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ENGINEERING REPORT

Head Homes Subdivision
Drainage Improvements

PREPARED FOR:

City of Lebanon Engineering Department

PREPARED BY:

Neel-Schaffer, Inc.

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Introduction

It has been reported that several properties near the intersection of Newbell Street and Rev. Harry Alexander Boulevard suffered flood damages during the May 2010 flood. Storm water runoff from the area generally bounded by C.L. Manier Street to the north, Beard Avenue to the east, Newbell Street to the south, and McGregor Street to the west, drains into a sinkhole located on the large parcel owned by Lebanon Church of God. This sinkhole is part of a system of sinkholes that generally drains north-northwest and empties into Sinking Creek just north of the City square.

The City of Lebanon commissioned Neel-Schaffer, Inc. to perform a comprehensive drainage analysis of this area in order to identify conceptual drainage improvements that will help reduce flooding. The following report describes methodology utilized and results obtained in the drainage analysis. In addition, both structural improvements and routine maintenance items were identified, and preliminary estimated project costs are included.

Field Review

The field review began at the south corner of Rome Pike. From the 16-inch corrugated metal pipe (CMP) cross drain, water flows into a catch basin at the north corner of Floral Street, which drains to a 6-inch reinforced concrete pipe (RCP) running east along East High Street. Further east on East High Street, water drains into a 24-inch RCP cross drain and emptied in a ditch running south along the property line behind Inman Court (through Ferguson Enterprises). The ditch flows into a 24-inch cross drain, which also collects run off from street flows of Inman Court, Inman Loop, and Inman North Stub, and then flows into another ditch flowing south. At East Main Street, the ditch and street runoff flows into a 30-inch RCP connected to a 2-foot by 6-foot catch basin. The catch basin then empties into a ditch that flows into another 3-foot by 2-foot catch basin that empties into another ditch flowing into a 3-foot by 9-foot catch basin at Reed Street. The catch basin drains into a ditch along the property line that flows into a catch basin at Glover Street. The catch basin empties into a 24-inch RCP cross drain that flows into another catch basin. The catch basin empties into a ditch running south along the property lines at C.L. Manier Street, through a series of catch basins, and empties into the large sinkhole described above. During an interview with a resident at 630 C.L. Manier Street, the resident stated that this area (including a significant amount of Glover Street lots) flood excessively with heavy rains.

Water also drains into the sinkhole from a 36-inch RCP at Head Court, which flows into a ditch that runs along the property lines at Beard Avenue and through a series of catch basins and storm sewers that outfall in the back yard of 222 Beard Avenue. Near Rev. Harry Alexander Boulevard, the area between the lots and the sinkhole is particularly flat and is often flooded with a moderate amount of rain. The property at 222 Beard Avenue (which contains the outfall of the storm sewer described above) is not allowed to drain properly to the sinkhole due to a berm at the back of the property.

Further south, at Tennessee Boulevard, water is collected in two catch basins on either side of the street and emptied into a ditch flowing west into a small creek. The creek also collects water from Wheeler and Newbell Streets, and flows south through a series of ditches and catch basins. On East Market Street, water flows south down to East Main Street from a 12-inch CMP through a series of ditches and catch basins. There are also several small sinkholes located throughout the limits of the project area, but their connectivity to the main drainage system is unclear.

Watershed Description

The watershed covers an area of approximately 143 acres (0.22 square miles), and extends from Carthage Highway southwest to a sink hole located south of C.L. Manier Street and west of Beard Avenue. The primary point of interest is the sink hole, which receives runoff from the entire watershed.

Sub-basins for the watershed were delineated to provide a realistic estimation of the storm water runoff. The sub-basin boundaries were estimated based on the 5-foot interval topographic mapping provided by the City, and from information obtained during the field review.

The hydrologic model used in this analysis in HEC-HMS, developed by the U.S. Army Corps of Engineers. The Soil Conservation Service (SCS) method was used to compute storm water runoff for various frequency recurrence intervals. The SCS procedure is based on land use, soil data, and other topographic features which together are used to estimate the runoff potential (known as the runoff curve number) at each area of interest.

Land use within the watershed was determined from aerial photography and information gathered during the field review. Land use is residential and commercial, with the commercial areas located adjacent to Carthage Highway. Hydrologic Soil Group data was obtained from the NRCS. Runoff curve numbers within the watershed range from 84 to 87. This reflects the relatively uniform urbanization within the watershed. A summary of the hydrologic parameters is presented on Figure 1.

Analysis and Recommendations

During the technical analysis, it was determined that during significant storm events exceeding several inches per hour, the amount of storm water runoff exceeds the capacity of the sinkhole system. Therefore, the water backs up and begins to submerge the outlets of the pipes draining across C.L. Manier Street and Beard Avenue and into the Church of God parcel containing the sinkhole. Therefore, the storm sewer systems cannot convey the 2-year storm runoff without inducing backwater onto adjacent properties.

Structural Drainage Improvements

Two alternatives were evaluated to add storm water storage around the sinkhole on the Church of God property. The first alternative consists of minimal excavation and disturbance of the sinkhole, and will add approximately 11.4 acre-feet of storage. The second alternative consists of aggressive excavation and lowering of the sinkhole throat (inlet) elevation. The second alternative will add approximately 27.3 acre-feet of storage.

Better reduction in flood levels is achieved with the more aggressive alternative 2, but it should be noted that neither of the alternatives may be feasible due to property acquisition constraints and unknown subsurface conditions. Therefore, it is recommended to investigate the possibility of acquiring a drainage easement from the Church of God. It should be emphasized during property negotiations that upon completion of the excavation activities for either alternative, the property could still be utilized for various purposes such as picnic and recreational areas, and can be enhanced with landscaping to hide the sinkhole.

If property acquisition is determined to be feasible, it is recommended to perform a geotechnical analysis prior to performing any construction activities. If test borings indicate that karst topography is present within the proposed excavation zone, then it is not recommended to perform the excavation project due to the possibility of damaging the sinkhole and causing cave-ins.

In addition to the two alternatives for excavating the area around the sinkhole, a third alternative was analyzed for the property at 222 Beard Avenue, consisting of installing a surface drain and 30 linear feet of 24-inch RCP that will penetrate beneath the berm and drain into a proposed 30-foot-long swale that will create positive drainage toward the sinkhole. This alternative will only reduce nuisance flooding for this residence, and is not intended to solve regional flooding issues in this project area.

A description of the proposed alternatives and preliminary estimated project costs are shown below. The following costs include engineering/design fees and provision for 20% contingency:

Structural Alternatives (See Figure 2)	**Preliminary Estimated Project Cost**
Alternative 1. Minimal excavation around sinkhole (11.4 acre-feet of additional storm water storage)	$ 215,000.00
Alternative 2. Aggressive excavation around sinkhole (27.3 acre-feet of additional storm water storage)	$ 494,000.00
Alternative 3. Install surface inlet, 30 linear feet of 24-inch RCP, and 30 linear feet of drainage swale	$ 9,000.00

<u>Routine Maintenance</u>

In addition to removing debris and obstructions described above, numerous routine maintenance issues were found throughout the study area during the field reconnaissance. Examples of required maintenance items include removing sediment buildup from culvert inlets, removing excess vegetation and debris from culvert inlets, and repairing damage culvert end sections. While correcting these deficiencies will not solve flooding problems, it is critical to correct them sooner, rather than later, so that the drainage system can function as designed and conditions do not worsen, leading to possible flooding problems in the future. In addition, it is important to

note that areas identified as requiring remediation should be regularly scheduled for maintenance by City crews to prevent future buildup of debris and sediment. A map showing locations identified as requiring maintenance is included as Figure 3. In addition, a document containing captioned photographs of each maintenance location is included as Appendix A, with locations and orientations of each photograph indicated with red arrows on Figure 3. A preliminary cost estimate for the proposed maintenance items are shown below:

Infrastructure Maintenance Items (See Figure 3)	**Preliminary Estimated Project Cost**
1. Debris/sediment removal from roadside ditch at two locations – 640 L.F. (Items 1 and 10)	$ 3,200.00
2. Debris/sediment removal from channel at five locations – 1,335 L.F. (Items 2, 7, 12, 14, 15)	$ 6,675.00
3. Debris/sediment removal from culvert ends at five locations (Items 3, 4, 6, 9, 11)	$ 2,500.00
4. Repair grate on catch basin at one location (Item 5)	$ 1,000.00
5. Culvert end repair at one location (Item 8)	$ 1,000.00
6. Install erosion control measures at one location (Item 8)	$ 340.00
Total Maintenance Cost	**$ 14,715.00**

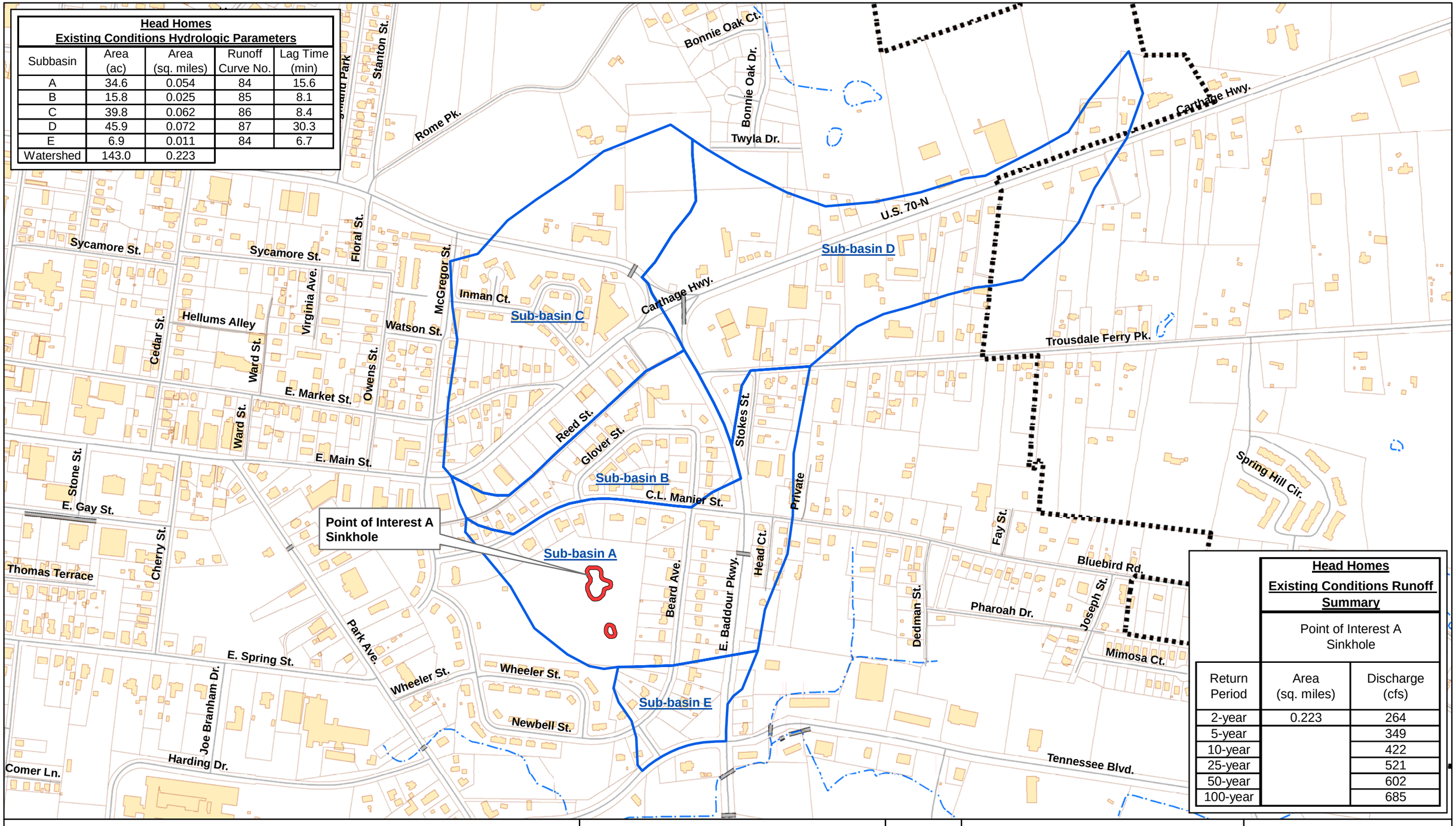
It should be noted that no field survey data was available for this study. Elevations of the sinkhole and surrounding storage areas were estimated based on the 5-foot interval topographic mapping provided by the City, and from information obtained during the field reconnaissance. Therefore, evaluation of the proposed improvements included in this study should be regarded as conceptual.

The above costs do not include property acquisition, which may be necessary for Structural Alternatives 1 or 2 (excavation around the existing sinkhole). As stated previously, it should be emphasized during property negotiations that upon completion of the excavation activities for either alternative, the property could still be utilized for recreational purposes and can be enhanced with landscaping to hide the sinkhole.

Although many steps will have to be taken prior to implementing structural drainage improvements in the study area, including survey and design; the infrastructure maintenance items discussed above and shown in Figure 3 can be performed by City crews immediately.

Head Homes
Existing Conditions Hydrologic Parameters

Subbasin	Area (ac)	Area (sq. miles)	Runoff Curve No.	Lag Time (min)
A	34.6	0.054	84	15.6
B	15.8	0.025	85	8.1
C	39.8	0.062	86	8.4
D	45.9	0.072	87	30.3
E	6.9	0.011	84	6.7
Watershed	143.0	0.223		



Head Homes
Existing Conditions Runoff Summary

Point of Interest A Sinkhole

Return Period	Area (sq. miles)	Discharge (cfs)
2-year	0.223	264
5-year		349
10-year		422
25-year		521
50-year		602
100-year		685

Legend

- Streams
- Parcels
- Existing Culverts
- Buildings
- City Limits
- Streets/Roads
- Sub-basins
- Sink Hole

City of Lebanon Drainage Analysis
Head Homes Subdivision
Drainage Improvements

N W E S

1 inch equals 500 feet

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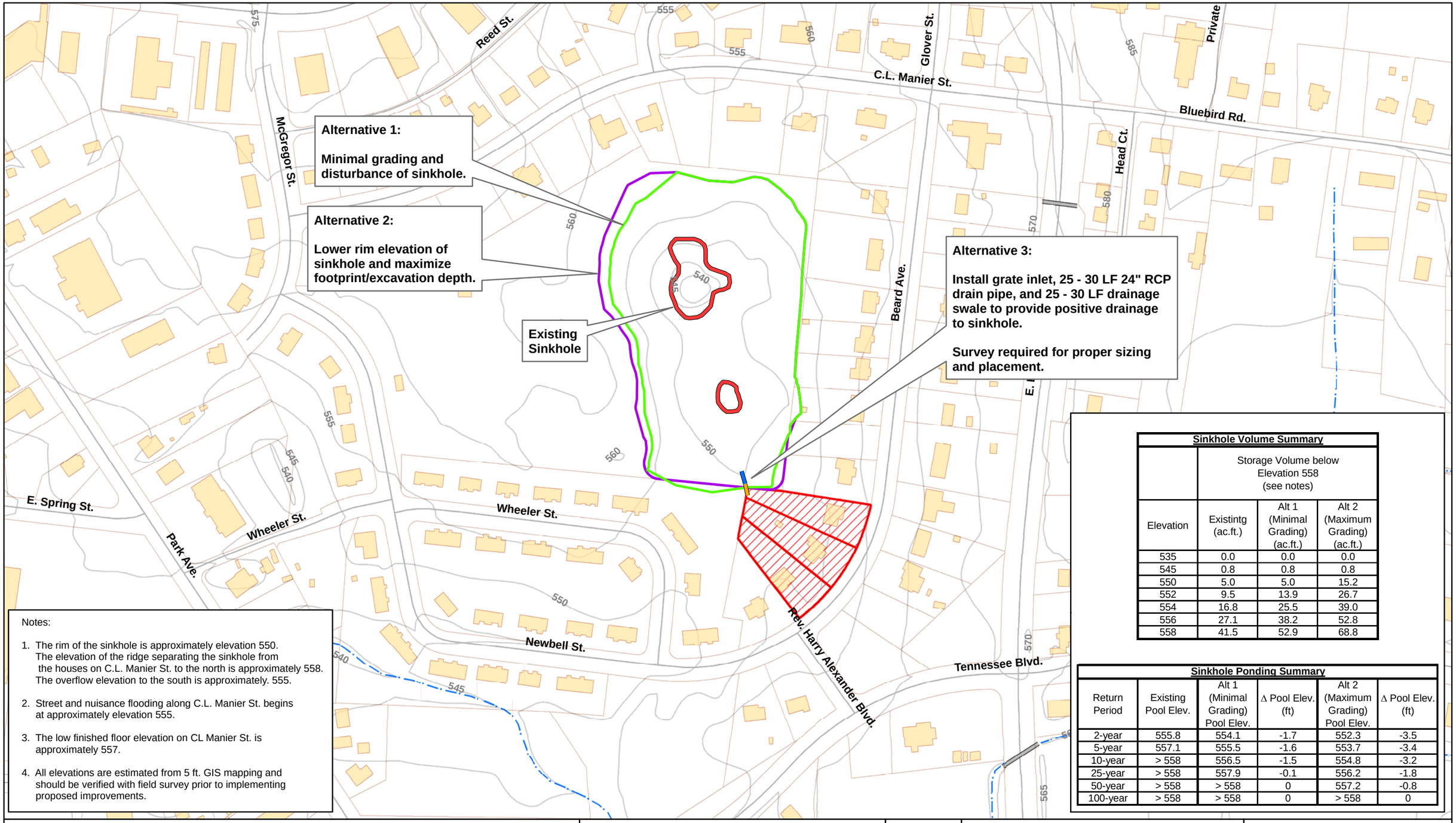
Existing Hydrology Results

Figure 1



Notes:

1. The rim of the sinkhole is approximately elevation 550. The elevation of the ridge separating the sinkhole from the houses on C.L. Manier St. to the north is approximately 558. The overflow elevation to the south is approximately. 555.
2. Street and nuisance flooding along C.L. Manier St. begins at approximately elevation 555.
3. The low finished floor elevation on CL Manier St. is approximately 557.
4. All elevations are estimated from 5 ft. GIS mapping and should be verified with field survey prior to implementing proposed improvements.

Sinkhole Volume Summary

	Storage Volume below Elevation 558 (see notes)		
Elevation	Existintg (ac.ft.)	Alt 1 (Minimal Grading) (ac.ft.)	Alt 2 (Maximum Grading) (ac.ft.)
535	0.0	0.0	0.0
545	0.8	0.8	0.8
550	5.0	5.0	15.2
552	9.5	13.9	26.7
554	16.8	25.5	39.0
556	27.1	38.2	52.8
558	41.5	52.9	68.8

Sinkhole Ponding Summary

Return Period	Existing Pool Elev.	Alt 1 (Minimal Grading) Pool Elev.	Δ Pool Elev. (ft)	Alt 2 (Maximum Grading) Pool Elev.	Δ Pool Elev. (ft)
2-year	555.8	554.1	-1.7	552.3	-3.5
5-year	557.1	555.5	-1.6	553.7	-3.4
10-year	> 558	556.5	-1.5	554.8	-3.2
25-year	> 558	557.9	-0.1	556.2	-1.8
50-year	> 558	> 558	0	557.2	-0.8
100-year	> 558	> 558	0	> 558	0

Legend

- Streams
- Parcels
- Existing Culverts
- Buildings
- Streets/Roads
- City Limits
- Sink Hole
- Alternative 1 Area of Excavation
- Alternative 2 Area of Excavation
- Flooded Parcels

Proposed Drainage Improvements

- Ditch
- Pipe

City of Lebanon Drainage Analysis
Head Homes Subdivision
Drainage Improvements

N W E S

1 inch equals 200 feet

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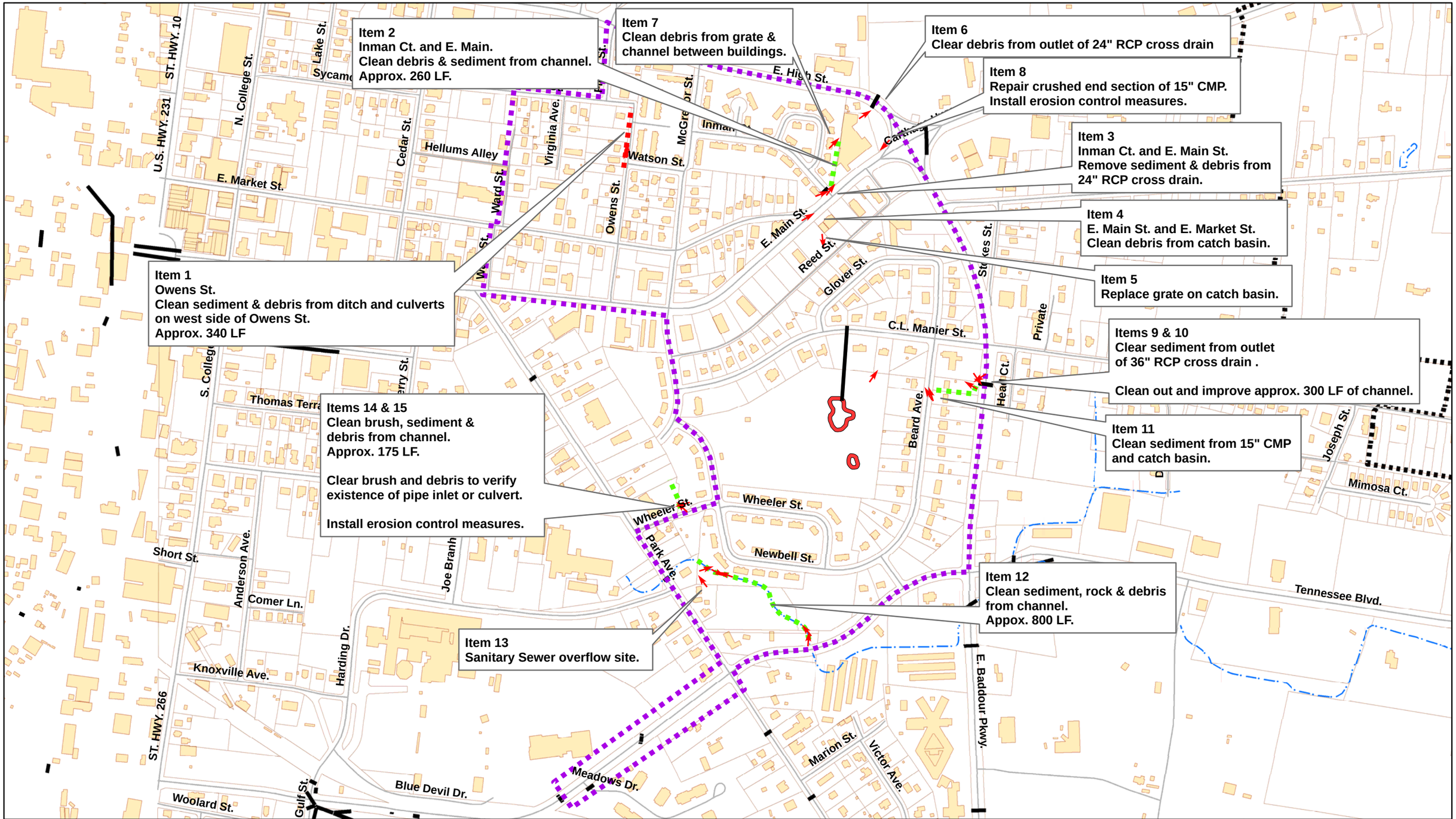
Conceptual Drainage Improvement Recommendations

Figure 2



City of Lebanon Drainage Analysis
Head Homes Subdivision
Drainage Improvements

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Infrastructure Maintenance Locations

Figure 3

APPENDIX A

Routine Maintenance Location Photographs

Item 1 – Owens St. from Sycamore St. to Watson St. Clean sediment and debris from approx. 340 LF of roadside ditch and culverts on the west side of Owens St. Repair eroded subgrade & pavement. Install erosion control measures.

Looking north from 222 N. Owens St. Picture 1878.

Looking south from 222 N. Owens St. Picture 1879.

Item 2 – Inman Ct. and E. Main St. looking northeast. Clean debris and sediment from approx. 260 LF of channel. Picture 1892.

Item 3 – Inman Ct. and E. Main St. looking northeast. Remove sediment and debris from 24" RCP cross drain . Picture 1894.

Item 4 – E. Main St. and E. Market St. Clean debris from catch basin on south side of E. Main St. Picture 1897.

Item 5 – Between E. Main St. and Reed St. Replace grate on catch basin. Picture 1898.

Item 6 – E. High St. north of E. Main St. Clear debris from outlet of 24" RCP cross drain under E. High St. Culvert drains onto private property at 713 E. Main St. Picture 1902.

Item 7 – 713 E. Main St. Clean debris from grate and channel between buildings. Channel receives drainage from the 24" RCP cross drain under E. High St. shown in Item 6. Picture 1906.

Item 8 – 713 E. Main St. Repair crushed end section of 15” CMP. Install erosion control measures. Picture 1908.

Item 9 – E Baddour Pkwy. south of C.L. Maier St. Clear sediment from outlet of 36” RCP cross drain . Picture 1910.

Item 10 –203 Beard Ave. Clean out and improve approx. 300 LF of channel from 36" RCP cross drain under E. Baddour Pkwy. to Beard Ave.

Looking south from cross drain outlet. Picture 1911.

Looking west towards Beard Ave. Picture 1912.

Item 11 –203 Beard Ave. Clean sediment from 15” CMP and catch basin.

15” CMP. Picture 1938.

Catch basin choked with sediment and debris. Picture 1939.

Item 12 –Tennessee Blvd. to Park Ave. Clean sediment, rock and debris from appox. 800 LF of channel.

Looking north from Tennessee Blv. Picture 1984.

Looking southwest. Picture 1986.

Item 12 – Continued.

Looking east. Picture 1978.

Looking west towards Park Ave. Picture 1978.

Item 12 – Continued.

Looking west towards Park Ave. Picture 1999.

Item 13 – Adjacent to 521 Park Ave. Sanitary Sewer overflow site. Picture 2000.

Item 14 – Wheeler St. between Park Ave. and Newbell St. Clean brush, sediment and debris from approx. 175 LF of channel. View is looking north from Wheeler St. Picture 2002.

Item 15 – Wheeler St. between Park Ave. and Newbell St. No culvert found at this location. Possible sink hole. Clear brush and debris to verify existence of pipe inlet or culvert. Install erosion control measures. Picture 2004.

Item 16 – 630 C.L. Manier St. Clean debris from outlet of 15" CMP. Picture 2011.