added at strategic locations in order to more accurately determine the maximum water elevations at total build out. It will be necessary to update the model on an on-going basis to accurately reflect as-built conditions.

Watershed 3: Watershed 3, like Watershed 2, currently consists of predominantly farmland and open space. The drainage area is approximately 239 Acres with elevations ranging from 480 to 445. The soils in this watershed are slightly more absorbent than those of Watershed 2 and have therefore been classified as Type B soils. Past models showed spot flooding occurring to elevation 461. Currently only a natural drainage exists in this area. The Final Model proposes a primary drainage network that will flow to the west with an outfall through the proposed pump station R237-PUMP located in Watershed 7. This area has been designated as Planned Commercial with 85% impervious area. This classification will increase the curve number and decrease the time of concentration. The time of concentration has been calculated assuming lots being graded to the channel. This increased development and impervious coverage will result in higher flows through the channel network. The channels have been sized to receive a small portion of overflow drainage from Watershed 4, but not to accept the entire watershed. Pipes have been sized for this area to gain access to the northern section of the watershed and to direct flow under Olive Street. The proposed channel is located in the middle of the basin, and flows from east to west. Small bleeder ditches are possible along Old Olive Road to the main ditch to the north. Culvert crossings have been added to the master model to account for future potential road crossings. It will be necessary to update the model on an on-going basis to accurately reflect as conditions.

Watershed 4: Watershed 4 is partially developed with commercial buildings; the undeveloped areas have been designated as Planned Commercial – 85% impervious throughout except for the existing athletic complex. The drainage area is approximately 853 Acres with hydrologic soil classifications B & D, moderate to no percolation. The elevations in this watershed are between 482 and 444 feet.

The master planned channel has been realigned in the area between the Chesterfield Exchange and Long Road to flow north of the parcels along Highway 40. Channel R4-42C has been added to the model as a 10' flat bottom channel with a 3:1 side slope on the north side of the channel and a vertical wall on the south side to accommodate the existing structures on the site. All channels running north/south in this area are now directed to flow north into this relocated channel. This change will move water away from the area quickly. The Chesterfield Exchange site has a maximum water elevation of 455.5. This elevation will inundate the back parking lot 0.5 ft if the site is not raised from the existing proposed parking lot elevation. Because of this, it is recommended that the site be raised 1 foot on the undeveloped portion. This will then increase the warning elevation to 456 in this area, therefore enabling the channel and pipe sizes to remain as they presently exist. This area has been updated to match the approved construction plans. Two additional 10' flat bottom channels and culverts have been added near the Chesterfield Exchange site to show a more accurate picture of the full build out stages. The proposed channel south of the culvert crossing on these bleeder channels have been modeled as stage area. Existing nodes along the main channel have been moved to accommodate this addition.

Areas north of Highway 40 have been updated to include culvert crossings for all undeveloped parcels which are Planned Commercial areas. Large parcels have two future crossings and smaller parcels have one future crossing as suggested by the City of Chesterfield. Channel widths have been increased from previous models based on the increased flow rates brought about by the decreased time of concentration and increased curve numbers that result due to the increased developments. Between nodes N4-OEPE and N4-SGP a 7X7 box has been proposed. The box will be two feet below the existing bottom of the channel to provide future cleanout accessibility and also to aide with future flows. It is assumed that adjacent lots will tie directly into the box for the stormwater discharge.

The Chesterfield Valley Athletic Complex shows an additional, future culvert crossing. This second culvert crossing has not been built yet but has been added to the model as 4-36" RCP to keep stages at a reasonable level up stream. The Athletic Complex accommodates a high volume of dry detention so this crossing will be updated with a functional equivalence study at the time of construction to illustrate the size that will be installed. Future crossing have been added to the east of the Athletic Complex before the existing Watershed 4 pump station to give parcel access. One crossing for small parcels and two crossings for larger parcels has been added to the model. These crossings have been sized to accommodate the proposed future flows. Location and length may change due to development design and will be updated to accurately reflect as-build conditions. It is proposed to connect the channel between the two pump stations (R4-PUMP and R4-PUAC) to relieve overly strained areas with interconnecting channels. Channel widths from N4-80P to N4-15C have been re-graded to give a more consistent flow line and to divert flow to both pump stations N4-PUAC and N4-PUMP. Interconnecting channels will relieve the strained areas more quickly and also aid in case of a pump failure.

Based on the review of the Valley Village plans it was determined that the warning stage elevation could be increased, and the existing bleeder ditches could be incorporated into the model. Therefore this change has been updated in the Final Model. To better utilize the existing culvert crossing under Hwy 41/60, the existing channel has been regraded to direct additional flow into Watershed 3. Additional drainage to Watershed 3 was not possible considering the channel elevations in watershed 4; however, the interconnection will improve the Valley Village area. Other existing channels in this area added to the proposed Master Plan may also reduce the maximum flow elevation.

An existing interconnection between Watersheds 4 and 6 has been added to the model. This temporary connection is between N4-34P and N6-69P to help drain water to the existing pump stations and to help prevent excess flooding in the future. This connection exists on site and has now been added to the model. All over bank stage areas have been removed in areas of flooding nodes because of this change.

Watershed 5: Currently, Watershed 5 consists predominantly of undeveloped land, excluding the Summit Ice Complex. The area is primarily zoned as Non Urban. The Watershed is not interconnected to the majority of the valley and has a drainage area of 250 acres. The elevations are as high as 472 in the middle region to 450 in the southernmost parts. The soils have moderate to non-existent percolation rate with soil classifications falling between Type B and D.

All drainage flows south-east following Highway 40. A proposed pump station is located in the south corner of the watershed. This pump station will pump storm water over the levee from the proposed reservoir. Culvert crossing have been added to all parcels, larger parcels have two crossings. The channel has been lowered two feet to minimize the channel width throughout. Currently the floodplain in this area is set for non-levee protected flooding based on the Missouri River. These elevations may be increased when an amendment to the floodplain map is completed. The Booker study required a reservoir and one pump in this watershed. These features are still needed in the proposed model with the addition of two more 40 cfs pumps for full build out. It has been determined that additional pumps and a lower channel are the most cost effective way to provide positive drainage for Watershed 5.

Watershed 6: Watershed 6 consists predominantly of developed commercial property with elevations ranging from 472 to 447 feet. The watershed is 535 acres with soil classification Type D. Previous models indicate spot flooding in the Chesterfield

Commons West and St. Louis Family Church areas. These problems have been alleviated in the Final Model in several ways. First, a reservoir has been added northwest of the St. Louis Family Church site that will give the area more time to drain. Second, an existing culvert crossing R6-85C has been reversed to provide flow from the west side to the east side of the basin. This area currently has full flowing channels throughout the lower areas. St. Louis Family Church has been updated in the model to complement the as-built drawings provided by the City of Chesterfield.

An additional culvert has been added to Chesterfield Commons east of Chesterfield Commons Drive. This culvert is attached to node N6-34P which will drain to the west and ultimately through pump station N6-PUMP. This channel behaves as a reservoir in the model so it has been remodeled and the node map has been updated to the appropriate graphical representation.

Node N6-RES2C has been removed from the model and combined with N6-RES2B. This change was made after reviewing the area to find that the two nodes were acting more like a reservoir than the channel that is was modeled as. The new alignment has been graphically updated in the node map.

Proposed pump station R237-Pump, provides relief for Watershed 6 by accepting more flow from Watershed 7. Because of this, more flow from Watershed 6 can flow to the west to reduce the maximum stages in the low lying areas. This diversion allows R72-Pump to pump water from a smaller drainage area; therefore the maximum water level throughout has decreased.

Several functional equivalencies have been done in this area. These functional equivalencies have proposed some small channel realignments to Chesterfield Commons West. Watershed 6 is currently near complete development; therefore minimal changes were made to the Final Model. The basins have been delineated for each basin/node. New curve numbers and time of concentrations have been calculated based on existing or proposed construction drawings. To maintain the assumptions made throughout the model, the basin information for existing portions of Watershed 6 were recalculated. This provides consistency and is more accurate. Because of this recalculation, curve numbers and time of concentration are not comparable to the past models.

It is important to note that Watershed 6 has reached channel capacity in several areas. This implies the channels are no longer strictly conveying the stormwater runoff from the sites. Instead, some channels are acting like reservoirs to store water until the downstream structures are able to accept additional water. This situation will result in dramatic differences in water elevations if construction is different from the master plan.

Watershed 7: Watershed 7 currently is about half developed and has a future land use designation of Airport-Industrial-Commercial. There is a golf course on the south side of the watershed that has been designed to store water during the 100 year design storm. This area has been designated to be Airport-Industrial but it has been determined the area will stay as golf course for stormwater purposes. There is existing dry detention storage between the runways and throughout the watershed. The watershed area is 2,468 acres with elevations ranging from 472 to 448. The Soil Survey shows a mixture of hydrologic soil type B, C, and D. The FAA requires that all channels in Watershed 7 must be empty within 48 hours of any storm. This is to discourage any water fowl from inhabiting the area.

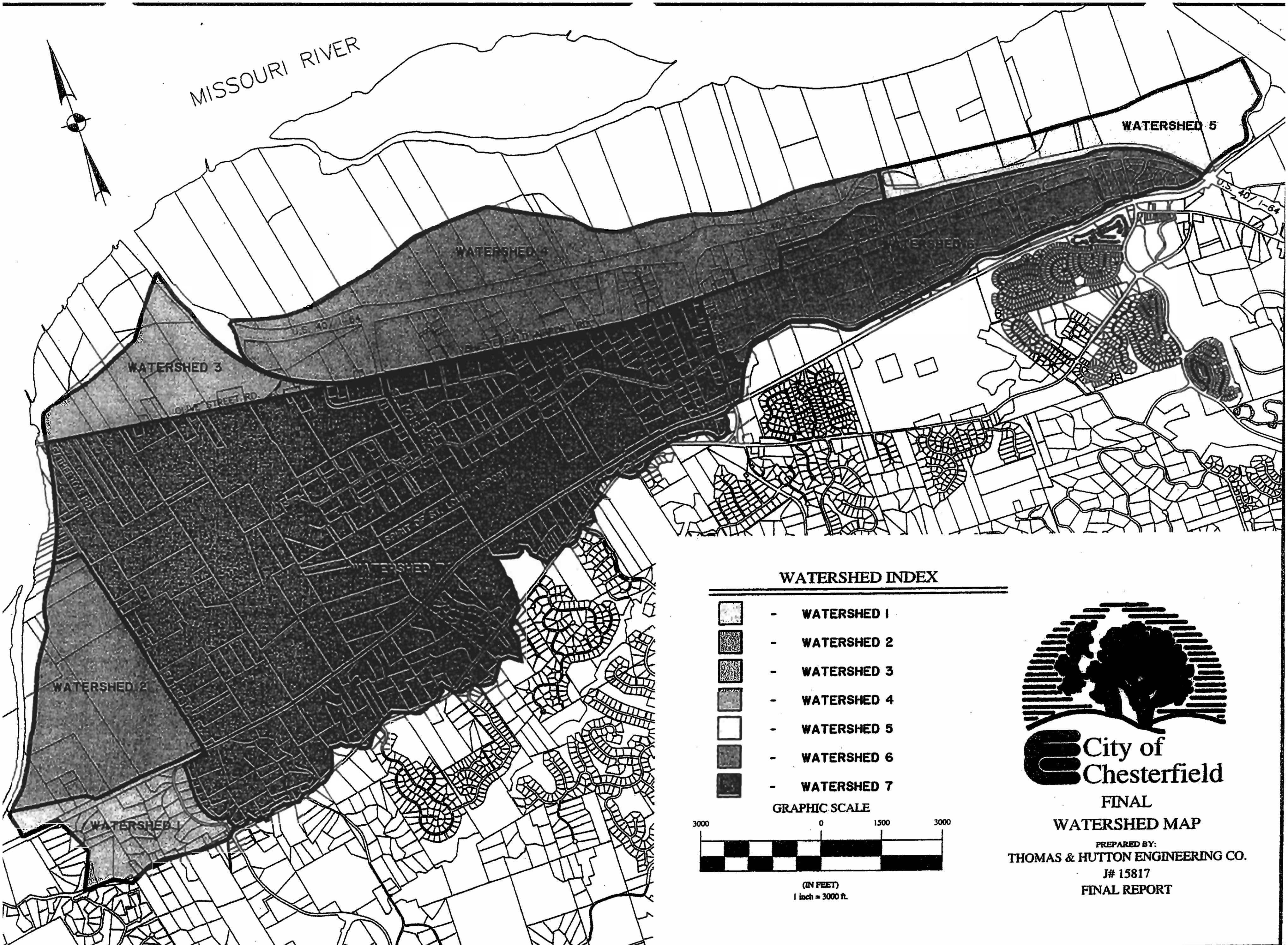
Previous models were designed to drain Watersheds 2 and 7 westwardly to the Watershed 7 pump station located near Watershed 6. The Final Model proposes a pump station located in the northwest corner of Watershed 7. Existing channels have been graded to flow to the east but it is presumed that future channels designed and built by the airport will drain to the west. A functional equivalency will be done at the time of design to update the model to the as-built information in the future. This change may change current elevations through out Watersheds 2, 3, 7 and 6.

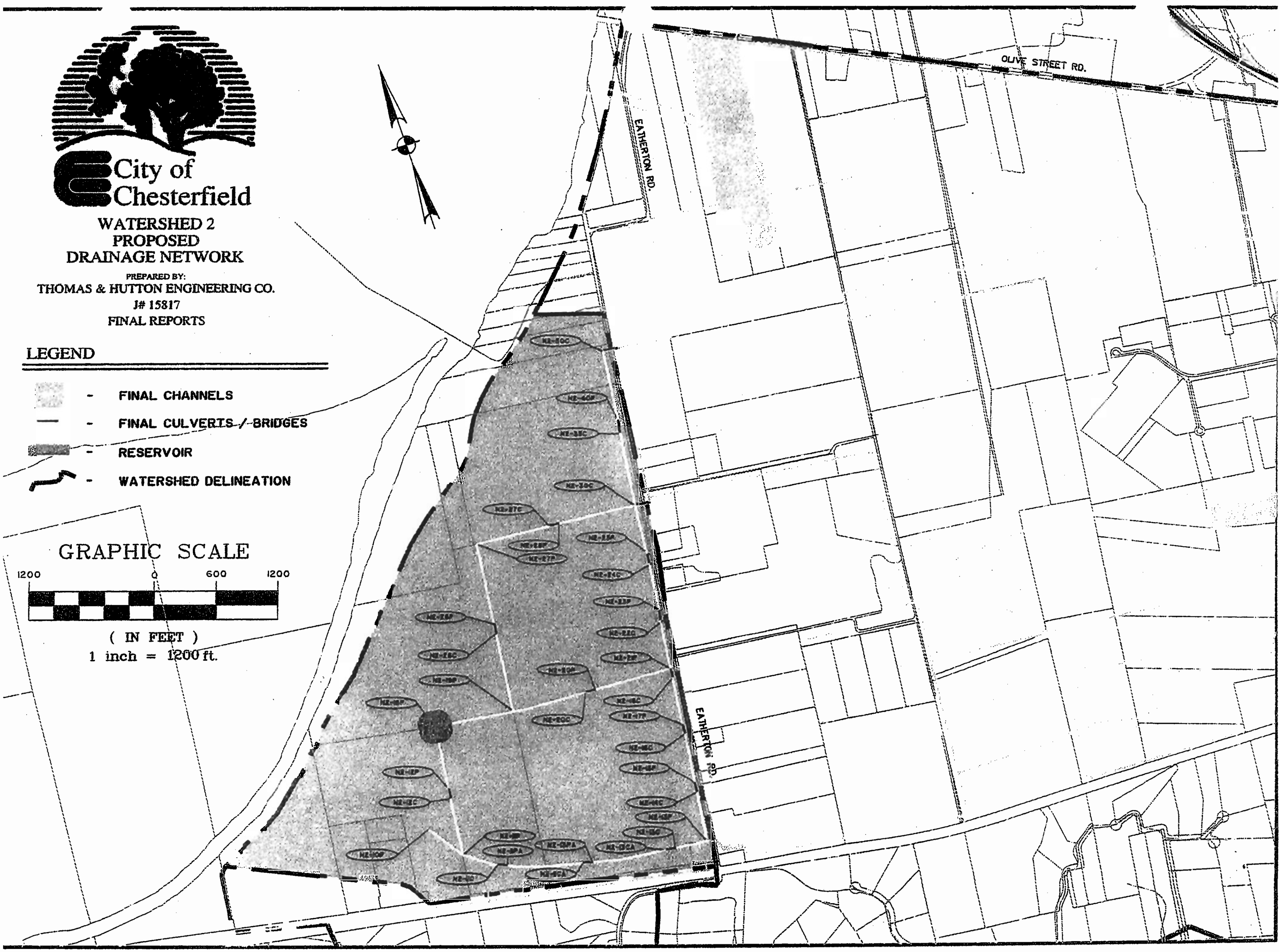
Currently, the Final Model proposes adding pump station R237-Pump to handle drainage from watersheds 2, 3, and the west portion of Watershed 7. This pump station will also handle overflow water that will drain into Watershed 7 through interconnections. There have been several channel realignments in the western portion of the watersheds. These channels have been relocated to follow existing property lines and utilize existing land slope where possible. Links R79-41P and R7-WCP have been reduced to a 100' flat bottom from the previous 300'. This was possible due to the split in flow to the new pump station. The north airfield has been reconfigured per request by the Spirit of St. Louis Airport. There is some localized flooding in this area, but there is potential for modification at a later date. Some isolated flooding occurring in the Final Model may not be as extensive as the model shows, due to several small channels and conveyance systems on the airport's property that have not been added to the Final Model. The changes in the golf course areas will have a large effect on stages in this area if the storage is reduced.

The North Airfield may be relieved of existing flooding if the area were to be regraded to flow to the west, towards proposed pump station N237-Pump. There is also additional storage in this area that is not being represented in the model. The North Airfield functional equivalencies show a warning stage of 465. Based on the FEMA Flood Maps and the existing contour data these warning stages have been reduced to follow the procedures used throughout the Valley.

The proposed channels on the west end of the watershed have been drawn schematically and moved to graphically show the centerline of the channel that will allow for the top of bank cross-sectional width within the property when adjacent to existing roadways. Pipe crossings around the proposed pump station have also been reviewed and reduced to provide flow capacities for the flow shown in the Final Model. If the airport redirects its flow west, these pipe sizes may need to increase. One crossing per parcel has been added to the area to provide driveway access from Olive Street Road onto the parcels. The basins have been delineated to give each node a proposed basin. This direction may alleviate existing flooding in the developed parts of Watershed 7. As in Watershed 2, Watershed 7 also has a natural high area located in the middle of the watershed. A proposed channel is to be installed through the hill and will appear deep. The channels must maintain a slight down hill slope in order to drain upstream areas. As proposed developments apply for approval, individual revisions to the channel top width must be reviewed for possible adjustment.

Model Utilization: The use of the computer model will provide the City of Chesterfield with a guide to assist in the layout of the city's comprehensive drainage network. The model includes sizes of ditches, pipes, reservoirs and pump stations to serve as a guide. In addition, the computer model states elevations to construct the drainage network, as well as the longitudinal slopes. As with all master plans, they must be perpetually updated to reflect ever changing conditions. This may be easily accomplished by developers submitting functional equivalency studies (plans & hardcopy calculations) for projects that differ from the master plan. It is recommended the City of Chesterfield's representative review the equivalency studies and update the model to determine acceptability. Sharing the computer model with the developer is recommended, however, under no condition, should the City replace their computer model with a developers or other outside source (electronic swapping or data omissions may occur). This perpetual updating and utilization of this tool will insure the City protects the public from flooding during internal storms with a up to 100-year, 24-hour frequency or less.


MISSOURI RIVER
WATERSHED 5
U.S. 40 / I-64
WATERSHED 4
WATERSHED 6
WATERSHED 3
WATERSHED 7
WATERSHED 2
WATERSHED 1
WATERSHED INDEX
- WATERSHED 1
- WATERSHED 2
- WATERSHED 3
- WATERSHED 4
- WATERSHED 5
- WATERSHED 6
- WATERSHED 7
GRAPHIC SCALE
3000 0 1500 3000
(IN FEET)
1 inch = 3000 ft.
City of Chesterfield
FINAL
WATERSHED MAP
PREPARED BY:
THOMAS & HUTTON ENGINEERING CO.
J# 15817
FINAL REPORT


City of Chesterfield
WATERSHED 2
PROPOSED
DRAINAGE NETWORK
PREPARED BY:
THOMAS & HUTTON ENGINEERING CO.
J# 15817
FINAL REPORTS
LEGEND
- FINAL CHANNELS
- FINAL CULVERTS / BRIDGES
- RESERVOIR
- WATERSHED DELINEATION
GRAPHIC SCALE
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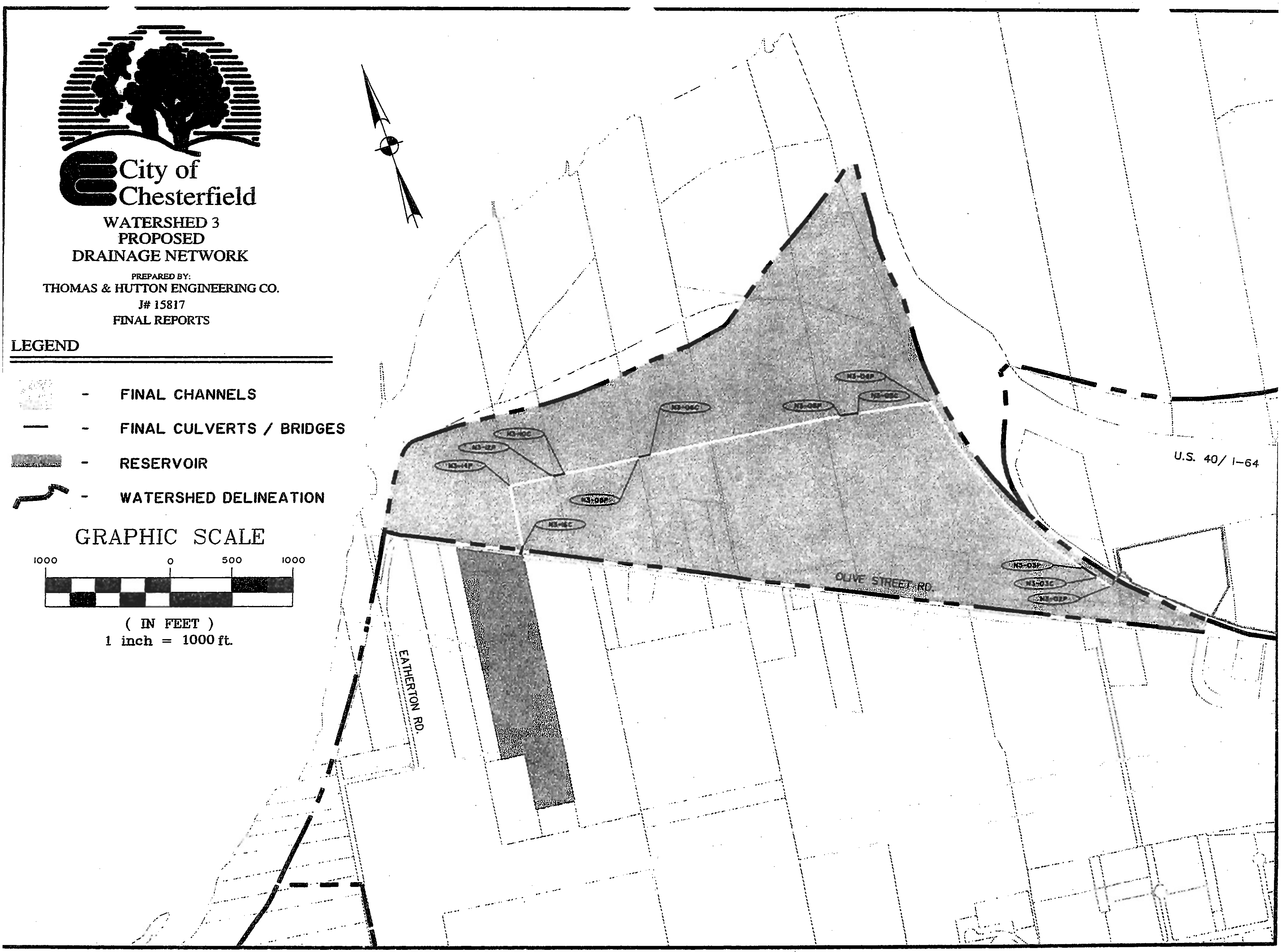
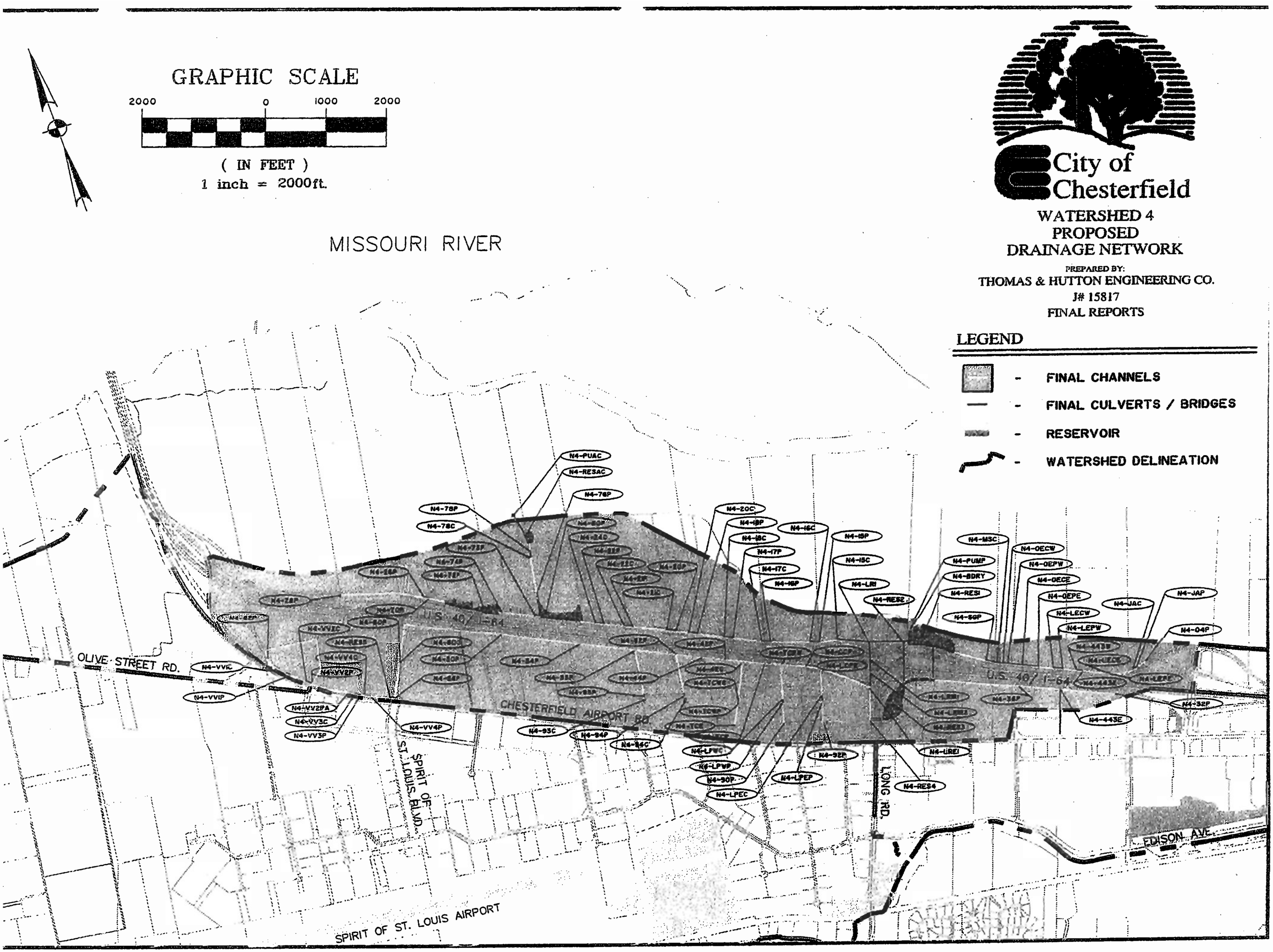
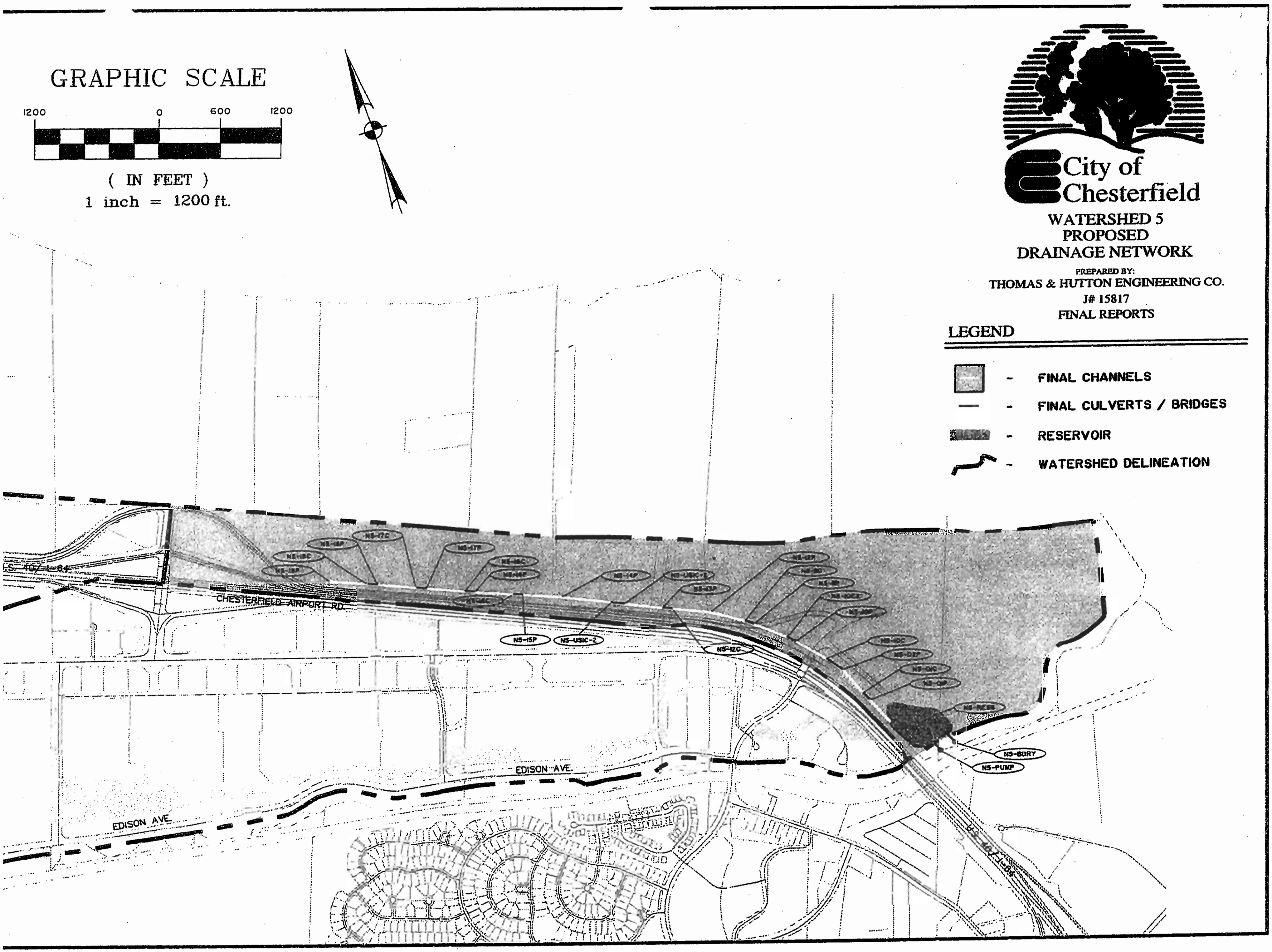
0
600
1200
(IN FEET)
1 inch = 1200 ft.
OLIVE STREET RD.
EATHERTON RD.
EATHERTON RD.

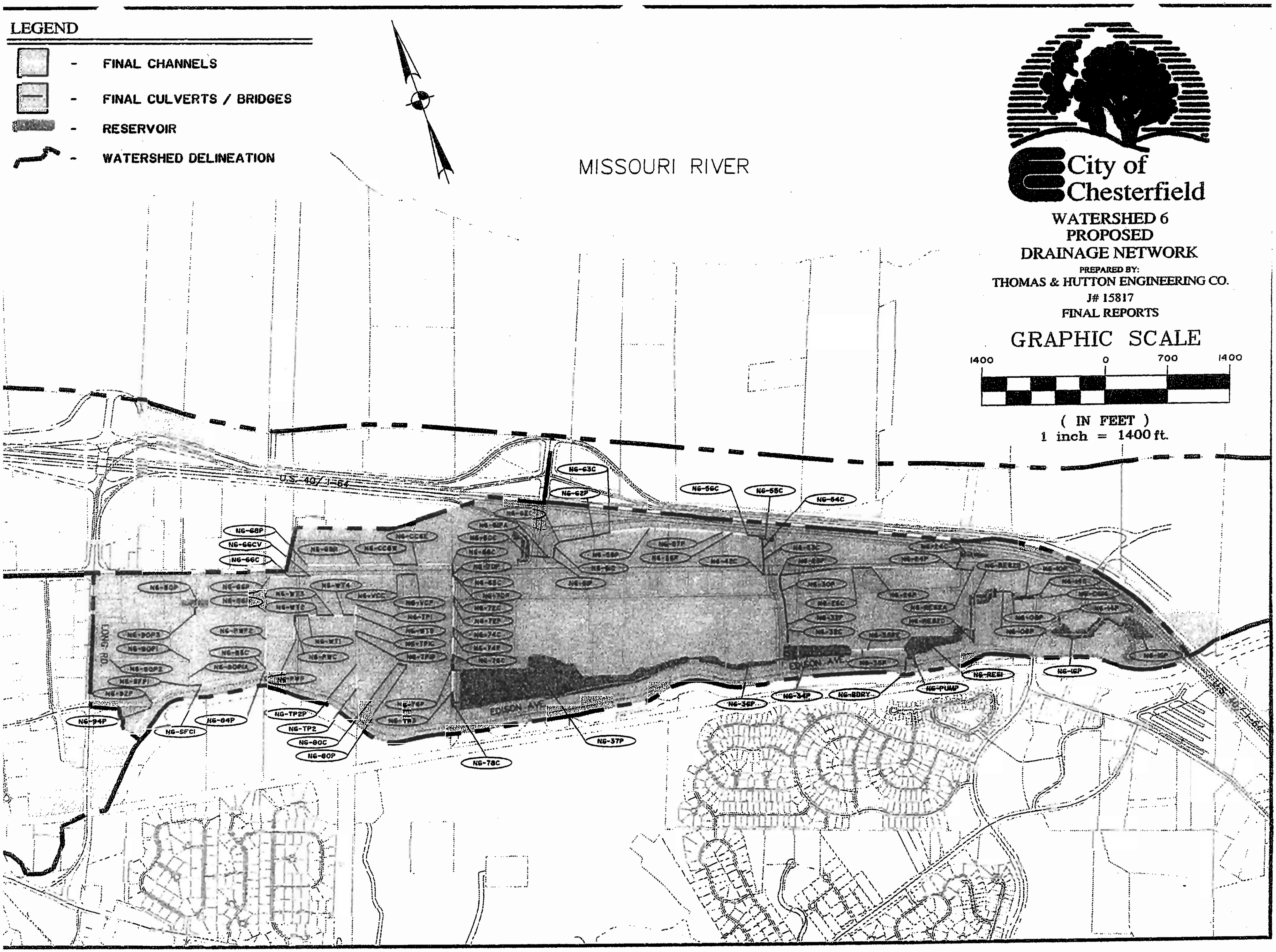

City of Chesterfield
WATERSHED 3
PROPOSED
DRAINAGE NETWORK
PREPARED BY:
THOMAS & HUTTON ENGINEERING CO.
J# 15817
FINAL REPORTS
LEGEND
- FINAL CHANNELS
- FINAL CULVERTS / BRIDGES
- RESERVOIR
- WATERSHED DELINEATION
GRAPHIC SCALE
1000
0
500
1000
(IN FEET)
1 inch = 1000 ft.
U.S. 40/ I-64
OLIVE STREET RD.
EATHERTON RD.



GRAPHIC SCALE
2000 0 1000 2000
(IN FEET)
1 inch = 2000ft.
MISSOURI RIVER
City of Chesterfield
WATERSHED 4
PROPOSED
DRAINAGE NETWORK
PREPARED BY:
THOMAS & HUTTON ENGINEERING CO.
J# 15817
FINAL REPORTS
LEGEND
- FINAL CHANNELS
- FINAL CULVERTS / BRIDGES
- RESERVOIR
- WATERSHED DELINEATION
U.S. 40/ I-64
CHESTERFIELD AIRPORT RD.
OLIVE STREET RD.
SPIRIT OF ST. LOUIS BLVD.
SPIRIT OF ST. LOUIS AIRPORT
LONG RD.
EDISON AVE.
N4-PUAC
N4-RESAC
N4-76P
N4-78P
N4-78C
N4-20C
N4-16C
N4-15P
N4-15C
N4-LRI
N4-17P
N4-17C
N4-RES2
N4-MSC
N4-PUMP
N4-BDRY
N4-RESI
N4-OECW
N4-OEPW
N4-OECE
N4-OEPE
N4-LECW
N4-LEPW
N4-JAC
N4-JAP
N4-04P
N4-32P
N4-443E
N4-VVIC
N4-VVIP
N4-VV2PA
N4-VV3C
N4-VV3P
N4-VV4P
N4-93C
N4-94P
N4-94C
N4-LPWC
N4-LPWP
N4-90P
N4-LPEC
N4-LPEP
N4-92P
N4-UREI
N4-RES4



GRAPHIC SCALE
1200
0
600
1200
(IN FEET)
1 inch = 1200 ft.
City of Chesterfield
WATERSHED 5
PROPOSED
DRAINAGE NETWORK
PREPARED BY:
THOMAS & HUTTON ENGINEERING CO.
J# 15817
FINAL REPORTS
LEGEND
- FINAL CHANNELS
- FINAL CULVERTS / BRIDGES
- RESERVOIR
- WATERSHED DELINEATION
CHESTERFIELD AIRPORT RD.
EDISON AVE.
EDISON AVE.
N5-15P
N5-USIC-2
N5-12C
N5-BDRY
N5-PUMP


LEGEND
- FINAL CHANNELS
- FINAL CULVERTS / BRIDGES
- RESERVOIR
- WATERSHED DELINEATION
MISSOURI RIVER
City of Chesterfield
WATERSHED 6
PROPOSED
DRAINAGE NETWORK
PREPARED BY:
THOMAS & HUTTON ENGINEERING CO.
J# 15817
FINAL REPORTS
GRAPHIC SCALE
1400
0
700
1400
(IN FEET)
1 inch = 1400 ft.
U.S. 40/I-64
EDISON AVE.
LONG RD.
NG-63C
NG-62P
NG-56C
NG-55C
NG-54C
NG-68P
NG-66CV
NG-66C
NG-94P
NG-SFCI
NG-84P
NG-TP2P
NG-TP2
NG-80C
NG-80P
NG-78C
NG-37P
NG-36P
NG-34P
NG-BDRY
NG-PUMP
NG-RESI
NG-16P


City of Chesterfield
WATERSHED 7
PROPOSED
DRAINAGE NETWORK
PREPARED BY:
THOMAS & HUTTON ENGINEERING CO.
J# 15817
FINAL REPORTS
GRAPHIC SCALE
2000
0
1000
2000
(IN FEET)
1 inch = 2000ft.
LEGEND
- FINAL CHANNELS
- FINAL CULVERTS / BRIDGES
- RESERVOIR
- WATERSHED DELINEATION
OLIVE STREET RD.
CHESTERFIELD AIRPORT RD.
U.S. 40 / I-64
LONG RD.
EATHERTON RD.
SPIRIT OF ST. LOUIS BLVD.
SPIRIT OF ST. LOUIS AIRPORT
N7-93C
N7-93P
N7-94C
N7-94P
N7-95C
N7-97C
N7-97P
N7-98C
N7-99C
N7-99P
N7-91P
N7-96P
N7-NA21
N7-NA22C
N7-NA22P
N7-88P
N7-87C
N7-75P
N7P-41P
N7-TCC
N7-TCP2
NST-2P
N7-TCP3
N7Z-PUMP
N7Z-BGRY

MEMORANDUM

Date: January 10, 2006

To: Mike Herring, City Administrator

From: Brian McGownd, Deputy Director of Public Works/ Assistant City Engineer

Re: Chesterfield Valley Stormwater Master Plan

Thomas & Hutton has completed the "Point in Time" Chesterfield Valley Stormwater Master Plan dated December 2005. Therefore, **as directed by the Public Works/Parks Committee at their meeting held on August 2, 2005, the master plan can now be forwarded to City Council for formal acceptance and adoption via the attached resolution.**

Attach to this memo is a copy of the minutes from the August 2, 2005 Public Works/Parks Committee meeting, as well as a copy of the Final Report which includes an Executive Summary.

As previously stated in Mr. Geisel's memo dated July 22, 2005, copy of which is attached, it is important to note that our relationship with Thomas & Hutton will continue for the foreseeable future as the master plan evolves and as the Valley continues to develop.

If you have any questions, or need additional information regarding this matter, please advise.

SEE RESOLUTION 326

1/11/06

cc: Mike Geisel, Director of Public Works/City Engineer

(1)

City of Chesterfield

DATE: August 5, 2005

TO: Michael G. Herring, CA

FROM: Mike Geisel, DPW\CE

SUBJECT: Meeting Minutes, PW\Parks 8/2/05

A meeting of the Public Works/Parks Committee began at 5:45 p.m. on Tuesday, August 2, 2005. Those in attendance included Chairperson Barry Streeter (Ward 2), Councilmember Dan Hurt (Ward 3) and Councilmember Mary Brown (Ward 4). Also in attendance were Mike Herring - City Administrator, Mike Geisel – Director of Public Works/City Engineer, Bonnie Hubert – Superintendent of Engineering, Darren Dunkle – Superintendent of Parks, Recreation and Arts, Councilmember Casey (Ward 3) who came in toward the latter part of the meeting, Tom Rothwell of the Parks, Recreation and Arts Citizen Advisory Committee (PRACAC), Jean Favara representing the U.S. Fish and Wildlife's Big Muddy preservation project, and Chris Kehr of Kehr Development.

*** To be discussed at the 8/15/05 meeting of City Council.**

***Agenda Item #1*:** **Councilmember Brown moved and Councilmember Hurt seconded to approve the minutes of the August 2, 2005 meeting. The motion passed, 3 – 0.**

***Agenda Item #2b*:** Mr. Tom Rothwell of the PRACAC discussed the logistics the committee had developed relative to a September Stroll event designed to celebrate the opening of the Pathway on the Parkway, including a walk, entertainment, vendor exhibits, concessions and to develop a sense of community. The date proposed for the event is Saturday, September 24, 2005. The Committee suggested that the opening of the Pathway on the Parkway be cited on the flyer. **Councilmember Brown motioned to authorize PRACAC to proceed with the event as planned. The motion was seconded by Councilmember Hurt and passed, 3 – 0.** The City will print the flyers the PRACAC needs and Mr. Rothwell with meet with the City Administrator to discuss any proposals regarding sponsorships or need for the City to send official letters.

***Agenda Item #3*:** Mr. Geisel updated the Committee on the status of the Chesterfield Valley Master Storm Water Plan. Final quality assurance work is being completed for the model that reflects improvements as proposed at this point in time, and the model will be forwarded to City Council for approval as soon as that work is completed. The plan is a living document that will be updated continuously as improvements are installed or modified; however, it is important to officially adopt the model at key points in time. The model and the storm events modeled in it are used in negotiations with the Levee District and Corps of Engineers regarding the design of the levee and pump stations throughout the Valley. In response to questions, Mr. Geisel indicated that slightly over $500,000 had been spent to date in development of the current model, that expenditures of up to $700,000 has been authorized to date, and that he anticipates approximately $1,000,000 to be spent on the model as development in Chesterfield Valley continues. There are currently four pump locations in the Valley, consisting of three with 60,000 gallon per minute capacity and one with 10,000 gallon per minute capacity. Two large pump stations and one small additional pump station are planned. $935,000 in EDA Disaster Relief funds were used in 1995, to leverage local funding from the TIF district after the Great Flood of 1993 for construction of the 3 existing stations at a total cost of $3,500,000. The Monarch Chesterfield Levee District is the regional drainage authority and the pumps were subsequently turned over to them and are now owned, controlled and operated by the Levee District. The City incurs no costs for operation of the pumps. Future pumps will be built primarily with federal funding through the Corps of Engineers, with TIF funding being used to expedite construction or fund the incremental cost of upsizing a facility from that which serves the storm event utilized by the Corps of Engineers. **Councilmember Brown moved, and Councilmember Hurt seconded, to receive and file the Chesterfield Valley Master Storm Water Plan report. The motion passed, 3 – 0.** The final report will be forwarded to City Council for approval and adoption once the quality control work on the model is completed.

Agenda Item #2d – a and b: Mr. Geisel reported that only due to the cooperation and assistance of the Monarch-Chesterfield Levee and the monumental effort put forth by Engineering and Parks Division personnel, for the City to successfully place more than 100,000 cubic yards of engineered fill at the west end of the Chesterfield Valley Athletic Complex (CVAC) as well as to get bermuda sod placed and rooted such that new soccer and football fields were open for play by August 1. All those involved performed at peak levels in order to deliver this portion of the project in such a short timeframe. Football practice began last night. Mr. Geisel reminded the Committee that the fill placement was necessary because the sand berm traversed through the middle of the property, resulting in a large amount of unusable acreage due to grade differences. By bringing the entire area south of the sand berm to the level of the sand berm, the City gained several acres of premier field space. In addition, due to ongoing discussions with the representatives of the football leagues, the master plan has been adjusted such that football activities will permanently remain at the west end of the CVAC. In addition, practice fields will be constructed outside of the main levee protected area that will result in less costly field use for football users. These fields outside of the main levee protected portion of the CVAC will not be maintained to the same degree that is expected for the rest of the CVAC. Master site planning for the CVAC also includes upgrade of the existing emergency access road at the toe of the levee, such that it could be used to facilitate emergency access, additional parking, and better traffic flow. Expanding the existing roadway makes the most efficient use of space and minimizes road construction costs. Access is still provided across City property to the Big Muddy conservation area and the wetlands at the CVAC that were constructed outside the levee. Ms. Jean Favara, a master naturalist representing the Big Muddy Fish and Wildlife Service indicated their support of the work the City has done outside the levee and appreciation of the speed with which the work was able to be accomplished. She requested information regarding the timeline for construction of the improved access to the parking lot for the Big Muddy area and was told work was in progress and should be completed within 2 weeks.

After discussion regarding the need to clarify the intent and use of the open play area proposed at the east end of the CVAC – specifically that it is not to be used for organized teams who have the use of the sports field available to them – and for staff to keep in mind the Committee's desire to have the amount of open space increased, **Councilmember Brown motioned to approve the CVAC Master Plan. The motion was seconded by Councilmember Hurt and passed, 3 – 0.** Mr. Geisel noted that except for the Maintenance Facility, nothing on the newly acquired land was identified as a Tier 1 priority and construction of those facilities was not imminent; however, staff would continue to identify opportunities to maximize the return on the City's investment in facilities at the Complex.

Agenda Item #2.d.b: Mr. Geisel reviewed the proposed Way Finding and signage plan for the Chesterfield Valley Athletic Complex.. The plan includes a hierarchy of signs starting with three project level signs incorporating changeable message boards providing highway visibility and information, to primary and secondary roadside directional and information signs, parking aisle identification, complex portal monuments, quad identification and field identification signage. The Committee discussed concerns about the need for easily interpreted signs and label systems indicating type and locations of fields, a directory providing an overview of the Complex, size of signs relative to those permitted for other properties in the area, and a memo generated by the Department of Planning regarding the wayfinding\signage plan. The Committee expressed general support for the plan but suggested that the project level signs be reduced in height such that they were comparable with other developments previously approved by the City. The Committee also suggested that quad identifiers correlate with the athletic activity, such as "F" for football for ease of communication.. Staff was directed to proceed with the plan, but to modify the plan with the specified suggestions for Committee approval.

__Agenda Item #2.c__: Mr. Geisel summarized his memo of July 22, 2005 regarding conceptual planning for a proposed 2006 Independence Day fireworks display. He indicated that in order to have a fireworks show on July 4, 2006, proposals for a pyrotechnic contractor need to be sought as soon as possible and a contract needs to be executed this fiscal year. Accordingly, the purchase order has to be written in the 2005 fiscal year, which will require a supplemental appropriation in an amount estimated to be $40,000 - $45,000. The funds would then be brought forward to the 2006 fiscal year, in which they would be expended. The 2006 budget would likewise include an appropriation for the 2007 event. **The Committee expressed support and directed Staff to continue efforts towards a 2006 fireworks display. The Committee confirmed that the City sponsored display would be in addition to the annual funding provided for the fireworks display planned by the Chamber as part of the City's birthday celebration.**

Relative to park land acquisition, both Ward 3 Councilmembers expressed their support for moving forward with acquisition of previously identified park land in Ward 3 as the next priority. After discussion, it was determined that this item be added to the Executive Session for the September 7, 2005 meeting of City Council.

__ Agenda Item #2.a__*: Mr. Geisel reviewed his memo of July 22, 2005 regarding the Parks Master Plan, which has been updated to reflect the work associated with the passage of Proposition P. **Councilmember Brown moved and Councilmember Streeter seconded to forward the Parks Master Plan to the City Council with this Committee's recommendation for approval. The motion passed, 3 – 0.**

__Agenda Item #4__: **Councilmember Brown motioned and Councilmember Streeter seconded, to approve construction of the private streets in Nooning Tree Addition, Village A subdivision. The motion passed, 3 – 0.**

__Agenda Item #5__: Mr. Geisel summarized his memo of July 26, 2005 concerning a potential lease for a communications tower at the Public Works Facility. After discussion regarding the adjacent property, which is currently approved for construction of a communications tower, the City's prior efforts in following the rezoning process for the original construction of the Public Works Facility and City Hall, the need for public input into the process, and the potential income of approximately $1,100 per month for the lease, it was determined that the City could not react in the timeframe required by the service provider, and the Committee elected not to pursue the matter further.

The meeting was adjourned at 7:20 pm

Cc: Mayor John Nations
Department Heads/Executive Staff

DATE: July 22, 2005

TO: Mike Herring, CA

FROM: Mike Geisel, DPW\CE

SUBJECT: Stormwater Master Plan

As previously committed, Staff is prepared to update the Public Works\Parks Committee relative to the progress and current status of the Chesterfield Valley Stormwater Master Plan, as prepared by the City's Valley stormwater consultant, Thomas and Hutton. We have received a final draft of the plan and Staff is currently performing quality assurance\quality control review. Given the frequency of the Public Works\Parks Committee meetings, it is anticipated that the current Master Plan will be in a condition that it may be forwarded to the City Council for formal adoption prior to the next Committee meeting. As such, in order to maintain a common understanding, facilitate maximum exchange of information, and to assure that Staff's actions continue to represent Council direction, **I recommend that we update the Public Works\Parks Committee at their upcoming meeting, such that the Chesterfield Valley Stormwater Master Plan, when the final QA\QC has been completed, can be forwarded directly to City Council for formal acceptance and adoption.** I've included selected text and exhibits from the current master plan for informational purposes. The full text and exhibits are available, but are simply too voluminous to reproduce for committee discussion.

It should be noted, that the Stormwater Master Plan is continuously changing, as it is revised to reflect each specific individual development, reflect those improvements associated with the 500-year levee project, and as individual improvements are constructed. City Council has authorized cumulative expenditures from the TIF Special Allocation Fund to Thomas and Hutton in an amount not to exceed $700,000 for engineering services related to the Valley Master Stormwater Model. This work was originally initiated in 2003 and the first item of work was to re-create the model in its "then present state" to validate and eliminate any structural errors. Once that portion of work was completed, Thomas and Hutton has worked continuously to update our model, create a point-in-time model, and re-engineered the drainage scheme proposed for the westernmost portion of Chesterfield Valley.

It should be noted that we will continue to have an ongoing consulting relationship for the foreseeable future and we will continue to request periodic funding authorizations as necessary until the drainage system is complete. Thomas and Hutton has revised, updated, and validated our

INTRODUCTION

Flooding in Missouri between 1989 and 1998 caused $3.5 billion in property damages and tragically killed 64 people. St. Louis County was declared a federal disaster area 5 times during this same time period. It is possible for the City of Chesterfield to experience flooding by rising water from the Mississippi and Missouri Rivers, or from falling water (rainfall). This study focuses on flooding which occurs from rainfall and not the Missouri River (The City of Chesterfield has no control over flooding caused by the Missouri River but can control flooding caused by rainfall). The objective of this report is to determine the flood elevations throughout Chesterfield Valley for a 100 year rainfall event for existing conditions and to prepare a drainage master plan to accommodate fully developed, future conditions according to the City's adopted Comprehensive Plan. This report presents and recommends a stormwater master plan for Chesterfield Valley – Chesterfield, Missouri. The Chesterfield Valley Storm Water Master Plan, once adopted will serve as a tool to reduce future flood risks safely and with sound floodplain management, a requirement of the National Flood Insurance Program. The report summarizes the work performed, findings, and recommendations for managing the quantity of stormwater in the valley.

A. BACKGROUND

The City of Chesterfield is located twenty-two miles west of St. Louis, Missouri, along the western edge of the St. Louis County metropolitan area. Incorporated in 1988 and covering approximately 32 square miles, the City of Chesterfield is a thriving community with a population of 46,802 (US Census 2000). Development within the city is guided by a comprehensive plan adopted by the city in 1990 and updated through the years when deemed appropriate. The area of focus for this project is Chesterfield Valley.

The western corridor of the City of Chesterfield is known as Chesterfield Valley. The Chesterfield Valley watershed is approximately 4,500 acres surrounded by a levee system that keeps the valley dry when the Missouri and Mississippi Rivers flood. Elevations within the valley range from 432 feet (next to the Missouri River) to 470 feet at the levee. The internal storm water master plan will act as a guide to ensure that the storm drainage system design for future developments will comply with the City's adopted comprehensive master plan. An annual rainfall of 56 inches and the rapid development within Chesterfield Valley are two factors that weigh heavily in the storm water master plan. Exhibit A presents a location map showing the Chesterfield Valley boundaries, major watersheds, upland areas, and roads.

Since the City of Chesterfield has been incorporated, it has been proactive in preparing and maintaining storm drainage master plans. The history of the long list of storm drainage computer models prepared for the City follow:

B. PURPOSE

The City of Chesterfield may flood by rising waters from the Missouri or Mississippi Rivers; or from localized rainfall. Chesterfield Valley is a levee protected community of approximately 4,500 acres. Portions of the Chesterfield Valley are considered 'Special Flood Hazard Areas' by the federal government. A Special Flood Hazard Area (SFHA) is defined as an area of land that would be inundated by a flood as a result of a 100-year rain event (or a flood having a 1% chance of occurring in any given year). A SFHA realizes the need for building restrictions to minimize potential loss of life/property and the economic benefits to be derived from floodplain development. Development may take place within the SFHA, provided that development complies with local floodplain management ordinances, which must also meet the minimum Federal requirements. The levee has both negative and positive impacts on the Chesterfield Valley. The purpose of the levee is to keep rising waters from the Missouri River from inundating the Chesterfield Valley area. To the contrary, the levee also dams water on the inside and doesn't allow gravity flow of storm water into the Missouri River when the river is low. Therefore, it is an obligation of the City of Chesterfield to establish a master storm water drainage system that can be adopted and enforced to protect the property owners from the possibility of rising waters inside the levee when a storm of 7.0 inches of rainfall occurs in 24-hours (interior 100-yr design storm event). To participate in the Federal Flood Insurance Program FEMA requires an adopted and enforced floodplain management ordinance that reduces future flood risks to new construction in special flood hazard areas. The final storm drainage computer model – Chesterfield Valley Storm Water Master Plan, will be one of the planning tools to assist the City of Chesterfield in qualifying for the National Flood Insurance Program. This project focuses on the analysis of localized rainfall flooding and <u>not</u> flooding caused by the Missouri and Mississippi Rivers.

This report has been prepared to serve as a planning tool for the management of water courses and surface water runoff. The study has considered aesthetics, hydrology, hydraulics and regulatory requirements. Sound flood plain management, efficiency and safety are all major considerations for the future potential growth of the Chesterfield Valley area. To assist in preparing this report, Thomas & Hutton Engineering Co. created maps of the existing drainage inventory within the City of Chesterfield. Information pertaining to the utilities was compiled from the most reliable sources of information available. Archives, record drawings or City provided information was used as the source of information. The drainage inventory consists of a map and a data base. The map shows the storm drainage facility locations and respective node number. The data base lists all pertinent information such as elevation, size, length, etc. for each node number.

The ultimate reasons for the Valley's Drainage Study were:

1. Guide future developments' drainage system designs to comply with the City's adopted Comprehensive Plan.

C. SUMMARY

The original drainage computer models have been updated and validated to include present day existing channels and structures and to better project future developments and drainage networks to accommodate full build out conditions. The final model takes into account existing flood plain elevations within the Valley as well as projecting new floodplain elevations based on future developments. This project focuses on preparing a final storm drainage computer model to assist in the comprehensive drainage plan for the Chesterfield Valley. Typically, drainage systems are assembled as a hodgepodge of mismatched storm piping, ditching and pumping which are often a direct cause of flooding. However, with a comprehensive approach and proper maintenance, storm drainage systems can be functional, reliable, safe, include sound flood plain management and straightforward to expand as the community grows.

The products for the final storm water model are to serve the complete Chesterfield Valley Area. The products consist of:

1. Node/Link map for each watershed
2. GIS database which includes storm drainage Nodes and Links
3. Warning stage/water elevation Map
4. Methodologies for calculating drainage parameters
5. Recommended drainage master plan reflecting pipe, channel, pump station sizes, inverts and locations to accommodate full build-out conditions.

The final computer model displays the proposed Chesterfield Valley Storm Water Master Plan to fully accommodate the 100 year storm (7.0 inches of rain in 24 hours). The master plan will be a planning tool to guide future storm drainage designs to be properly interconnected and work efficiently as a complete watershed storm drainage system. It is recommended to reference the results of this study, as it maybe revised from time to time, as part of the City's adopted Comprehensive Plan. as a planning tool.