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Appendix D – Water Distribution System Evaluation Technical Memorandum

Water Master Plan

Distribution System Evaluation Technical Memorandum (WMP Section 5)

Englewood Water District

District Contract No. 2022-129

Englewood, FL

December 15, 2023

Contents

Tables

Figures

1 Introduction

The Englewood Water District (District) has retained HDR Engineering, Inc. (HDR) to provide professional services to develop a Potable Water Master Plan. This Master Plan will assess the District's water service and facility needs for the next 20-year planning period from 2023 through 2043 for treatment and pumping equipment upgrades needed and the next 50-year period from 2023 to 2073 for verifying useful life of new wells, pipelines, and treatment basins with recommended upgrades. The purpose of this Technical Memorandum is to evaluate the distribution system infrastructure needs with corresponding projected distribution demands over the 20-year and 50-year planning periods.

2 Background

Since 1959, the District has developed a finished water distribution system within approximately 44.5 square miles and consisting of over 3,571 miles of water transmission and distribution pipelines and appurtenances, with emergency interconnections with Sarasota and Charlotte Counties. There is one High Service Pump Station located at the water treatment plant (WTP) to convey finished water to the elevated storage tank and distribution system.

As part of the 2017 Utility Master Plan, a potable water distribution system hydraulic model (Model) was developed using Bentley WaterGEMS to provide the District a tool that can conduct ongoing evaluations of their existing and future potable water system infrastructure. This model was rudimentary, and calibration of this hydraulic model was documented as beyond the scope of the 2017 Utility Master Plan, and it is beyond the scope of this 2023 Water Master Plan. However, this rudimentary hydraulic model was carried forward to this Master Plan effort. This hydraulic model is now updated with pipelines installed through 2022 using the District's GIS information, updated with customer demand information from March 2023, and has been validated for a snapshot of March 2023 distribution system flow and contributing high service pump station capabilities as discussed in section 3 below. The updated and validated hydraulic model network was also expanded to evaluate the pipe sizes needed for future development service mains as discussed in section 4 below. The updated and validated hydraulic model was also used to assess system pressures using 2023, 2043, and 2073 conditions as discussed in sections 5, 6, and 7 below.

3 Model Update and Validation

HDR updated the existing District Model as part of this Water Master Plan effort. The updates included pipe imports from District-provided GIS and demand updates from geocoded water meter data. To update the pipe network, the Model was compared with the GIS provided by the District. 165 pipes were identified as new or necessary (Figure 3-1). These pipes were added to the distribution system as part of the model update. This model does not include all pipes; because of this, there is limited accuracy in the analysis of pressures and available fire flow (FF) at many locations within the District. All analysis is based on the location where the service mains tie into the transmission mains. A minimum pipe diameter of 8 inches was kept for the pipe network. A few smaller connections were added later in the process to improve the accuracy of customer meter connections. System pipe diameters can be seen in Figure 3-2.

To allocate system demands, water billing data was geolocated. The meters were imported from a 1-month consumption data table representing March 2023 for Charlotte and Sarasota County. The data was then filtered by zip code to remove any addresses outside of the District. Once the data was filtered, it was imported into the GIS model. Geocoded addresses were used to match the meter addresses to the parcel data in the model. Once matched, the meters could then be imported and adjusted in the WaterGEMS model. The current demand was compared to the total produced finished water for the month of March and was acceptable.

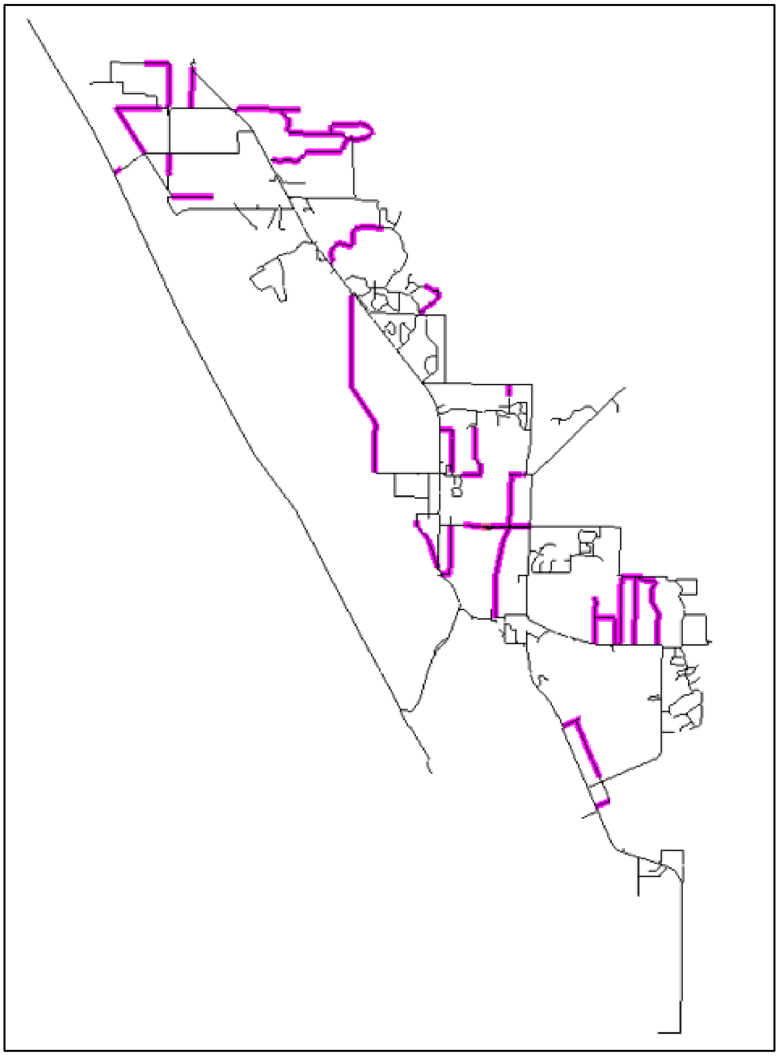

Figure 3-1: Baseline Model Pipe Additions Highlighted

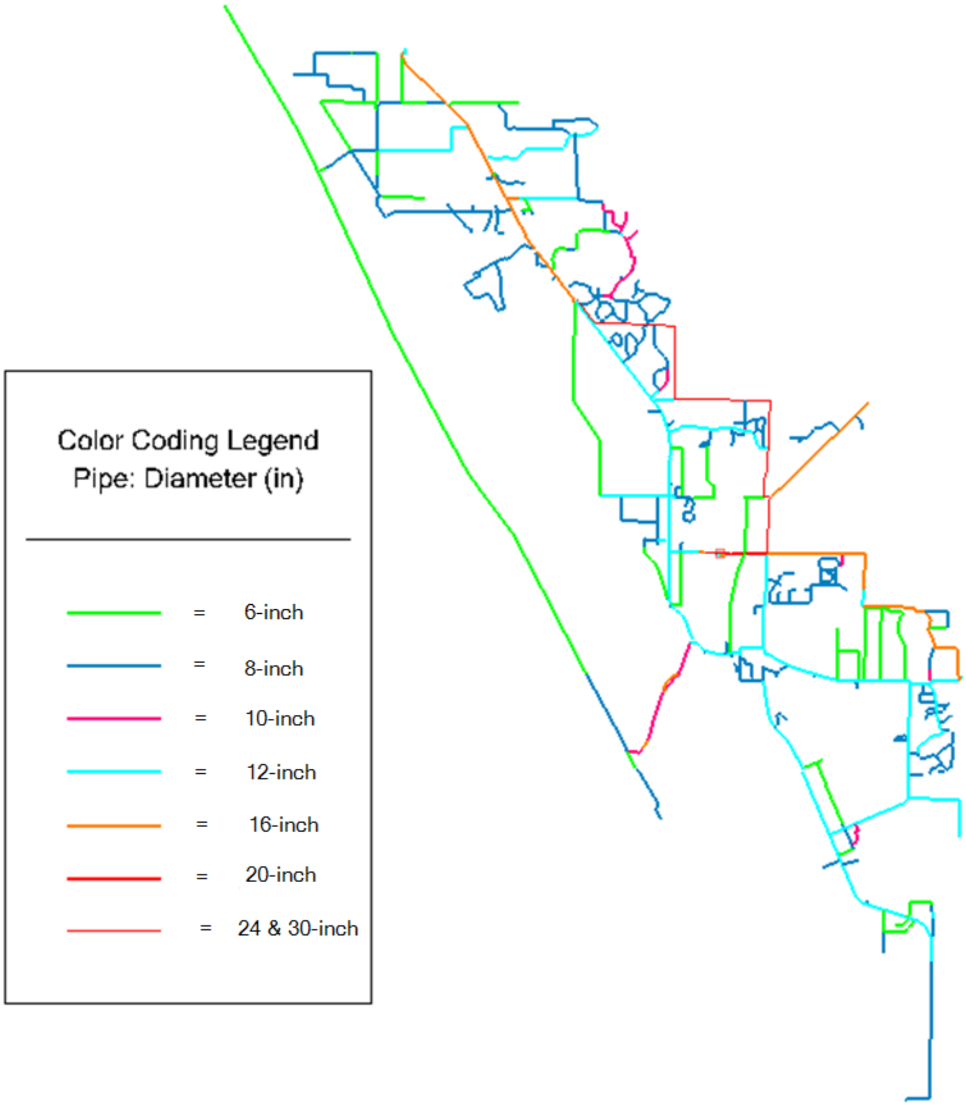

Figure 3-2: Baseline Model Pipe Diameters

4 Future Development Model Additions and Assessment

Future demands were allocated using a list of planned developments provided by the District and projected maximum month daily (MMD) water demands within the District from the Population and Flow Projections TM, section 4.3.4. Forecast water production can be seen in Table 4-2. HDR and the District discussed potential piping connections and details about each development site. The District provided a development master plan, which shows a 15+ year projection of build out percentages for all new developments. HDR considered these in the future projections and included them in the model. The details of FF requirement, land use type and expected demand were verified in the meeting. Anticipated piping was sized based on max day demand + FF. Suggested pipe diameters can be seen below in Table 4-1. It is assumed that all pipes within neighborhoods that are not included in Table 4-1 are 8-inch looped main. A loop will have two connections to the main sized in Table 4-1. Wellen Park is the most complex of the expected developments and will require 16-inch and 12-inch mains. To clarify requirements, Figure 4-1 displays Wellen Park minimum pipe diameters for water mains and includes an example of an 8-inch loop neighborhood.

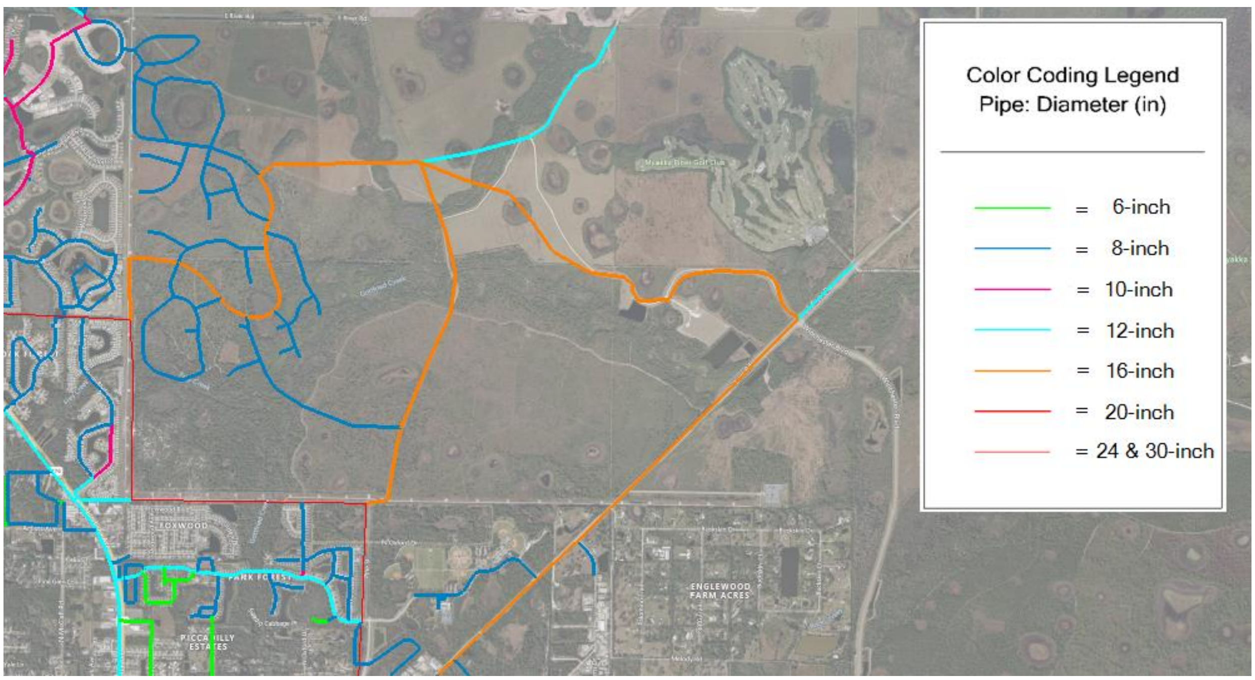

Figure 4-1: Suggested Wellen Park Pipe Diameters

Table 4-1: Suggested Minimum Diameters for New Developments

Development	Minimum Diameter
Wellen Park	16-inch main loop with 12-inch piping as needed
Beachwalk PH1 & 2	12-inch
Beachwalk PH3 & 4	12-inch
Beachwalk Outparcels	8-inch
Boca Royale Unit 14 & 16	10-inch

Development	Minimum Diameter
Boca Royale Unit 17 & 18	8-inch
Gateway Court	8-inch
Prose Apartments	8-inch
200 Artists	8-inch
Park Forest 7	8-inch
Paddock Pines	8-inch
Englewood Gardens	8-inch
Generation of Englewood	8-inch
Manatee Cay	8-inch
Medical Twins	8-inch
Sandy Lane Townhomes	8-inch
Heritage Oaks Multifamily	8-inch
Lake Emily	8-inch
Island Lake Estates-Coco- Bay	8-inch

Projected water flows were allocated to the added junctions at each of the new developments. In addition to the planned developments, assumed build-out and period water flows from future developments in the District were considered for the 2043 projected model. These additional 2043 system demands were distributed throughout the customer meter network. For the 2073 projection, an adjustment was made based on the MMD water demands in 2043 shown in Table 4-2. Future 2073 system demands were assumed to be added throughout the District.

Table 4-2: Projected Max Month Water Demands within the District

Year	MMD (mgd)	MMD with Diurnal Peaking Factor of 2 (mgd)
2023	5.320	10.640
2043	6.944	13.888
2073	9.287	18.574

Five modeled scenarios were developed to analyze the District's level of service:

- 2023 Existing condition MMD
- 2023 Existing condition MMD + FF
- 2043 With CIP MMD
- 2043 With CIP MMD + FF
- 2073 With CIP MMD

After the scenarios and physical network were completed and capacity assessments were conducted, the modeled demand and FF availability were compared using existing pipe geometry and proposed projects for improvements. One component that is not able to be assessed by the current model is water age. Water age is an indicator of disinfection biproducts such as trihalomethanes (THMs). An extended period simulation is required to calculate water age. The capacity of the system was assessed using the following criteria:

- Pressures no lower than 40 psi during MMD
- Velocities to remain below 10 fps
- Pressures during MMD + FF no lower than 20 psi

The updated and validated hydraulic model was used to evaluate system pressures and velocities for 2023 Existing Condition MMD, 2043 existing condition MMD, and FF scenarios for both Existing Condition MMD and 2043 MMD with a diurnal peaking factor of 2.0 for existing infrastructure conditions. Pipe velocities and junction pressures were analyzed to determine low service areas and corridors for capital improvement projects (CIP). After CIPs were identified these projects were incorporated into the model making the CIP pipe network. The CIP hydraulic model network was used to evaluate 2043 MMD, 2043 MMD + FF, and 2073 MMD with a diurnal peaking factor of 2.0.

5 Model Results – Existing System

The existing system model was simulated for steady state conditions at the MMD with diurnal peaking factor as noted above. Conversations with the District led to an understanding that the discharge from the Pump Station operates under a variable frequency drive (VFD) and the setting for the VFD is 57 pounds per square inch (psi) from the high service pump station. The model has a valve that reduces the pressure at the pump station to simulate standard operating conditions of the District's typical water distribution.

The existing model scenario simulation showed moderate pressure reduction throughout the system. The largest areas of pressure drop were at the north and south extremes where head losses have been able to accumulate. The pressure reduction from the WTP to the farthest north and south junctions is approximately 65.78 feet (29 psi) of head and 25.94 feet of head (11 psi) respectively. Modeled pressures in the distribution system can be seen on Figure 5-2. The existing model results confirmed the District's capacity issues on Manasota Key. This model simulation delivers a total flow of 7,390 gpm (10.64 MGD) from the WTP which is within the operating range of the existing high service pump station. Similarly, most of the distribution piping system appeared adequate with few locations of major head loss gradients greater than 1 foot per 1,000 feet (ft/1,000 ft) and no single pipe velocity greater than 4 feet per second (fps). The average velocity within the distribution system for this model simulation is 1.12 fps (Figure 5-1). FF availability was modeled for the system and can be seen in Figure 5-3. The available FF is low in the extremes of the system due to the head loss gradient to the location. Available FF is also affected by pipe diameter. In many locations within the system there is additional piping that will significantly contribute head losses. If the District would like to better analyze available FF throughout the system, an all-pipes model and calibration is recommended. An immediate consideration to the system is to increase the target discharge pressure at the Pump Station. Typically pressures between 40-80 are preferred pressures and are standard operating pressures in a distribution system. Increasing the target pressure of the VFD at the Pump Station to 70 psi right now will improve the pressure issues at the extents of the distribution system. Accordingly, provisions to the elevated storage tank would need to be made, such as adding an influent pressure reducing valve, to limit the tank being overfilled.

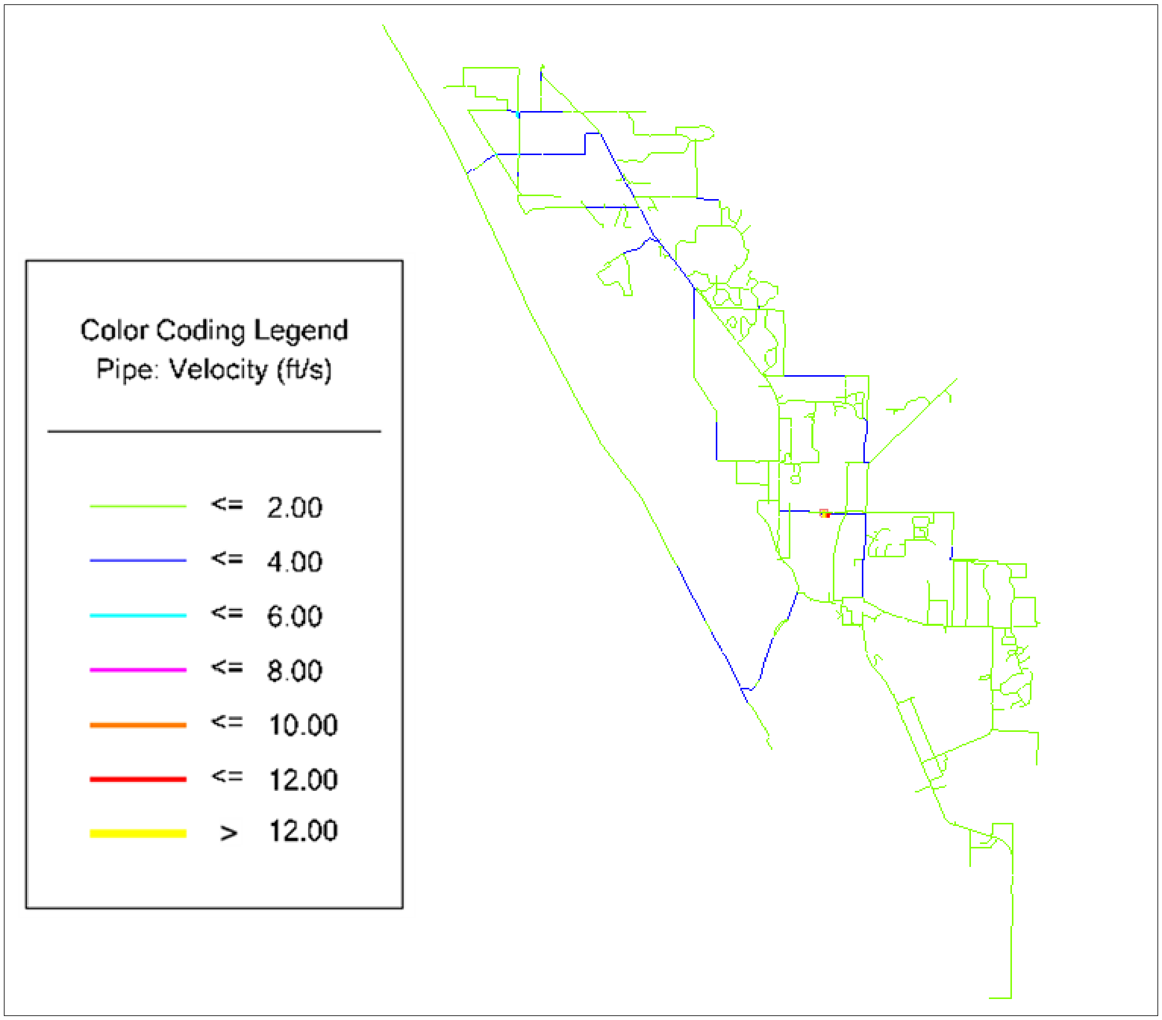

Figure 5-1: Velocity Results from Existing Model MMD

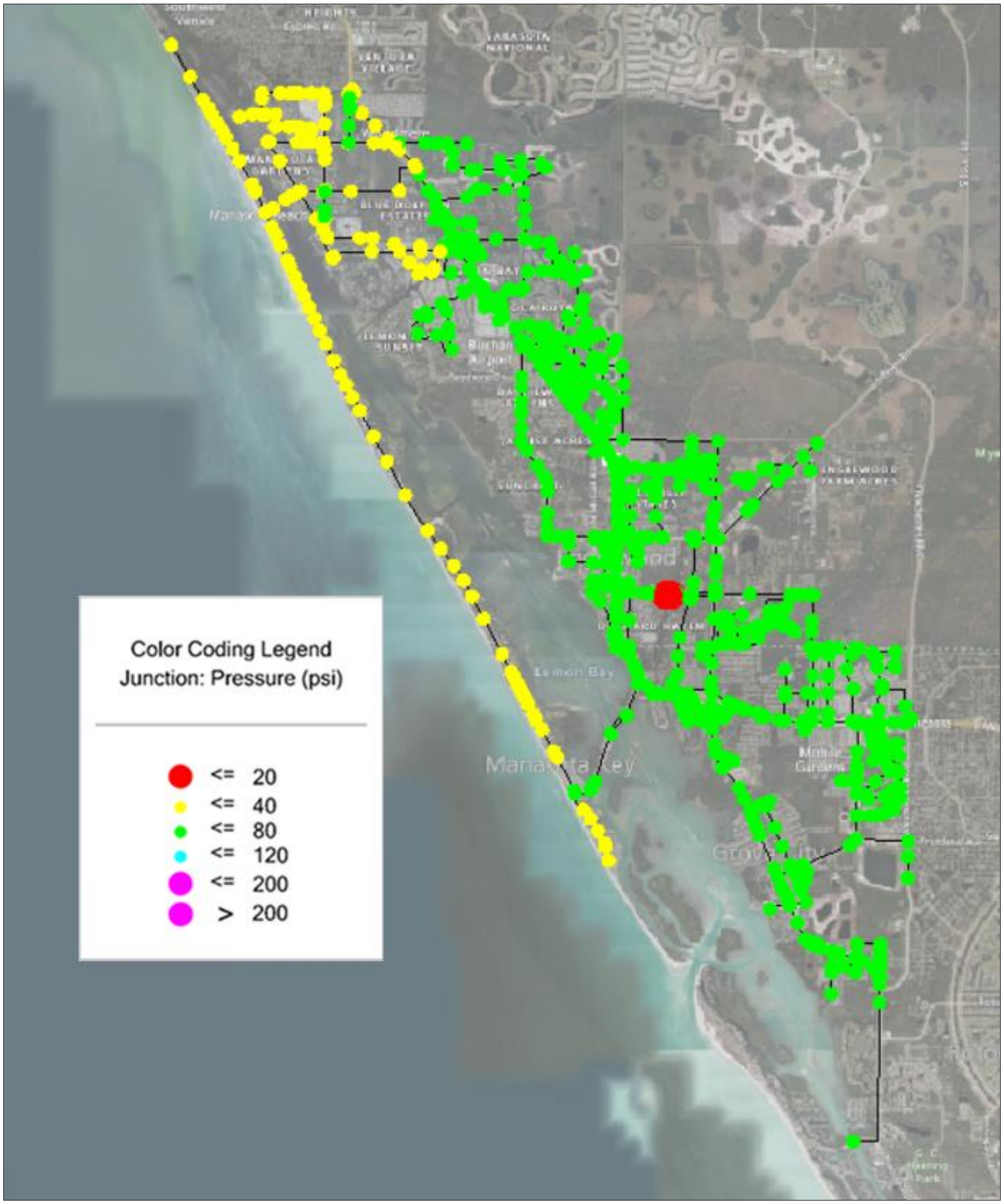

Figure 5-2: Pressure Results from Existing Model MMD

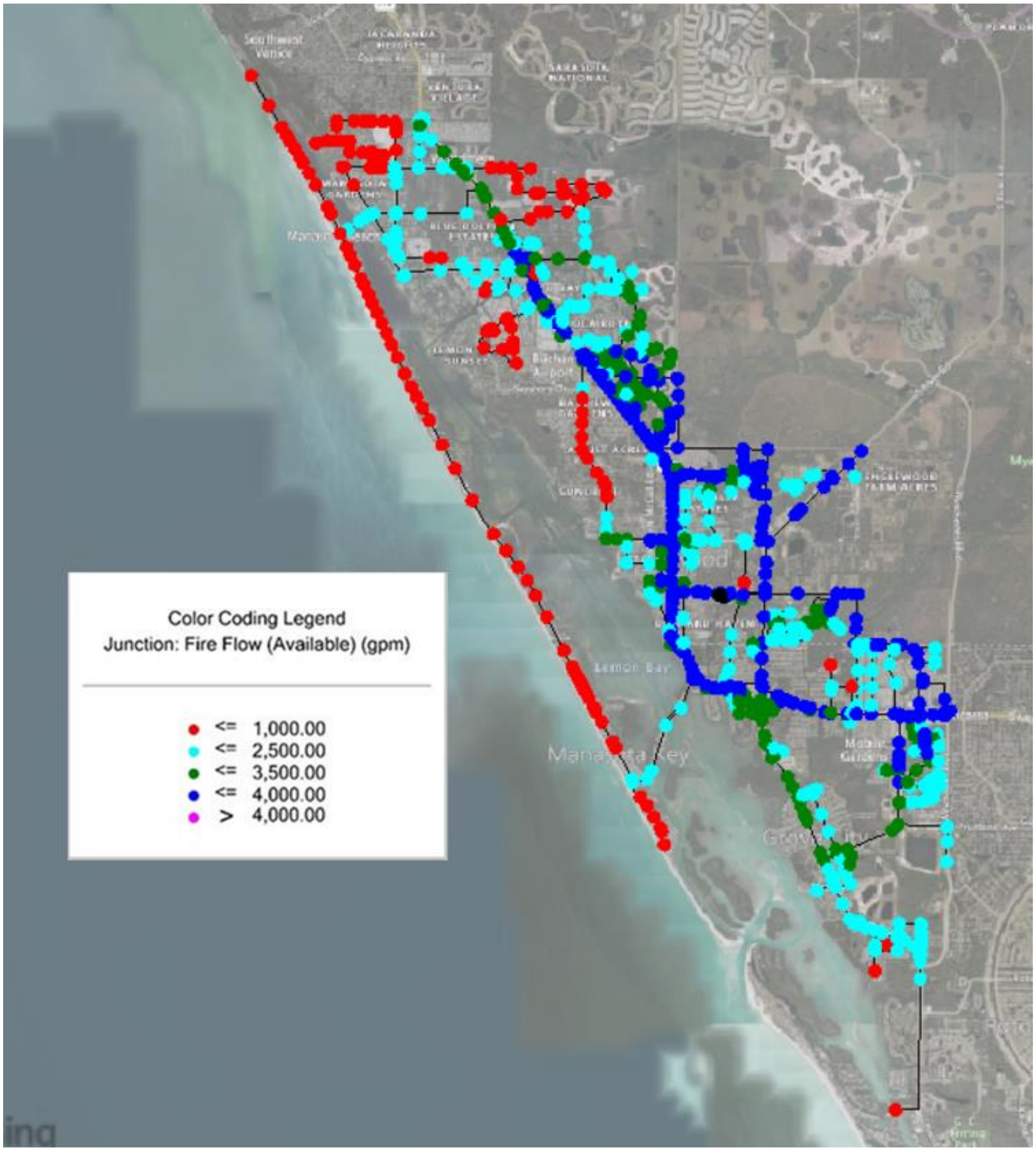

Figure 5-3: Fire Flow Results from Existing Model MMD

6 Model Results – Future System in 2043

The future system model was simulated for steady state conditions at the MMD with diurnal peaking factor of 2.0. Demands in the model were adjusted to the MMD water demands shown in table 4-2. This model simulation delivers a total flow of 9582.40 gpm. The pressure reduction from the WTP to the farthest north and south junctions is approximately 103.03 feet (45 psi) of head and 62.38 feet of head (27 psi) respectively. This model simulation showed that the pressure reductions (Figure 6-2) for the modeled future demand period were significant. Results show the average head loss gradient of the 20-year future demand projection is approximately 1.67 ft/1000ft. The average velocity within the distribution system is 1.14 fps (Figure 6-1). The area with the lowest level of service is Manasota Key, which according to the results of the existing model, showed increased head losses in the system along Beach Road and moving north on the barrier island. Because the head losses on the existing system were already significant, any further reductions due to increased demands elsewhere in the system may further compromise the ability to provide service to Manasota Key. FF availability was also modeled for this scenario and can be seen in Figure 6-3. The available FF is low in the extremes of the system, especially in areas like Manasota Key, Japanese Gardens and Englewood Isles.

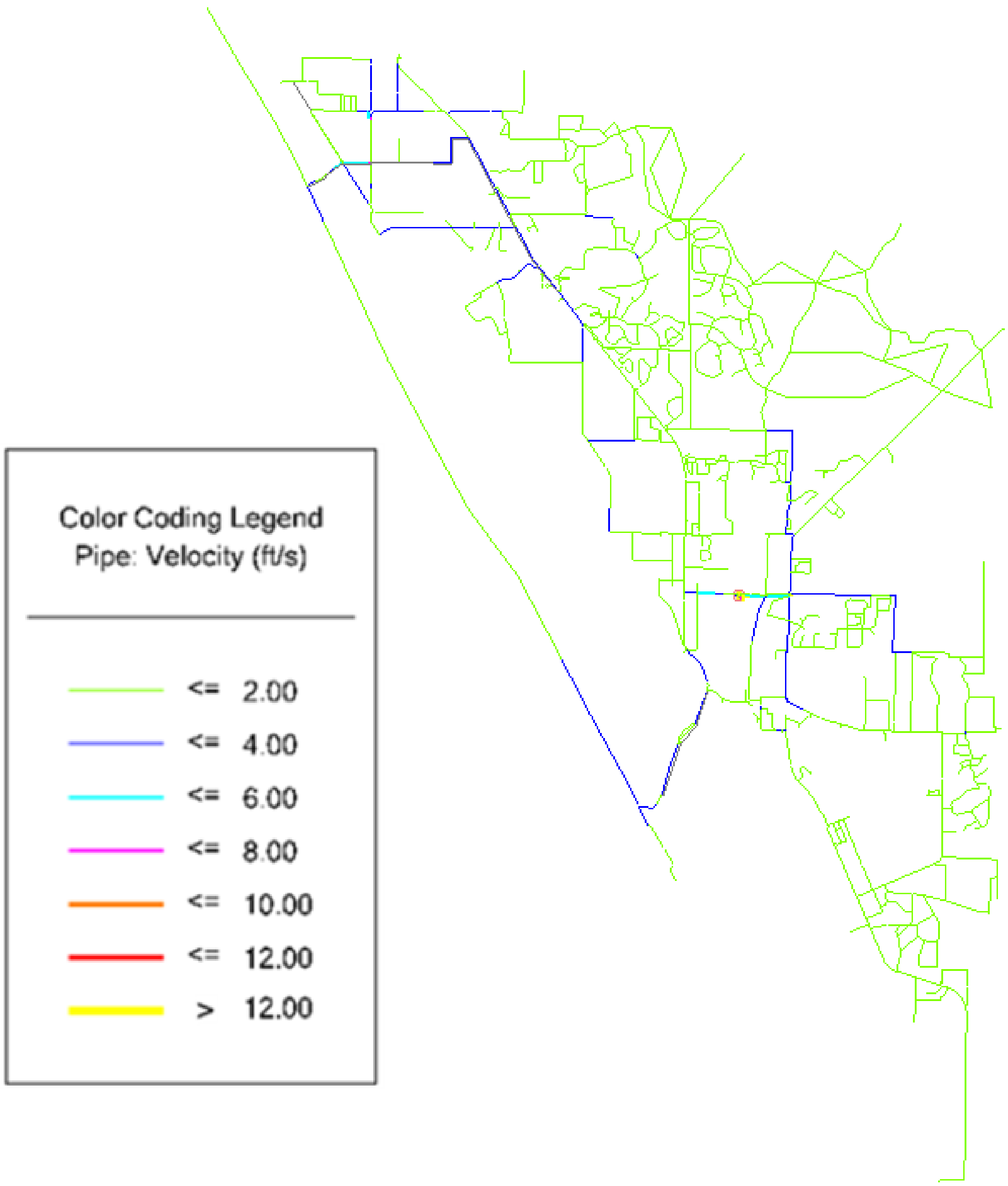

Figure 6-1: Velocity Results from Future System Model MMD 2043

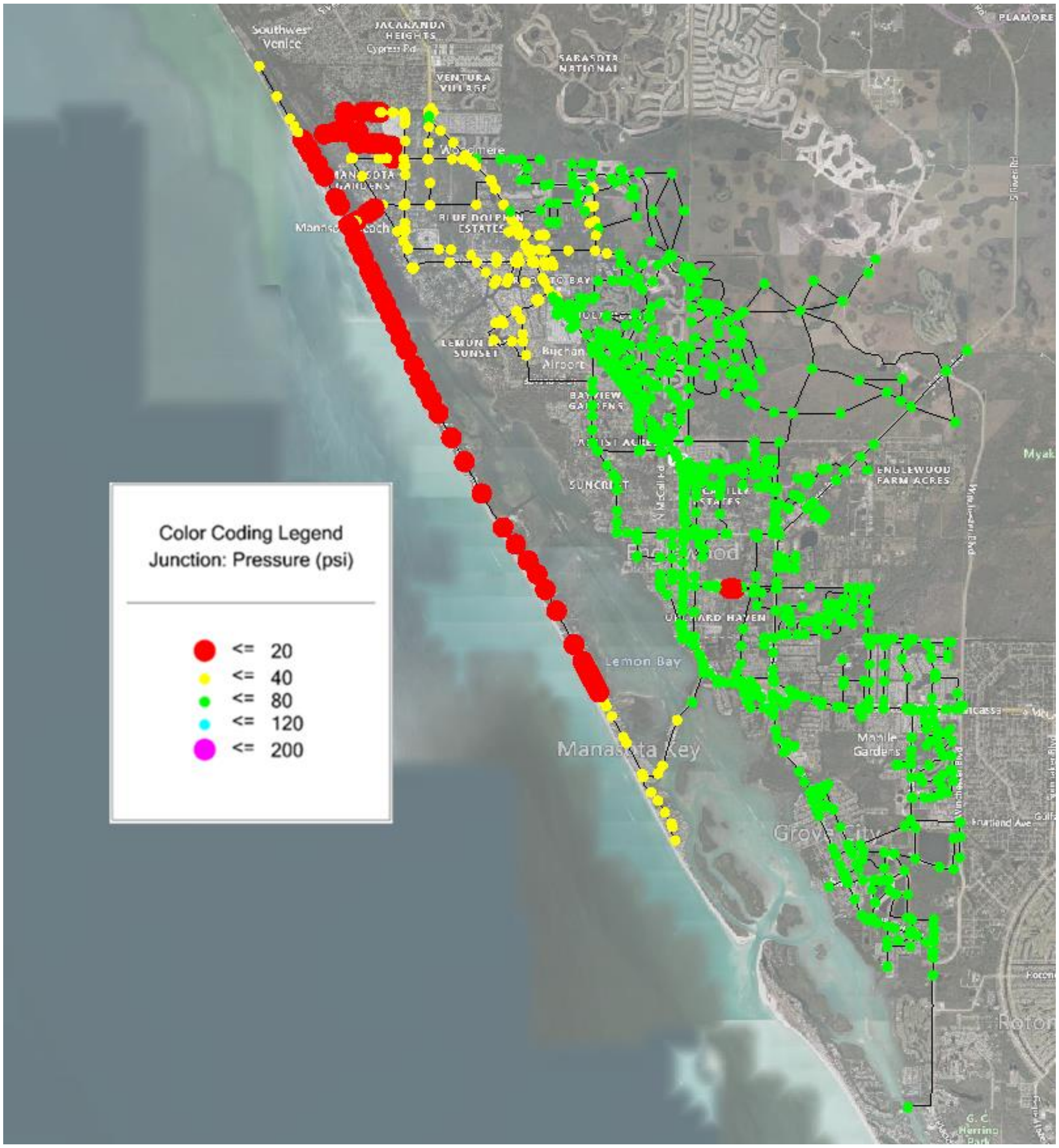

Figure 6-2: Pressure Results from Future System Model MMD 2043

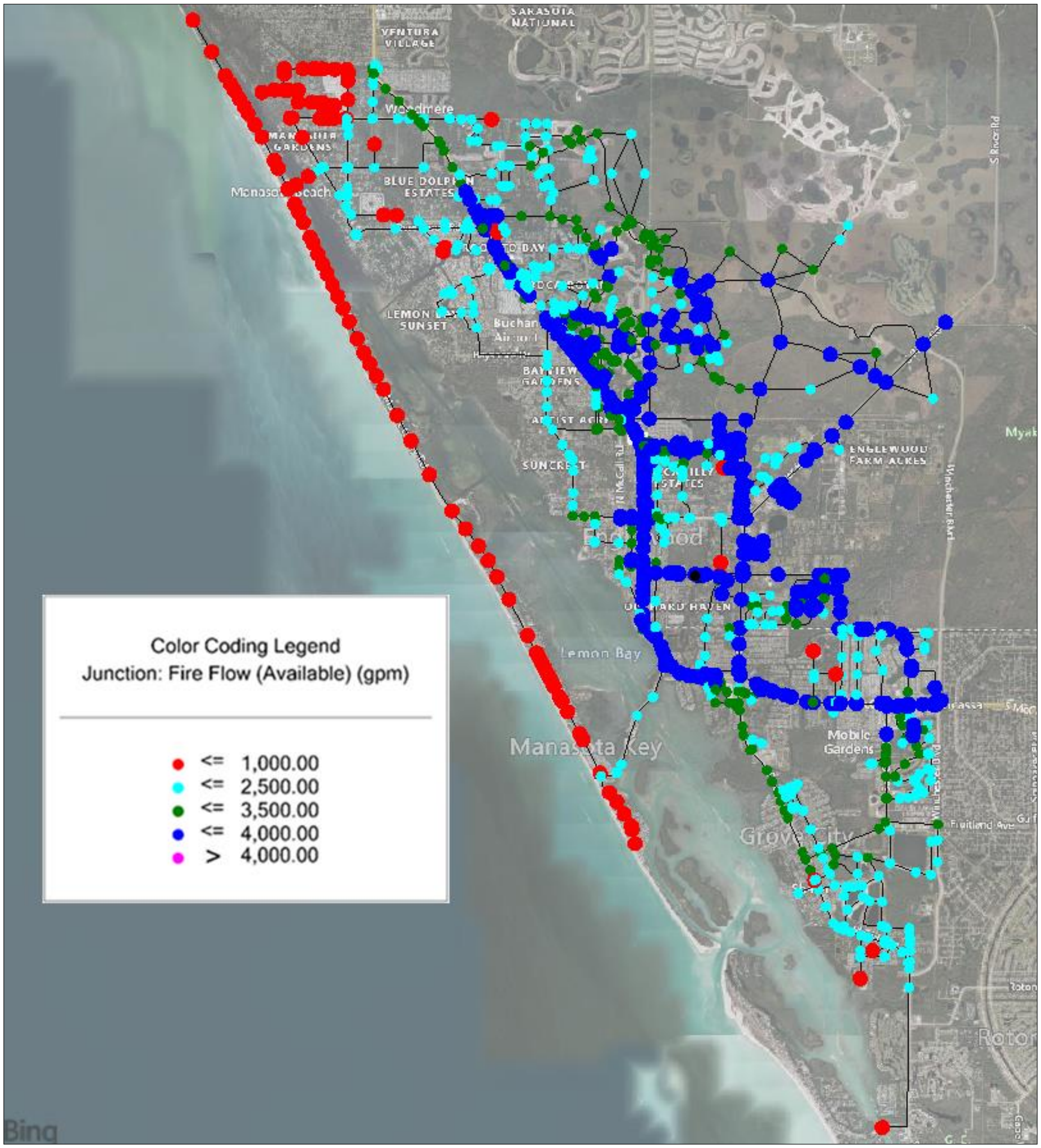

Figure 6-3: Fire Flow Results from Future System Model MMD 2043

7 Model Results – Future System in 2073

The future system model was simulated for steady state conditions at the MMD with diurnal peaking factor as noted above. The 2073 model was used to validate long-term pipeline capacities, particularly for new piping or current piping that needs replacement. Demands were taken from the 2043 model and were then adjusted by allocating demands to areas of future developments (Figure 4-1). This model simulation delivers a total flow of 12,893.40 gpm and showed that the pressure reduction for the future 2073 system was significant. The pressure reduction from the WTP to the farthest north and south junctions is approximately 126.91 feet (54 psi) of head and 120.7 feet of head (51 psi) respectively. Modeled pressures in the distribution system can be seen in Figure 7-2, showing major pressure loss in areas such as Manasota Key and Japanese Gardens. Results show the average head loss gradient of the 50-year future demand projection is approximately 3 ft/1000ft. The average velocity within the distribution system is 1.61 fps (Figure 7-1). Based on these results the existing system will not be adequate to handle the future demands in the locations of the anticipated developments with respect to system head losses. One area of concern is Manasota Key where pressures drop below 20 psi., however, over half the system is below acceptable pressure if there are no improvements before 2073.

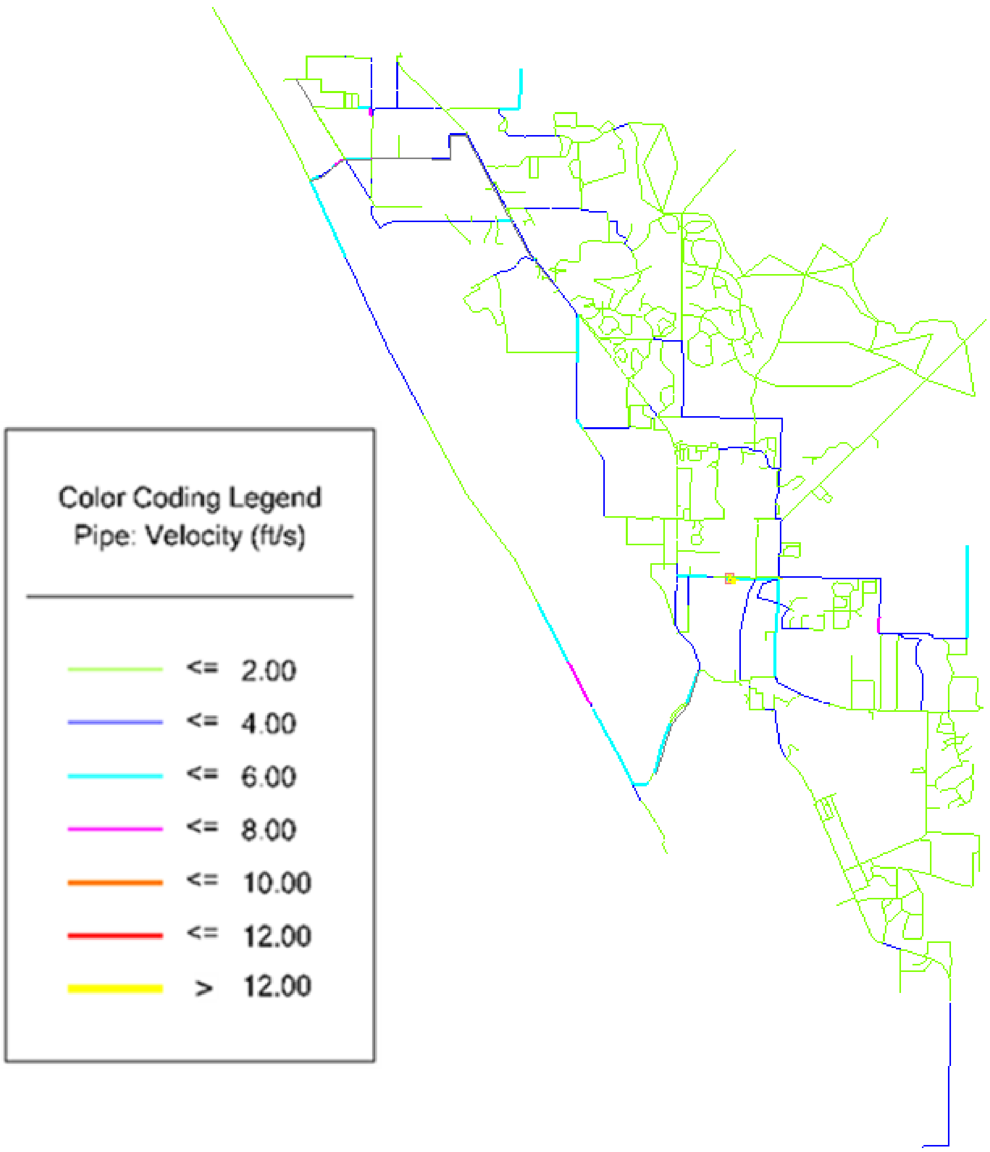

Figure 7-1: Velocity Results from Future System Model MMD 2073

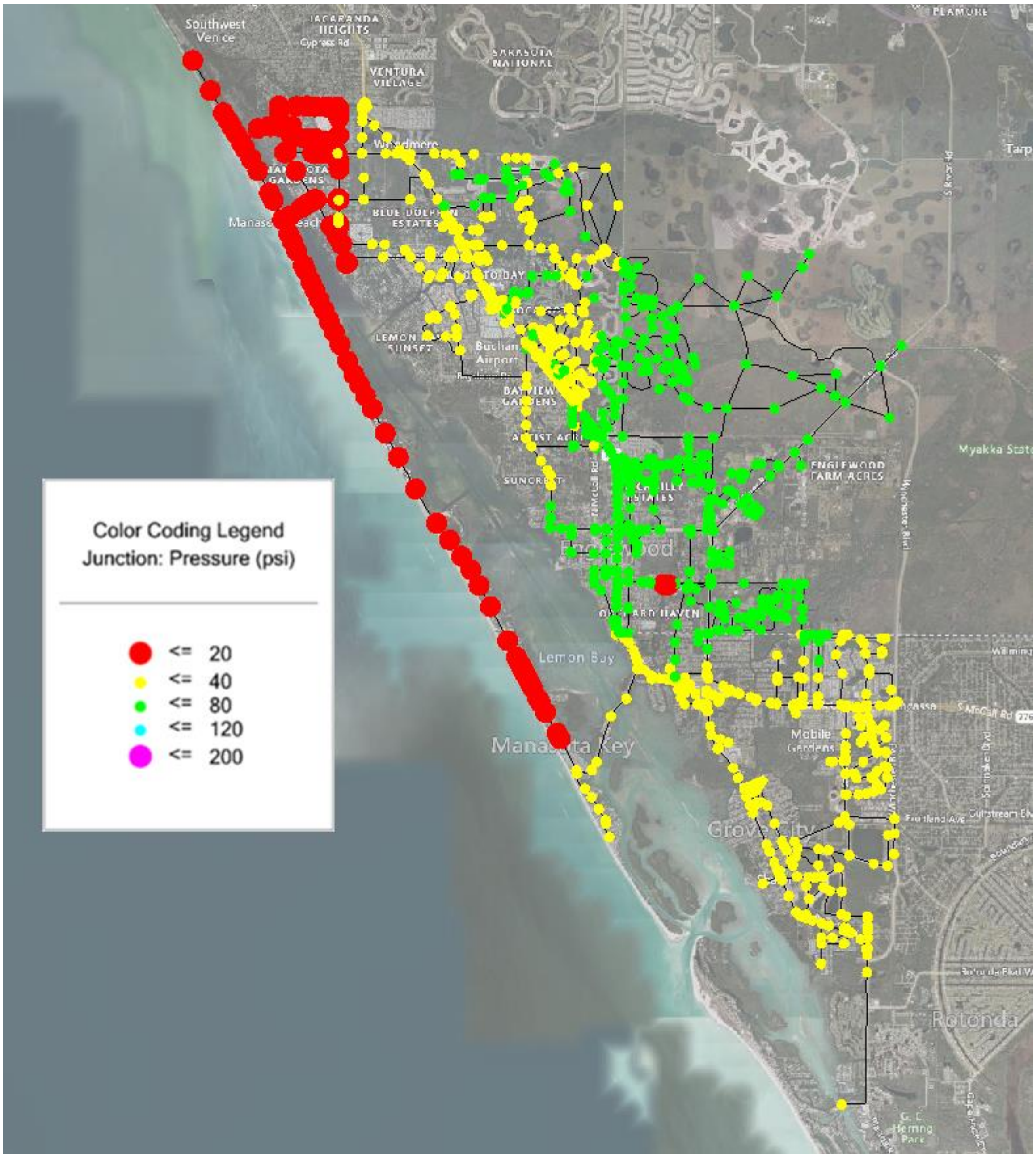

Figure 7-2: Pressure Results from Future System Model MMD 2073

8 Distribution System Recommendations

The primary areas of concern in the model are Manasota Key, Japanese Gardens, Englewood Isles, Englewood Rd, and the Southeast Region of Grove City and Mobile Gardens. These areas have shown a sensitivity to increased demand which results in an increase in head loss. There are five pipelines that are recommended for CIPs (Figure 8-1). The CIPs are numbered according to priority: number 1 being the most urgent and the most impactful to the system and number 5 affecting the least number of customers. Each of these CIPs was modeled as an additional parallel pipeline with no tie overs along the assumed path. Before any of these improvements were analyzed the discharge pressure at the Pump Station was increased to 70 psi as recommended for consideration in Project 6. Additionally, Project 7 is recommended to improve distribution system understanding and effectiveness of the modeling tool.

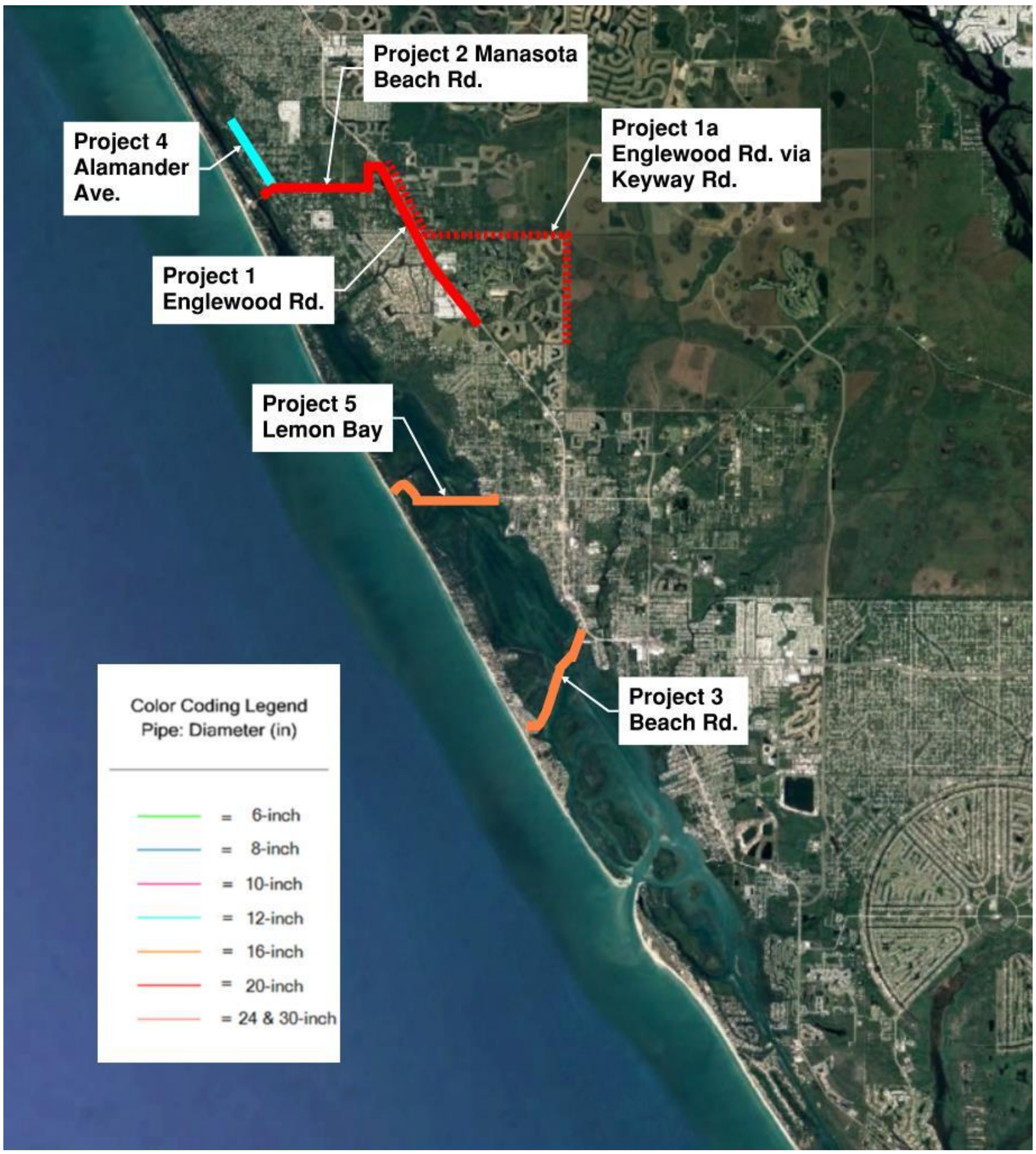

Figure 8-1: Recommended Pipeline Projects Overview

Project 1 – Englewood Rd

Project 1 will increase capacity to the northwest part of the District and is the most critical of all the projects. It will improve service to north Manasota Key and the areas of the system that are currently showing deficiencies. It consists of improvements along Englewood Rd and starts within the intersection of Englewood Rd and Old Englewood Rd. The project consists of approximately 11,000 ft of 20-inch diameter pipe. It runs with the alignment of Englewood Rd. and ends at the intersection of Englewood Rd and Shane Rd.

An alternative layout to Project 1, herein called Project 1a, is also shown in Figure 8-2. This alternative would connect to the existing 24-inch pipe which runs east of the Boca Royale development, run north to Keyway Rd, follow Keyway Rd west until reaching Englewood Rd, and would then run northwest along the same path as Project 1. This project (20,500 ft) would be considerably longer than Project 1 and more costly but would be less disruptive during construction since the majority of the alignment avoids major roads. In addition, this alternative route may create less pressure to customers tying into the existing 16-inch main along Englewood Rd between Keyway Rd and Old Englewood Rd. A more detailed and calibrated hydraulic model may be beneficial to view the intricacies in all neighborhoods.

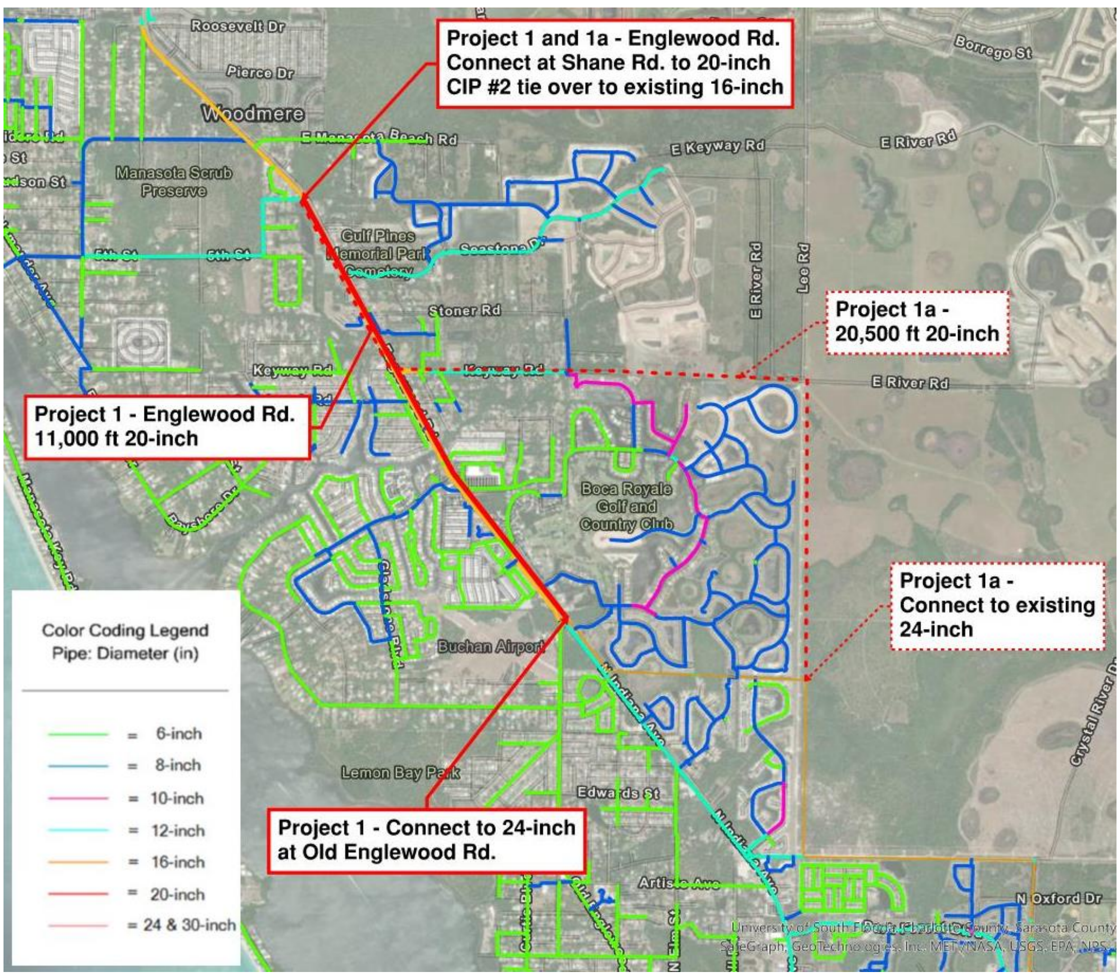

Figure 8-2: Project 1 and 1a – Englewood Rd

Project 2 – Manasota Beach Rd

Project 2 consists of improvements along Manasota beach Rd, 5th St, Belle Rd., and Shane Rd. The improvements start within the intersection of Englewood Rd and Shane Rd. The pipeline heads west within Shane Rd. for 1,000 ft. then turns south at the Bell Rd. for 1,300 ft. At the intersection of 5th St. and Belle Rd., the pipeline turns and travels west 5,500, then turns southwest at Alamander Ave. and travels 1,000 ft within Manasota Beach Rd. until it ends and connects to the 8-inch line that crosses Lemon Bay. The project consists of 8,800 ft. of 20-inch diameter pipe.

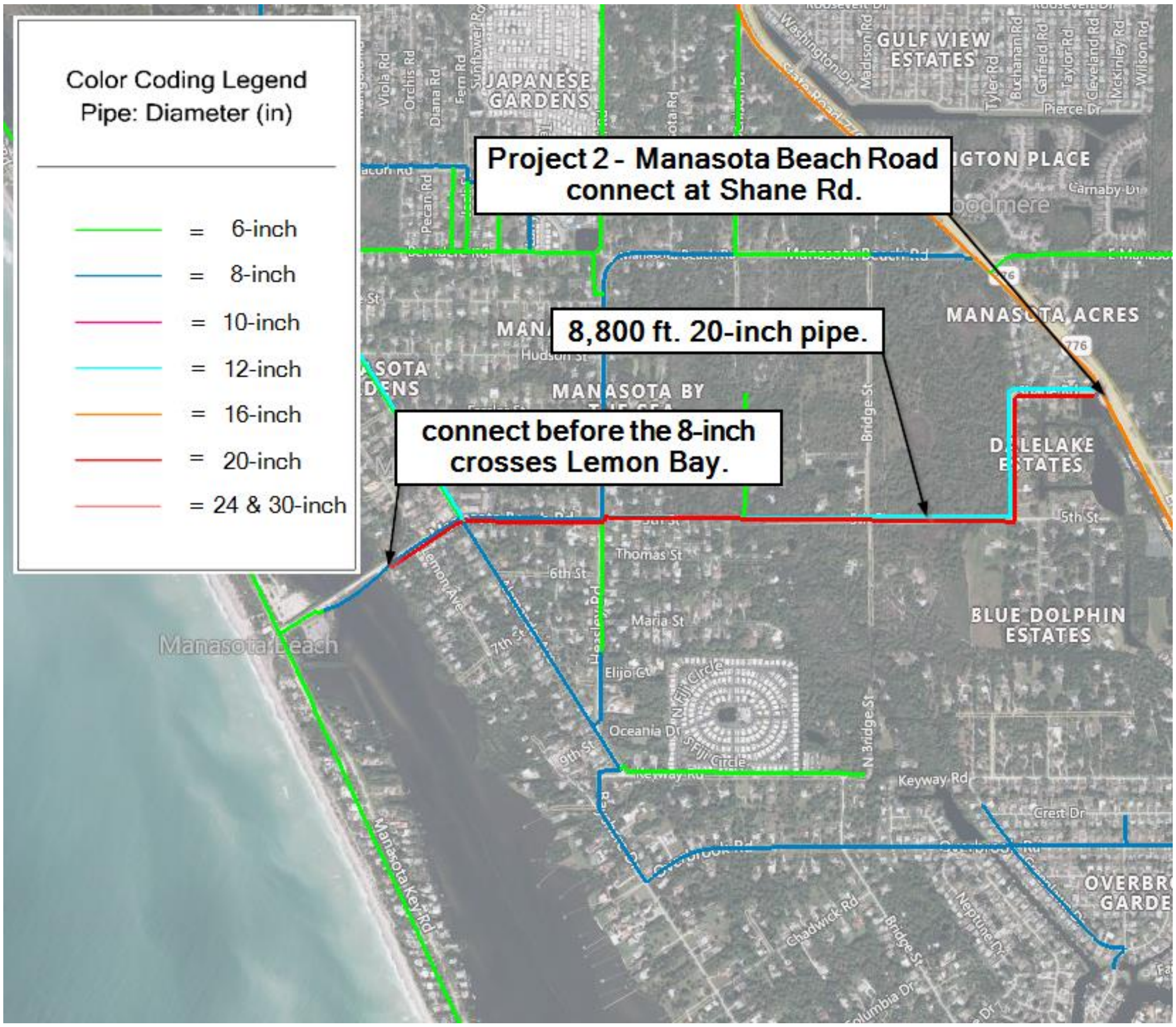

Figure 8-3: Project 2 – Manasota Beach Rd

Project 3 – Beach Rd

Project 3 consists of improvements along Beach Rd and starts within the intersection of Beach Rd and S McCall Rd. The project will consist of 6,000 ft. of 16-inch diameter pipe and ends at the intersection of Beach Rd, Gulf Blvd., and N Beach Rd. The project will add parallel pipes where there are mains less than 16 inches. The bridges currently have 16-inch mains crossing the bay and will not have improvements. The Project consists of three segments of pipe within the land portion of the road. The segments are 1,000, 3,000, and 2,000 feet long.

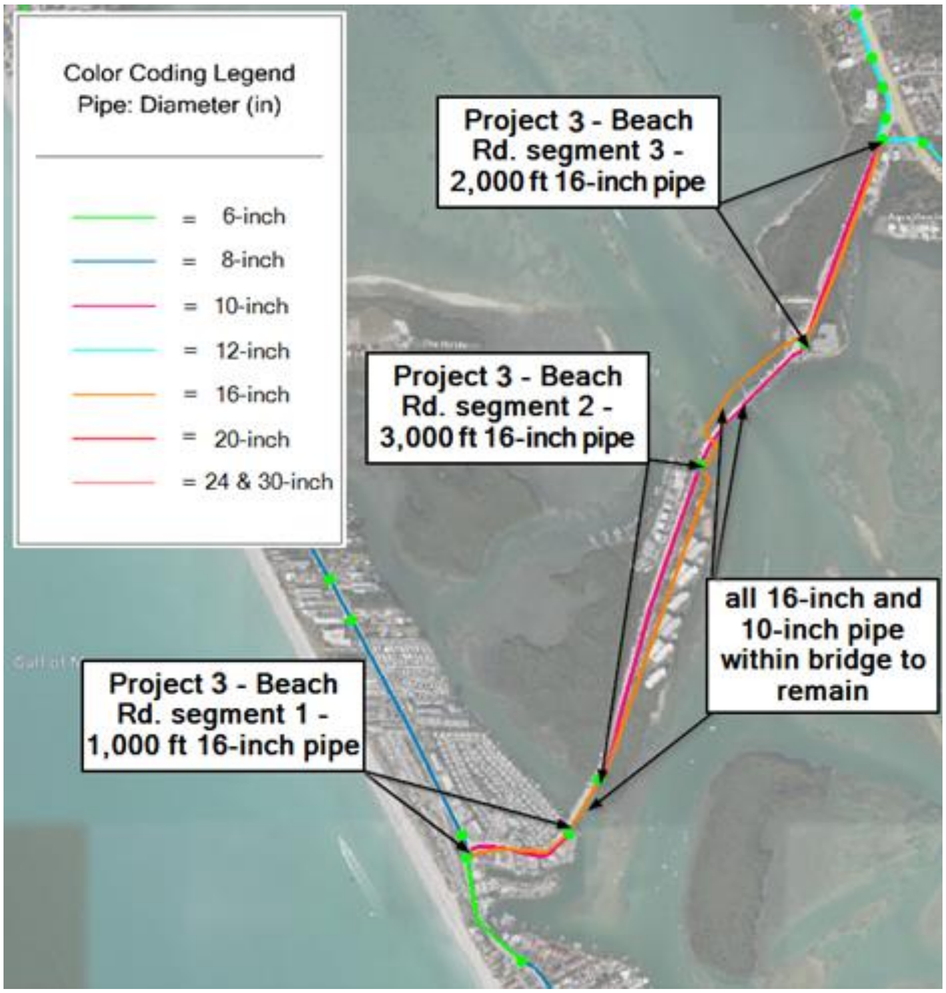

Figure 8-4: Project 3 – Beach Rd

Project 4 – Alamander Ave

Project 4 consists of an additional pipe along Alamander Ave. This project builds upon project 1 and increases capacity to the northwest. Project 4 starts within the intersection of Alamander Ave and Manasota Beach Rd. The project consists of 5,000 ft. of 12-inch diameter pipe and ends at the intersection of Alamander Ave and Ocelot Rd.

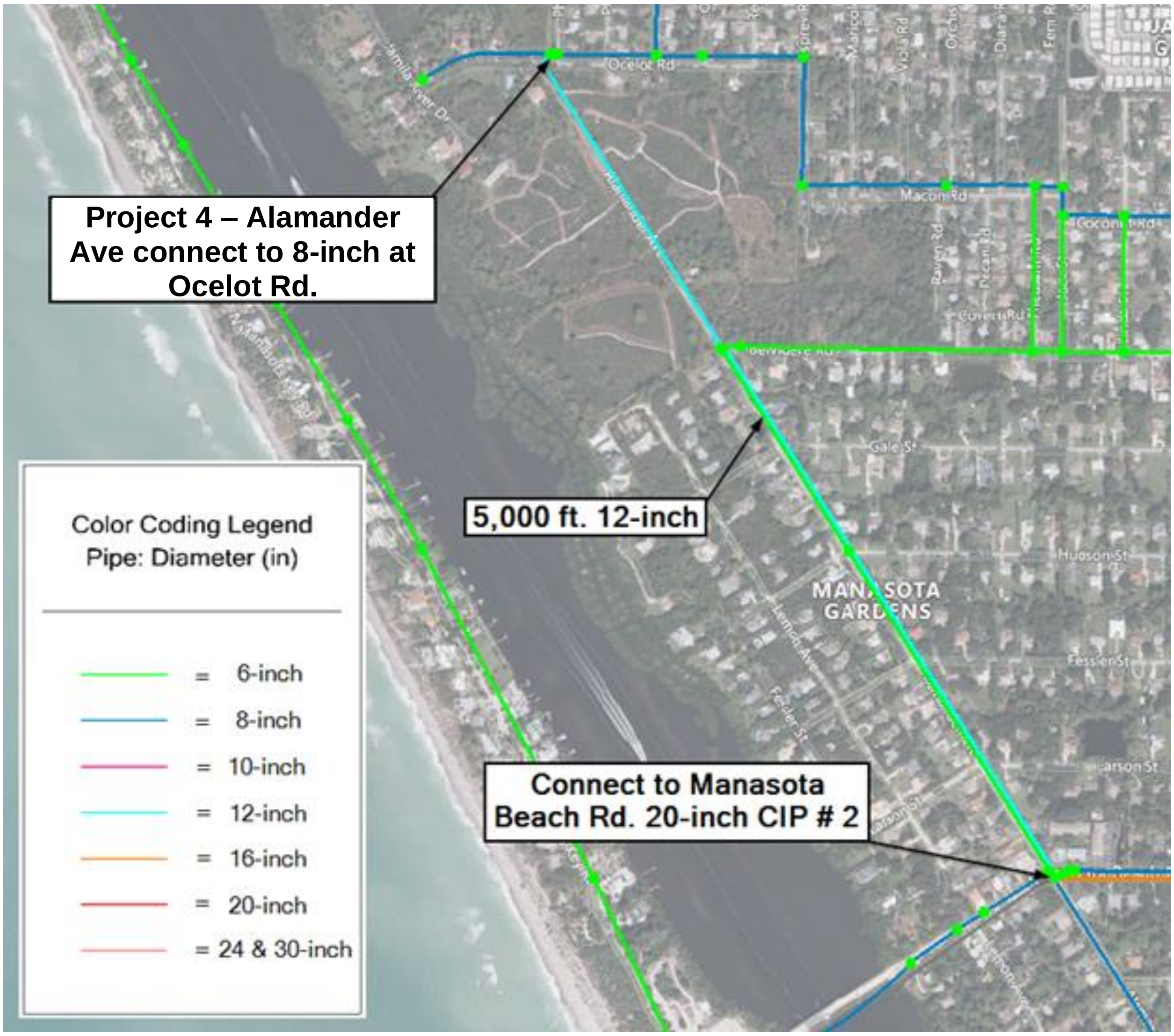

Figure 8-5: Project 4 – Alamander Ave

Project 5 – Lemon Bay

Project 5 is an alternative to projects 2 and 3. It consists of a directional drill across Lemon Bay and additional piping within the land. The directional drill will be 5,100 ft. of 16-inch pipe and the pipeline on land will be approximately 2,500 ft. The pipeline will connect to the 12-inch pipe within the intersection of Dearborn St. and Old Englewood Rd. Then the pipe will route to a pit location and be directionally drilled across Lemon Bay due west. From the receiving pit the pipe will then connect to the existing 6-inch pipe within Manasota Key Rd. This alternative brings more redundancy to the system, but it does not provide as high a level of service to the northwest part of the district as projects 2 and 5. There are pressures at 39 and 40 psi near Lemmon Ave. and Beach Rd. during the 2043 simulation.

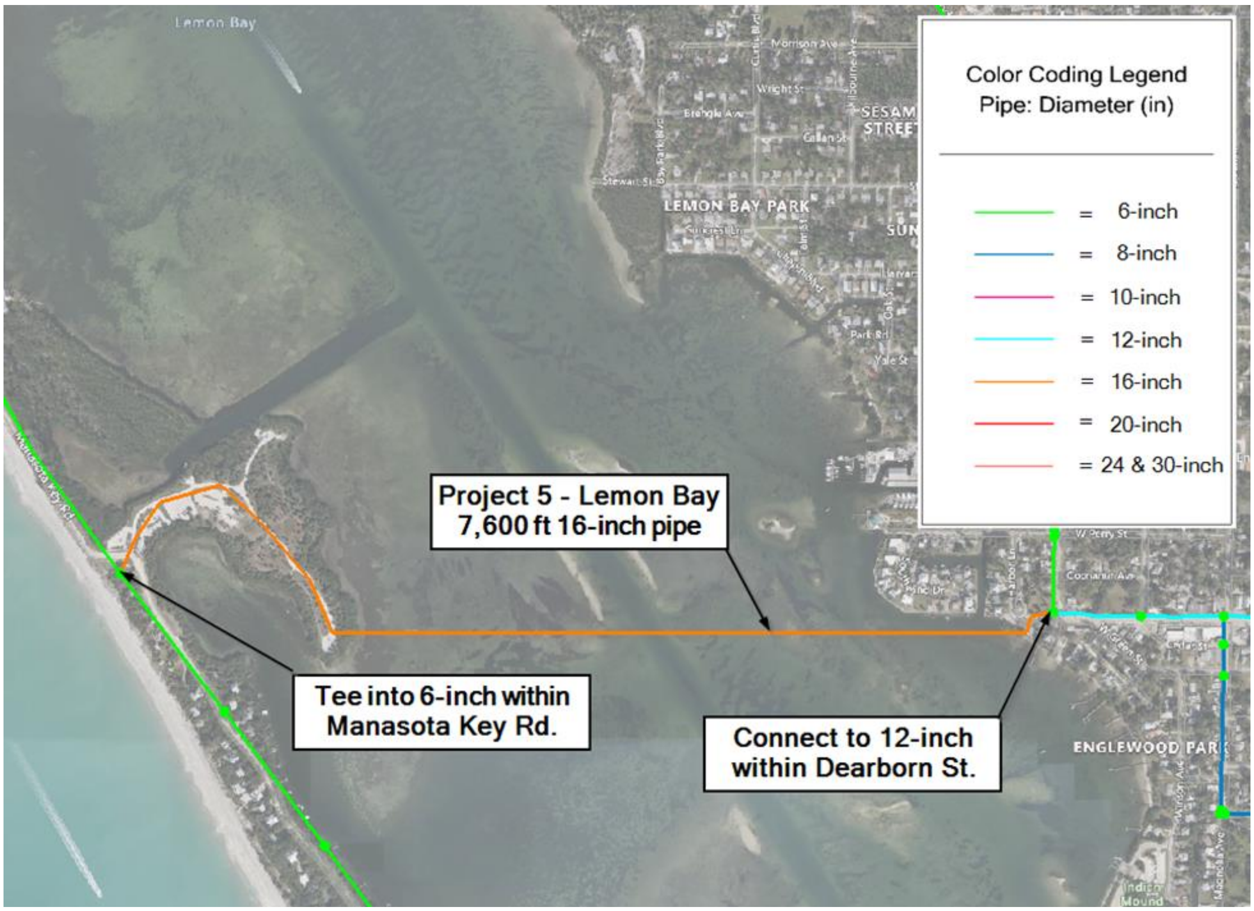

Figure 8-6: Project 5 – Lemon Bay

Project 6 – Pump Station Upgrades

This project would involve upgrades to the booster pump station to increase pressure through the distribution system and achieve additional capacity. It is recommended that the District consider increasing the pumping pressure from 57 to 70 psi. Increasing the pressure threshold in with the VFD is recommended for the existing system as well as for the 2043 and 2073 scenarios to increase pressure throughout the system and deliver targeted level of service.

In the state of Florida, statutes require the largest pump at a pump station to be considered out of service to determine firm capacity. With a projected peak flow of over 9,500 gpm, the existing pumping station will be operating at or beyond its firm capacity within the next 20 years. Additional pumping capacity is recommended to achieve the projected operating requirements. This pump will need to be equal to or greater than the largest existing pump. Correspondingly, increasing the pumping pressure to 70 psi requires provisions to the elevated storage tank would need to be made, such as adding an altitude valve, to limit the tank being overfilled. This tank may also be replaced with a hydropneumatic tank at ground level or a reinforced concrete elevated storage tank.

Project 7 – Hydraulic Model Upgrades

Consider improving the WaterGEMS steady-state hydraulic model to include a more comprehensive network to better analyze fire flow, water age, and Diurnal patterns. This would include further expansion of the hydraulic model network with GIS information, performing field testing of system pressures and flows, calibrating the hydraulic model, and running flow scenarios.

9 Conclusions

HDR has modeled how the future distribution system will perform after all the above CIPs are implemented. There are two options to provide similar levels of service. As stated earlier, project 5 can replace projects 2 and 3. Projects 1, 4, 5, 6, and 7 will be considered Alternative 1 and projects 1, 2, 3, 4, 6, and 7 will be considered Alternative 2. Neither alternative modeled herein shows results with Project 1a utilized.

Alternatives 1 and 2 both evenly distribute pressure throughout the system in the 2043 projection. In the 2073 projection, Alternative 1 has lower pressure in the southmost area of the system, while Alternative 2 keeps a low pressure throughout the system. The velocity distributions are similar for both alternatives, however, Alternative 1 distributes a higher velocity at the center of Manasota Key, while Alternative 2 distributes a higher velocity at the ends of Manasota Key. Both Alternatives provide similar fire flow distribution, however, Alternative 1 provides more fire flow availability at Manasota Key.

Alternatives 1 and 2 provide similar improvements of the systems velocity distribution and fire flow availability, but Alternative 2 provides a better long-term distribution of pressure throughout the network. Alternative 1 will be less impactful on the community, while construction on the beach roads in Alternative 2 will require a traffic control plan.

9.1 Alternative 1

Alternative 1 will meet or exceed the design criteria established for the master plan in the modeled 2043 scenario and will require additional infrastructure upgrades by 2073. During model simulations Alternative 1 Improved velocity and pressure modeled in 2043 and 2073. Results are shown in Figure 9-1, Figure 9-2, Figure 9-3, and Figure 9-4. Additionally, a FF test was also run with the CIP recommendations for the 2043 scenario shown in Figure 9-5. In addition to Project 6 upgrades to the booster station should be anticipated before 2073 and after 2043.

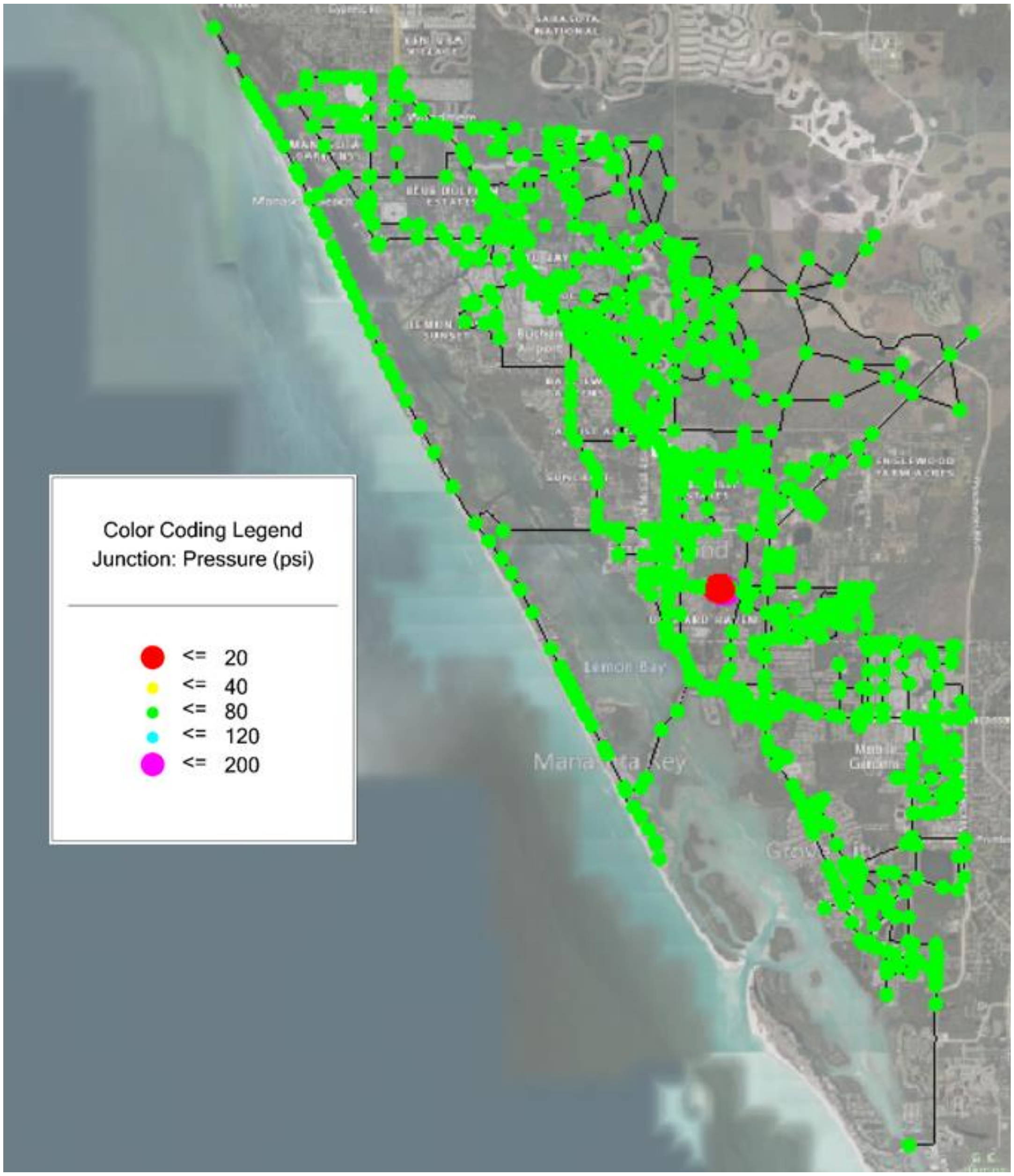

Figure 9-1: Alternative 1 Pressure Results from CIP Improvements Simulation in 2043

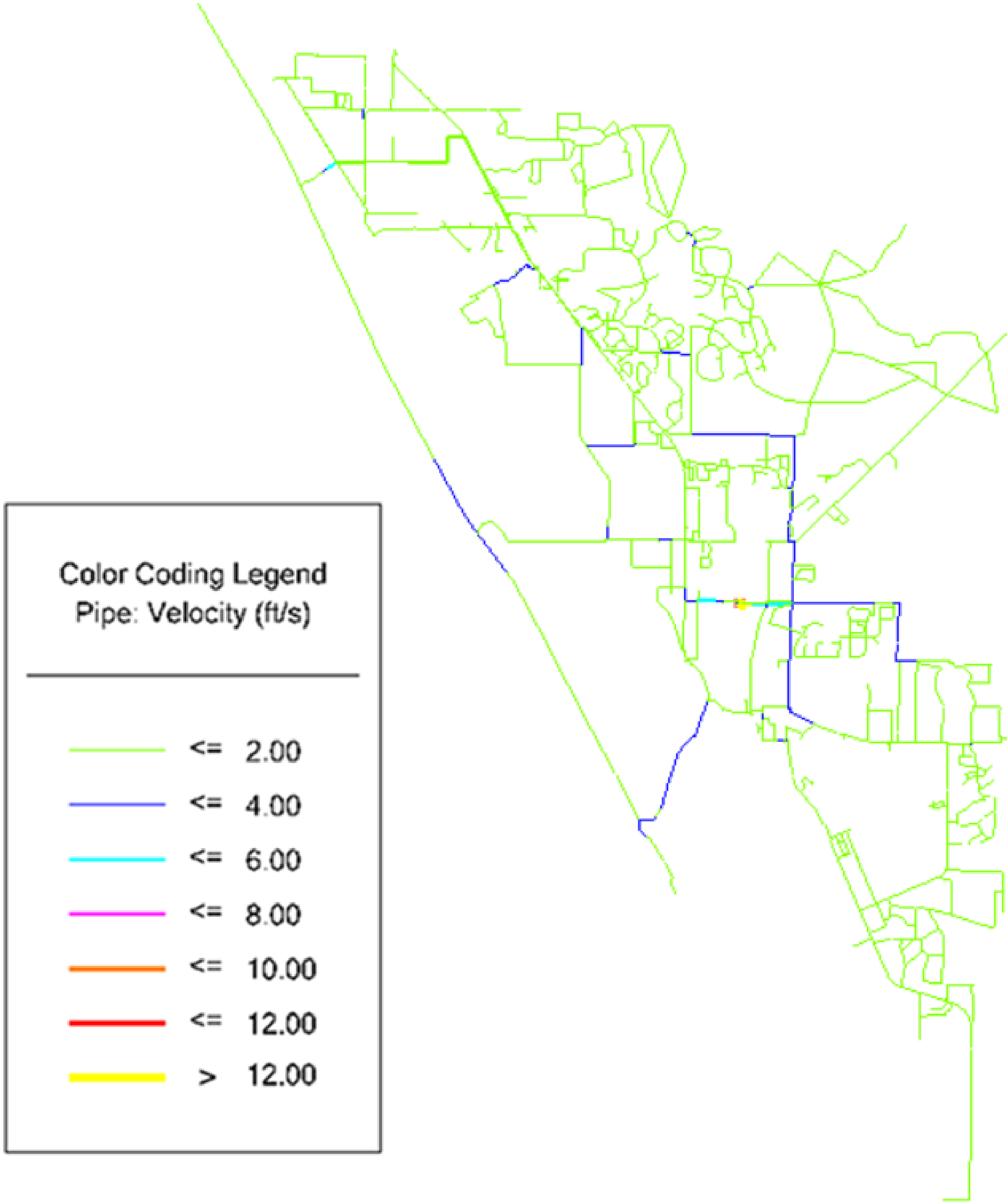

Figure 9-2: Alternative 1 Velocity Results from CIP Improvements Simulation in 2043

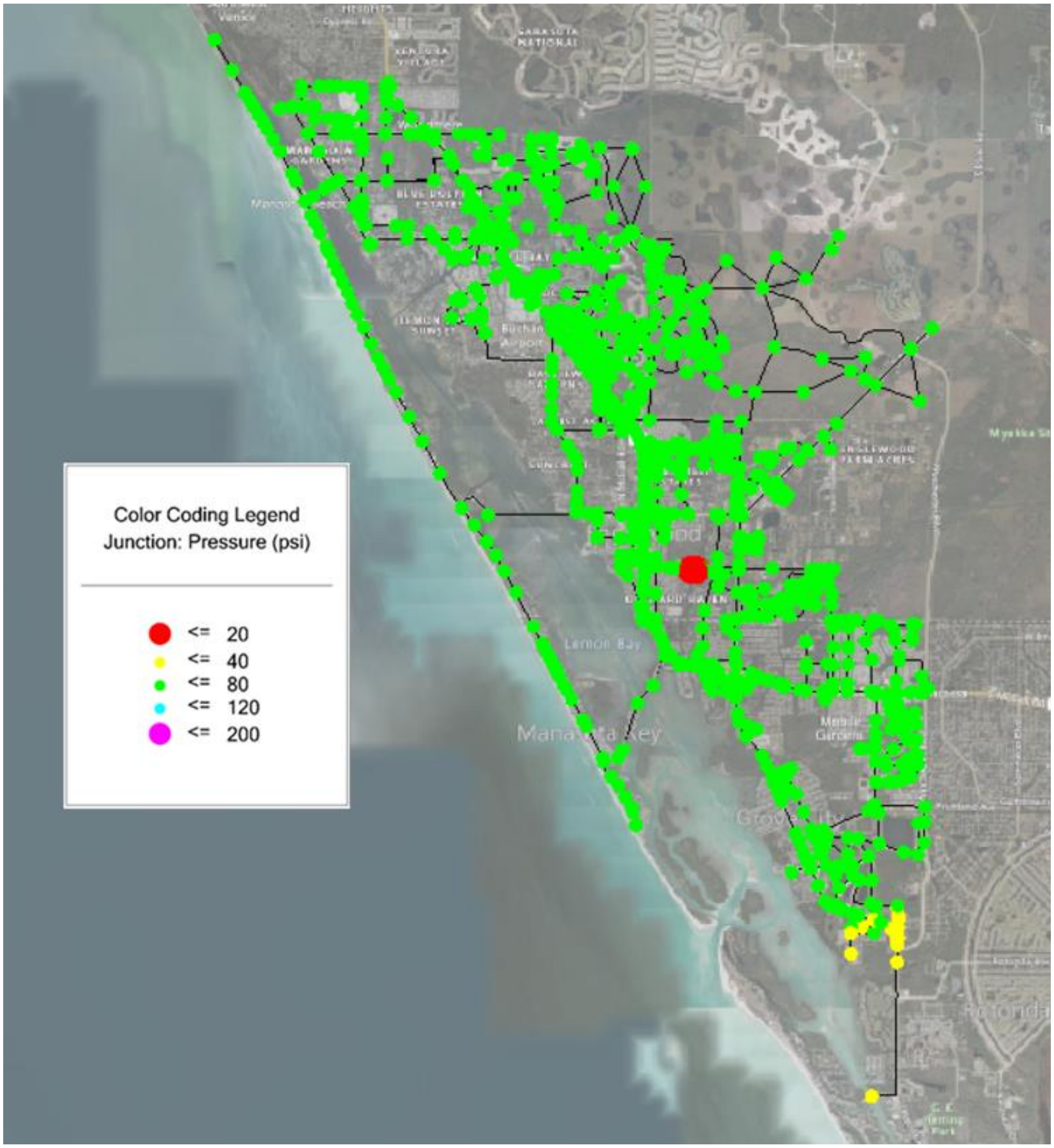

Figure 9-3: Alternative 1 Pressure Results from CIP Improvements Simulation in 2073

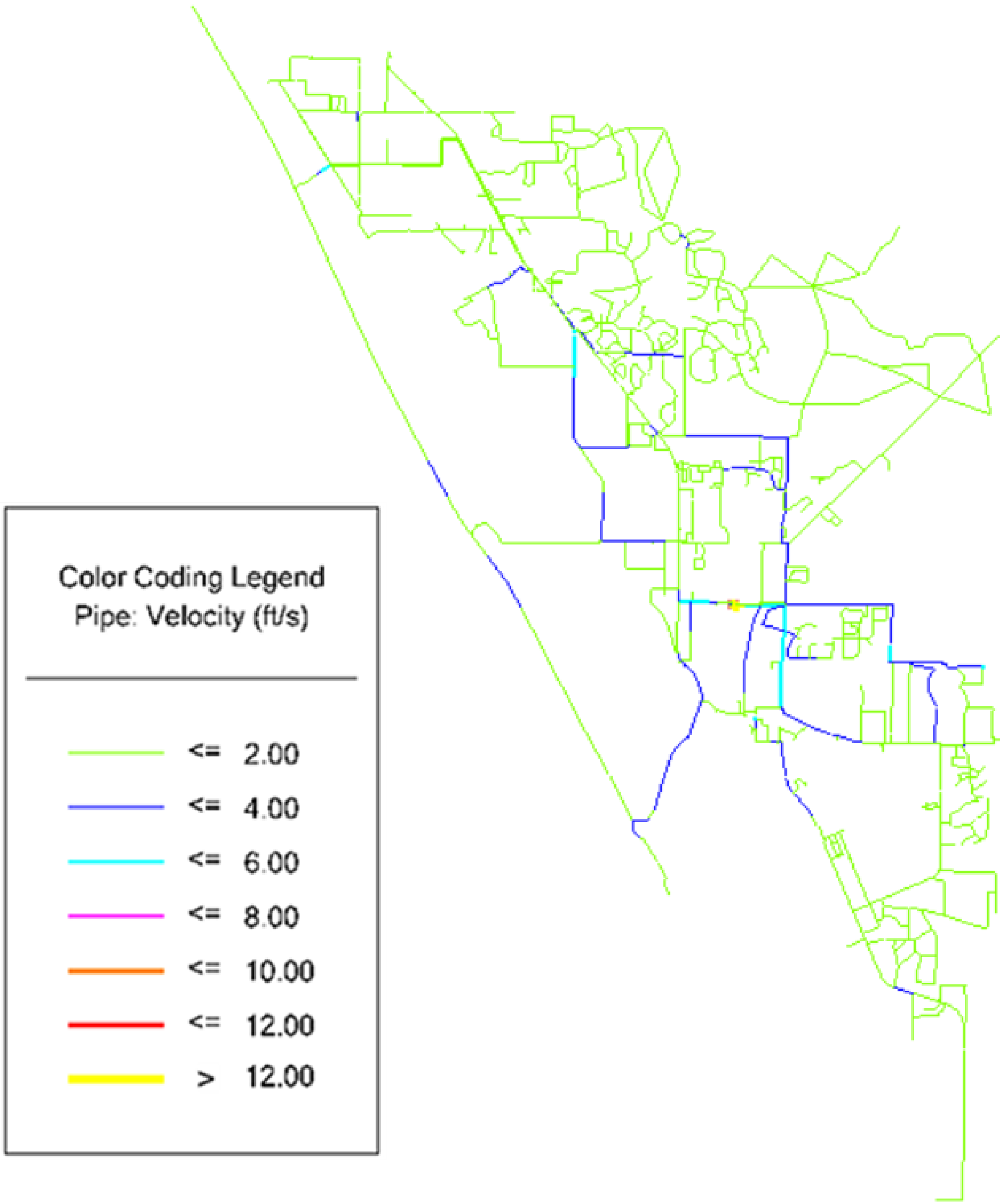

Figure 9-4: Alternative 1 Velocity Results from CIP Improvements Simulation in 2073

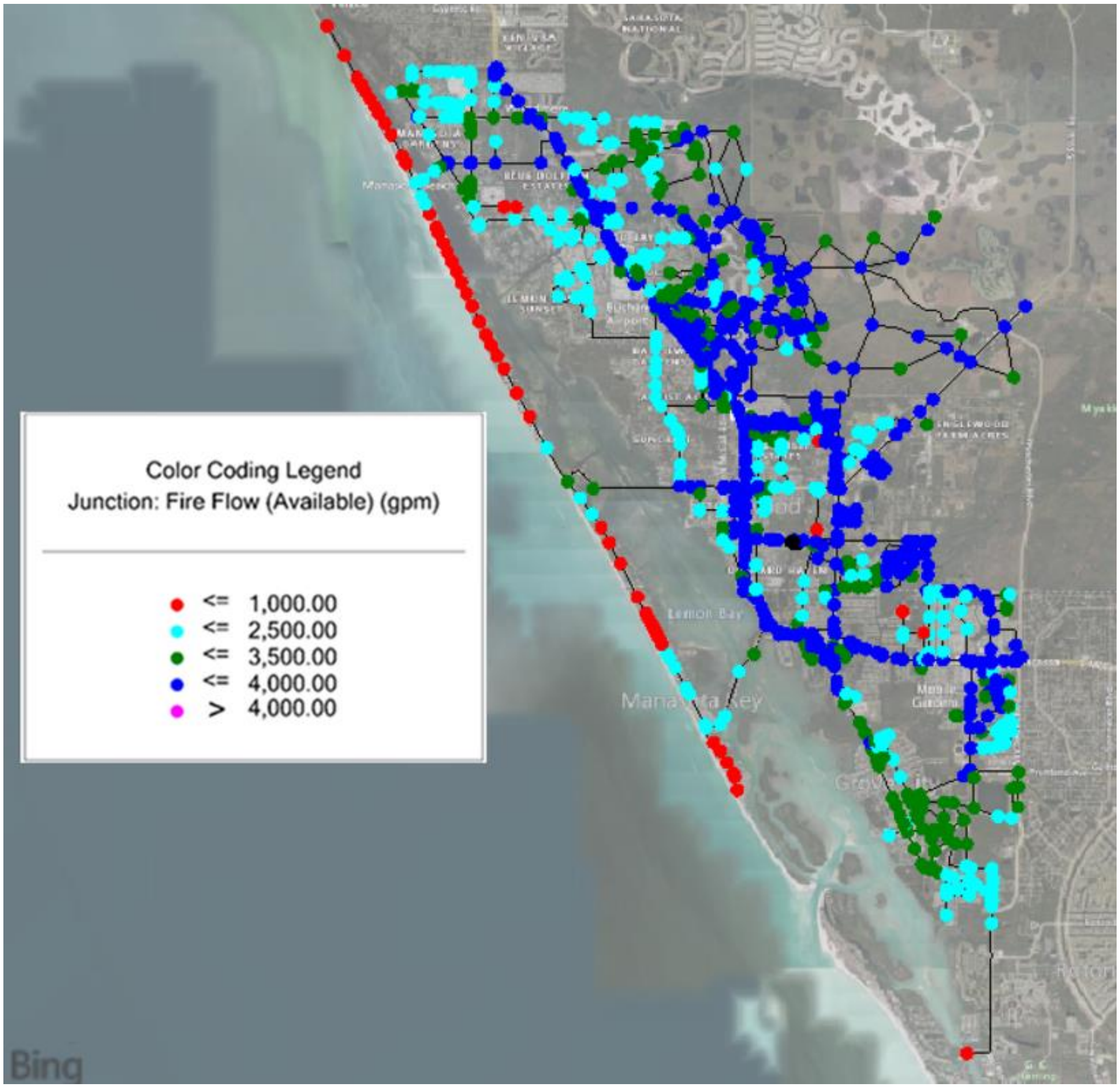

Figure 9-5: Alternative 1 Fire Flow Results from CIP Improvements Simulation in 2043

9.2 Alternative 2

Alternative 2 will meet or exceed the design criteria established for the master plan. During model simulations Alternative 2 Improved velocity and pressure modeled in 2043 and 2073 results are shown in Figure 9-6, Figure 9-7, Figure 9-8, and Figure 9-9. Additionally, a FF test was also run with the CIP recommendations for the 2043 scenario shown in Figure 9-10. In addition to Project 6 upgrades to the booster station should be anticipated before 2073 and after 2043.

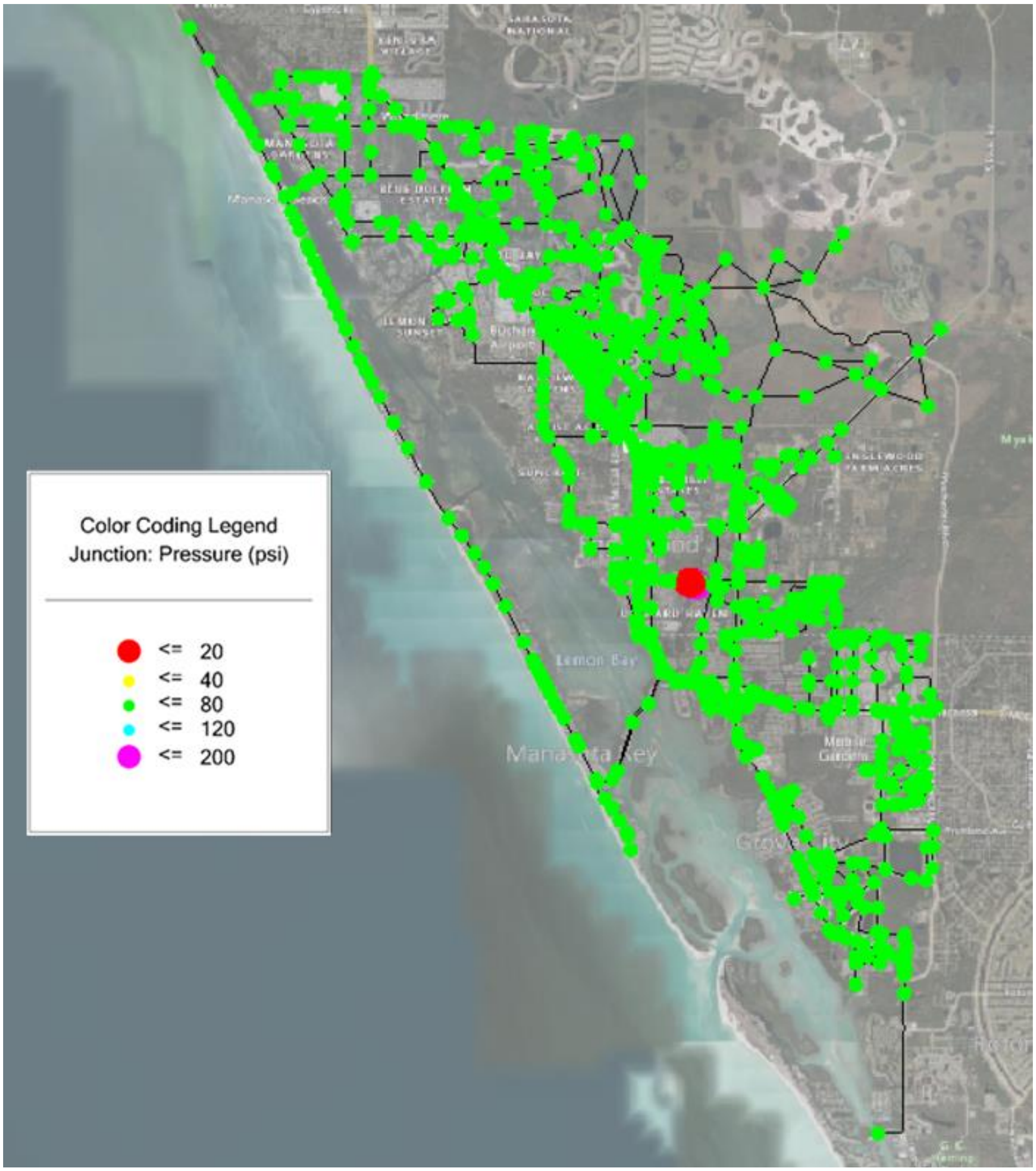

Figure 9-6: Alternative 2 Pressure Results from CIP Improvements Simulation in 2043

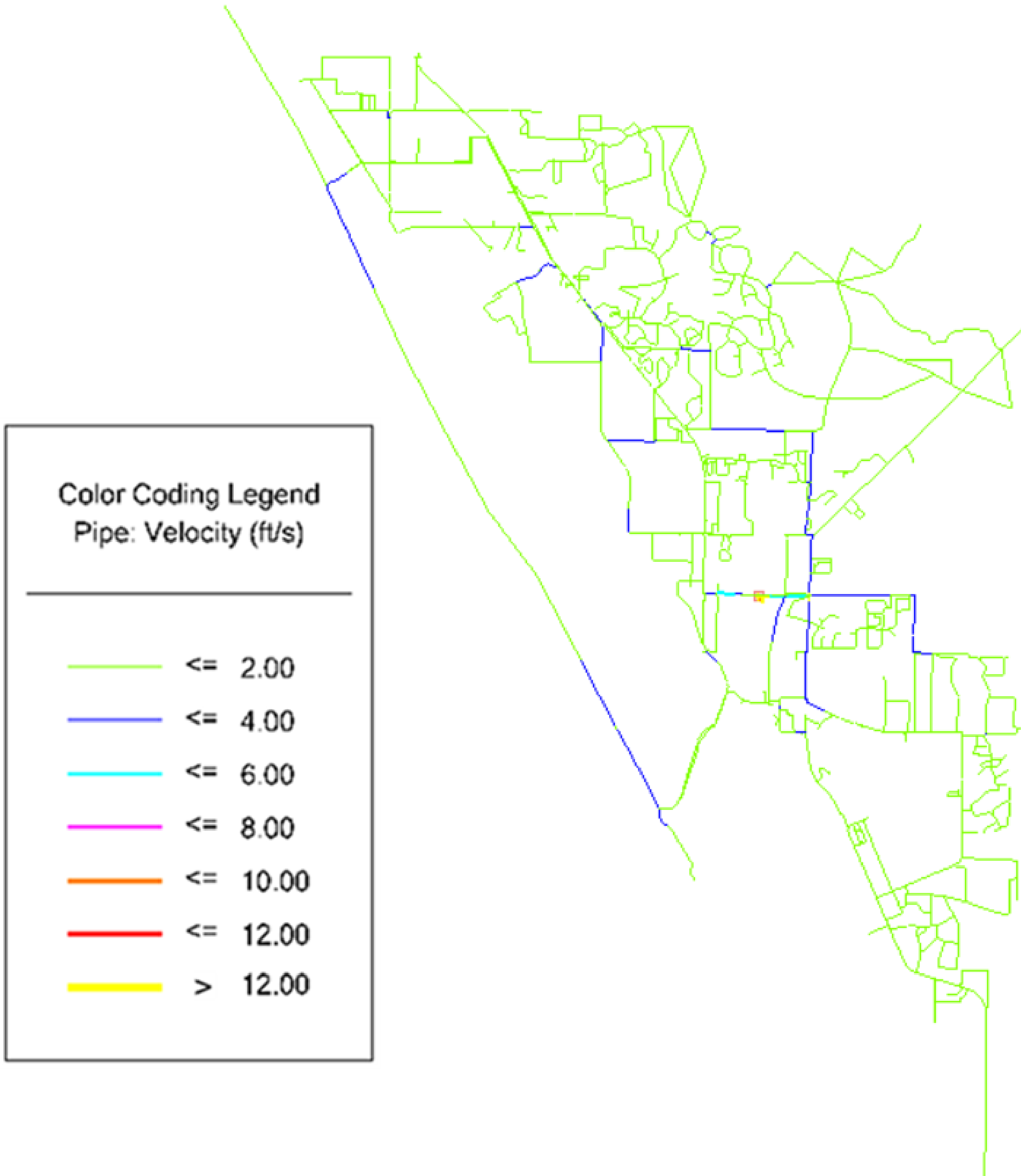

Figure 9-7: Alternative 2 Velocity Results from CIP Improvements Simulation in 2043

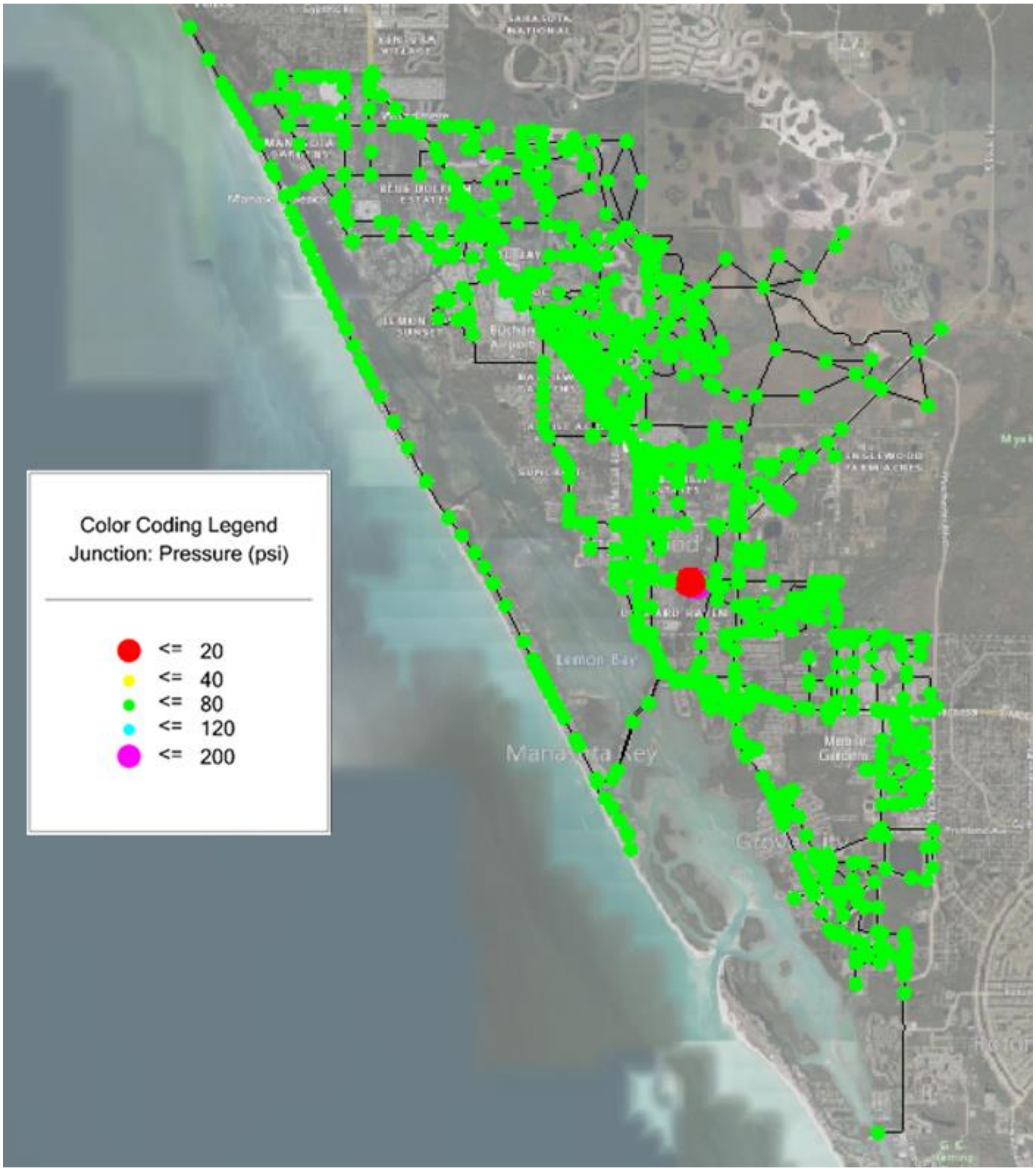

Figure 9-8: Alternative 2 Pressure Results from CIP Improvements Simulation in 2073

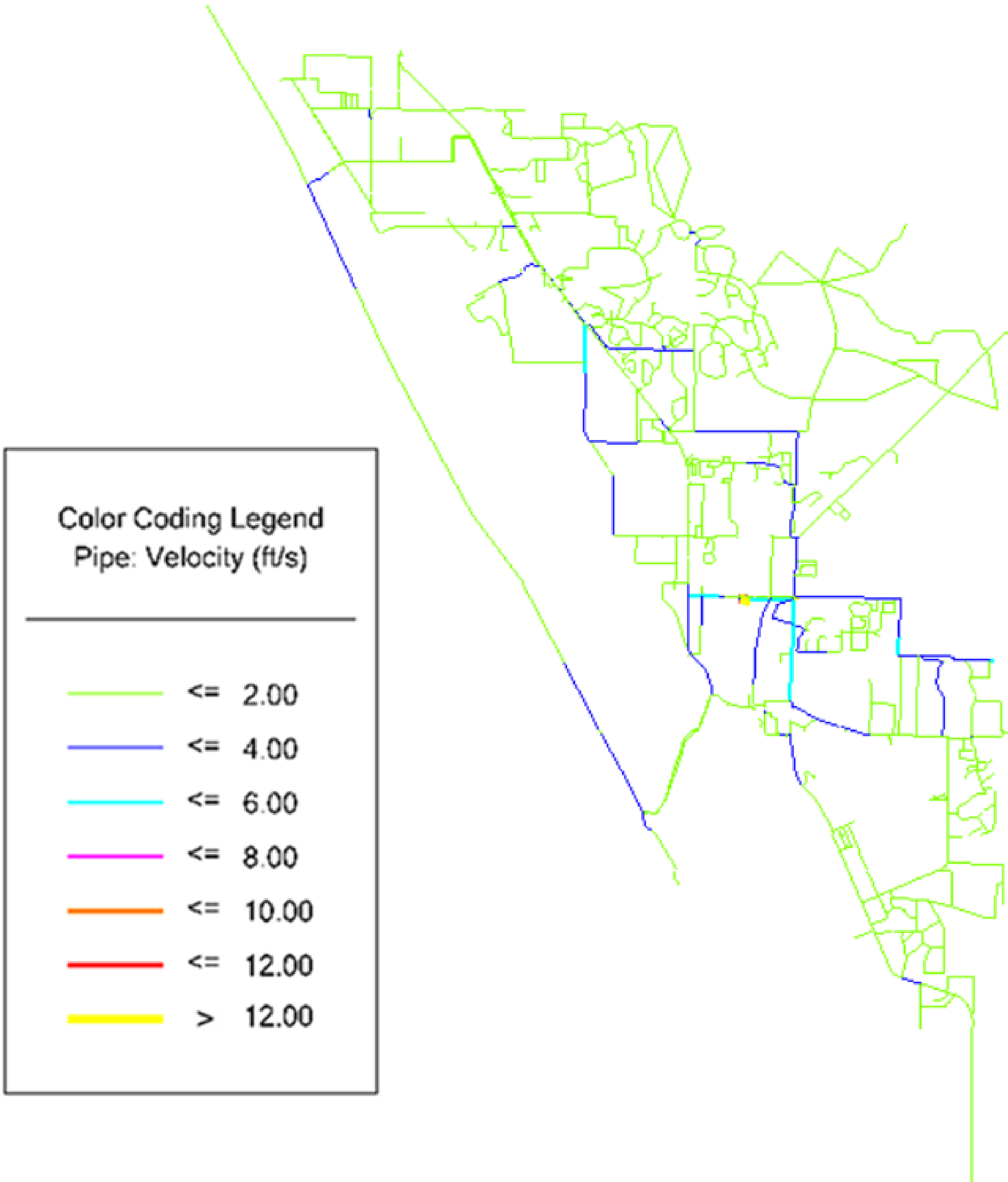

Figure 9-9: Alternative 2 Velocity Results from CIP Improvements Simulation in 2073

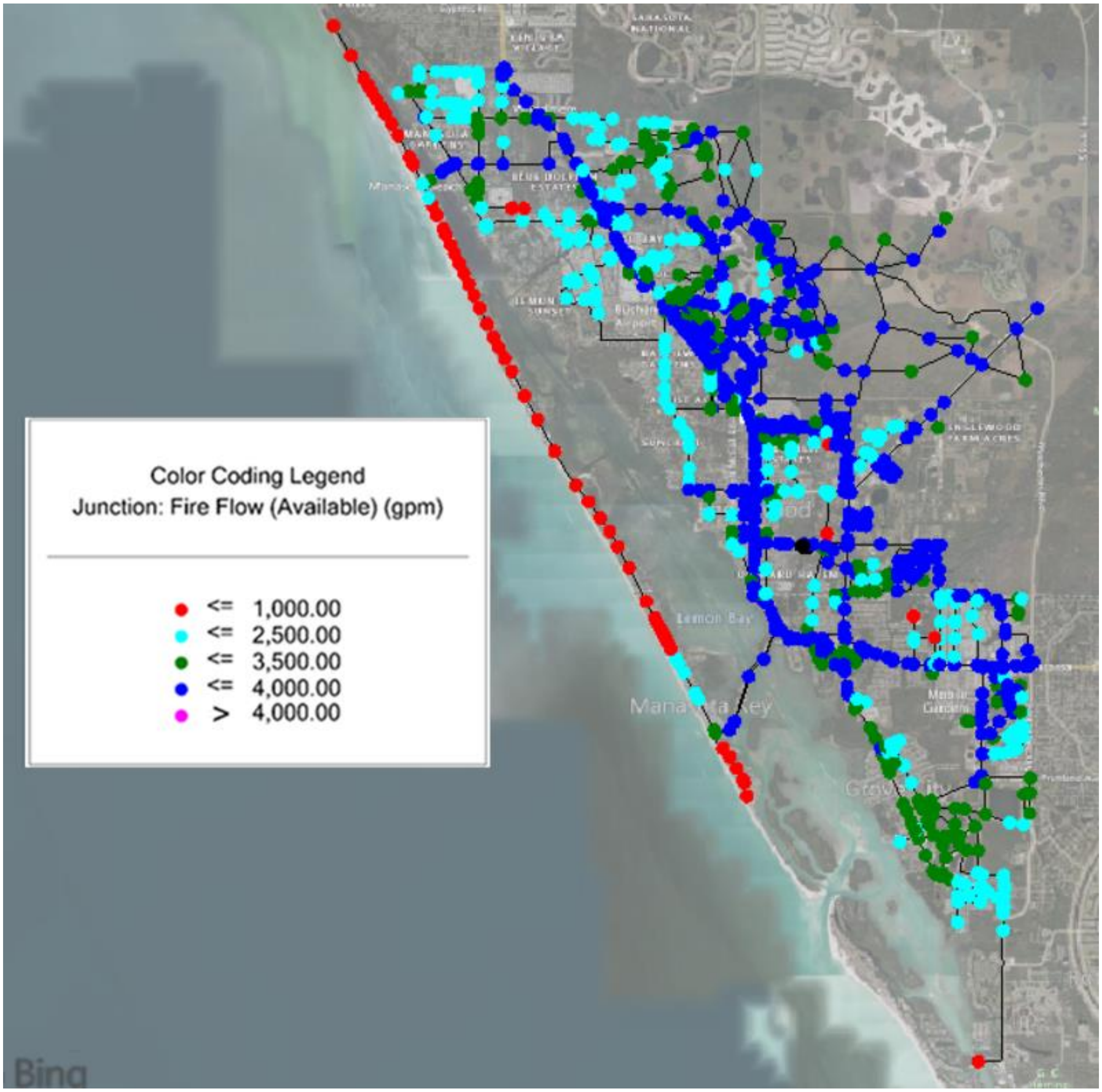

Figure 9-10: Alternative 2 Fire Flow Results from CIP Improvements Simulation in 2043