Streets and Stormwater Evaluation

City of Roosevelt Park,

Muskegon County, Michigan

June 2014

2130286

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I. INTRODUCTION

The City of Roosevelt Park is a 1-square mile municipality bordered by the City of Muskegon on the north side, the City of Norton Shores on the west, south, and east sides, and the City of Muskegon Heights is nearby to the east. The City is faced with several problems regarding its streets and its storm water and wastewater infrastructure. These include:

- ***Streets-*** *Over 60% are rated as poor(per typical standards)*
- ***Storm Sewers –*** *The existing storm sewer system is not adequate to prevent frequent flooding and contributes to poor pavement condition and significant infiltration to already high groundwater levels.*
- ***Groundwater and Inflow/Infiltration -*** *Underdrains from sanitary sewers, footing drains, and residential sump pumps discharge directly to the sanitary sewer. The city and its residents are, therefore, paying to treat stormwater/groundwater.*

Prein&Newhof has reviewed previous studies that have been prepared over the last 20 to 25 years for the city of Roosevelt Park to address these issues. Additional information that was reviewed included design drawings of recent street construction projects, topographic information from Muskegon County Geographic Information Systems Department, an engineering report on the West Branch of Ruddiman Creek, and ratings of street conditions.

This report summarizes our review and presents alternatives and costs to address these issues.

II. STREETS

The City of Roosevelt Park has 14 miles of streets. The West Michigan Regional Shoreline Development Commission (WMRSDC) rated the city's streets in 2008 according to the Pavement Surface and Evaluation and Rating (PASER) system. The ratings range from 1 through 10, with 1 being poor and 10 being excellent condition. The ratings and the portion of streets that falls in each category are provided in Table 1:

TABLE 1 - PASER RATING SUMMARY

General Description	Ratings	General Description	% in Roosevelt Park
Poor	1 - 3	Requires structural Improvements	63
Fair	4 - 6	Capital preventative maintenance needed to slow deterioration	16
Good	7 -1 0	Needs routine maintenance	21

Figure 1 shows the ratings for the City on a map. It can be seen above that over 60% are in poor condition. Generally the roads that are rated in good condition are those repaved or reconstructed since 2001. These projects are listed in Table 2 below:

Table 2 – Street Projects Since 2001

Year	Street	Length (ft)	Approx. cost	Comments
2001	Maple Grove – Broadway to Norton	3,600	$748,000	Road w/ concrete curb and gutter and storm sewer, partial MDOT funding
2004	Summit – Glenside to Roosevelt	1,800	$402,000	Road w/concrete curb and gutter, storm sewer and watermain, partial MDOT funding
2005	Oakridge – Maple Grove to Henry	1,230	$260,000	Road w/ concrete curb, storm, some watermain; DDA funded
2006	Glenside – RR tracks to Greenwich	1,600	$829,000	Road w/ concrete curb, storm sewer trunk line, partial MDOT funded
2009	Glenside – Greenwich to Roosevelt	1,900	$755,000	Road w/ concrete curb, storm sewer; Partially MDOT funded
2009	Summit – Coolidge to Henry	1,900	$175,000	Road w/ concrete curb, storm sewer; Partially MDOT funded
2010	Post Road – Maple Grove to Henry	1,270	$154,000	Road w/ HMA valley gutter, storm sewer; CDBG ICE grant
2011	Woodside - Lindland to Davis	2,400	$29,000	Road mill and repave, General Fund

2011	Sherwood - Maple Grove to Coolidge	1,300	$20,000	Road mill and repave, General Fund
2012	Woodside – Roosevelt to Wickham	1,400	$39,000	Road mill and repave, General Fund
2012	Glenside – Greenwich to Davis	2,100	$415,000	Road w/ Concrete curb, storm sewer; $369,000 in MDOT funds
TOTALS		**15,400**	**$3,738,000**	

It can be seen that several of the streets are in serious need of repair and that the cost to replace those streets will be large in the coming years.

The lack of adequate storm sewer in several areas of the City has a significant impact on the quality of the streets. The existing storm sewer system is not adequate to prevent flooding and contributes to poor pavement condition. Some of the existing storm sewers are old and root clogged, and need to be replaced. Other areas have no storm water collection system at all.

Pavement relies on the strength of its sub-base to perform as designed, and a wet or frozen sub-base allows pavement to flex and crack, beginning the failure process as described below:

- *Water standing on the surface of the road will seep into the pavement structure*
- *The expansion and contraction of the pavement during freeze-thaw cycles enlarge the cracks.*
- *The water works its way to the subsurface and softens the base.*
- *The pavement begins to give way and buckles under traffic*
- *Removing of standing water decreases the amount of water available to seep into the pavement. (This is generally done by grading a crown in the road and draining the low spots)*
- *A storm sewer contains the runoff and directs it to a detention or retention basin, or surface water outfall. A ditch can be used but even good soils become saturated (or blocked by frost) and start wicking water back under the pavement. The ditch must also be properly maintained. Homeowners and tight commercial lots generally do not like ditches in their front yards and have a tendency to fill them in over time.*
- *Underdrain and sand subbase (road elements for poor soils) help remove water from below the pavement. Storm sewer is needed for the underdrain to flow into.*

An example of water sitting on a street in Roosevelt Park is shown in the following photograph. This occurs more often than desired and reduces pavement life.

Germaine Street - April 9, 2013

During several recent construction projects in Roosevelt Park, both topsoil and foundry sand were discovered under the existing roadways; neither of which allows adequate drainage of the road subsurface. When water is trapped in the road subbase, the roadway becomes unstable and is likely to crack when subjected to traffic.

Foundry sand was discovered under Summit Avenue between Glenside Avenue and Dawes Road that had a consistency similar to hard pan causing storm water to pond on the surface. Once the layer of foundry sand was broken up and mixed with the clean sand under it, storm water drained readily into the ground. Similarly, a layer of topsoil was found under Summit Avenue, where the roadway was badly deteriorated just west of Henry Street. Due to the high organic content of topsoil, it holds moisture, weakening the pavement cross-section.

For planning purposes, the cost estimates in this report include complete road reconstruction. During the preliminary engineering phase of future projects, resurfacing instead of complete reconstruction can be considered in order to reduce costs. Resurfacing would only be an option where soil borings show that the existing road base does not contain materials that would impede drainage, where existing aggregate base material is thick enough, and if no utilities are being installed.

III. STORMWATER COLLECTION SYSTEM

A. Existing System

The City has a limited existing stormwater system as shown in the map provided in Appendix A. This map is from the 2004 Drainage and Groundwater Study Update by FTC&H, which was completed prior to stormwater improvements on Glenside, Oakridge, and Post Road. Existing infrastructure is primarily located in the northern and eastern portions of the City, with three drainage areas discharging to Mona Lake to the south or Muskegon Lake to the north via Ruddiman Creek.

The City has analyzed the stormwater system several times in the past including studies summarized by the following:

- 1966 – Preliminary Design Report for a Storm Sewerage System (Moore & Bruggink)
- 1990 – Drainage and Groundwater Study (FTC&H)
- 2004 - Drainage and Groundwater Study Update (FTC&H)
- 2005 – State Revolving Loan Fund Project Plan (FTC&H)
- 2006 – West Branch of Ruddiman Creek Engineering Report (FTC&H)

These studies provide differing focuses and results. Several have concentrated on handling the impact of the infiltration of stormwater by removing groundwater. The City has had significant issues with high groundwater levels impacting basements and flowing to the sanitary sewer via basement sump pumps and through underdrains that were permanently connected to the sanitary sewer system when it was constructed. This results in a continuous flow from groundwater to the sanitary sewer system leading to high wastewater treatment expenditures for this water. Reduction of this groundwater to sanitary sewer flow has been addressed in the past with the addition of four pumping stations to lower the water table. The groundwater pumping stations pump water to the storm sewers. These have provided some relief, but flooding remains a concern with no stormwater infrastructure in many areas.

The general topography in Roosevelt Park slopes toward Lake Michigan, from northeast to the southwest. However, stormwater could be conveyed in any direction. This evaluation considered various potential outfalls. In each case, water quality was considered, including options to provide natural treatment. In addition, the cost of each alternative was considered. Results were then reduced to a single list of recommended projects presented herein.

Since the last study (2006 – West Branch of Ruddiman Creek Engineering Report), the City has completed 3 significant projects to improve the conveyance of stormwater. Combined, these make up a trunk sewer along Glenside Boulevard. This trunk sewer has significant capacity and was considered when preparing alternatives. The recommended improvement projects are based on cost, feasibility of construction, ability to obtain a permit, ability to maintain the natural stream systems, and ability to effectively convey stormwater from the City to nearby water bodies. With substantial infrastructure needs to convey stormwater, a long term plan was prepared to provide storm sewer needs as streets are reconstructed.

B. Capacity Review

Initially, the capacity of the existing system was analyzed to determine any limitations of the system. The original system was believed to be designed for a 20% annual probability event (5-year event) as defined at the time. It is recommended that the system convey stormwater from at least a 10% annual probability event (10-year event).

Previous reports have indicated, and available data confirms, that some storm sewers are on a flat or adverse slope. This significantly reduces the capacity of the storm sewer system and can create regular maintenance needs.

A Storm Water Management Model (SWMM) was developed to analyze the system. Given the size of the tributary areas, the rational method was used to determine the system hydrology. Available data, including inverts, pipe sizes and County Geographical Information System (GIS) surface contours were used to develop the model.

The large trunk sewers are located on Glenside Boulevard, Maple Grove Road, Henry Street and Broadway Road. It should be noted that there are limited locations with curb and gutter and the stormwater system does not collect runoff in many areas. If the system is expanded to collect storm flow from all areas, SWMM model simulations indicate that the storm sewer system is undersized in many locations, conveying less than a 10% frequency event (10-year event) and less than a 50% frequency event (2-year event) in some locations. Some trunk sewers are undersized; however, the largest sewer on Glenside Boulevard adequately conveys flows from its current service area including a significant portion of the City, to the outlet on the west branch of Ruddiman Creek.

C. Alternative Outlets

The City's existing stormwater system has 3 outlets as follows:

- Southeast of the City at Mona Lake
- Northeast of the City at Ruddiman Creek, which discharges into Muskegon Lake
- Northwest of the City at the western tributary to Ruddiman Creek

Water quality in the Mona Lake and Muskegon Lake watersheds is important to area residents. The Mona Lake Watershed Council and the Muskegon Lake Watershed Partnership supports grassroots, local, state, regional, federal and international programs to restore their lakes as well as the Great Lakes. Muskegon Lake is considered an "area of concern" by the EPA, and Ruddiman Creek and Pond have been dredged to remove contamination in recent years. Thus, our recommendation considers the impacts to the receiving stream and lake.

D. New Service Areas

Currently, areas in the southwest quadrant of the City have minimal stormwater relief. Stormwater collects and ponds at low points and infiltrates into the groundwater. The ground surface does slope to the southwest, so some stormwater may run off into stormwater systems in neighboring communities for larger rain events. However, existing leaching basins in that area contribute to high groundwater levels and do not prevent flooding.

The proposed relief storm sewer system for this area includes construction of new storm sewers on Davis Street, Rockland Road, Brookfield Road, Royal Oak Road, Roosevelt Road, Woodside Road, Marlboro Road, Haverhill Road, and Chapel Road.

Many other areas in the system do not have direct storm sewer inlets so storm water infiltrates into the ground. As a result, some new service sewers are also needed to collect water from other areas of the system. This includes the potential addition of storm sewers on streets including: Amherst Road, Drexel Road, Sherwood Road, Hampden Road, Durham Road, Le Roux Road, Eastland Road, Roosevelt Road, Westland Road, Broadway Road, Cornell Road, Summit Avenue, Princeton Road, Greenwich Road and Colonial Road. The need for and length of extensions on each of these streets should be evaluated during road redesign.

E. Hydraulic Analysis

1. Stormwater Collection System

An analysis of the system using the hydraulic model was completed. As mentioned previously, the existing system capacity is limited in some areas. It is evident that the existing storm sewers were not designed to convey the flow from the entire area, and design standards for capacity were less than current standard recommendations (10% event or 10-year event) for storm sewers.

The most critical storm sewer is the trunk sewer on Glenside. This storm sewer was recently constructed (projects in 2006, 2009 and 2012) and currently is responsible for conveying flow for a large portion of the City. In addition, storm sewer extensions are proposed on many streets to convey water from the area through the Glenside sewer rather than allowing infiltration to the groundwater.

Several options were considered with a final recommendation developed to collect water from the streets and convey it out of the City to the nearby lakes via the existing outlets.

2. Detention

The use of detention to reduce peak flows from the City and provide the opportunity for settling sediment was briefly reviewed. A hydraulic analysis was completed including a detention basin located to the northwest of the City. The peak outflow from the site can be reduced approximately 40% by providing approximately 6 acre-feet of storage. A parcel located northwest of the City is vacant and could be acquired for a detention basin constructed to perform as a natural filter for stormwater to remove sediments. However, there are known sites of contamination nearby and further study would be required to determine if a detention pond could be constructed in this area.

3. Groundwater System

Currently, seasonal high ground water levels have the potential to cause basement flooding in the City of Roosevelt Park. This is, in part, due to the lack of storm sewers to convey the runoff to nearby lakes. To mitigate the high groundwater levels, the City constructed 4 pumping stations and connected selected underdrains associated with the sanitary sewer. These stations, however, are no longer in good condition.

Groundwater levels are expected to drop when storm water for the entire City is collected in newly constructed and existing storm sewers instead of continuing to infiltrate to the ground. Options for further reducing the groundwater level are discussed below in Section IV. Groundwater Control.

F. Prioritization

With a significant number of proposed projects, master planning for the long term is critical. Each potential project was evaluated to determine prioritization based on the following:

- Current areas of most significant flooding
- Larger sewers first rather than collector sewers (so that existing trunk sewers are not overloaded)
- PASER ratings for the roads (construct storm sewers in conjunction with redesign of roads)

- Planned water system projects (construct storm sewers in conjunction with other utilities).

While some of the variables may be considered more critical than others, the combination was considered. It should be noted that recommended water system projects were provided in the most recent "Water System Master Plan and Reliability Study for the City of Muskegon, Roosevelt Park, and North Muskegon; and Muskegon County." This report does not identify any water main projects for the 20-year planning period.

This priority list should be regularly reviewed as the areas of most frequent flooding and PASER rating may change in the future. The following projects in order by priority are also shown in Figure 2:

1. Roosevelt Road Reconstruction from Broadway to Norton and Greenwich Road from Glenside to Broadway.
2. Construction of 12" to 24" storm sewer on Eastland Road, Royal Oak Road, Brookfield Road, and Rockland Road.
3. Construction of 12" collector storm sewers on Durham Road and Le Roux Road.
4. Construction of 30" storm sewer in Coolidge; 12 to 24" storm sewer on Lambert Drive, Woodside Road, Germaine Road, Hawley Road, and Davis Road.
5. Construction of 42" trunk sewer at outlet of the Glenside storm sewer replacing remaining 24" storm sewer.
6. Construction of 12" to 24" storm sewer on Coolidge Road, Sherwood Road, Hampden Road, Drexel Road and Amherst Road. Construction of collector sewer on Eastland Drive northeast of Lambert Drive.
7. Construction of 12" collector sewers at north end of Eastland Road, Westland Road, Princeton Road, and Dawes Road.

8. Extend and upsize storm sewers west of Glenside Boulevard on Chapel Road, Haverhill Road, Marlboro Road, and Woodside Road.

9. Extend and upsize storm sewers west of Glenside Boulevard on Colonial Road, Greenwich Road, Princeton Road, Summit Road, Cornell Road and Garrison Road.

10. Construction of 12" collector sewer east of Maple Grove Road on Woodside Road, Hampden Road, and Sherwood Road.

11. Upsize storm sewer in Summit Avenue west of Henry Street.

G. Probable Costs

An Opinion of Project Costs has been prepared for each potential project. Costs for projects of similar size and scope that have been constructed in western Michigan were reviewed for relevant information.

The storm sewer cost estimates have been prepared including an allowance of approximately 25% above the estimated construction cost. This allowance is intended to include the cost of construction contingencies (issues which are presently unknown), legal fees, engineering design and construction services (including preliminary and final design, soil borings, topographic survey, bidding assistance, construction staking, compaction testing, construction observation and project administration during the entire project) and administrative expenses related to the project.

It has been assumed that land is available for construction of the described improvements. No provision has been made in the cost estimate for extraordinary cost of land or right-of-way purchase or easements.

Using the previous assumptions, an Estimate of Probable Cost for each of the recommended projects was generated and is included in Appendix B.

IV. Groundwater Control

As discussed previously, groundwater levels are high in several areas of the City of Roosevelt Park, which results in periodic basement flooding and pumping of water by basement sump pumps. It is important to note that these problems exist despite the connection of several existing underdrains to the sanitary sewer system. These underdrains are continually discharging groundwater to the sanitary sewers.

Therefore, new groundwater control methods should account both for the existing flow to the sanitary sewer and additional groundwater removal to keep basements dry and reduce the need for sump pumps. If the groundwater currently being removed by the sanitary sewer was removed by a different method, the underdrain connections to the sanitary sewer could be plugged, which would reduce sanitary sewer costs for the City.

A. Hydrogeologic Description

There is a shallow sand aquifer in the City of Roosevelt Park present above a clay layer as shown in the cross sections provided in Figures 3 and 4. These cross sections were developed based on data available from previous reports and area well logs. A cross section location map is provided in Figure 5. The thickness of the shallow sand varies from around 10 feet to around 40 feet and the water table is generally present from about 5 to 10 feet below ground.

Below the clay layer there is another sand layer and the water level in this lower aquifer varies from approximately 30 to 40 feet below ground. In some areas, the static water level in wells screened in the lower aquifer is near the top of the clay layer and in other areas, the static water level is 10 to 15 feet below the bottom of the clay layer.

Review of area well logs surrounding Roosevelt Park suggest that the upper aquifer observed in the City may not be continuous to the north, east, or south of the City. Given the apparent flow direction to the southwest, this suggests there may be very little horizontal flow into the area of the City in the shallow aquifer. Most of the water above the clay layer is likely due to recharge inside the City limits.

B. Determination of Target Groundwater Removal Rate

The goal of all of the below groundwater control methods is to be able to eliminate the direct connections of underdrains to the sanitary sewer and to reduce the amount of pumping required in basements as much as possible.

1. Estimation of Existing Groundwater Flow to Sanitary Sewer

Based on approximately 4,000 residents and average sanitary sewer flow of 100 gallons per capita per day (gpcd), base flow for sanitary sewer in Roosevelt Park is predicted to be approximately 400,000 gpd. Flow data is available from the Roosevelt Park lift station which pumps all of the sanitary flow from Roosevelt Park to the Muskegon County system. During dry periods since January 2011, the metered wastewater flow has been observed to be as low as 360,000 gpd (90 gpcd). A graph of wastewater flow from the City of Roosevelt Park and inches of rain per day is provided as Figure 6.

Average sanitary flow from 2011 through September 2013 was 600,000 gpd with several sustained peaks of 1,000,000 gpd and one peak to 2,000,000 gpd in April 2013. Assuming a base flow of 400,000 gpd, the average excess flow is 200,000 gpd (140 gpm) with peak excess flows of up to 1,600,000 gpd (1,100 gpm). The estimated cost to treat this excess sanitary flow is approximately $200,000 per year.

2. Estimation of Rainfall and Recharge

Rainfall per year is approximately 35 inches, and the 2004 Drainage and Groundwater Study Update by FTC&H suggests recharge to the groundwater is approximately 323 gpm. FTC&H also estimated groundwater flow into and out of the city in the shallow sand aquifer and determined there was approximately 250 gpm more water entering the shallow aquifer than leaving as groundwater flow to the southwest.

As discussed above, average groundwater flow to the wastewater system is estimated to be 140 gpm and there is an unknown rate of water being removed by existing groundwater pumping stations that may account for the remainder of the 250 gpm.

3. Target Groundwater Removal Rate

It is important to note that current groundwater levels would be even higher if not for the existing extraction of water due to the underdrains to the sanitary and the storm water pump stations. Given the previously estimated 250 gpm average flow already being removed by these methods to maintain existing groundwater levels, it is recommended that a new extraction system would have a combined average extraction rate of 250 gpm plus a rate sufficient to cause a drawdown of approximately 2 feet at the perimeter of the City.

In order to estimate the additional amount of water needed to be removed from the system to be effective, the Theis equation was used to calculate the drawdown impact at the perimeter of the City of pumping at 4 locations near the existing pumping stations. Flow and aquifer parameters were varied to come up with a reasonable range of expected drawdown and the result was a reduction in groundwater level of 1.75 to 2 feet at a combined flow rate of 300 gpm.

Therefore, in order to replace the existing estimated groundwater flow to sanitary sewers and to the existing pump stations a total average flow rate of 550 gpm is recommended for a new groundwater control method (250 gpm existing flow plus the estimated 300 gpm to effect an approximate 2 foot drawdown at the perimeter of the City). In order to handle some peaking, the peak capacity for a groundwater control option should be at least 1,100 gpm.

C. Alternatives

Alternatives for groundwater control methods are discussed below. A summary of these options including pros and cons and costs is provided in Appendix C.

1. Additional Storm Sewers

As discussed above, the amount of water infiltrating through the ground due to the lack of adequate storm sewers is a significant input to the groundwater and could have a large impact on the groundwater level. Additional storm sewers should have a significant impact based by removing a significant portion of the above target rates prior to infiltrating to the ground. Any reduction in the percent of rainfall that becomes groundwater recharge would significantly reduce the amount that needs to be removed in the ground. For example, in areas of the City where no storm sewer exists, the recharge could theoretically be reduced by 50% or more.

Reducing the static water level in the ground will reduce the risk of water in basements, reduce the use of sump pumps in basements and reduce the continuous flow of groundwater to the sanitary sewer system through the existing underdrains. The impact of added storm sewer on groundwater levels will occur gradually as stormwater improvement projects will be completed over a time period of several years. Even when all storm sewers are complete, the amount of water redirected may not be sufficient alone to allow for plugging of all existing underdrains discharging to the sanitary system.

2. Rehabilitate Existing Pumping Stations

It is believed that the existing four pumping stations are removing groundwater at a combined rate of 100 gpm or less, but good data does not exist. The amount of work necessary to rehabilitate the existing pumping stations would depend on the potential capacity of existing underdrains and/or the ability to connect new underdrains to the existing stations. Information needed to make a decision on the feasibility of rehabilitating the existing pumping stations includes:

- Verification of dimensions of pump stations
- Condition of existing structures
- Depth of existing underdrains
- Space available for new pumps

If it was determined that the existing underdrains were providing a significantly higher rate than the existing pumps could remove, it may be more cost effective to replace the pumps and maintain the existing pump stations. Generators would be necessary to add reliability during storm events when peak infiltration would occur.

One significant drawback would be that the pump stations discharge to the storm sewer system. This would directly reduce capacity of these storm sewers. In addition, it may be necessary to provide a new outlet for discharge from the upgraded pump stations or to improve downstream sewers and/or culverts, depending on downstream capacities.

This option would also require ongoing operation costs to run the pumps and generators and maintenance. A rough calculation of the power needed to lift 1,100 gpm 15 feet results in the need for combined motor power of approximately 10 hp. Running continuously 24 hours per day for 365 days per year would therefore cost approximately $6,500 per year in electrical costs at $0.10 per kw-hr. In reality, the pump stations would cycle and the costs would likely be less than half of that amount. The total cost to rehabilitate the existing pump stations, install new underdrains, and install a generator at each location is estimated to be approximately $1,300,000. A figure showing the existing pump stations with potential connections to proposed underdrains is provided in Figure 7.

3. New Stormwater Pumping Stations

The condition and dimensions of the existing pump stations may not allow for rehabilitating the existing structures at a reasonable cost. The pump stations could instead be replaced with new stations. Installation of new storm pump stations would require installation of two submersible pumps in a precast structure, a control system, multiple new underdrains at depths of 10 to 15 feet, and potentially groundwater collection piping to transport water to the pump station. New underdrains could be installed in streets as new storm sewer is added and connected to the pump stations. The concept is shown in Figure 7. Operating cost would be similar to the above cost for utilizing the existing pump stations with new pumps. This option would have the same disadvantage as rehabilitating the existing pumping station in that all discharge from the pumping stations would use storm sewer capacity. The cost to construct four new pump stations including discharge forcemain, new underdrains and a generator at each location is estimated to be approximately $1,700,000.

4. Gravity Groundwater Discharge

Instead of pumping groundwater, slotted HDPE drain tile could be installed as horizontal wells at depths of 10 to 15 feet and connected to a pipeline that discharges to surface water by gravity. Groundwater could be discharged by gravity to multiple surface water locations including Ruddiman Creek to the northwest, a stream to Mona Lake directly south of Maple Grove Rd or a stream to Mona Lake at Roosevelt Road and Seminole Road. Current stormwater outlet elevations at Ruddiman Creek and the location south of Maple Grove Road are approximately 610 feet (NAVD88). An elevation of 600 feet or lower would be required to install a new gravity storm line in Roosevelt Park for gravity discharge of groundwater. Therefore, a new line would need to extend approximately 1,200 feet farther than the current outlet locations at Ruddiman Creek or Maple Grove Road. This would provide the potential for groundwater to flow by gravity from the elevations of the existing underdrains discharging to the sanitary sewer lines.

The Roosevelt Road and Seminole outlet is at an elevation of approximately 597 feet. This has the potential to provide an outlet for groundwater discharge by gravity from much of the City. This option would require building approximately 1,800 feet of pipe at a depth that varies from 10 to 15 feet through Norton Shores on Roosevelt Road. Existing and proposed underdrains could be connected to this gravity line to provide for groundwater flow from the City of up to 1,500 gpm based on the expected gravity flow through an 18-inch sewer.

This option is favorable because it will allow for continual removal of groundwater without pump operating costs. However, it would require installation of approximately 1,800 feet of pipe in the City of Norton Shores on Roosevelt Road where Norton

Shores has no current plans to complete any construction. In addition, the ability to discharge water to the surface at Roosevelt Road and Seminole Road would need to be coordinated with Norton Shores. Capacity and ownership issues at this discharge location would need to be verified.

The estimated cost to install a gravity groundwater pipeline in Roosevelt Road including directional drilling of pipeline within Norton Shores, installation of new underdrains and connection to existing underdrains is approximately $1,800,000. A conceptual drawing of this option is provided in Figure 8.

5. Infiltration Trenches

A 2005 FTC&H memo suggests a system that would allow the entire estimated recharge of approximately 325 gpm to infiltrate to the lower aquifer through infiltration trenches. They proposed transporting water from various underdrains to trenches cut through the upper clay layer in areas where the clay was shallow and thin to allow for water discharge to the lower aquifer.

Note that this rate of 325 gpm takes the place of the existing estimated 250 gpm being removed by the sanitary sewer and storm pump stations, meaning there is only a 75 gpm proposed increase in the rate of water removed from the system. This may not be sufficient to eliminate water problems during peak events.

Groundwater removal in excess of the total recharge would provide additional space for storage of peak infiltration, but particularly in areas where the clay is present within 10 feet of the ground surface, there could be a very rapid response in groundwater level to peak infiltration rates (major storm events). Therefore, if this option would be chosen, the peak flows may need to be adequately captured by improved storm sewer systems.

The cost of this system is estimated to be $2,300,000, which is the highest of the alternatives. In addition, the Michigan Department of Environmental Quality may require a groundwater discharge permit for this option and it is not known what the requirements of this permit might be. This concept is shown in Figure 9.

6. Sanitary System

It is estimated that the average groundwater flow to the sanitary sewer system is approximately 200,000 gallons per day (gpd). Sanitary sewers could be upsized and underdrains improved to remove additional water through the sanitary sewer, but this option will not be considered as it increases the volume of clean groundwater being sent to the sanitary sewer and would substantially increase the City's wastewater costs.

V. SUMMARY AND CONCLUSIONS

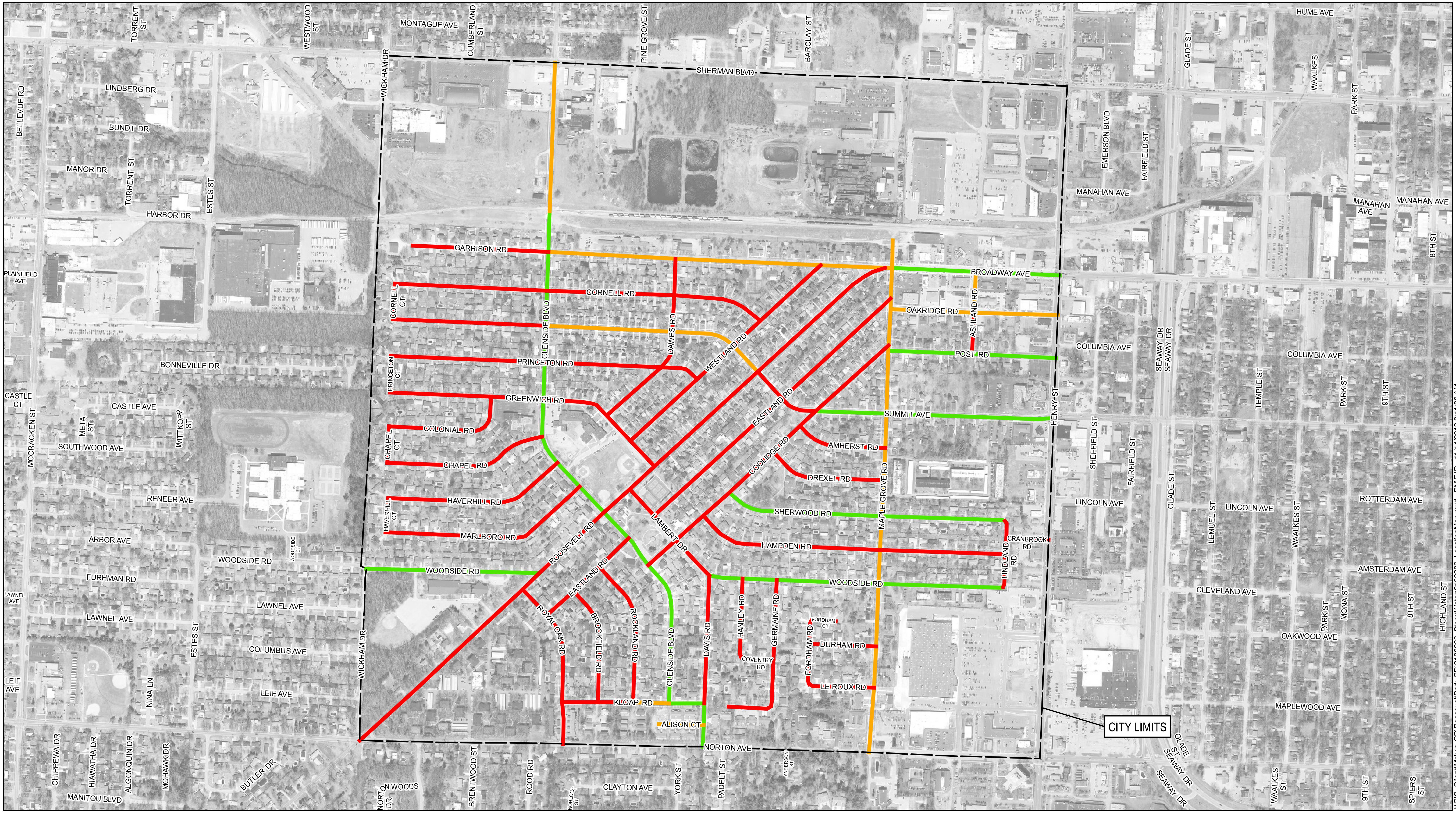
A prioritized list of proposed stormwater improvement projects including costs estimates has been provided. Completion of these projects in conjunction with road improvements necessary in the City will result in higher quality streets with a longer life, reduced street flooding and reduced infiltration/recharge to groundwater.

Multiple options with estimated construction costs have been provided for removing groundwater to lessen the City's costs to treat a large volume of groundwater as wastewater and to reduce the need for basement sump pumps.

Installation of a gravity groundwater pipeline is recommended. A gravity line that could provide for removal of groundwater could be constructed in Roosevelt Road and discharge to surface water south of Roosevelt Road and Seminole Road. This would allow for connection of multiple underdrains with a positive gravity outlet that would not require operation and maintenance of pumping equipment. Construction could occur with planned road work in Roosevelt Road, but will require coordination with the City of Norton Shores.

Improving the City's stormwater system and reducing groundwater levels will have a significant positive impact on the City's infrastructure and resident's quality of life.

Figures



SCALE: 1 " = 700 '

LEGEND

STREET SURFACE RATING

POOR FAIR GOOD

CITY OF ROOSEVELT PARK
MUSKEGON COUNTY, MICHIGAN

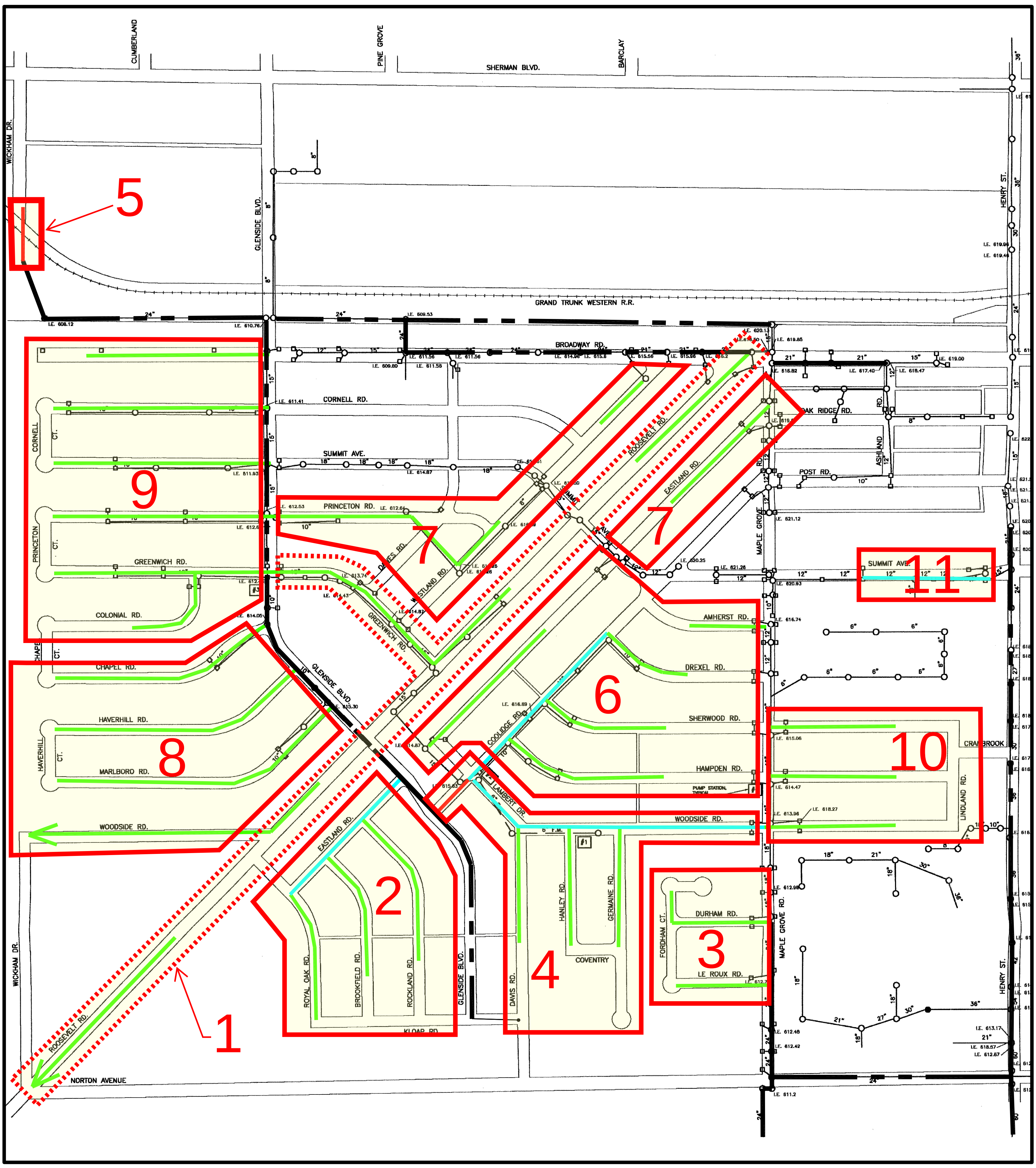
FIGURE 1

STREET SURFACE RATING

Prein&Newhof
2130286

North

SCALE: 1"=600'



L E G E N D

(thick black line)	EXISTING COLLECTOR SYSTEM
(black line)	EXISTING TRUNK SEWER
(green line)	RECOMMENDED STORM SEWER 12" – 15"
(cyan line)	RECOMMENDED STORM SEWER 18" – 24"
(red line)	RECOMMENDED STORM SEWER > 30"

CITY OF ROOSEVELT PARK

MUSKEGON COUNTY, MICHIGAN

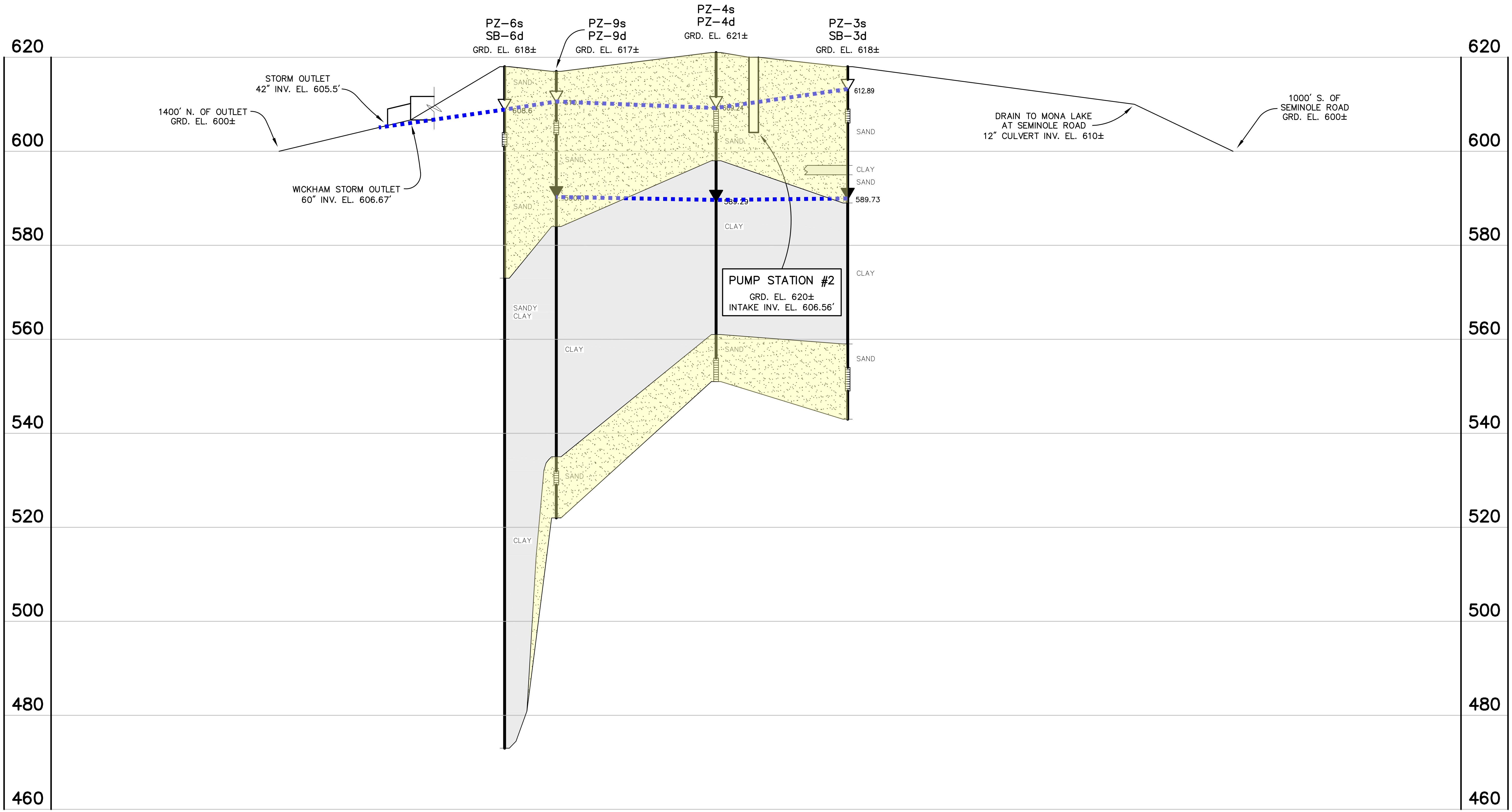
STORMWATER MASTER PLAN STUDY

RECOMMENDED PROJECTS

FIGURE 2

Prein&Newhof

2130286



SCALES : 1" = 1000' HORIZONTAL
1" = 20' VERTICAL

LEGEND

- SAND
- CLAY, SANDY CLAY OR SILT
- ▽ UPPER WATER LEVEL
- ▼ LOWER WATER LEVEL

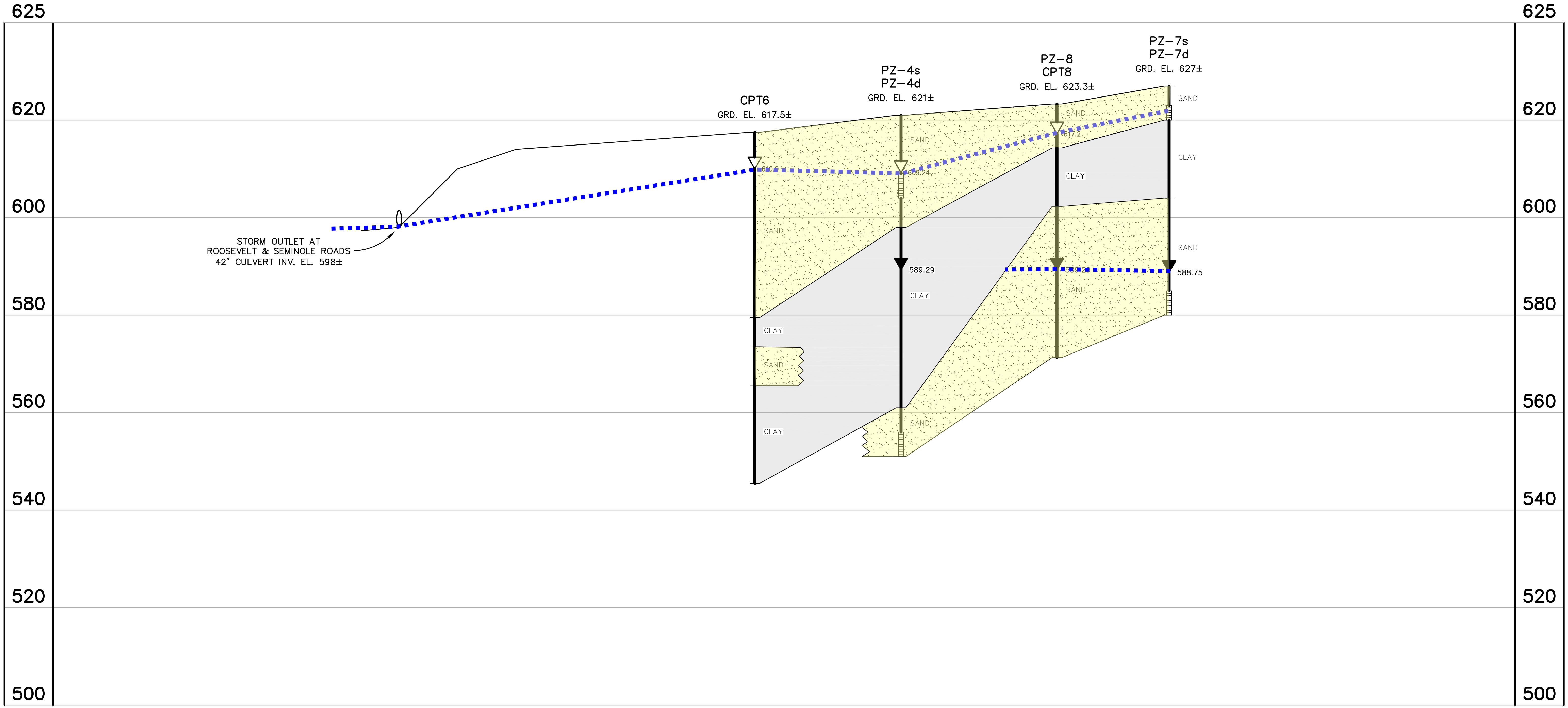
CITY OF ROOSEVELT PARK
MUSKEGON COUNTY, MICHIGAN

PRELIMINARY ENGINEERING
DRAINAGE/STORMWATER IMPROVEMENTS

SECTION A–A

FIGURE 3

Prein&Newhof
2120552



SCALES : 1" = 1000' HORIZONTAL
1" = 20' VERTICAL

LEGEND

SAND	
CLAY, SANDY CLAY OR SILT	
▽	UPPER WATER LEVEL
▼	LOWER WATER LEVEL

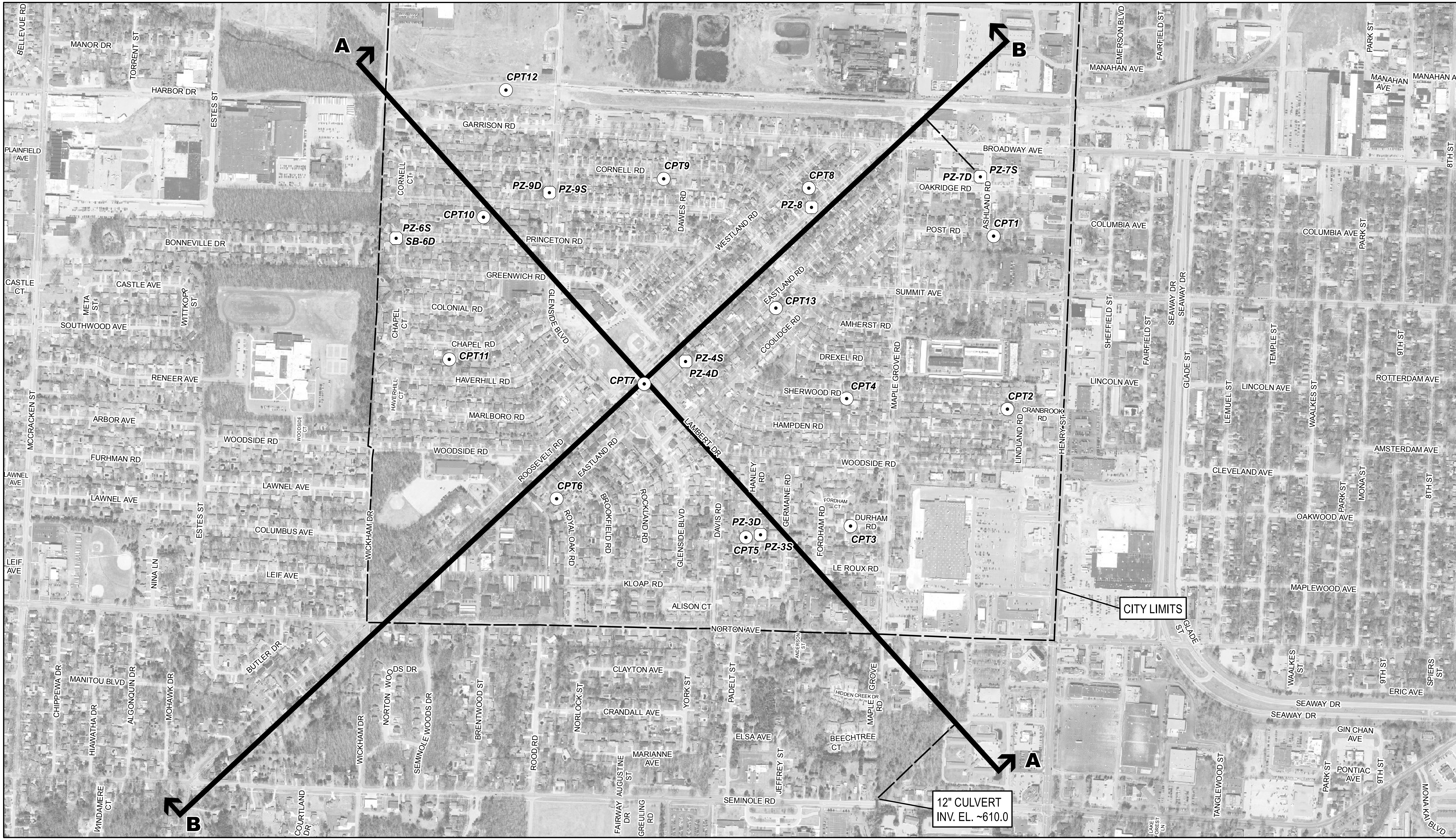
CITY OF ROOSEVELT PARK
MUSKEGON COUNTY, MICHIGAN

PRELIMINARY ENGINEERING
DRAINAGE/STORMWATER IMPROVEMENTS

SECTION B-B

FIGURE 4

Prein&Newhof
2120552



N

SCALE: 1 " = 700 '

LEGEND

- PIEZOMETER/PIEZOMETER CLUSTER
- CPT BORINGS (LOCATION APPROXIMATE)
- CROSS SECTIONS

CITY OF ROOSEVELT PARK
MUSKEGON COUNTY, MICHIGAN
PRELIMINARY ENGINEERING
DRAINAGE/STORMWATER IMPROVEMENTS

CROSS SECTION LOCATION MAP

FIGURE 5

Prein&Newhof

2130286

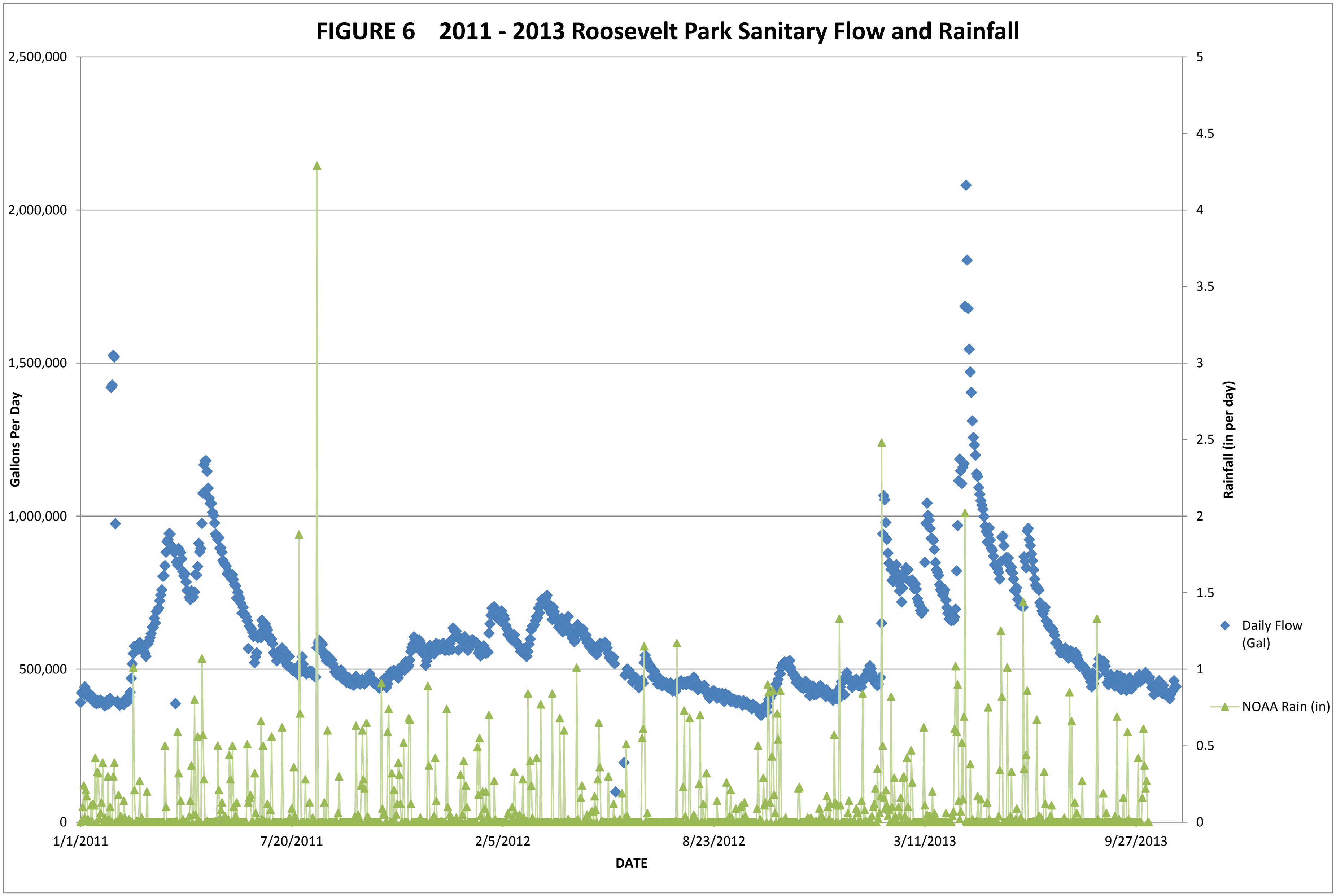
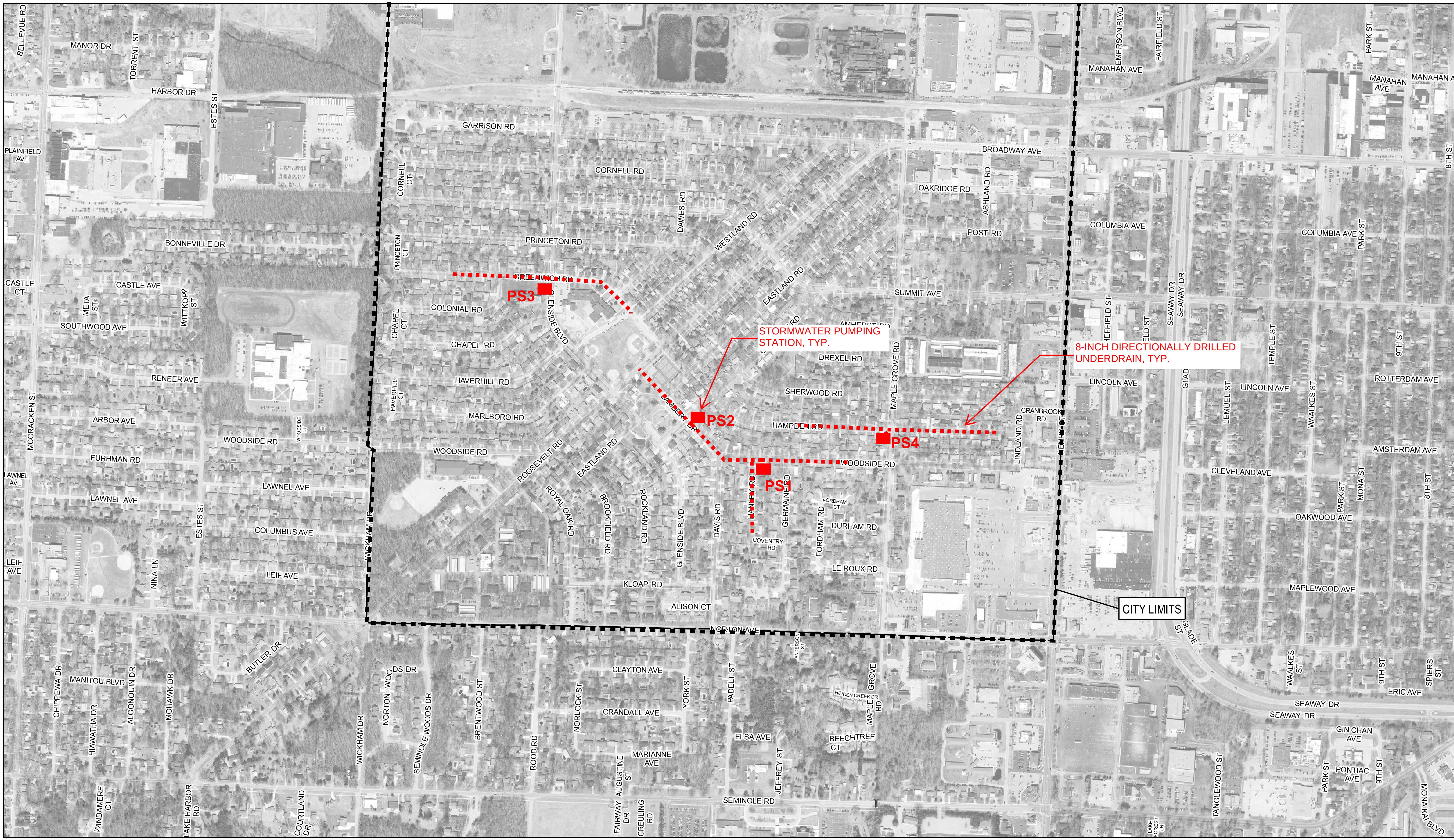


FIGURE 6 2011 - 2013 Roosevelt Park Sanitary Flow and Rainfall
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
Gallons Per Day
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Rainfall (in per day)
1/1/2011
7/20/2011
2/5/2012
8/23/2012
3/11/2013
9/27/2013
DATE
Daily Flow (Gal)
NOAA Rain (in)



SCALE: 1 " = 700 '

CITY OF ROOSEVELT PARK

MUSKEGON COUNTY, MICHIGAN

FIGURE 7 - PUMP STATION OPTIONS

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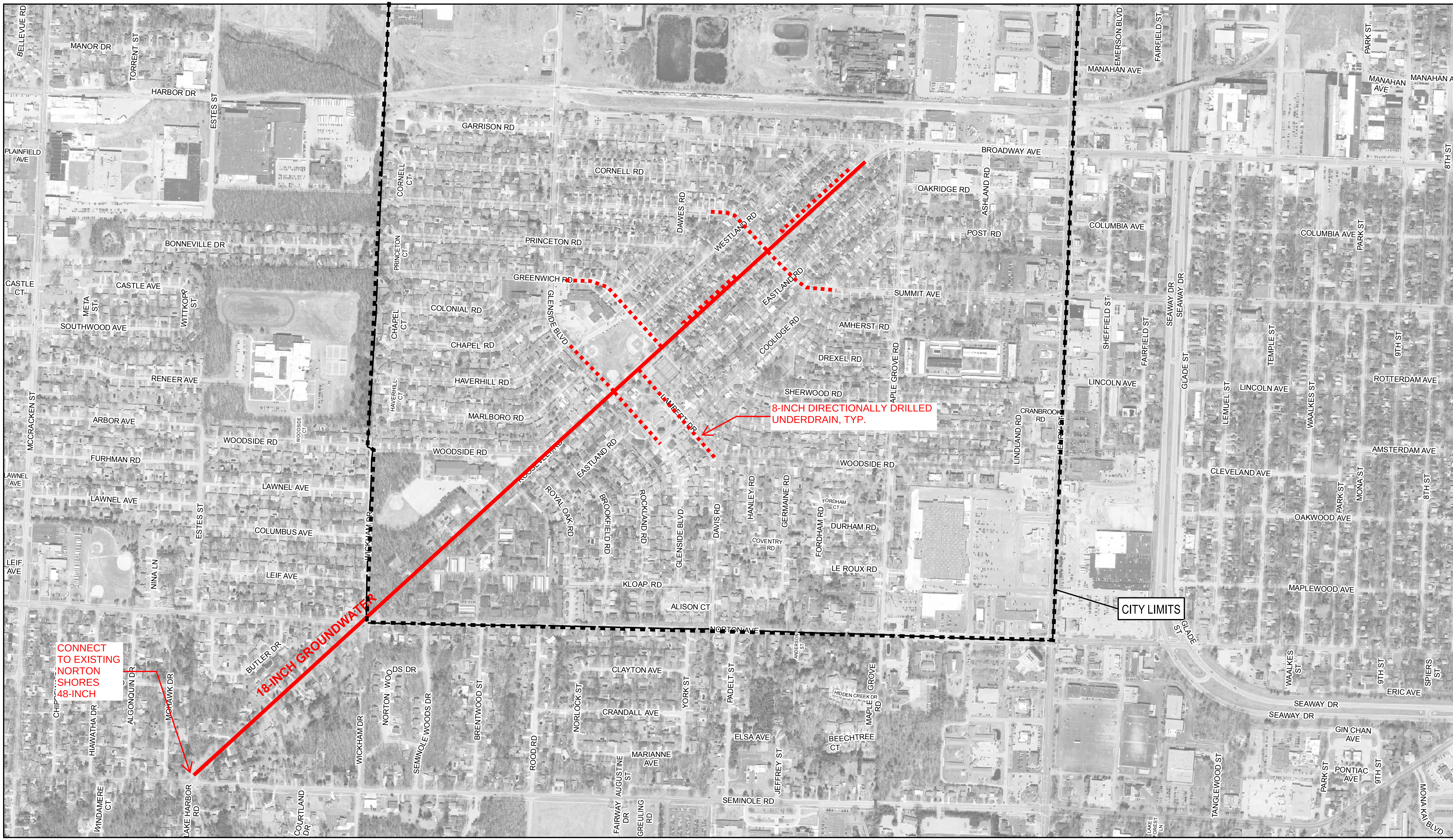
2130286



SCALE: 1 " = 700 '

CITY OF ROOSEVELT PARK
MUSKEGON COUNTY, MICHIGAN

FIGURE 8 - GRAVITY GROUNDWATER DISCHARGE OPTION

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2130286

EXISTING PUMP STATION

EXISTING UNDERDRAIN SYSTEM

PROPOSED GROUNDWATER DIVERSION TRENCH

PROPOSED GROUNDWATER PIPING

FIGURE 9 - INFILTRATION TRENCHES OPTION

GROUNDWATER DIVERSION ALTERNATIVE

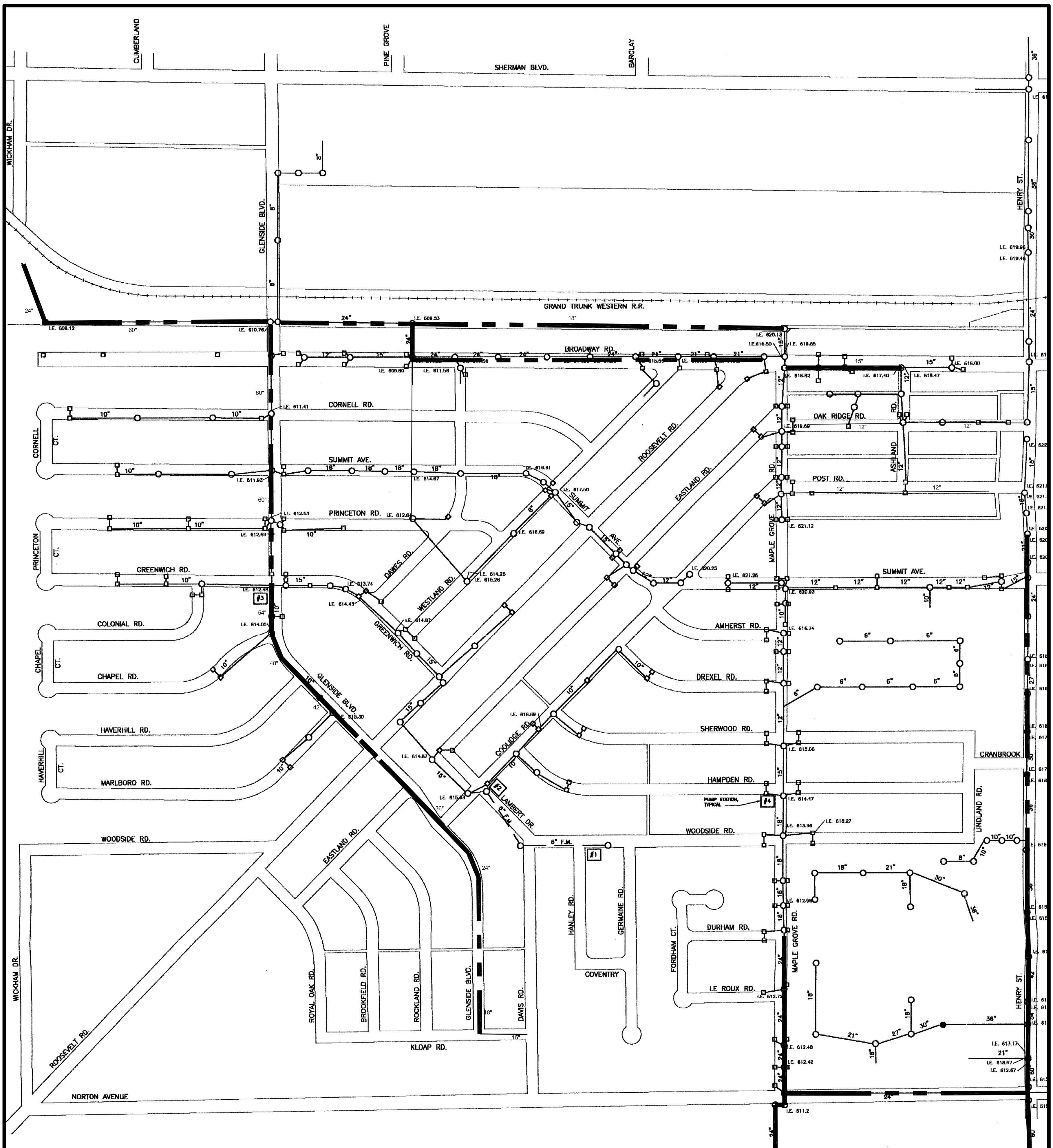
SOURCE: **FIGURE 8 FROM FTC&H JUNE 2005 SRF PROJECT PLAN**

Appendix A

Existing Stormwater System

North

APPROX. SCALE: 1"=600'



LEGEND

(thin line)	EXISTING COLLECTOR SYSTEM
(thick line)	EXISTING TRUNK SEWER

BASEMAP SOURCE: FTC&H FIGURE
STORM SEWERS COMPLETED SINCE CREATION OF THE FTC&H FIGURE HAVE BEEN ADDED PER INFORMATION PROVIDED BY THE CITY OF ROOSEVELT PARK

CITY OF ROOSEVELT PARK
MUSKEGON COUNTY, MICHIGAN

STORMWATER MASTER PLAN STUDY

EXISTING STORMWATER SYSTEM

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Appendix B

Proposed Stormwater/Street Improvements

City of Roosevelt Park
Proposed Storm Sewer/Street Improvements

Project	Description	Total Amount	Comments
1	Roosevelt Road Reconstruction from Broadway to Norton and Greenwich Road from Glenside to Broadway.	$1,890,000	City has a $350,000 MDOT grant for 2016 that can be used towards this project. Consider dividing the project up and applying for additional MDOT monies in a later funding cycle.
2	Construction of 12" to 24" storm sewer on Eastland Road, Royal Oak Road, Brookfield Road, and Rockland Road.	$1,080,000	These three projects will provide storm sewer in the southerly residential areas of the City that experience frequent surface flooding. The projects can be constructed in any order as funding allows. The storm sewer in Phase 4 in Woodside will provide relief for the Maple Grove sewer which is somewhat under sized.
3	Construction of 12" collector storm sewers on Durham Road and Le Roux Road	$380,000	
4	Construction of 30" storm sewer in Coolidge; 12 to 24" storm sewer on Lambert Drive, Woodside Road, Germaine Road, Hawley Road and Davis Road.	$1,230,000	
5	Construction of 42" trunk sewer at outlet replacing remaining 24" storm sewer.	$70,000	Currently the flow from the City's storm water collection system to the northwest is restricted by a section of undersized storm sewer under the RR tracks This project will increase the size of the City's storm sewer outlet under the RR tracks at the northwest corner of the City.
6	Construction of 12" to 24" storm sewer on Coolidge Road, Sherwood Road, Hampden Road, Drexel Road and Amherst Road. Construction of collector sewer on Eastland Drive northeast of Lambert Drive.	$1,230,000	
7	Construction of 12" collector sewers at north end of Eastland Road, Westland Road, Princeton Road, and Dawes Road	$930,000	
8	Extend and upsize storm sewers west of Glenside Boulevard on Chapel Road, Haverhill Road, Marlboro Road, and Woodside Road.	$1,420,000	A portion of the Woodside Road storm sewer is proposed to discharge to the City of Norton Shores.
9	Extend and upsize storm sewers west of Glenside Boulevard on Colonial Road, Greenwich Road, Princeton Road, Summit Road, Cornell Road and Garrison Road.	$1,790,000	
10	Construction of 12" collector sewer east of Maple Grove Road on Woodside Road, Hampden Road, and Sherwood Road.	$880,000	If the Maple Grove sewer is close to capacity. It may be possible to direct the storm water from these streets to the Henry Street storm sewer.
11	Upsize storm sewer in Summit Avenue west of Henry Street	$230,000	The existing storm sewer in Summit Avenue is undersized; since this road was recently reconstructed, this would be a low priority project unless some surface flooding issues start to develop.
	Total:	$11,130,000	

Roads Eligible for MDOT funding

Roosevelt Road
Maple Grove Road
Broadway Avenue between Glenside and Henry Street
Summit Avenue between Glenside and Henry Street
Glenside Avenue

Appendix C

Groundwater Control Alternatives

CITY OF ROOSEVELT PARK
GROUNDWATER CONTROL OPTIONS

Option		Advantages	Disadvantages	Approximate Cost	Coordination with Other Projects
1	Rehabilitate Existing Pump Stations (new duplex submersible pump system with standby generator and install and connect new underdrains)	● Reduce groundwater flow from sump pumps and underdrains to sanitary sewer, ● Could allow for reducing or eliminating flow from existing open underdrains flowing into sanitary sewer, which could reduce billed sanitary flow by up to 300,000 gallons/day ($200,000+ per year)	● Relies on old manhole structures and flow from existing underdrains which are known to be plugged with roots and may be structurally failing, ● Requires electrical usage and long term maintenance, repair, replacement ● Will use up to 1,200 gpm of storm water system capacity	$1,300,000	Need to verify sufficient depth at each existing pump station. Will require major excavation at each pump station, but piping would be installed by directional drilling so could be installed independent of other storm sewer/road work, For approximately $750,000 could rehabilitate each pump station without connections to any new underdrains, this would require testing of capacity of existing underdrains
2	Install New Storm water Pump Stations	● Reduce groundwater flow from sump pumps and underdrains to sanitary sewer, ● Could allow for reducing or eliminating flow from existing open underdrains flowing into sanitary sewer, which could reduce billed sanitary flow by up to 300,000 gallons/day ($200,000+ per year) ● New stations would be more reliable and have a longer life	● Requires electrical usage and long term maintenance/repair/replacement, ● Will use up to 1,200 gpm of storm water system capacity	$1,700,000	Will require major excavation at each pump station, but piping would be installed by directional drilling so could be installed independent of other storm sewer/road work
3	Gravity Groundwater Pipe to Seminole and Roosevelt Road, Connect to Existing Underdrains ad Proposed Underdrains	● Provides for discharge of groundwater to reduce flow from sump pumps and underdrains to sanitary sewer, ● Gravity discharge does not require any routine operation/maintenance, ● Could reduce billed sanitary flow by up to 300,000 gallons/day ($200,000+ per year)	● Does not provide any storm water capacity, ● Requires installation in Norton Shores and Norton Shores has no current plans to complete road or utility work in this area	$1,800,000	Install during work in Roosevelt Road, also requires work in Norton Shores requiring coordination with Norton Shores. May require upgrading culvert under Forest Park Rd (cost not included), status/ownership of drain at outlet needs to be investigated
4	Install Drain Trenches through Clay Layer	● Provides for discharge of groundwater to reduce flow from sump pumps and underdrains to sanitary sewer, ● Gravity discharge does not require any routine operation/maintenance, ● Could reduce billed sanitary flow by up to 300,000 gallons/day ($200,000+ per year)	● Significant amount of piping required to transport water to the northeast portion of the City where the trenches are feasible due to depth and thickness of clay layer, ● Gravity lines from the west side may need to be >20 feet deep , installing stone at depth under road could result in future settling	$2,300,000	Complete trenches and groundwater transport piping in phases along with road/storm work

NOTE - COSTS DO NOT INCLUDE ASSOCIATED ROAD REMOVAL/RESTORATION FOR PIPELINE AND TRENCHES INSIDE ROOSEVELT PARK