6.0 Distribution System Facilities and Analyses

The LWS service area is currently divided into six service levels - Low, High, Belmont, Southeast and more recently the Cheney and Northwest Service Levels. The Cheney Service Level was created in Year 2001 and serves the southeast portion of the service area. The Northwest Service Level was created in Year 2002 near the NW 12th Street Reservoir, to serve a new development on high ground in that area. A schematic hydraulic profile of Lincoln's water distribution system facilities and service levels is shown on Figure 6-1 located on the following page.

6.1 High Service Pumping and Transmission

The high service pumps at the Ashland WTP are located in three separate buildings. Pumps 1 through 6 are located in the North Pumping Station. Pumps 7, 8, and 9 are located in the West Pumping Station. Pumps 10, 11, and 12 are located in the South Pumping Station. Data on the WTP high service pumping units is shown in Table 6-1.

Table 6-1 WTP High Service Pumps

Pump No.	Drive Type	Rated Capacity (gpm)	Rated Capacity (mgd)	Head (ft)	Pump Motor (hp)	Pump Motor (rpm)
1	Electric - 2400 V	14,000	20.2	115	600	900
2	Electric - 2400 V	9,800	14.1	205	700	1200
3	Electric - 480 V	14,000	20.2	130	700	900
4	Electric - 2400 V	14,000	20.2	233	1250	900
5	Electric - 2400 V	14,000	20.2	233	1250	900
6	Electric - 2400 V	14,000	20.2	233	1250	900
7	Diesel Engine	15,000	21.6	345	1950	900
8	Electric - 4160 V	15,000	21.6	345	1750	888
9	Diesel Engine	15,000	21.6	345	1950	900
10	VFD – 480 V	14,000	20.2	130	600	710
11	VFD – 2400 V	14,500	20.9	350	1750	720
12	VFD – 2400 V	14,500	20.9	350	1750	720

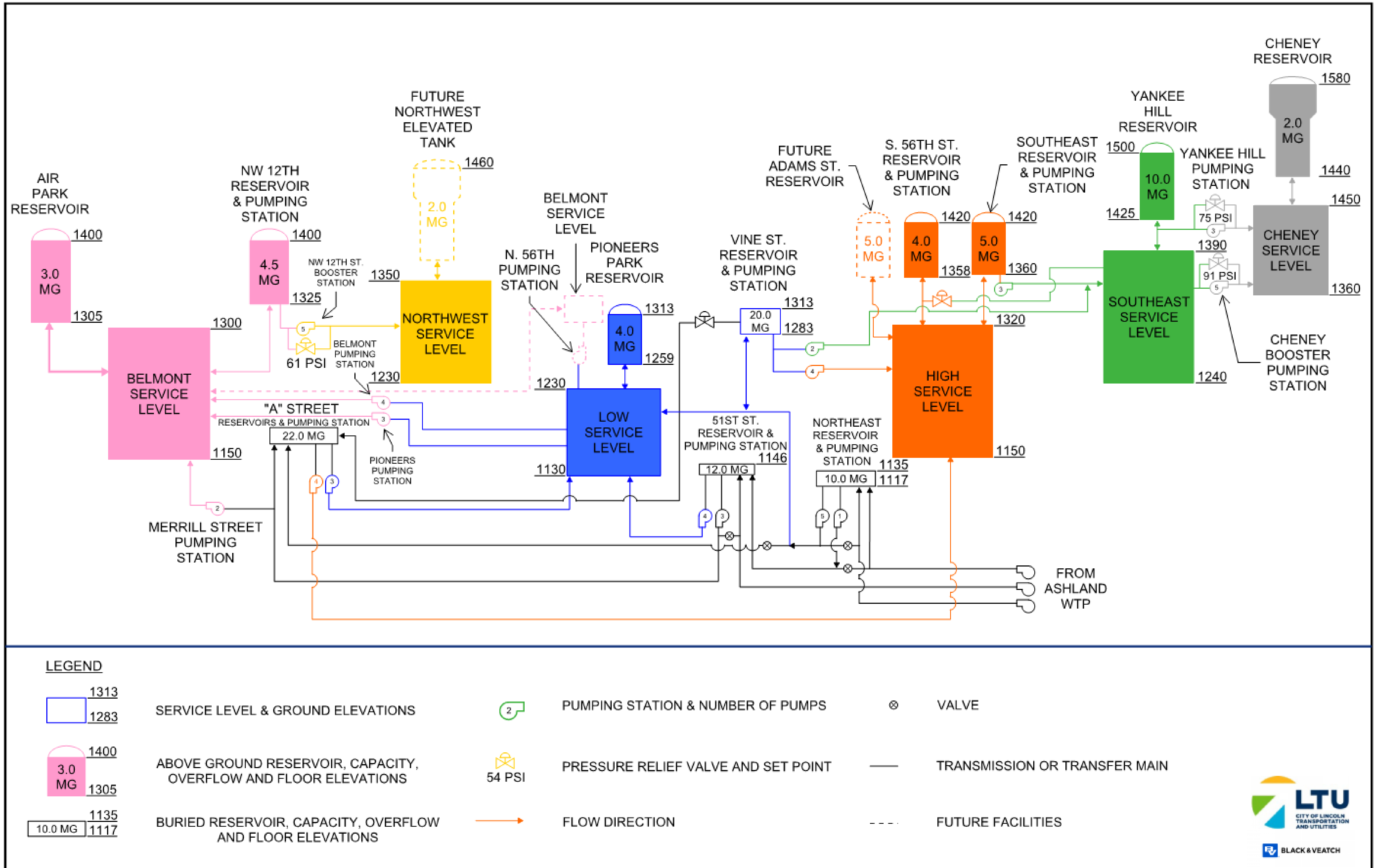


Figure 6-1 Existing Transmission and Distribution System Schematic

Treated water from the Ashland treatment facilities is pumped to Lincoln through approximately 17 miles of parallel 36-inch and 48-inch transmission mains, plus 17 miles of 54/60-inch main that parallels the two other mains for a portion of the distance to Lincoln. An established 100 psi operating pressure limitation for the 36-inch main requires that it be operated separately from the 48-inch (except at low pressures) and also separate from the 54/60-inch mains, which have working pressures of 150 psi.

Previous studies recommended construction of the 54-inch/60-inch transmission main, approximately 23 miles in length, from the Ashland WTP to the Vine Street Reservoir and Pumping Station. The segment from the Ashland WTP to an interconnection with the existing 48-inch main at Greenwood, approximately 7.8 miles in length, was completed in 1994. A second segment, 60-inch main extending 10 miles from Greenwood to the Northeast Reservoir, was completed in Year 2010. The remaining portion of approximately 5 miles of 54-inch from the Northeast Reservoir to the Vine Street Reservoir, not including approximately 1 mile previously constructed, was evaluated for this project and is recommended to be constructed around Year 2032 as discussed in Chapter 8.

Under lower flow conditions, approximately 48 mgd pumped from the Ashland WTP can be delivered directly to the Low Service Level. Under higher flow conditions, which result in greater head losses in the transmission mains, the water must be re-pumped into the Low Service Level by pumps located at the Northeast, 51st Street, and “A” Street locations. And under even greater flow rates, a transfer pump at the Northeast location is used to deliver flow to the 51st Street Reservoir, and transfer pumps at the 51st Street location are used to deliver flow to the “A” Street Reservoirs. Additional information on the transmission system storage and pumping facilities are described later in this chapter, in the section on the Low Service Level.

6.2 Service Levels

Ground elevations within the existing service area range from about 1,130 feet (USGS datum) along Salt Creek to about 1,450 feet in the Cheney Service Level. The highest ground is located in the northwest and southeast portions of the service area.

Service level boundaries are established to maintain acceptable distribution system pressures. The boundaries should have sufficient flexibility to allow minor modifications to provide adequate service, particularly at higher elevations and in developing areas. The service area is currently divided into four major service levels - Low, High, Belmont, and Southeast, and two smaller service levels including the Cheney and Northwest Service Levels. The static hydraulic gradient for all of the service levels are established by the maximum water service elevation of floating storage facilities within the service area, except the Northwest Service Level which is controlled by a PRV but has floating storage recommended with the recommendations of this report. The ground elevations served and static hydraulic gradient for each service level are shown in Table 6-2.

Table 6-2 Service Levels

Service Level	Ground Elevation[1] (ft)	Static Hydraulic Gradient Elevation (ft)
Belmont Service Level	1130 – 1290	1,400[2]
Low Service Level	1130 – 1230	1,313[2]
High Service Level	1150 – 1320	1,420[2]
Southeast Service Level	1240 – 1390	1,500[2]
Cheney Service Level	1340 – 1430	1,580[2]
Northwest Service Level	1240 – 1320	1,460[3]

[1]Principal part of service level, USGS datum.
[2]Established by overflow elevation of floating storage within service level.
[3]Currently established by PRV setting at pumping station discharge.

6.3 Pumping Stations and System Storage

6.3.1 Low Service Level

The Low Service Level services the area bordering Salt Creek and encompasses the main business district, the University of Nebraska, and major industrial areas.

The 51st Street, Northeast, and "A" Street Pumping Stations supply the Low Service Level. Direct pumping from Ashland can also supply the Low Service Level during lower demand periods. The Low Service Level is also served by the Vine Street Reservoir and the Pioneers Park Reservoir, with reservoir overflows of 1313 which establish the static hydraulic gradient.

6.3.1.1 Northeast Pumping Station and Reservoir

The Northeast Pumping Station and Reservoir is located east of the intersection of 98th Street and U.S. Highway 6. In Year 1997, a facility expansion was completed that expanded the storage volume from 5.0 MG to 10.0 MG and included the addition of a fourth Low Service Level pump. The reservoir is supplied from the Ashland Water Treatment Plant located approximately 17 miles away through the 48-inch and 54/60-inch transmission mains. The reservoirs have overflow elevations of 1,135 feet, sidewater depth of 18 feet, and normally operate between 12 and 15.5 feet.

The Northeast Pumping Station contains one transfer pump, No. 1, with a rated capacity of 31,250 gpm (45 mgd) at 60 feet. This transfer pump was replaced in Year 2007 and discharges to the 48-inch transmission main, which extends to the 51st Street Reservoir. A variable speed drive allows the pumping capacity to vary from about 60 percent to 100 percent of the rated capacity at maximum speed (range of 27 mgd to 45 mgd).

The Northeast Pumping Station contains five Low Service Level distribution system pumps, Nos. 2 through 6. Pump No. 6 is equipped with an eddy current adjustable speed drive, but the pump is not currently used due to failure of the electronic controls for the drive. Pump No. 2 was installed in 2006. Both the transfer and distribution system pumps take suction from the adjacent reservoir. Data for the Northeast pumping units is given in Table 6-3.

Due to the hydraulic capacity of the 54/60-inch transmission main, the Northeast Pumping Station is bypassed during peak and time of day periods to avoid higher energy charges. As Low Service system demands increase in the future, opportunities for bypass may be more limited than at present.

Table 6-3 Northeast Pumping Station

Pump No.	Make	Rated Capacity (gpm)	Rated Capacity (mgd)	Head (ft)	Pump Motor (hp)	Pump Motor (rpm)
1(1)	Ruhrpumpen	31,250	45	60	600	705
2(2)	Ruhrpumpen	14,000	20.2	255	1,200	890
3(2)	Fairbanks	14,000	20.2	255	1,250	900
4(2)	Fairbanks	10,500	15.1	245	800	900
5(2)	Fairbanks	10,500	15.1	245	800	900
6(2)(3)	Fairbanks	10,500	15.1	245	800	900

(1)Transfer pump with variable speed drive.
(2)Low Service Level distribution system pumps.
(3)Pump No. 6 is currently out of service and not included in firm pump calculations

6.3.1.2 51st Street Pumping Station and Reservoirs

The 51st Pumping Station and Reservoirs are located east of the intersection of 48th Street and U.S. Highway 6. The 6.0 million gallon, 5.0 million gallon, and 1.0 million gallon ground storage reservoirs are supplied through the 36-inch and 48-inch transmission mains from the Ashland water treatment plant and Northeast Pumping Station depending on operations. The 5.0 and 1.0 million gallon reservoirs have overflow elevations of 1,148 feet and sidewater depths of 14.2 feet. The 6.0 million gallon reservoir has an overflow elevation of 1,148 feet and a sidewater depth of 15.33 feet. The pumping station contains three transfer pumps, Nos. 1 through 3. The transfer pumps were replaced in 2001 with new units each with a rated capacity of 10,500 gpm (15.1 mgd) at 185 feet. The transfer pumps discharge to a 36-inch low pressure transmission/transfer main which extends to the "A" Street Reservoirs. The 51st Street Pumping Station contains four Low Service Level distribution system pumps, Nos. 4 through 7. New pumps and motors were installed in 2001 with rated capacity of 7,000 gpm (10.1 mgd) at 230 feet. Both the transfer and distribution system pumps take suction from the 51st Street Reservoirs. Data on the 51st Street pumping units is given in Table 6-4.

Table 6-4 51st Street Pumping Station

Pump No.	Make	Rated Capacity (gpm)	Rated Capacity (mgd)	Head (ft)	Pump Motor (hp)	Pump Motor (rpm)
1(1)	Ingersoll-Dresser	10,500	15.1	185	750	900
2(1)	Ingersoll-Dresser	10,500	15.1	185	750	900
3(1)	Ingersoll-Dresser	10,500	15.1	185	750	900
4(2)	Ingersoll-Dresser	7,000	10.1	230	500	900
5(2)	Ingersoll-Dresser	7,000	10.1	230	500	900
6(2)	Ingersoll-Dresser	7,000	10.1	230	500	900
7(2)	Ingersoll-Dresser	7,000	10.1	230	500	900

(1)Transfer pumps – new in 2001.
(2)Low Service Level distribution system pumps – new pumps and motors in 2001.

6.3.1.3 "A" Street Pumping Station (Low Service Level) and Reservoirs

The "A" Street Pumping Station and Reservoirs are located near "A" Street, in the vicinity of Antelope Park. The three ground storage reservoirs have a total capacity of 22.0 million gallons and are supplied through the 36-inch transfer main from the 51st Street Pumping Station and through a 36-inch transfer main from the Vine Street Reservoirs. Reservoirs No. 4 and 5 were demolished early in the Year 2017 which reduced the total storage capacity by 6.0 million gallons. The remaining three reservoirs have different overflow elevations. However, the reservoirs are interconnected and float together establishing a common hydraulic gradient. Data on the "A" Street Reservoirs is shown in Table 6-5.

Table 6-5 "A" Street Reservoirs

Reservoir No.	Capacity MG	Ceiling or Overflow Elevation (ft)	Floor Elevation (ft)
6	6.0	1190.8	1174.8
8	8.0	1190.8	1171.5
9	8.0	1190.1	1175.0

The "A" Street Pumping Station, constructed in Year 1984, is a dual level pumping facility that discharges to the Low and High Service Levels. The station contains two Low Service Level pumps, Nos. L1 and L2, each with a rated capacity of 6,300 gpm (9.1 mgd) at 155 feet and two high service pumps Nos. H1 and H2 with a rated capacity of 6,300 gpm (9.1 mgd) at 265 feet. Three "satellite" pumps are located at the "A" Street facilities in three separate buildings. Satellite 8 discharges to the Low Service Level. Satellites 9 and 10 discharge to the High Service Level. All Low and High Service Level pumps take suction from the adjacent reservoirs. Data on the "A" Street pumping units is shown in Table 6-6.

Table 6-6 “A” Street Pumping Station

Pump NO.	Make	Rated Capacity (gpm)	Rated Capacity (mgd)	Head (ft)	Pump Motor (hp)	Pump Motor (rpm)
Low Service Level						
L1(1)	Patterson	6,300	9.1	155	350	1,200
L2(1)	Patterson	6,300	9.1	155	350	1,200
Sat. 8(1)	Flowserve	7,200	10.4	155	450	1,200
High Service Level						
H1(2)	Patterson	6,300	9.1	265	600	1,800
H2(2)	Patterson	6,300	9.1	265	600	1,800
Sat. 9(2)(3)	Flowserve	6,300	9.1	250	500	1,200
Sat. 10(2)(3)	Flowserve	6,300	9.1	250	500	1,200

(1)Low Service Level.
(2)High Service Level.
(3)Pumps Replaced in 2010.

6.3.1.4 Vine Street Reservoir

The Vine Street Reservoir is located just northeast of the intersection of Skyway Road and Vine Street. The reservoir was expanded from 10.0 MG to 20.0 MG in Year 2001. It floats on the Low Service Level, has an overflow elevation of 1,313 feet, a sidewater depth of 30 feet, and is normally operated between 18 and 27 feet.

The reservoir provides suction storage for the adjacent Vine Street Pumping Station, which supplies the High and Southeast Service Levels. The reservoir can also be used as a supply to transfer water through the 36/24-inch gravity transfer main to the “A” Street Reservoirs. A flow control/transfer vault is located adjacent to the Vine Street Pumping Station which regulates the flow of water from the Vine Street West Pumping Station into the 36/24-inch transfer main. Typically, water is transferred by gravity through the check valve in the transfer vault from the Vine Street to “A” Street Reservoirs. With both the Vine Street and “A” Street Reservoirs full, and using only the Low Service Level hydraulic gradient, the maximum delivery by gravity through the 36/24-inch transfer line is about 15 mgd according to the hydraulic model (18 mgd according to meter data). Using the discharge gradient from the Vine West pumps, the maximum transfer is increased to about 21 mgd through the PRV in the transfer vault. This pumped method of transferring water to “A” Street is not used very often as the gravity method does not require additional energy.

6.3.1.5 Pioneers Park Reservoir

The Pioneers Park Reservoir is located near the north entrance to Pioneers Park. The four million gallon reservoir floats on the Low Service Level, has an overflow elevation of 1,313 feet, a sidewater depth of 54 feet and is normally operated between 46 and 51 feet.

6.3.2 High Service Level

The High Service Level serves the areas south and southeast of the Low Service Level. It is supplied by the "A" Street and Vine Street Pumping Stations. The High Service Level static hydraulic gradient of 1,420 feet is established by the overflow elevations of the Southeast and South 56th Street Reservoirs.

6.3.2.1 "A" Street Pumping Station (High Service Level)

The "A" Street Pumping Station contains two High Service Level pumps, Nos. H1 and H2, each with a rated capacity of 6,300 gpm (9.0 mgd) at 265 feet. The "A" Street facilities also contain two satellite pumping stations, Nos. 9 and 10, each with a rated capacity of 6,300 gpm (9.0 mgd) at 250 feet that discharge to the High Service Level. Data on the "A" Street pumping units is shown above in Table 6-6.

6.3.2.2 Vine Street Pumping Stations

The Vine Street Pumping Stations are located at the Vine Street Reservoir site and take suction from the Vine Street Reservoir and the 54/48-inch Low Service transmission main from the Northeast Pumping Station.

The High Service Level Station (Vine Street West) contains four pumps. Pump No. 1 has a rated capacity of 10,500 gpm (15.0 mgd) at 115 feet and is equipped with an eddy current coupling which is inoperable. As part of an ongoing electrical rehabilitation project at the facility, Pump No. 1 is being removed. Pump Nos. 2 through 4 have a rated capacity of 14,000 gpm (20.2 mgd) at 115 feet. Space is available for a fifth pump.

The Southeast Service Level Station (Vine Street East) was constructed in Year 2001 in conjunction with expansion of the Vine Street Reservoir. The station contains two pumps each rated 7,000 gpm (10.1 mgd) at 210 feet. Formerly, one variable speed drive was used to operate either of the two pumps but was taken out of service in Year 2012. There is space available for a third pump. The facility is designed to accommodate 20 mgd pumps in each of the three pump slots.

Vine Street Pumping Station (West) is currently being rehabilitated under a separate construction project. This will include removal of Pump No. 1 which is no longer functional, and complete replacement of the Motor Control Line-Up and Motor Control Center which serves the facility. Data on the Vine Street pumping units is shown in Table 6-7.

Table 6-7 Vine Street Pumping Stations

Pump NO.	Make	Rated Capacity (gpm)	Rated Capacity (mgd)	Head (ft)	Pump Motor (hp)	Pump Motor (rpm)
High Service Level						
H2(1)	Worthington	14,000	20.2	115	500	1,175
H3(1)	Worthington	14,000	20.2	115	500	1,175
H4(1)	Worthington	14,000	20.2	115	500	1,175
Southeast Service Level						
SE1(2)	Ingersoll	7,000	10.1	210	450	895(4)
SE2(2)	Ingersoll	7,000	10.1	210	450	895(4)

(1)High Service Level.
(2)Southeast Service Level.
(3)Pump H1 is currently being removed under an electrical rehabilitation project.
(4)Common variable speed drive taken out of service 2012.

6.3.2.3 South 56th Street Reservoir and Pumping Station

The South 56th Street Reservoir is located southwest of the intersection of 56th Street and Pine Lake Road. The 4.0 million gallon reservoir floats on the High Service Level, has an overflow elevation of 1,420 feet, a sidewater depth of 62 feet, and is normally operated between 53 and 59.5 feet.

In Year 1998 a re-pumping station was added at the reservoir site. The station contains three pumps each rated 3,125 gpm (4.5 mgd) at 50 feet. The pumping station is intended to be used to increase pressures in the southern portion of the High Service Level under high flow conditions. Records indicate that the station was never used and is slated for demolition, except that an existing PRV from the Southeast Service Level to the High Service Level shall be maintained. Data on the South 56th Street pumping units is shown in Table 6-8.

Table 6-8 South 56th Street Pumping Station

Pump No.	Make	Rated Capacity (gpm)	Rated Capacity (mgd)	Head (ft)	Pump Motor (hp)	Pump Motor (rpm)
1	General Signal	3,125	4.5	50	50	1,170
2	General Signal	3,125	4.5	50	50	1,170
3	General Signal	3,125	4.5	50	50	1,170

6.3.2.4 Southeast Reservoir

The Southeast Reservoir is located near the intersection of South and 84th Streets. The 5.0 million gallon reservoir floats on the High Service Level, has an overflow elevation of 1,420 feet, a sidewater depth of 60 feet, and is normally operated between 51 and 58 feet. The reservoir also provides suction storage for the adjacent Southeast Pumping Station, which supplies the Southeast Service Level.

6.3.3 Belmont Service Level

The Belmont Service Level serves the northwest part of the City, including Lincoln Municipal Airport.

The Belmont Service Level is supplied by the Belmont, Merrill Street, and Pioneers Pumping Stations. The Belmont Service Level static hydraulic gradient of 1,400 feet is established by the overflow elevation of the Air Park and NW 12th Street Reservoirs.

6.3.3.1 Belmont Pumping Station

The Belmont Pumping Station is located southwest of the intersection of 14th and Superior Streets. The Belmont Pumping Station takes suction from 30-inch and 24-inch Low Service Level mains. It contains four pumps that pump to two 24-inch discharge mains.

The impeller in Pump No. 1 was replaced in Year 1999. A new impeller was installed in Pump No. 2 in Year 1990. Pump No. 3 was replaced in Year 2001 and Pump No. 4 was installed in Year 1990. A shared adjustable frequency drive for Pump Nos. 2 and 4 was removed in Year 2001. Data on the Belmont pumping units is shown in Table 6-9.

Table 6-9 Belmont Pumping Station

Pump No.	Make	Rated Capacity (gpm)	Rated Capacity (mgd)	Head (ft)	Pump Motor (hp)	Pump Motor (rpm)
1	Allis-Chalmers	4,200	6.1	135	200	1,170
2	Allis-Chalmers	4,200	6.1	135	200	1,170
3	Ingersoll-Dresser	6,300	9.1	135	300	1,185
4	Allis-Chalmers	6,300	9.1	135	300	1,185

6.3.3.2 Merrill Pumping Station

The Merrill Pumping Station is located near the intersection of 26th and Merrill Streets and is capable of supplying water to the Low Service Level. The pumps take suction from the 51st Street Pumping Station 36-inch transfer main. As part of the Year 2001 pumping station modifications project, a shared adjustable frequency drive was removed, and constant speed motors were installed on both units, allowing both to be operated at the same time. City staff has reported that the Merrill Pumping Station is not currently used since it is undersized for current demands, but should be maintained until scheduled main improvements in the vicinity are completed. The pumping station is scheduled for demolition, but the existing standpipe shall be maintained to provide surge protection of the 36-inch cast iron main from 51st Street to "A" Street. Data on the Merrill pumping units is shown in Table 6-10.

Table 6-10 Merrill Pumping Station

Pump No.	Make	Rated Capacity (gpm)	Rated Capacity (mgd)	Head (ft)	Pump Motor (hp)	Pump Motor (rpm)
1	Allis-Chalmers	2,600	3.7	215	200	1,760
2	Allis-Chalmers	2,600	3.7	215	200	1,760

6.3.3.3 Pioneers Pumping Station

The Pioneers Pumping Station is located southeast of the intersection of Coddington and West Van Dorn Streets, and became operational in Year 2005. The station contains three pumps that boost from the Low Service Level to the Belmont Service Level. There is space for addition of a fourth pump in the station. Data on the Pioneers Pumping Station is shown in Table 6-11.

Table 6-11 Pioneers Pumping Station

Pump No.	Make	Rated Capacity (gpm)	Rated Capacity (mgd)	Head (ft)	Pump Motor (hp)	Pump Motor (rpm)
1	Fairbanks-Morse	1,400	2.0	105	60	1,195
2	Fairbanks-Morse	2,100	3.0	105	75	1,190
3	Fairbanks-Morse	3,500	5.0	105	125	1,185

6.3.3.4 Air Park Reservoir

The Air Park Reservoir is located northwest of the intersection of West Superior and Northwest 54th Streets. The 3.0 million gallon reservoir floats on the Belmont Service Level, has an overflow elevation of 1,400 feet, a sidewater depth of 95 feet, and is currently operated between 77 and 90 feet.

6.3.3.5 NW 12th Street Reservoir

The NW 12th Street Reservoir is located north of the intersection of Alvo Road and Northwest 12th Street. The reservoir was placed into service in summer Year 2000. The 4.5 million gallon reservoir floats on the Belmont Service Level, has an overflow elevation of 1,400 feet, a sidewater depth of 75 feet, and is currently operated between 57 and 70 feet. The NW 12th Street Reservoir has an electronically actuated fill valve that can be used as an altitude valve when desired to balance flows with the Air Park Reservoir.

6.3.4 Southeast Service Level

The Southeast Service Level serves the high ground elevations in the southeastern section of the City. The Southeast Service Level is supplied by the Southeast Pumping Station and the Southeast Pumps from the Vine Street East Pumping Station. The Southeast static hydraulic gradient of 1,500 feet is currently established by the overflow elevation of the Yankee Hill Reservoir. Upon completion of the Yankee Hill Reservoir in Year 2003, the Pine Lake Reservoir which previously served the Southwest Service Level was demolished.

6.3.4.1 Vine Street Pumping Station

As previously noted in paragraph 4.3.3.2, two 10-mgd pumps at the Vine Street Pumping Station serve the Southeast Service Level.

6.3.4.2 Southeast Pumping Station

The Southeast Pumping Station is located northwest of the Southeast Reservoir, from which the pumps take suction.

The impeller in Pump No. 1 was replaced in Year 1999. A new impeller was installed in Pump No. 2 in Year 1999. Pump No. 3 was replaced in Year 2001 and Pump No. 4 was installed in Year 1988. A shared adjustable frequency drive for Pump Nos. 2 and 4 was removed in Year 2001. Data on the Southeast pumping units is shown in Table 6-12.

Table 6-12 Southeast Pumping Station

Pump No.	Make	Rated Capacity		Head	Pump Motor	
		(gpm)	(mgd)	(ft)	(hp)	(rpm)
1	Allis-Chalmers	4,200	6.1	155	200	1,180
2	Allis-Chalmers	4,200	6.1	155	200	1,170
3	Ingersoll-Dresser	6,300	9.1	155	350	1,185
4	Allis-Chalmers	6,300	9.1	155	350	1,185

6.3.4.3 Yankee Hill Reservoir

The Yankee Hill Reservoir is located south of the intersection of 84th Street and Yankee Hill Road. The 10.0 million gallon reservoir floats on the Southeast Service Level and has an overflow elevation of 1,500 feet, a sidewater depth of 75 feet, and is normally operated between 64 and 71 feet.

6.3.5 Cheney Service Level

The Cheney Service Level was placed into service in Year 2001 to serve high ground in the southeast corner of the City. A portion of the existing Southeast Service Level was converted to the Cheney Service Level. The Cheney Booster Pumping Station (BPS) was installed in Year 2001 in the northeast corner of the intersection of South 84th Street and Pine Lake Road. The Cheney Service Level initially operated as a closed system with no floating storage. In Year 2018, the Yankee Hill Pumping Station was constructed at the site of the Yankee Hill Reservoir. It now serves the Cheney Service Level with Cheney BPS remaining for backup service.

The static hydraulic gradient is established by the Cheney Elevated Reservoir which has an overflow 1,580 feet.

6.3.5.1 Yankee Hill Pumping Station

The Yankee Hill Pumping Station was constructed in Year 2018 at the site of the Yankee Hill Reservoir and has been recently put into service. The Yankee Hill Pumping Station now serves as the primary pumping station for the Cheney Service Level and contains four pump bays with three pumps installed. Current pumping station firm capacity is 4 mgd. The pumping station is designed for ultimate total capacity of 24 mgd (18 mgd firm). Data on the current Yankee Hill pumping units is shown in Table 6-13. The station also contains a PRV which is needed when Cheney Reservoir is offline, and it can also be used to cycle Cheney Reservoir for water quality. The Yankee Hill Pumping Station and the Northwest 12th Pumping Station are the only pumping stations in the distribution system which have connected backup power generation.

Table 6-13 Yankee Hill Pumping Station

Pump No.	Make	Rated Capacity (gpm)	Rated Capacity (mgd)	Head (ft)	Pump Motor (hp)	Pump Motor (rpm)
1	Fairbanks-Morse	700	1	110	40	1,800
2	Fairbanks-Morse	2,100	3	115	100	1,200
3	Fairbanks-Morse	2,100	3	115	100	1,200
4	Future					

6.3.5.2 Cheney Booster Pumping Station

The Cheney Booster Pumping Station is a pre-packaged below-grade pumping station constructed in Year 2001, containing five pumps with a firm capacity of 6.2 mgd. As noted above, the Cheney BPS is now a standby pump station serving backup duty to the newer Yankee Hill Pumping Station. Data on the Cheney pumping units is shown in Table 6-14.

Table 6-14 Cheney Booster Pumping Station

Pump No.	Make	Rated Capacity (gpm)	Rated Capacity (mgd)	Head(1) (ft)	Pump Motor (hp)	Pump Motor (rpm)
1	Paco	130(2)	0.2	175	10	3,500
2	Paco	650	0.9	175	40	3,500
3	Paco	1,400	2.0	175	100	1,750
4	Paco	2,150	3.1	175	125	1,750
5	Paco	2,150	3.1	175	125	1,750

(1)Although pumps are rated at 175 feet of head, the discharge PRV throttles about 75 feet of head at 91 psi to maintain a hydraulic gradient of about 1600 feet.
(2)Pump used only for very low flow conditions.

6.3.5.3 Cheney Elevated Reservoir

The Cheney Elevated Reservoir is located at Breagan Road and South 98th Street. The 2.0 million gallon reservoir floats on the Cheney Service Level and has an overflow elevation of 1,580 feet, a sidewater depth of 40 feet, and is normally operated between 26 and 36 feet.

6.3.6 Northwest Service Level

The Northwest Service Level was placed into service in 2002 to serve new development on high ground in the northern portion of the city near the NW 12th Street Reservoir. The NW 12th Street BPS was installed in Year 2002 at the NW 12th Street Reservoir site. The Northwest Service Level is operated as a closed system with no floating storage. The static hydraulic gradient is established by the pressure reducing valve (PRV) setting on the pumping station discharge. LWS reports that the valve set-point is set at 61 psi which equates to a hydraulic gradient of about 1,460 feet.

6.3.6.1 NW 12th Street Booster Pumping Station

The NW 12th Street Pumping Station is a pre-packaged above-grade pumping station containing five pumps with a firm capacity of 6.3 mgd. Data on the NW 12th Street pumping units is shown in Table 6-15 . Operations of the facility are automated based upon discharge pressures.

Table 6-15 NW 12th Street Booster Pumping Station

Pump No.	Make	Rated Capacity (gpm)	Rated Capacity (mgd)	Head(1) (ft)	Pump Motor (hp)	Pump Motor (rpm)
1	Paco	150(2)	0.2	100	7.5	3,600
2	Paco	650	0.9	100	25	1,800
3	Paco	1,400	2.0	100	50	1,800
4	Paco	2,200	3.2	100	75	1,800
5	Paco	2,200	3.2	100	75	1,800

(1)Although pumps are rated at 100 feet of head, the discharge PRV throttles about 50 feet of head at 61 psi to maintain a hydraulic gradient of about 1460 feet.
(2)Pump noted to no longer be used.

6.3.7 Pumping Capacity Summary

A summary of total and firm capacities for existing distribution system pumping stations is summarized in Table 6-16. Firm capacity is the capacity with the largest pump out of service.

Table 6-16 Distribution System Pumping Capacity Summary

Service Level	Pumping Station	Number of Pumps	Installed Capacity (mgd)	Firm Capacity (mgd)
Low	51st Street[(1)]	4	40.4	30.3
	Northeast[(1)(3)]	4	70.6	50.4
	"A" Street	3	28.6	18.2
	Total		139.6	98.9
High	"A" Street	4	36.4	27.3
	Vine Street	3	60.6	40.4
	S. 56th Street	3	13.5	9.0
	Total		110.5	76.7
Belmont	Belmont	4	30.4	21.3
	Merrill	2	7.4	3.7
	Pioneers	3	10.0	5.0
	Total		47.8	30.0
Southeast	Vine Street	2	20.2	10.1
	Southeast	4	30.4	21.3
	Total		50.6	31.4
Cheney	Yankee Hill	3	7	4.0
	Cheney[(2)]	5	9.1	6.0
Northwest	NW 12th Street	4[(2)]	9.3	6.1

(1)Transfer pumps not included.
(2)Does not include capacity of small pump.
(3)Northeast Pump No. 6 currently not included as eddy current coupling is inoperable.

6.3.8 Storage Capacity Summary

A summary of floating storage capacities by service level is given in Table 6-17. It is noted that a number of reservoirs provide both floating storage and suction storage to different service levels. Vine Street Reservoir enables stabilization of system pressures in the Low Service Level and can potentially supply peak hourly demands by gravity when the water level in the reservoir is near the overflow. However, because of its proximity to the Vine Pumping Station and the high discharge from the pumping station to the High Service Level, the reservoir will function primarily as a suction storage reservoir. During emergencies, the Vine Street and Southeast Reservoirs will be effective in supplying water by gravity to the Low and High Service Levels, respectively. Under these emergency conditions, marginal pressures would be expected at higher ground elevations.

Table 6-17 Distribution System Floating Storage Capacity Summary

Service Level	Reservoir	Capacity (MG)
Low	Vine Street	20.0
	Pioneers Park	4.0
	Total	24.0
High	Southeast	5.0
	High Service (S. 56th)	4.0
	Total	9.0
Belmont	Air Park	3.0
	NW 12th Street	4.5
	Total	7.5
Southeast	Yankee Hill	10.0
	Total	10.0
Cheney	Cheney	2.0
	Total	2.0
Grand Total		**52.5**

Additional ground storage is provided on the transmission system from the Ashland WTP for repumping to the distribution system as summarized in Table 6-18.

Table 6-18 Transmission Ground Storage Facilities

Reservoir	Capacity (MG)
Northeast	10.0
51st Street	12.0
“A” Street	22.0
Total	**44.0**

The total storage volume - including the transmission ground storage facilities and the distribution system floating storage - is 96.5 MG.

6.4 Distribution System Evaluations

Distribution system evaluations were performed to update the recommendations from the *2014 Master Plan* based on the updated demand projections. Desktop storage and pumping evaluations were performed to determine pumping and storage needs through Year 2032. The hydraulic model was updated to include any recent improvements that have been completed since the *2014 Master Plan* and two design year extended period simulations (EPS) were developed, for Year 2020 and for Year 2032.

6.4.1 Pumping Capacity Evaluation

Facility information for firm pumping capacity, which was detailed in the previous sections, was compared against the maximum day demands by each Service Level, and the pumpage needed into each Service Level, to determine if there are any capacity improvements required in the 12-year CIP. Shown in Table 6-19 is the pumping capacity evaluation for Year 2020 and in Table 6-20 for Year 2032. As can be seen, from a capacity stand-point, there are no pumping capacity deficits through the 12-year CIP that need to be addressed, beyond the pumping improvements already recommended and presented in Chapter 8.

Table 6-19 Year 2020 Pumping Capacity Evaluation

Service Level	Total Firm Pumping Capacity	Maximum Day Demand	Total Pumpage Required(1)	Capacity Surplus/ Deficit
Northwest	6.3	2.5	2.5	3.8
Belmont	26.3	13.6	16.0	10.3
Low	98.9	24.9	95.3	3.6
High	67.7	32.4	54.3	13.4
Southeast	31.4	16.7	21.9	9.5
Cheney (2)	10.2	5.2	5.2	5.0

(1)Total pumpage calculated as the sum of all Service Levels demands that must be transferred through the Service Level, as well as the Service Level's own maximum day demand (Belmont pumpage required include Belmont MD and Northwest MD).
(2)Includes the new Yankee Hill Pumping Station.

Table 6-20 Year 2032 Pumping Capacity Evaluation

Service Level	Total Firm Pumping Capacity	Maximum Day Demand	Total Pumpage Required(1)	Capacity Surplus/ Deficit
Northwest(2)	5.0	2.9	2.9	2.1
Belmont	36.3	16.7	19.6	16.7
Low	114.0	29.4	106.3	7.7
High (3)	67.7	33.4	57.3	10.4
Southeast	41.5	17.5	23.8	17.7
Cheney	7.0	6.4	6.4	0.6

(1)Total pumpage calculated as the sum of all Service Levels demands that must be transferred through the Service Level, as well as the Service Level's own maximum day demand (Belmont pumpage required includes Belmont MD and Northwest MD).

(2)New Northwest Pumping Station firm capacity of 5.0 mgd.

(3)Vine Street Pump H1 excluded from firm capacity because it is anticipated to be removed between 2020 and 2032.

6.4.2 Storage Capacity Evaluation

Storage capacity evaluations were updated from the *2014 Master Plan* to include the updated demand projections and estimated storage needs. Discussion is presented in the following sections related to the storage requirements, but one important aspect in consideration of the desktop, or "on-paper," results is the balancing of storage for equalization and emergency against the impact that new storage volume will have on water quality.

6.4.2.1 2020 Storage Evaluation

Table 6-21 presents this updated information on the storage evaluation for Year 2020. The key rows in Table 6-21 are the last two: Total Surplus/Deficiency - Equalization and Operational, and Total Surplus/Deficiency - All Components.

Table 6-21 Storage Evaluation 2020

Description	Service Level					
	Northwest	Belmont	Low	High	Southeast	Cheney
Average Day Demand, mgd	0.8	7.8	12.3	13.5	6.2	2.1
Maximum Day Demand, mgd	2.5	13.6	24.9	32.4	16.7	5.2
Maximum Hour Demand, mgd	4.9	19.6	35.7	65.7	40.3	13.5
Available Firm Capacity Into SL	6.3	26.3	114.0	82.8	31.4	10.2
Operational Storage(1)	0.0	0.4	0.2	0.3	0.7	0.2
Equalization Storage(2)	0.0	0.0	0.0	0.0	0.9	0.3
Emergency Storage(3)	0.8	4.5	8.3	10.8	5.6	1.7
Fire Storage(4)	0.4	0.4	0.4	0.4	0.4	0.4
Total Storage Requirements	1.2	5.4	9.0	11.6	7.6	2.7
Total Existing Storage @ 35 psi(5)	0.0	2.9	2.4	3.7	10.0	1.0
Total Existing Storage @ 20 psi(6)	0.0	6.1	22.8	7.4	10.0	1.5
Total Surplus/Deficiency - Equalization and Operational	0.0	2.5	2.2	3.4	8.4	0.5
Total Surplus/Deficiency - All Components	-1.2	0.7	13.8	-4.2	2.4	-1.2

(1)Operational storage is the volume above the normal high operating level in each tank.
(2)Required equalization storage is equal to [MH – Total Available Source] * 150 minutes, set as 0 if Available Firm Capacity into SL is greater than MH.
(3)Required emergency storage is 8 hours x MD.
(4)Required fire flow storage is equal to 3,500 gpm for 2 hours.
(5)Total existing storage @ 35 psi from the *2014 Master Plan*.
(6)Total existing storage @ 20 psi from the *2014 Master Plan*.

The first key category of *Total Surplus/Deficiency -Equalization and Operational Storage* identifies areas where storage would be needed to meet the equalization of summer peak hourly demands, up to a design (extremely hot and dry year) maximum day and maximum hour condition. If any Service Level had a deficiency in this category, it would generally call for the addition of storage unless there were surplus pumping capacity that could meet the needs with reliable backup power. However, there are no areas in the system where operational and equalization storage is a concern in Year 2020 in the desktop evaluation. In fact, all but Cheney and Southeast can sustain their maximum hour period without storage should an emergency occur, and a tank were needed to be taken out of service and removed from the system. This shows that there is a significantly robust pumping system in place which will meet current maximum day conditions, and sufficient storage for equalization. A process of system optimization as well as optimization of the CIP using T.O.U controls for a design maximum day demand was not performed in the *2014 Master Plan* or in this update. The City may want to consider using such an approach in the next Master Plan with the recognition that optimization using T.O.U. controls will require a significant level of effort and a large amount of energy-cost data to develop an energy-cost model that can be optimized against the planning CIP to be developed.

The second category, *Total Surplus/Deficiency - All Components* is more nuanced to diagnose when desktop evaluation goals don't look to be met. The reason for this is that emergency storage does not necessarily need to be located in the Service Level where the deficiency is shown on paper. It would be ideal if it were, and improvements in storage are recommended within the 12-year CIP to move towards meeting that ideal. As an example of this, High Service Level shows a deficiency of 4.2 MG of storage in Year 2020. The reason for this, is that the large amount of emergency storage required based on the storage goals developed in the *2014 Master Plan* and used in this update. However, there is a surplus of emergency storage in the Southeast Service Level. Should there be the need to move emergency storage into the High Service Level, reducing pumping into the Southeast Service Level, opening a boundary valve, or pulling directly into Southeast Reservoir with the ST-6 improvement (PRV Southeast SL to High SL - Vault near Southeast PS) would essentially shift the surplus storage from Southeast into High which would satisfy more than half of the emergency storage deficiency. Unless the emergency was a complete outage of Vine Street, Low Service Level also has a much larger storage surplus and flexibility in operations with the ability to move water up to Southeast Service Level, which can be wheeled back to the High Service Level.

It should be noted that many utilities set slightly different goals when it comes to fire and emergency storage. One of the major differences is that the larger of the fire or emergency, is taken and set as a single goal for an emergency/fire category to be added to equalization to come up with a total storage goal. The argument for this is that it is very conservative to assume that the maximum day demand, an emergency event, and a fire occur simultaneously, and designing for this level of risk to meet goals for every year can become cost-prohibitive for a CIP. For the purposes of this update, the same method was followed as in the *2014 Master Plan* to add operational, emergency, fire and equalization to obtain the total surplus/deficiency. The City may want to consider refining these goals in the next Master Plan or may decide to keep them as conservative goals with a much lower risk factor when system planning, albeit with a byproduct of higher CIP costs.

Table 6-21 shows three areas where total storage deficiencies occur "on paper," but there are caveats as to whether they are actual deficiencies:

High Service Level shows a total storage deficiency of 4.2 MG. As discussed previously, the ability to shift some emergency storage from Southeast to High indicates that this deficiency can be partially mitigated through operations in the next several years until the Adams Road Reservoir is completed, currently scheduled for Year 2030.

The Northwest Service Level shows a total storage deficiency related to the emergency requirements. The new Northwest Pumping Station, planned for Year 2020, in conjunction with the existing booster station will increase the available pumping capacity into this Service Level in the interim years until the Northwest Storage Reservoir is put into service, in 2026 at which point the existing booster station may be decommissioned and storage requirements will be met.

The Cheney Service Level shows a total storage deficiency as it did in the *2014 Master Plan*. This is due to the combination of fire storage requirements and the emergency storage requirements. Equalization and operational storage in the Cheney Service Level shows very little deficiency. Improvements to storage within the Cheney Service Level were recommended in Year 2040 in the *2014 Master Plan*. Because of the large impact that adding additional storage to the Cheney Service Level would have on water quality in an already challenging area, it is recommended to maintain the storage improvement in the Cheney Service Level in Year 2040, beyond the 12-year CIP. More so than other Service Levels, growth in the Cheney Service Level has generally occurred at a slower rate than predicted in previous planning projections (*LPlan 2040* and prior planning documents used in previous Master Plans). With the updated planning projections placing slightly more emphasis on infill and redevelopment, growth in the Cheney Service Level should be monitored over the next few years to verify that the rate of growth keeps pace with projections. Should the growth match or exceed the planning projections, in the next Master Plan, it should be determined whether this tank needs to move up some years. If historical precedence continues and growth in the Cheney Service Level occurs much more gradually than the planning projections, this facility might be a candidate to defer beyond the Year 2040 planning horizon. Of note, the Year 2020 Census data will be available in Year 2021 for use in the next Master Plan and data-driven planning projections will be much more straightforward to develop, rather than having to rely on benchmarked base-year estimations of population by Service Level.

Other strategies for Northwest and Cheney Service Levels in the interim years (until storage can be completed) could include targeted "Smart-watering" programs. Other utilities have had success piloting a small low-budget public-relations aspect of informing customers at a high level about how proper setting of irrigation days and times based on address can help. A well-informed targeted public that can be led to understand how storage improvement capital cost ultimately affects rates and how potential deferment is a win-win for all stakeholders, will be likely to participate. Reaching out to local sprinkling installers and discussing irrigation settings based on address has also been done effectively in developing/newly developed areas. These together can reduce drain rates during the first hours of irrigation in targeted areas, like Cheney, resulting in higher pressures for longer.

6.4.2.2 2032 Storage Evaluations

The Storage Evaluation for Year 2032 (12-year CIP) is provided in Table 6-22. Three Service Levels stand-out as having a deficiency in storage in a desktop evaluation.

Belmont Service Level has a total storage deficiency of 0.3 MG. However, with the addition of the I-80 Booster Pumping Station and the Belmont loop, there is a significant amount of surplus pumping capacity and there is also surplus emergency storage in the Northwest Service Level after the addition of the Northwest Storage Facility. Emergency storage surplus from the Northwest Service Level can be used to offset the deficiency in the Belmont Service Level by similar methods described above.

High Service Level shows a deficiency in the desktop evaluation, but the same discussion presented with the 2020 evaluation holds true in Year 2032, and the deficiency is much smaller.

Cheney shows a deficiency in the desktop evaluation in both equalization and total storage. The discussion presented in the previous section details the plan for the Cheney Service Level regarding storage.

Table 6-22 Storage Evaluation 2032

Description	Service Level					
	Northwest	Belmont	Low	High	Southeast	Cheney
Average Day Demand, mgd	1.0	13.6	13.4	12.9	6.5	2.6
Maximum Day Demand, mgd	2.9	16.7	29.4	33.4	17.5	6.4
Maximum Hour Demand, mgd	5.8	19.2	41.4	66.9	42.7	16.8
Available Firm Capacity Into SL	5.0	36.3	114.0	67.7	41.5	7.0
Operational Storage [(1)]	0.0	0.4	0.2	0.3	0.7	0.2
Equalization Storage[(2)]	0.1	0.0	0.0	0.0	0.1	1.0
Emergency Storage[(3)]	1.0	5.6	9.8	11.1	5.8	2.1
Fire Storage[(4)]	0.4	0.4	0.4	0.4	0.4	0.4
Total Storage Requirements[(5)]	1.5	6.4	10.4	11.9	7.1	3.8
Total Existing Storage @ 35 psi[(6)]	1.2	2.9	2.4	5.4	10.0	1.0
Total Existing Storage @ 20 psi[(7)]	1.7	6.1	22.8	11.4	10.0	1.5
Total Surplus/Deficiency - Equalization and Operational	1.1	2.5	2.2	5.1	9.2	-0.2
Total Surplus/Deficiency - All Components	0.3	-0.3	12.4	-0.5	2.9	-2.3

[(1)]Operational storage is the volume above the normal high operating level in each tank

[(2)]Required equalization storage is equal to [MH – Total Available Source] * 150 minutes, set as 0 if Available Firm Capacity into SL is greater than MH.

[(3)]Required emergency storage is 8 hours x MD

[(4)]Required fire flow storage is equal to 3,500 gpm for 2 hours

[(5)]Numbers may not add exactly due to rounding

[(6)]Total existing storage @ 35 psi from the *2014 Master Plan*

[(7)]Total existing storage @ 20 psi from the *2014 Master Plan*

6.4.3 Distribution System Modeling Evaluations and Model Updates

The 12-year CIP was evaluated through distribution system modeling using extended period simulations (EPS) for maximum day demand conditions. These EPS scenarios model the system demands and operations for a continuous 24-hour period and include the peak hourly demand (MH), replenishment conditions, and the average total demand over the day equals the maximum day demand for the given year.

The model was updated to include recent pipeline projects that would have a hydraulic impact on the system, generally 12-inch and larger mains. Updates were also made to the facilities surrounding the WTP to improve spatial accuracy. Some updates were necessary to improve modeling for the pumping and transmission network and closer resemble the way it is operated to provide supply into the system (i.e. opening and closing of certain valves to isolate transmission sections). The model demand allocation was updated based on the Year 2018 metered sales data, for which there was a 99 percent spatial match on accounts by usage volume.

6.4.3.1 Model Update - Hourly Peaking Patterns

Diurnal usage patterns by Service Level were developed using SCADA data from 2018 during an average week condition and a maximum week condition. The diurnal pattern represents the hourly usage characteristics for each Service Level and applied to the model junctions provides a realistic hourly usage throughout the 24-hour EPS. Figure 6-2 provides the hourly peaking factors to be applied to the maximum day demands by Service Level for the maximum day EPS evaluations. Figure 6-3 provides the hourly peaking factors to be applied to the average day demands by Service Level for the water age modeling evaluations which will be discussed in the following chapter. As expected, the hourly peaking factors are much greater for a maximum day demand condition than they are for an average day demand condition which is related to the irrigation component of use.

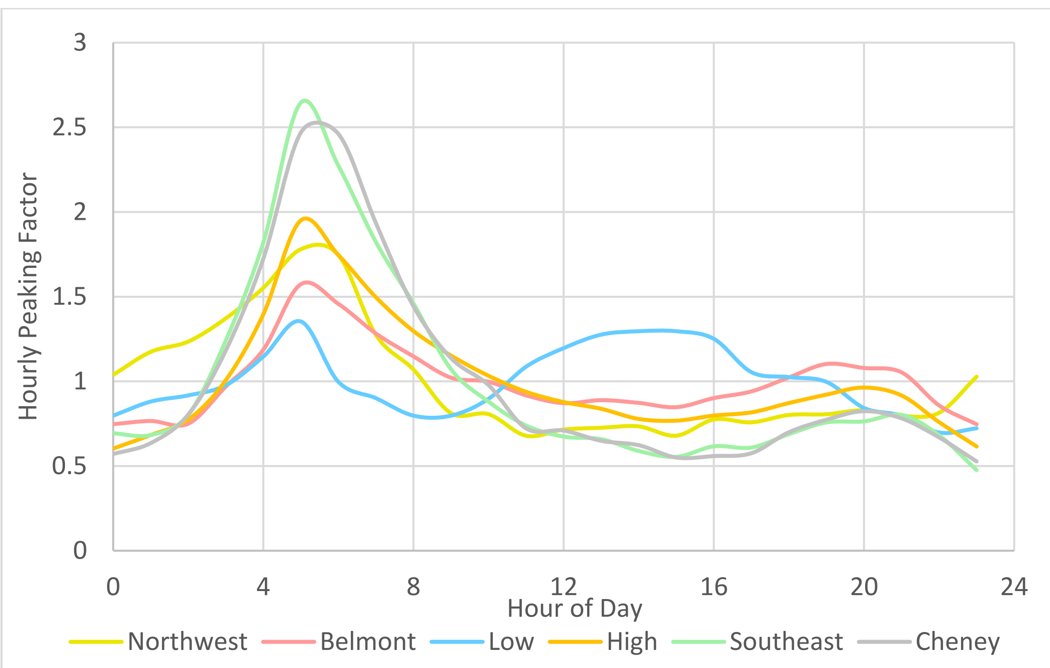


Figure 6-2 Maximum Day Hourly Peaking Factors

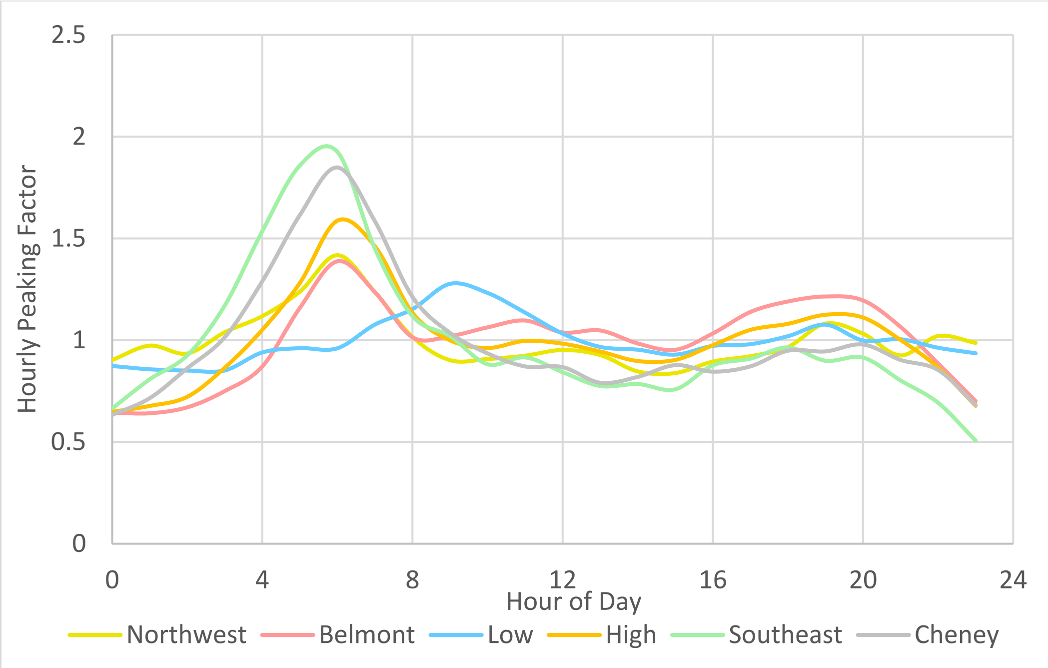


Figure 6-3 Average Day Hourly Peaking Factors

6.4.3.2 Model Update - Modeled Demands by Service Level

Figure 6-4 shows the maximum day hourly demands by Service Level for Year 2020 resulting from the MD:AD peaking factor multiplied by the hourly pattern for a maximum day.

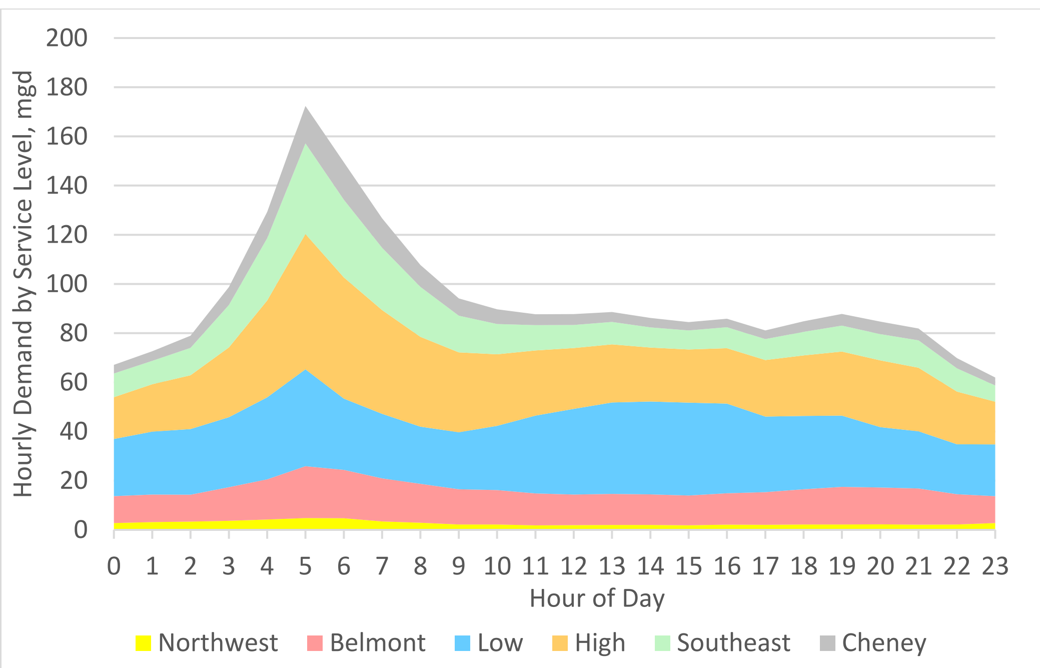


Figure 6-4 Modeled Maximum Day Hourly Usage, 2020

Figure 6-5 shows the average day hourly demands by Service Level for Year 2020, used in the water age modeling evaluations presented in the next Chapter.

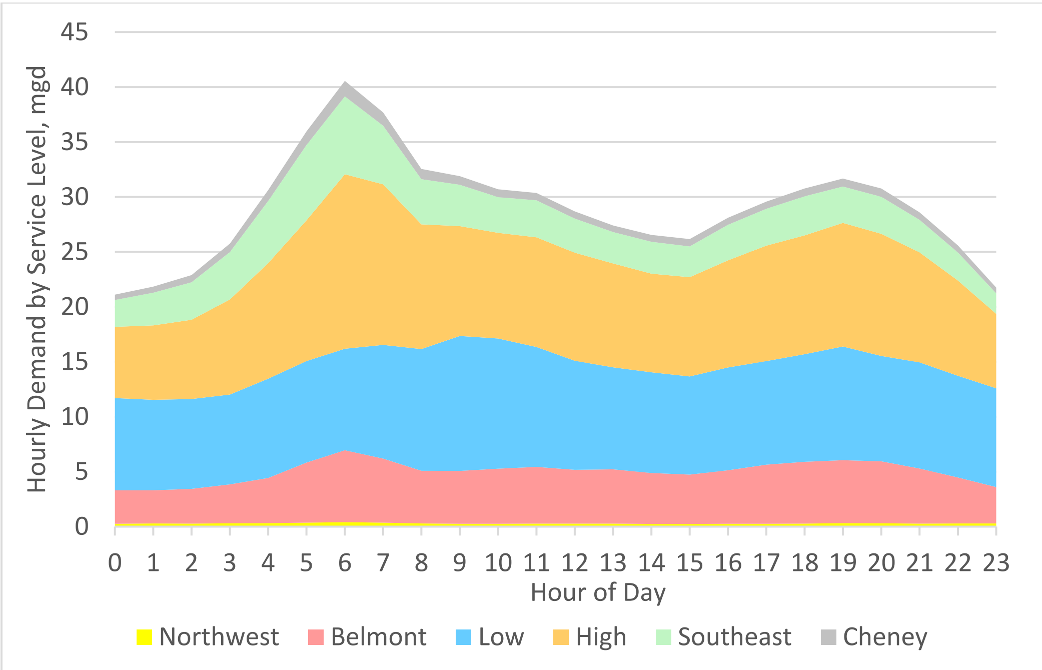


Figure 6-5 Modeled Average Day Hourly Usage, 2020

Figure 6-6 shows the hourly demands by Service Level for the maximum day evaluation for Year 2032.

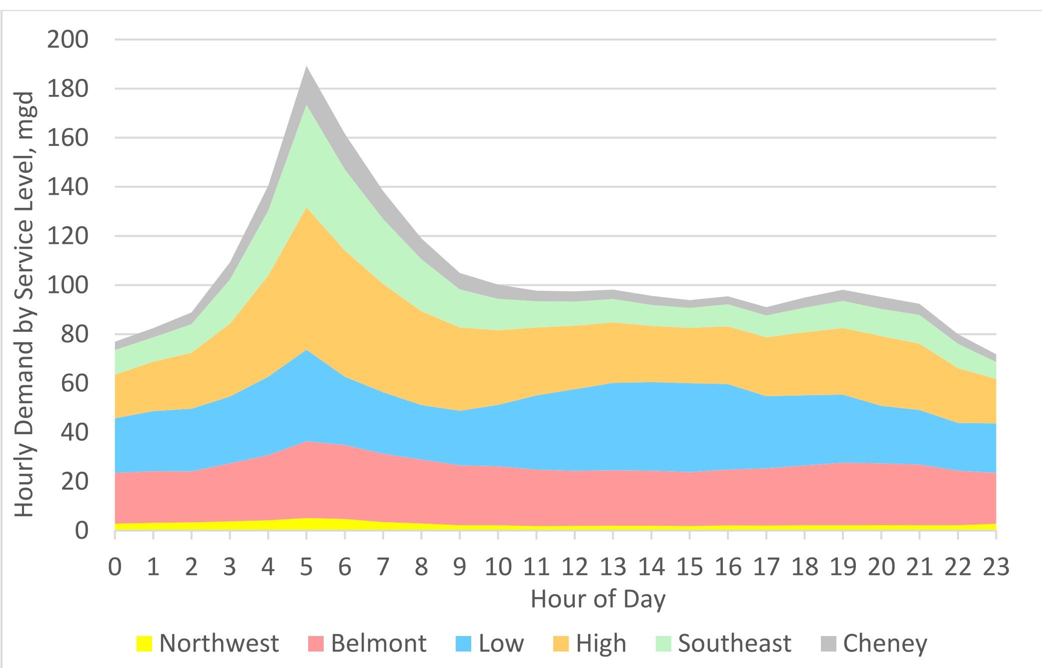


Figure 6-6 Modeled Maximum Day Hourly Usage, 2032

6.5 Focus Area Evaluations

Three focus areas were assessed specifically in this update.

- North 56th Street and I-80.
- Folsom and Old Cheney.
- 27th and Rokeby.

In addition, the City asked Black & Veatch to look at the runway crossing in the Belmont Service Level which was included in the focus areas evaluations.

6.5.1 North 56th Street and I-80

6.5.1.1 *2014 Master Plan* Recommendations

Improvements were recommended in the *2014 Master Plan* in this area to provide for future potential industrial demands north of I-80 along 56th St. The *2014 Master Plan* recommended a 3.0 mgd firm, 6.0 mgd total booster pumping station at I-80 and North 56th St plus improvement mains for development in the area. The timing of this recommendation was for 2018. A 24-inch Belmont North Loop connecting this area was recommended in Year 2035 from North 56th Street to North 14th Street (MT-6). A screen capture of CIP Figure from the *2014 Master Plan* for the area is shown below in Figure 6-7.

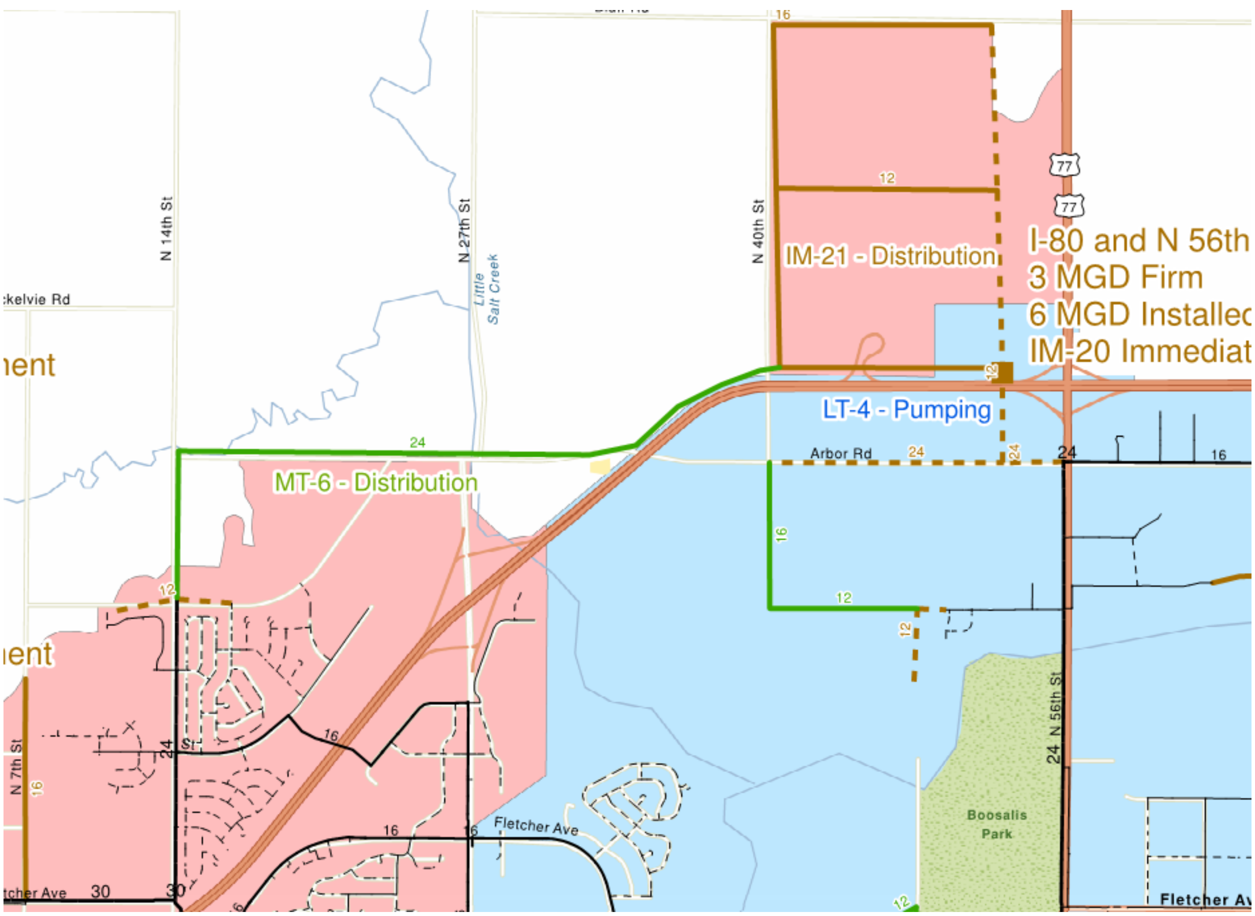


Figure 6-7 ***2014 Master Plan* Recommendations**

6.5.1.2 Update of Large Industrial Demands

Allowances for industrial growth north of I-80 were also included in this update with the exception that the demand projections were increased in this area for evaluation purposes. The demands evaluated for future large users or industrial customers in this development area are provided in Table 6-23.

Table 6-23 Large Use/Industrial Demand Projections

Demand Condition	2020	2025 and Beyond
Average Day Demand	1.75 mgd (25% of 7.0 mgd)	7.0 mgd
Maximum Day Demand	2.7 mgd (25% of 10.8)	10.8 mgd
Maximum Hour Demand	2.7 mgd (25% of 10.8)	10.8 mgd
Seasonal Peak Demand	2.7 mgd (25% of 10.8)	10.8 mgd

6.5.1.3 Recommended Improvements for Reliable Service

With localized large potential demands, it would be critical that this area be provided with reliability in case that a temporary outage of the I-80 and N 56th Street booster pump station (I-80 BPS) occurs, or if there was a main break on the 24-inch main that provides suction for this station. Multiple paths to provide water to an area will also help reduce bottlenecks and the energy cost of moving water. The implementation of a Belmont North Loop, shown in Figure 6-8 in red would provide reliability for consistent service of large demands. The dashed red lines shown on this figure are two different options for looping depending on long-term location of a pumping station. This will give the operational flexibility to meet a large variance in demand north of I-80. The Belmont Loop will expand the Belmont Service Level and will be at the same grade line as the Belmont Service Level. Any development north of I-80 and south of Bluff Road, bounded by N 56th Street on the east and roughly 1st Street on the west, could be part of the Belmont Service Level.

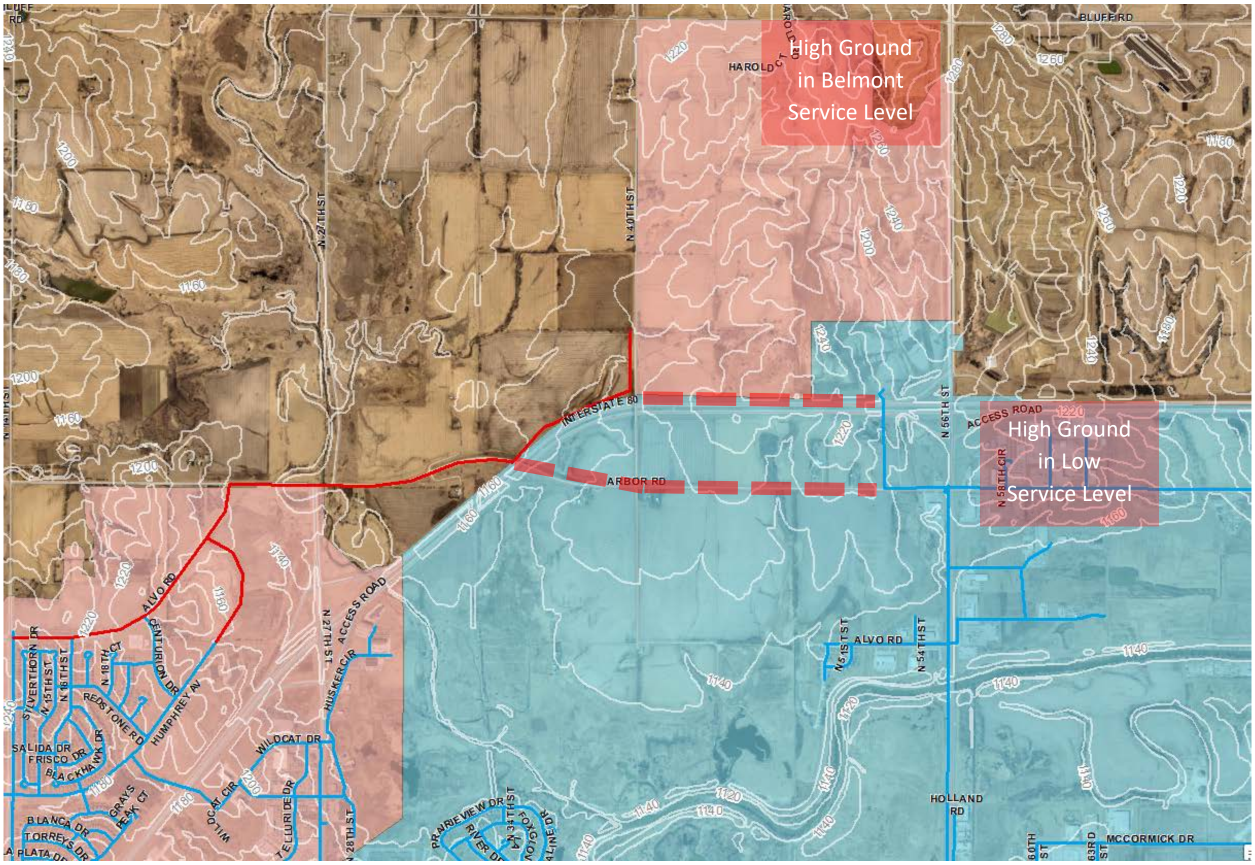


Figure 6-8 I-80 and N 56th Street Area Map

6.5.1.4 Modeling Evaluations

Hydraulic modeling scenarios were performed for Year 2020 and 2032 to evaluate the area and the improvements to meet any potential large use/industrial demands. The modeling scenarios were performed as maximum day EPS for a 48-hour period.

The results of the Year 2020 maximum day EPS showed that there is a high ground area in the Low Service Level just north of Arbor Road between N 56th Street and North 70th Street where pressures around 40 psi occur (Figure 6-9). Lincoln Trucking and Arbor Industries fall within this area. Should the I-80 BPS pump between 2 mgd and 4 mgd, these pressures around 40 psi are marginally acceptable, but flows above 4 mgd begin to cause pressure challenges. The Year 2032 evaluations showed that if using the I-80 BPS for almost 11 mgd of transfer, these same areas experience pressures less than 30 psi, with the highest ground around 23 psi.

Because pressures at these locations will be low and drop quickly with higher pumping from the I-80 BPS, three initial options that were evaluated.

- Supplying some of the demand through the Belmont Service Level during maximum demand conditions. Discussion is provided below in the emergency scenario evaluation.
- Constructing a parallel 24-inch improvement along N 56th Street from Superior to Arbor Road and N. 56th Street. This would increase the pressures by about 5 psi. These improvements would be cost-prohibitive for the benefit that they would provide.

- Operating 3 of the 51st Street pumps to Low continuously during periods of high demand. This will increase the pressures by about 5 psi but is energy intensive and operationally challenging.

These options were presented at a workshop with LWS staff and none of these options were noted as optimal solutions, so a fourth option, siting the booster pump station at a location south of I-80, was evaluated. This could provide acceptable pressures to the high ground along Arbor Road while allowing more pumping capacity at the I-80 BPS. Modeling results show that pumping 10.8 mgd on a Year 2032 maximum day, the average suction hydraulic grade line is 1285 feet and the average discharge hydraulic grade line is 1450 feet. This indicates two things: that areas above 1190 feet should be supplied through Belmont Service Level to avoid unacceptably low pressures (less than 40 psi), and that areas lower than 1170 feet should be supplied through the Low Service Level to avoid pressures that are unacceptably high (greater than 120 psi). The location where both requirements are met, is just south of Arbor Rd. along 56th Street. Figure 6-9 shows the area location with existing pipes symbolized with labeled diameters in blue and the future pipes that were in the model for development symbolized with labeled diameters in red. The ideal location of the booster pumping station is within the red rectangle and the yellow rectangle shows where a boundary valve would need to be closed with this site alternative.

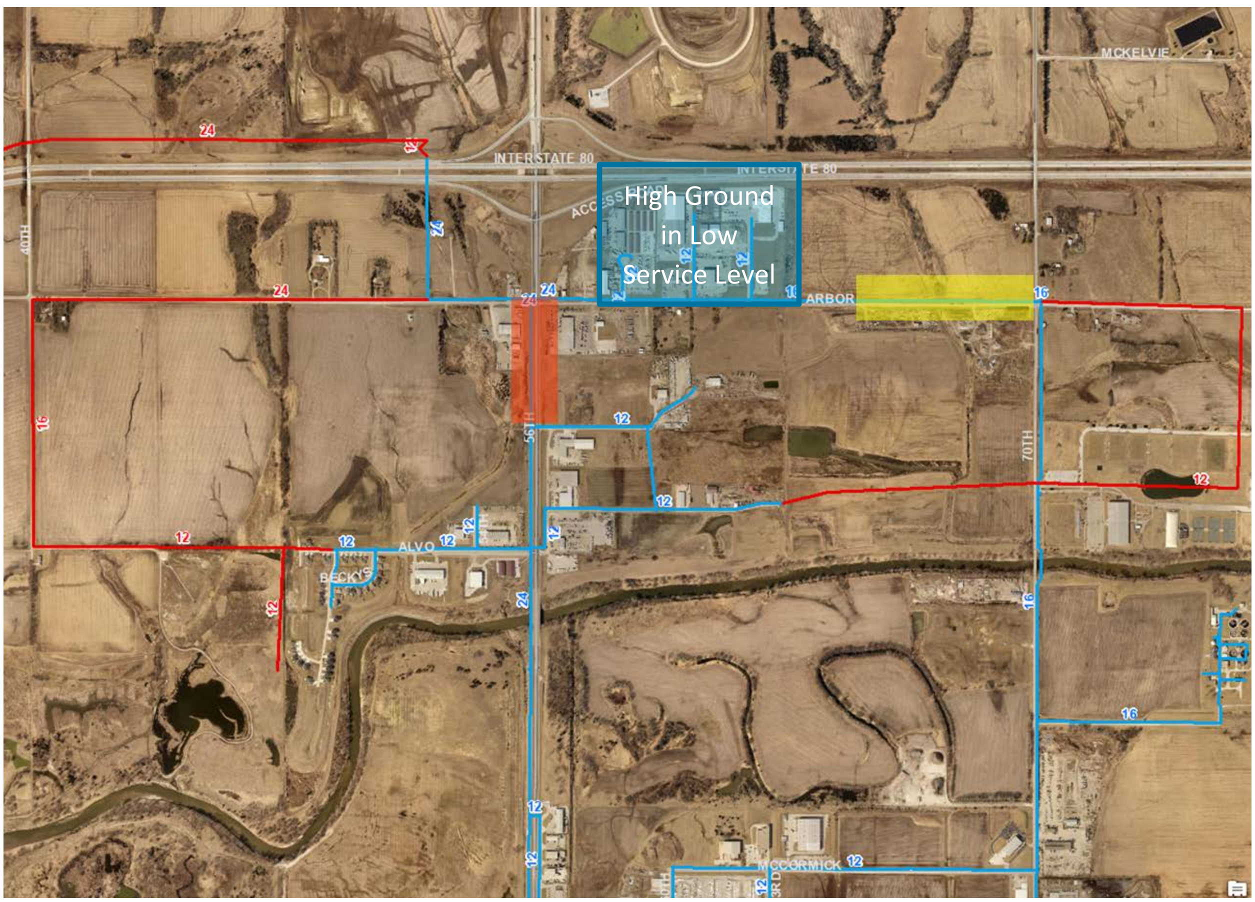


Figure 6-9 Booster Pump Station Alternative Location 1

A second scenario was performed to review the pressures if land cannot be acquired for siting of the booster pump station within the red rectangle shown above in Figure 6-9. This scenario evaluated the booster pumping station along 56th Street, but south of Alvo Rd. The locations of the booster pumping station and the necessary closed valves are show by the red and yellow rectangles respectively in the following Figure 6-10. This boundary configuration does provide the high ground areas along Arbor Rd. with pressures above 40 psi but results in extremely high pressures, up to 140 psi, at areas along Alvo Rd. If it is necessary to construct the booster pump station south of Alvo Rd. because of land acquisition factors, services that are along Alvo Rd. will likely need individual PRVs to reduce the high pressures. However, this would still result in pressures of 140 psi in the distribution system mains.

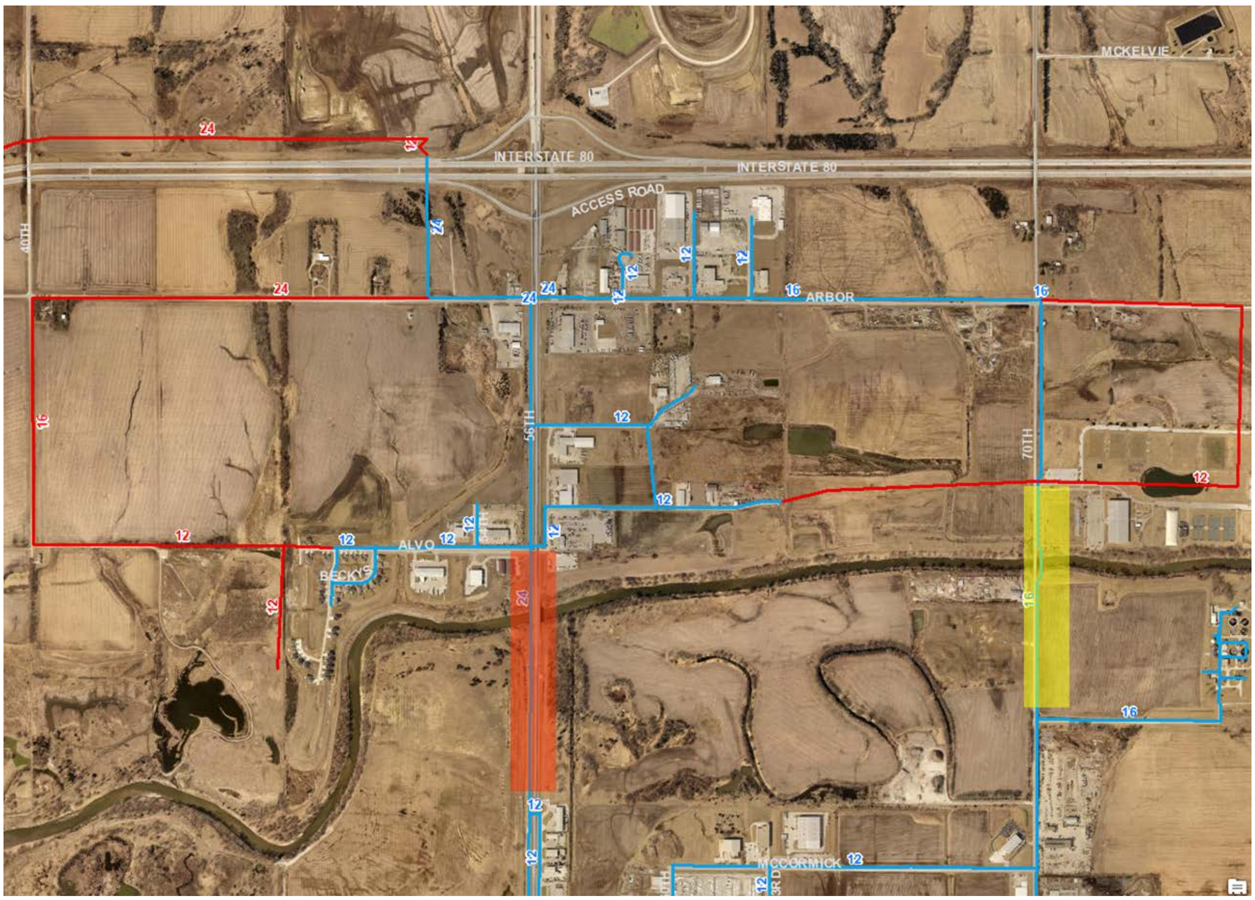


Figure 6-10 Booster Pump Station Alternative Location 2

6.5.1.5 Emergency Scenario

An "emergency" scenario was performed to evaluate supplying a portion of the demand through the Belmont Service Level. Pressures are increased at the Arbor Road location by almost 15 psi and are above 40 psi. However, during this emergency scenario pressures in the development area north of I-80 at high ground may be below 30 psi when moving more supply capacity through the Belmont Service Level.

6.5.1.6 North Loop Sizing

To provide full redundancy, the north loop will need to be 24-inches. If full redundancy is not desirable, a 16-inch will provide approximately 5 mgd to the east before pressures at high ground would drop below 40 psi. Minor sections of the looping as 16-inch mains along Alvo Road at the west in already developed areas could create some headloss, but if the loop mains along Arbor Road are maintained as 24-inch, these bottlenecks can be mitigated. The North Loop, while not currently needed to transfer water into existing areas of the Belmont Service Level, can be used to move water into the Belmont Service Level from the Low Service Level at higher capacities in the long-term plan.

6.5.1.7 Airport Runway Crossing Evaluation

The Year 2020 and Year 2032 EPS scenarios were used to evaluate the impact of removing the 16-inch main that crosses the runway in the Belmont Service Level. This area is shown in Figure 6-11. During the Year 2032 MD EPS scenario, the maximum flow through this main was only about 1.5 mgd, but flow moves through this main in both directions. Primarily during the morning peak, it moves west-east and during the periods of low demands (early morning/late night) it moves east-west. A second scenario was performed with this main closed to represent that it is out of service. Figure 6-12 shows the hydraulic grade line at the junctions to the west and east of the runway. The areas to the east of the runway will experience pressure about 4 psi (10 ft of HGL) lower during maximum hour conditions but there is additional pumping capacity at the Belmont Pumping Station that can be used if this leads to any low-pressure concerns. The areas to the west of the runway will experience a maximum pressure differential of about 2 psi (5 ft of HLG) during storage replenishment hours. Modeling indicates that the general conveyance capacity through this main is not needed for a Year 2032 maximum day non-emergency scenario. If the City is considering removal or abandonment of this main, the impact to water quality, fire flow and reliability should be further evaluated.

Figure 6-11 **Airport Runway 16-Inch Main Crossing**

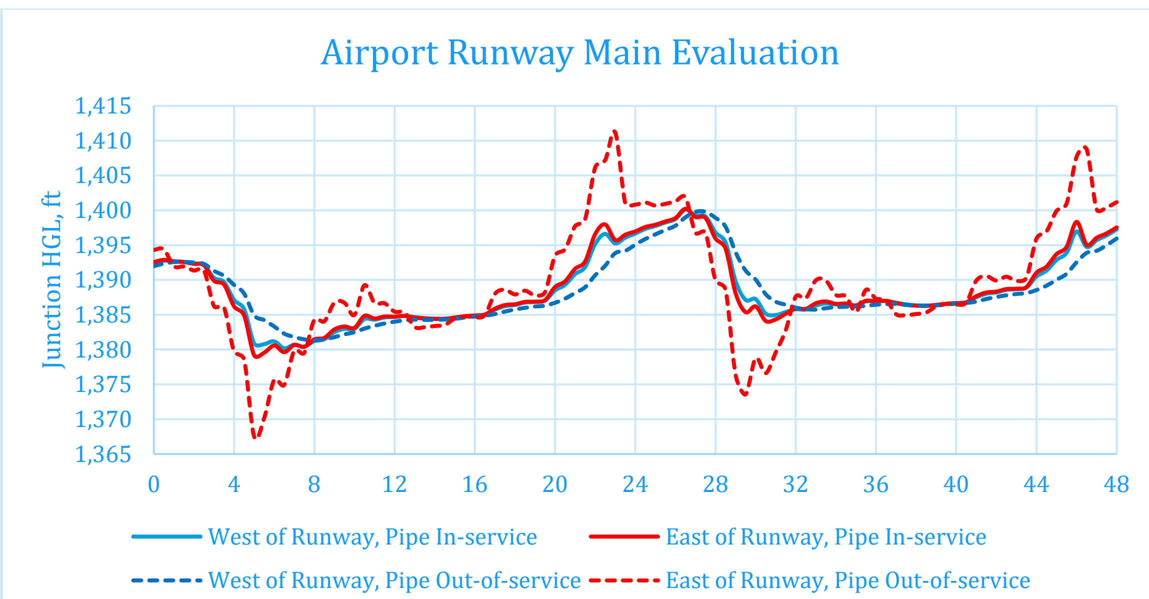


Figure 6-12 **Airport Runway Pipe Abandoned/Retired - Pressure Evaluation**

6.5.2 Folsom and Old Cheney

This area is currently fed from the Belmont Service Level through a 16-inch main coming south down Folsom from Old Proctor. Figure 6-13 shows the area with existing pipes (black) and system extension pipes (red-immediate, green-6 years, blue-12 years). From the planning projections provided, this area is anticipated to grow from a population of 550 (also existing population) to over 4,000 between Year 2026 and Year 2040. The 16-inch main alone provides enough capacity to serve the projected population at acceptable pressures, especially since this area is at relatively lower ground elevations considering the Belmont Service Level operating hydraulic grade line. However, it is served by a long 16-inch main and has no other redundant feed, so it is completely reliant on this main having no service interruptions. During maximum day conditions, the hydraulic grade line in the Belmont Service Level at Old Cheney and Folsom in the Belmont Service Level west of Wilderness Park operates near the same hydraulic grade line as the High Service Level at Old Cheney and 1st Street, east of Wilderness Park. This despite these areas being in different service levels. Modeling evaluations show that a pipe improvement along Old Cheney through Wilderness Park from the High Service Level to the Belmont Service Level could flow bi-directionally but only transfers 0.7 mgd east to west (High to Belmont) and 0.4 mgd from west to east (Belmont to High) at the maximum. This improvement would provide redundancy in the case that the 16-inch main along Old Folsom was taken out of service for maintenance or a break should occur. Because the operating grade lines of the Belmont Service Level and the High Service Level at the location of the intertie might be different during an average day scenario, a bi-directional control valve is recommended. If reliability is determined not to be a concern for the Folsom and Old Cheney focus area, the 12-inch main along Old Cheney connecting the two service levels is not needed for hydraulic conveyance.

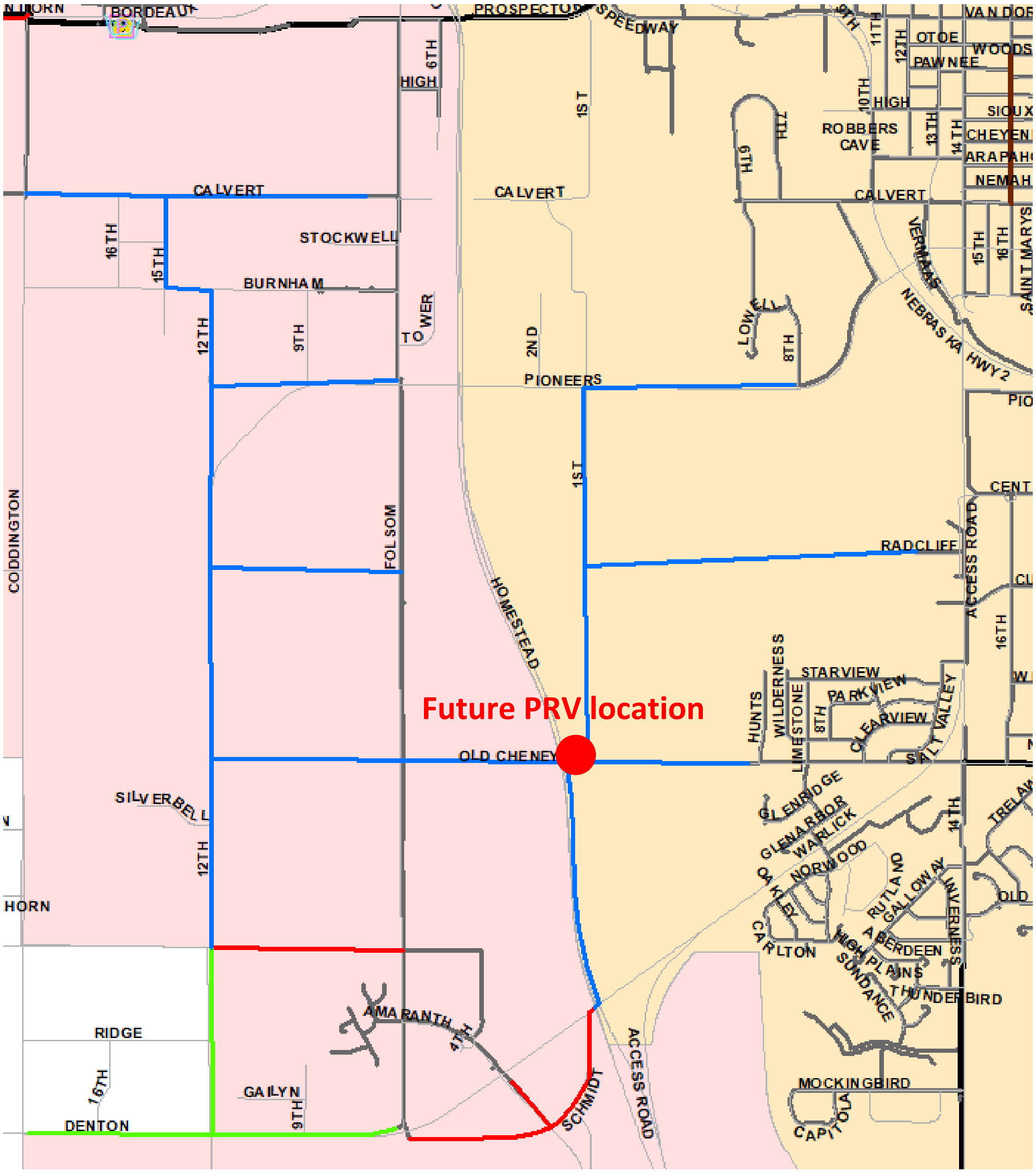


Figure 6-13 Folsom and Old Cheney Development Area

6.5.3 27th and Rokeby

Growth is expected in this area which is currently supplied at High Service Level pressure while areas at the north and to the east are supplied at Southeast Service Level pressure. There is an existing PRV between Southeast and High Service Levels at Williamson and Yankee Hill. Figure 6-14 shows the area with existing pipes (black) and system extension pipes (red-immediate, green-6 years, blue-12 years). The orange background is in the High Service Level and the green background is within the Southeast Service Level.

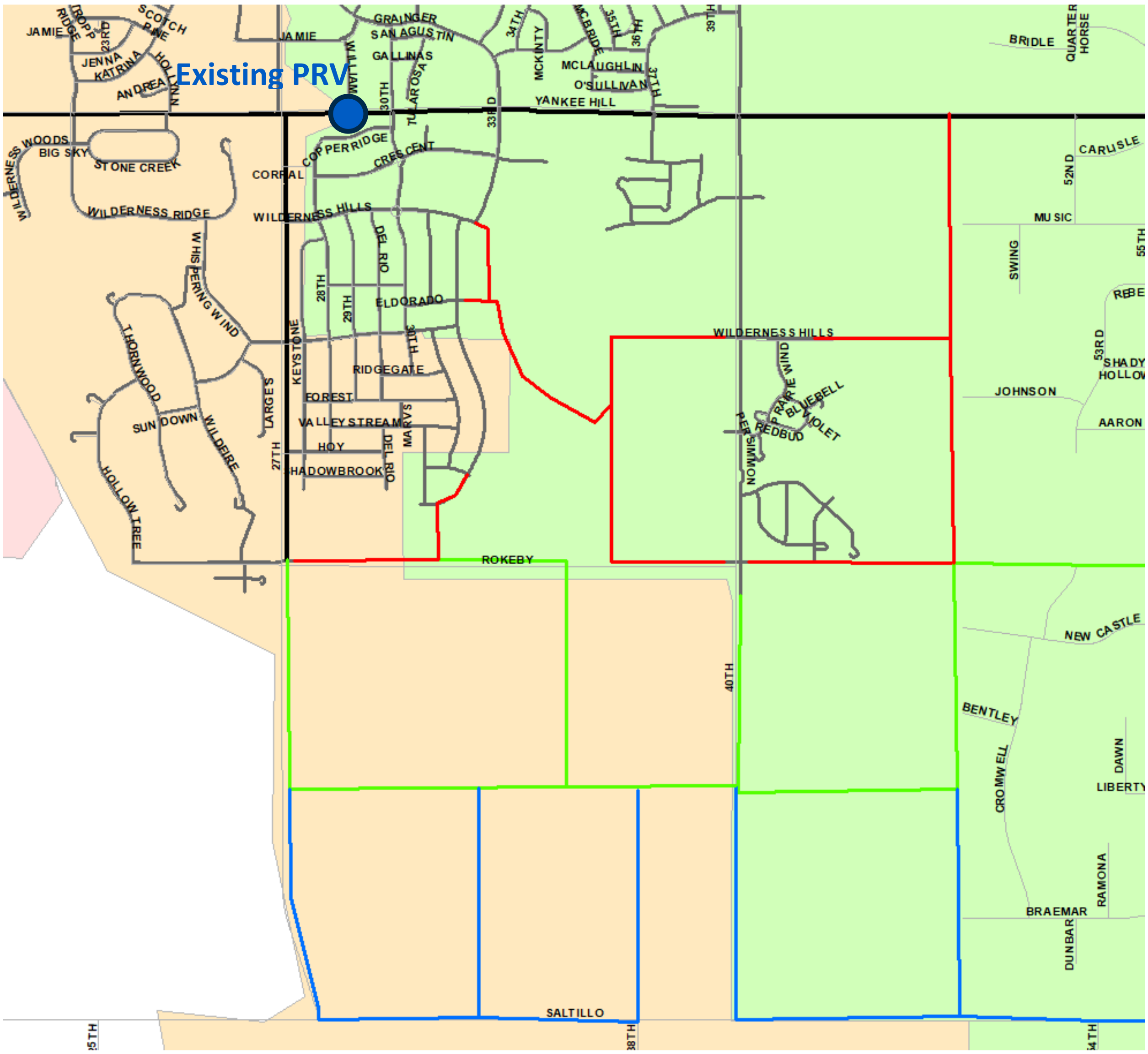
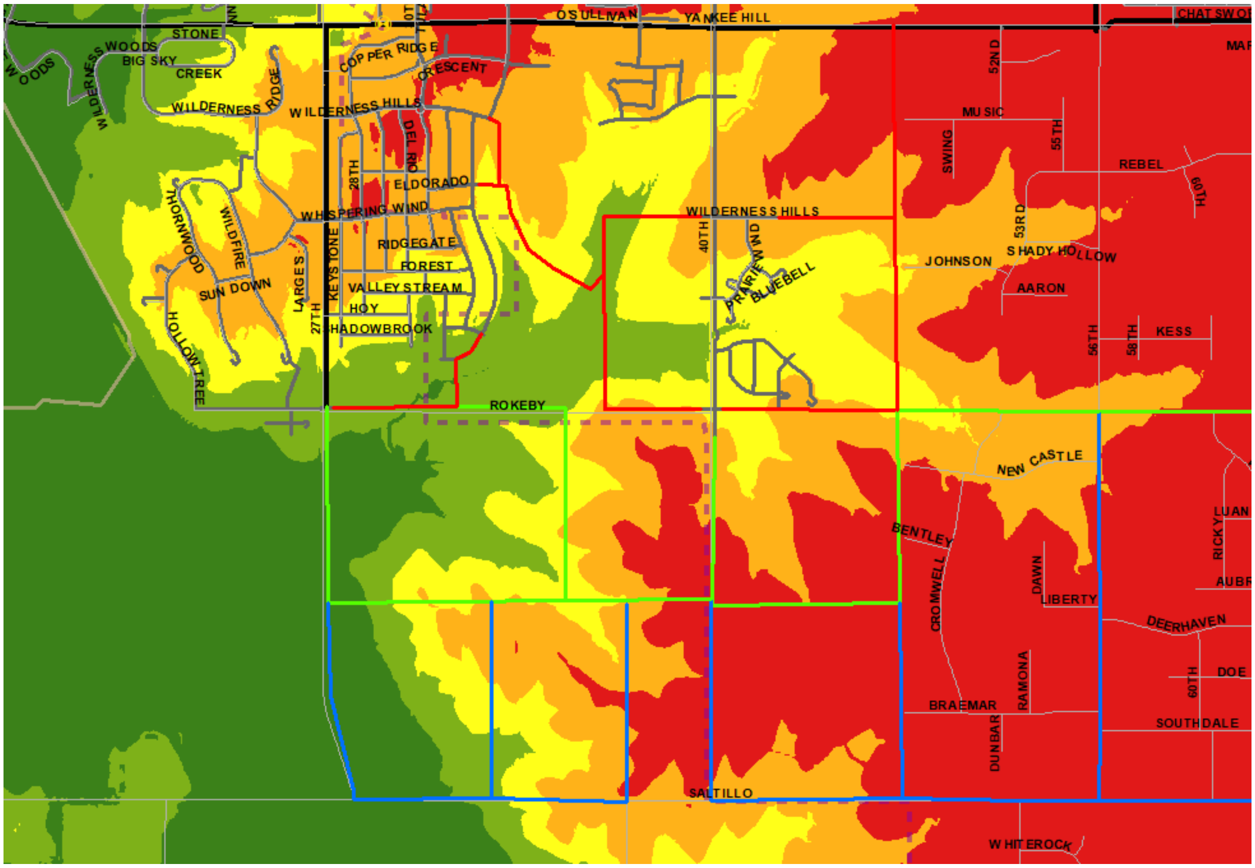


Figure 6-14 27th and Rokeby Existing and Future Pipes w/ Service Level Boundaries

During a Year 2032 maximum day condition, modeled operating hydraulic grade lines in this area in High Service Level will be between 1390 feet to 1420 feet and the operating hydraulic grade line in the Southeast Service Level will be between 1470 feet to 1490 feet. Because the average difference in the hydraulic grade line is only about 75 feet, much of these areas could be served from either service level. To identify an ideal pressure zone boundary within the area, a digital elevation model was used to show the topographic related pressure at the average range of the anticipated operating hydraulic grade line, shown in Figure 6-15.



Map Color	High Service Level		Southeast Service Level	
	Minimum Pressure, psi	Maximum Pressure, psi	Minimum Pressure, psi	Maximum Pressure, psi
(dark green)	82 or greater	95 or greater	117 or greater	126 or greater
(light green)	72	85	106	115
(yellow)	61	74	95	104
(orange)	50	63	85	93
(red)	Less than 50	Less than 63	Less than 85	Less than 93

Figure 6-15 27th and Rokeby Potential Pressures

The evaluation indicates that the only true design criteria for this area on a maximum day in Year 2032 to meet level of service goals is that any of the dark green areas must be within the High Service Level to avoid pressures greater than 120 psi. Ideally, the boundary would follow the orange areas. Another good guideline is that areas in red be within the Southeast Service Level as much as the network will allow and areas in greens should be within the High Service Level. The current network supports this but as development on the periphery occurs, the network should be reviewed to ensure that the ideal boundaries are followed as closely as possible when distribution extensions are put into service.

6.6 Year 2020 Distribution System Modeling

EPS modeling was performed for the Year 2020 design maximum day demand, with hourly peaking patterns that provide a full hourly view of system behavior, including storage draining during equalization periods and refill of system storage during off-peak periods of the day. These maximum day EPS scenarios provide more details than steady state scenarios with fewer assumptions, namely;

- Storage facilities in the same zone will show how the tanks equalize together over time.
- Tank levels for the maximum hour demands in a steady state scenario are assumed. In an EPS scenario, hourly tank levels are calculated based on the drain rates and the level at a maximum hour is a result of the scenario, rather than assumptive input.
- Pump controls do not need to be assumed at a constant rate like they do for a steady state because the ability exists within an EPS to develop controls that turn pumps off (or ramp down a speed) when tanks are at or near high alarm and turn pumps on (or increase a speed) when tanks are at or near low alarm. EPS scenarios give more control to model a system like it could be operated during a given day.

The scenarios were performed for a 48-hour period which would relate to design maximum day conditions occurring for two consecutive days. Although the two consecutive days of maximum daily demand is not a condition that the system design needs to accommodate, it does provide a look at how the system would respond to such a condition.

System controls were set based on the low and high alarms of storage facilities, with firm pumping capacity at Pumping Stations not to be exceeded (i.e. largest pump not used). The goal of the EPS modeling was to verify the desktop evaluations for storage and pumping capacities and see how the system responds to a design (extremely hot and dry year) demand condition. Results were captured for each Service Level in a visual dashboard for tank levels, pump flows, and discharge HGL and are provided at the end of this Chapter. The operation of the storage facilities (by Service Level), along with high alarms (dotted) and low alarms (dashed) are provided in Figure 6-16 through Figure 6-19. The model results support the desktop evaluation in that there is generally excess pumping capacity and storage to meet Year 2020 maximum day demands and the ability to refill storage during replenishment conditions exists. However, the rapid draft rate of Southeast and S. 56th Street during peak hourly demands that can be seen in Figure 6-17 on the left chart, shows that hydraulic restrictions do occur when pumping into the High Service Level. The addition of a pump at the Vine East Station, scheduled for Year 2020, will allow for more pumping to the Southeast Service Level from the Low Service Level which in turn will not need to be transferred through the High Service Level and the Southeast Pumping Station. This will reduce the hydraulic restrictions of having to pump a portion of the supply to the Southeast Service Level through the High Service Level. Additionally, the Adams Street Reservoir, scheduled in Year 2030, will provide equalization and emergency storage in the High Service Level.

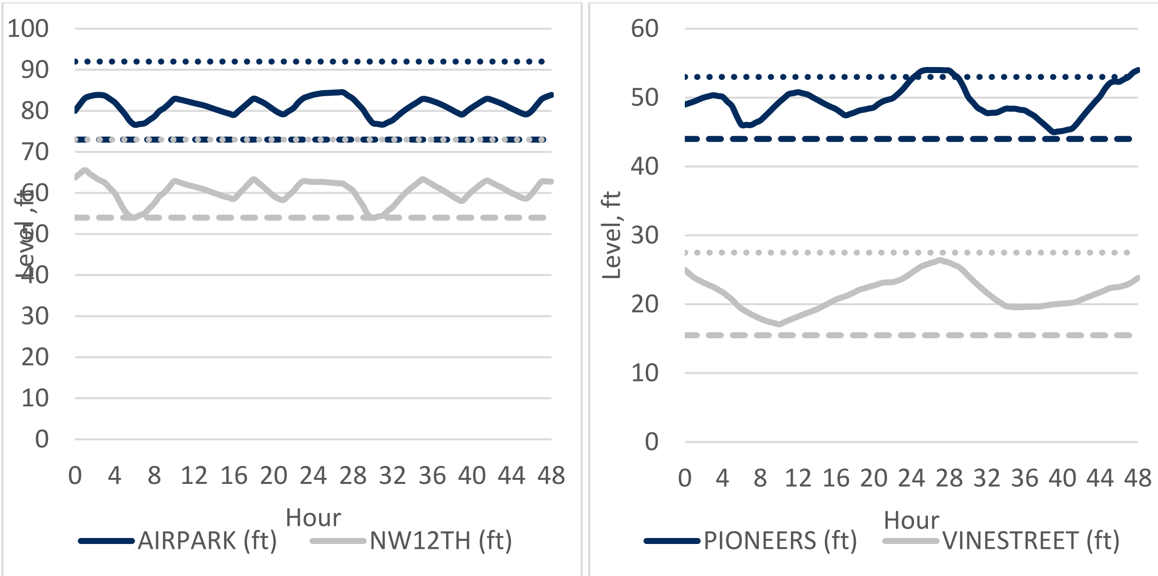


Figure 6-16 Belmont and Low Storage Levels (2020 MD EPS)

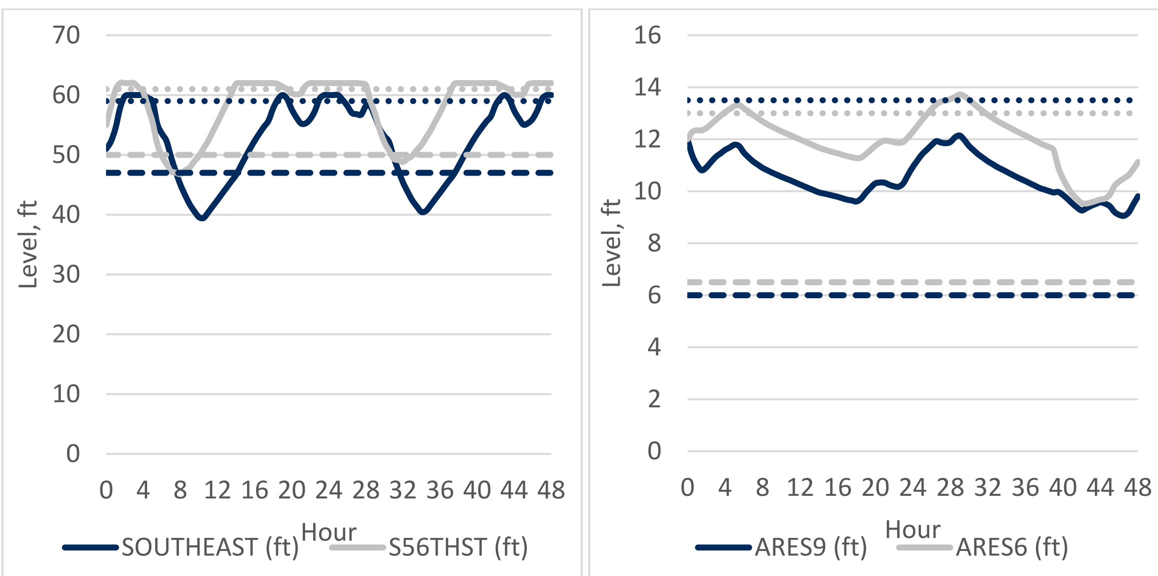


Figure 6-17 "A" Street and High Storage Levels (2020 MD EPS)

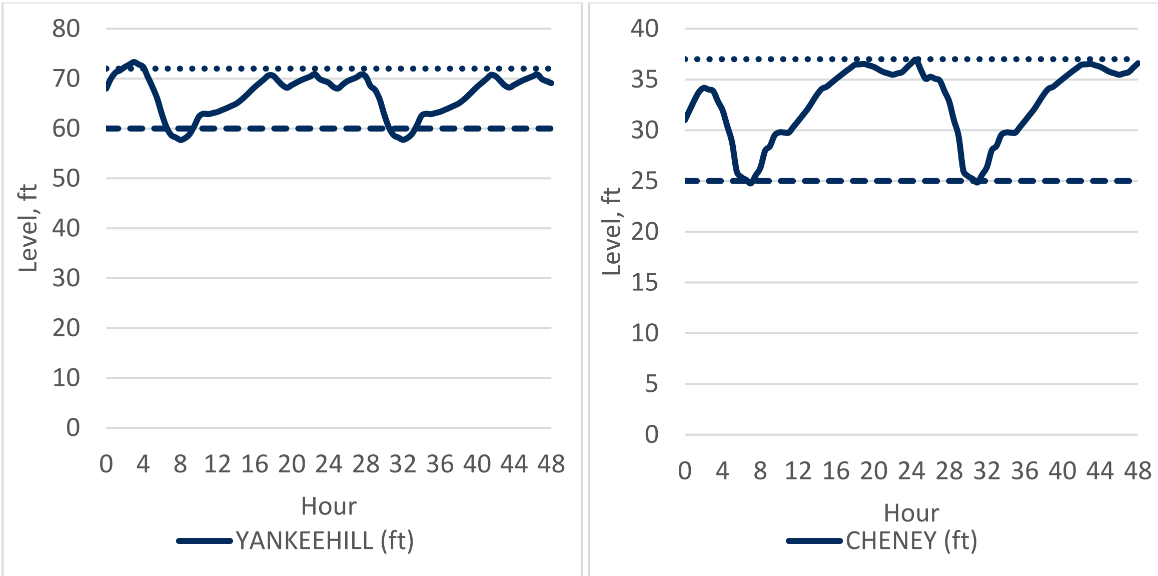


Figure 6-18 Southeast and Cheney Storage Levels (2020 MD EPS)

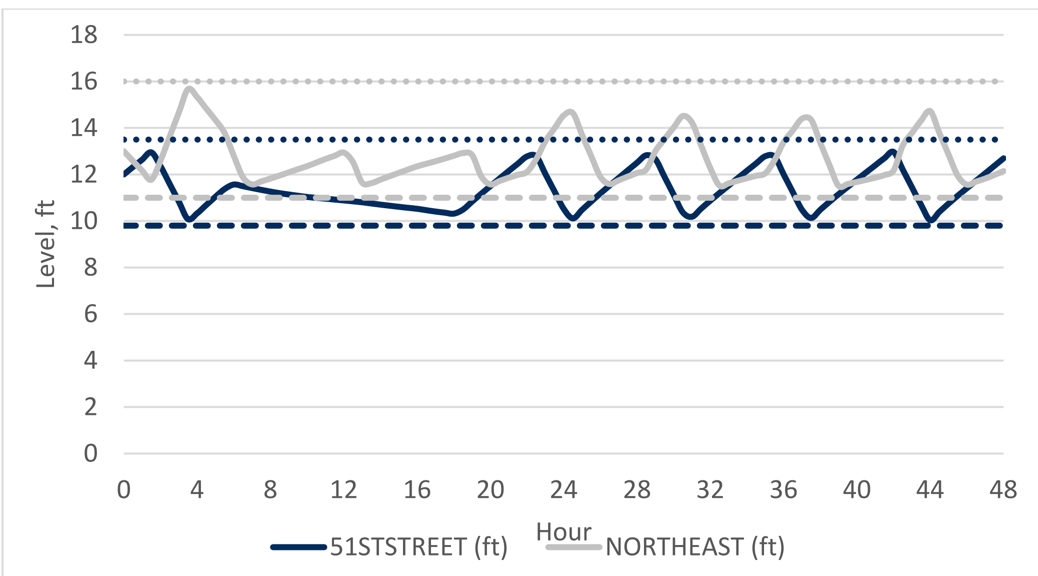


Figure 6-19 51st Street and Northeast Storage Levels (2020 MD EPS)

The average results of the Year 2020 maximum day modeling scenario showing the distribution system flow schematic and transfer through pumping stations and major transmission pipelines is provided in Figure 6-20.

An overall figure showing distribution system pressures, both minimum (left side) and maximum (right side), for the Year 2020 maximum day scenario is provided in Figure 6-21.

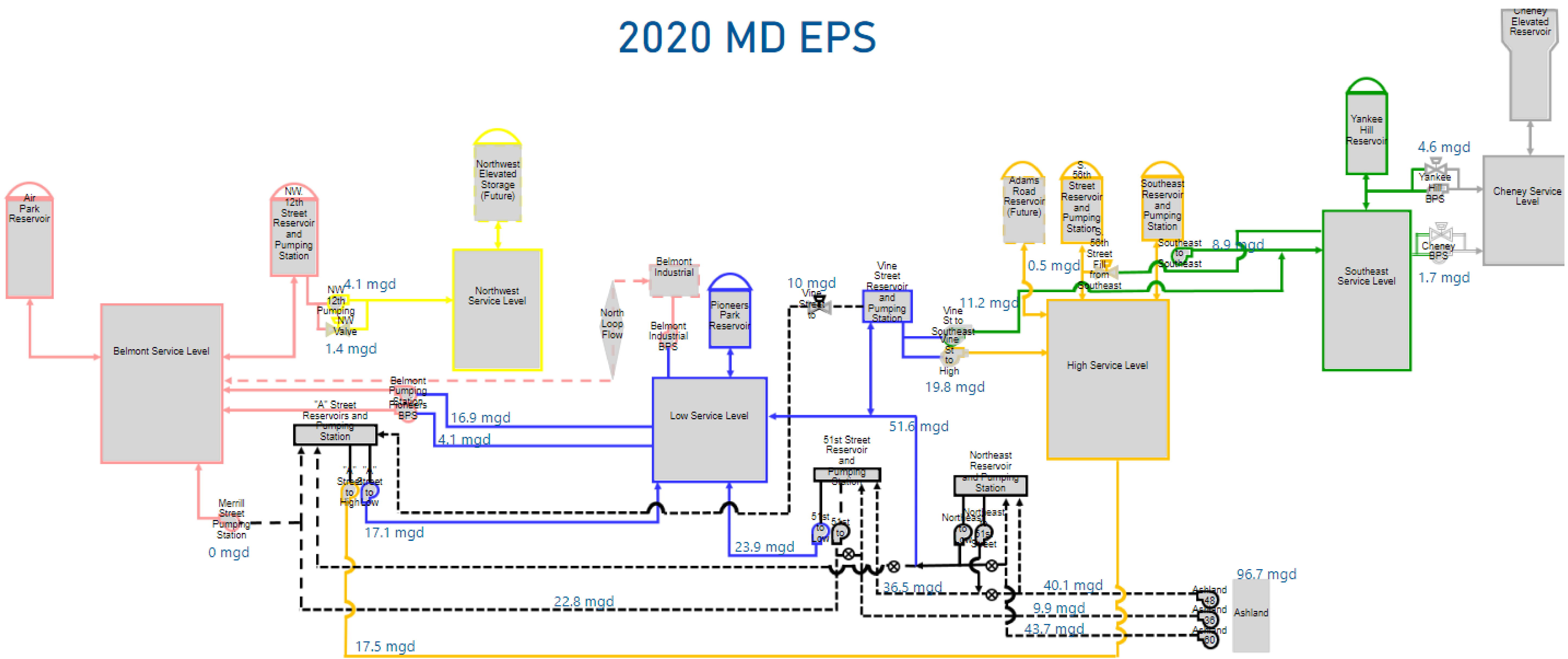


Figure 6-20 Year 2020 Maximum Day EPS Scenario Schematic

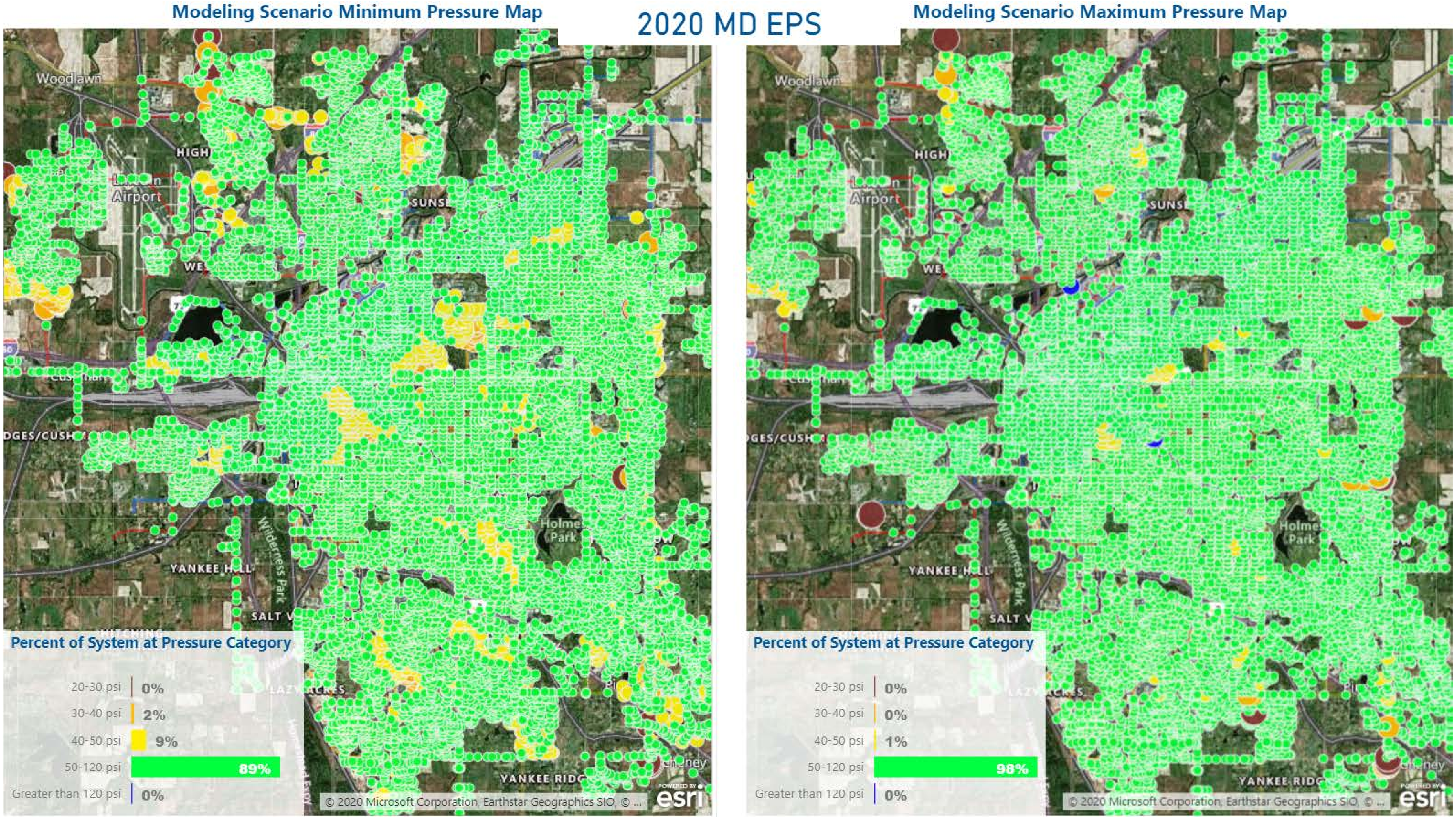


Figure 6-21 Year 2020 EPS Modeling Pressure Results

Year 2020 EPS minimum pressures, generally occurring during maximum hour, and maximum pressures, generally occurring during replenishment times, were also placed in a visual dashboard to review the results by Service Level in more detail. Figures showing these are provided at the end of the chapter. These show the minimum model pressures on the left side of the visual, with a count of how many model junctions fall within each category and the maximum model pressures on the right side of the visual, with a count of how many model junctions fall within each category. Model results only showed two areas which could see pressures greater than 120 psi but not higher than 125 psi. These are in existing areas of the system and do not present a new concern, they have likely been experienced in years past. The notable lower-pressure areas in the distribution system (not directly at facilities or along the transmission network) are listed below:

- Along the Low/Belmont Service Level boundary in the Low Service Level on high ground near North Hill and N 27th to N 31st streets.
- Along the High/Low Service Level boundary in the Low Service Level at "O" Street and 30th to 33rd Street
- Along the High/Low Service Level boundary in the Low Service Level at Washington Street and 21st to 23rd Street.
- Along the High/Low Service Level boundary in the Low Service Level at Vine Street from 42nd Street to 48th Street.
- In high ground areas within the High Service Level north of Prescott at 49th Street.
- Along the High/Southeast Service Level boundary within the High Service Level at London and Chiswick/Queens.
- Along the High/Southeast Service Level boundary within the High Service Level at Laredo Drive and S 30th Street.
- At high ground within the Cheney Service Level at Heritage Lakes and 91st Street.
- At high ground within the Belmont Service Level at NW 12th Street and Research Drive. Pressures are around 35-psi during a maximum hour.
- At high ground within the Belmont Service Level near Thatcher and NW 57th Street. There is an immediate recommended improvement to strengthen the network in the area (IM-9) and extension improvements in the 6-year CIP. AFD addition at Pioneers Pumping Station could also help to keep the area within acceptable pressures.

Pressures are only marginally low in these areas, below 35-psi but above 30 psi, and most of these occur where there is a pressure zone boundary or high ground in existing Service Levels. The areas along boundaries would be good candidates for future monitoring during design years and if it is deemed that low-pressures are resulting in customer complaints, pressure reducing valves could be added at the boundary locations.

As an example of this, a PRV was modeled at the low-pressure area at "O" Street and 33rd Street with a setting that would maintain Low Service Level pressures in this area above 35 psi at the minimum. The PRV only opened during 1 hour of the scenario and transferred approximately 1.5 mgd during that hour. This raised all the marginally low pressures in that area above 35-psi and the average flow transferred from the High Service Level to the Low Service Level over the entire 48-hour scenario was less than 0.1 mgd. These marginally low pressures only occur during the maximum hour of a design year and during a more typical year they would be above 40 psi. The downside of adding PRVs is that they will need to be exercised and maintained but would only operate during the most extreme conditions if an appropriate downstream pressure is set to avoid burning energy unnecessarily.

In summary, the results of the 2020 maximum day EPS scenario support the Vine East Pumping Station East – Pump No. 8 addition within the 6-year CIP and the addition of the Adams Road Reservoir and pipelines in the 12-year CIP. Pipeline improvements in the Belmont Service Level between "O" Street and Partridge are recommended in the 6-year CIP and will provide support to an area which could experience low pressure.

6.7 Year 2032 Distribution System Modeling

Growth from 2020 to 2032 was allocated to the model junctions based on the spatial growth in TAZ population, developed in Chapter 2. Growth was allocated as residential or non-residential to junctions within the growth areas. The 2032 EPS modeling scenario was developed using similar control-based pumping to fall within the low and high operating ranges for storage facilities while restricting pump stations to their firm capacity. Figure 6-22 through Figure 6-25 shows the modeling results of the hourly storage levels for the 2032 maximum day EPS evaluation. Results were captured for each Service Level in a visual dashboard for tank levels, pump flows, and discharge HGL and are provided at the end of this Chapter.

General observations on the ability to maintain storage within the operating ranges are provided after the figures.

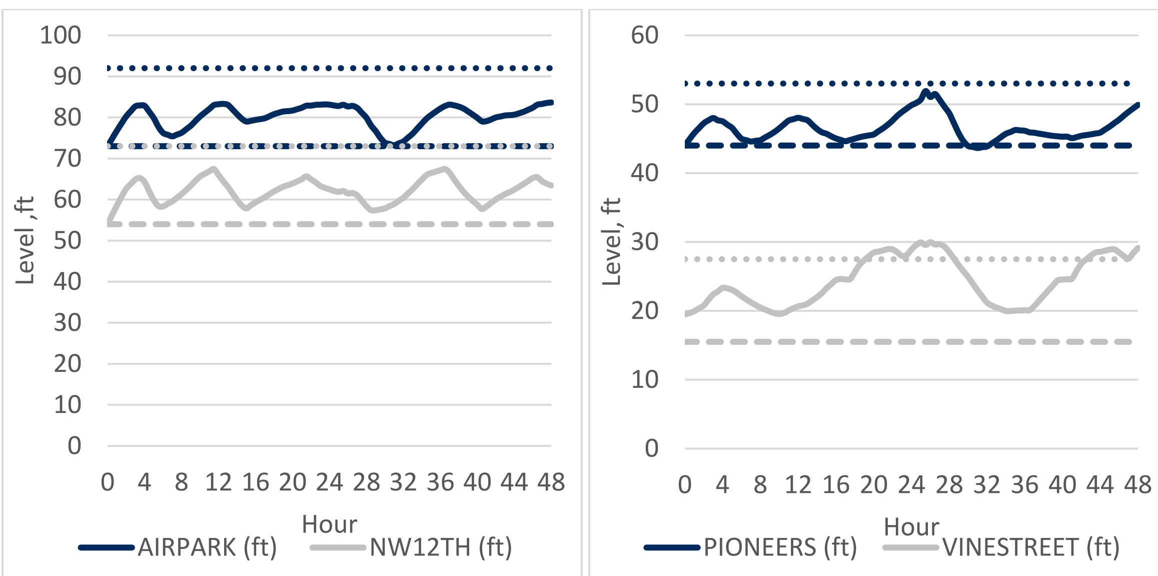


Figure 6-22 Belmont and Low Storage Levels (2032 MD EPS)

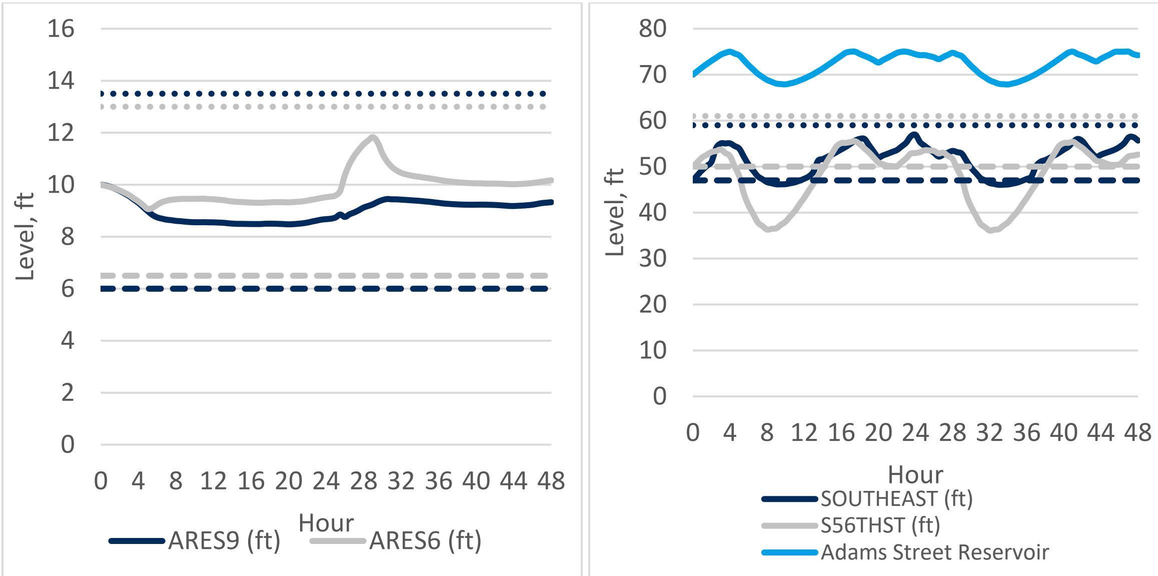


Figure 6-23 "A" Street and High Storage Levels (2032 MD EPS)

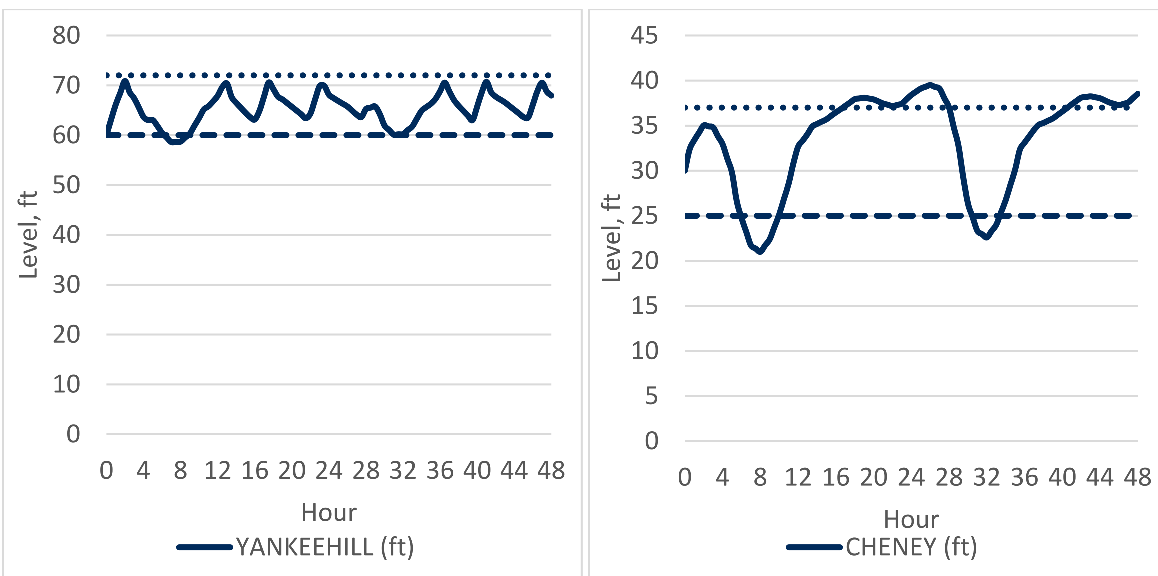


Figure 6-24 Southeast and Cheney Storage Levels (2032 MD EPS)

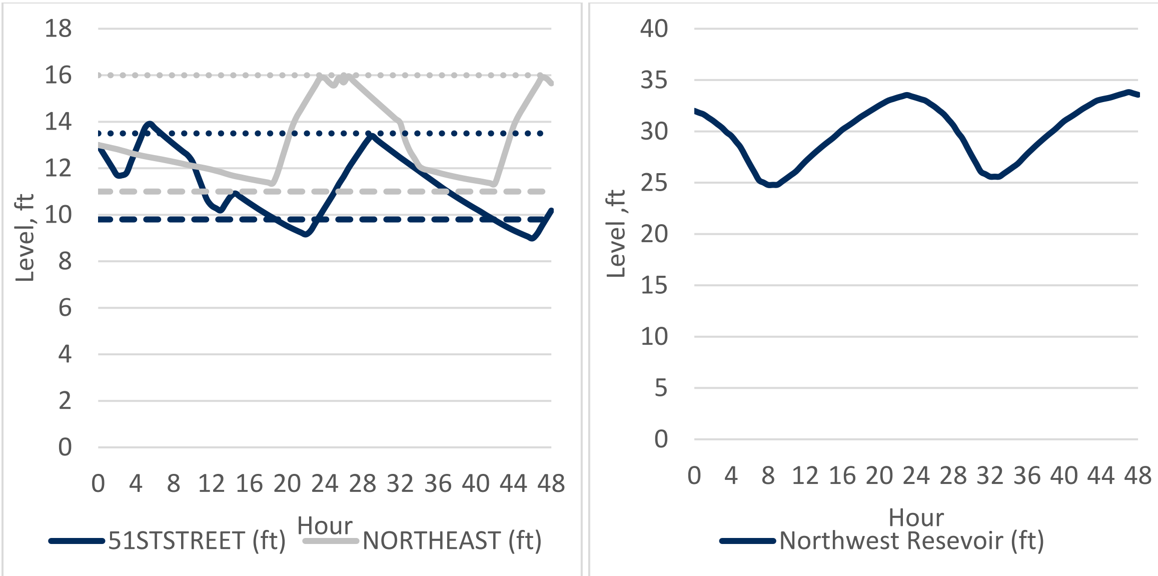


Figure 6-25 51st Street, Northeast, and the Northwest Storage Levels (2032 MD EPS)

The addition of pumping capacity at Vine Street Pumping Station East has improved the storage levels in the High Service Level as a by-product of reducing the need to pump some of the supply through the High Service Level to feed the Southeast Service Level. In the Year 2020 scenario, the S. 56th Street Reservoir generally had higher water levels than the Southeast Storage Facility. The reverse occurs in the Year 2032 evaluations, partly due to growth at the system peripheries and partly because less water is needed to be withdrawn from the High Service Level at the Southeast Pumping Station and Reservoir to supply the Southeast Service Level. In order to avoid dropping the water levels in the S. 56th Street Reservoir too low, the control valve between the Southeast Service Level and the High Service Level at the S. 56th Street Reservoir was used to supplement the tank level. The PRV at Yankee Hill and Williamson Drive could also be used in place of the S. 56th Street valve, or a combination of the two would support the pressures in southern High. This has been noted in several previous Master Plans and is not a new consideration. Using this valve may need to occur during design years when peak summer demands are experienced.

The “A” Street transfer was needed to maintain the water levels in the “A” Street Reservoirs. In this 2032 scenario, 8 mgd was transferred from Vine Street to the “A” Street Reservoirs. Capacity exists to transfer more water if necessary, up to 18 mgd, but this was not needed in the Year 2032 modeling scenario.

The Cheney Reservoir drops below the low alarm in the 2032 maximum day EPS scenario. What is interesting about the Cheney Service Level is that even though the reservoir drops lower than in the 2020 scenario, the low pressures that were experienced in 2020 modeling did not occur in 2032. The reason for this is that some of the development extensions provide more conveyance capacity within the Service Level in 2032. This highlights an important concept, which is that any low alarms that are based purely on maintaining levels to mitigate known concerns of low pressures, could be revisited once development extensions are added. This may have an impact in future winter operations by allowing storage to be maintained even lower, thus further reducing water age.

The average results of the Year 2032 maximum day modeling scenario showing the distribution system flow schematic and transfer through pumping stations and major transmission pipelines is provided in Figure 6-26.

An overall figure showing distribution system pressures, both minimum (left side) and maximum (right side), for the Year 2032 maximum day scenario is provided in Figure 6-27.

The same notable lower-pressure areas in the distribution system also occurred in the 2032 EPS scenario with the exception of the high ground area in the Cheney Service Level which has improved to above 40-psi. The pressures for the 2032 modeling evaluations by service level are provided at the end of this chapter.

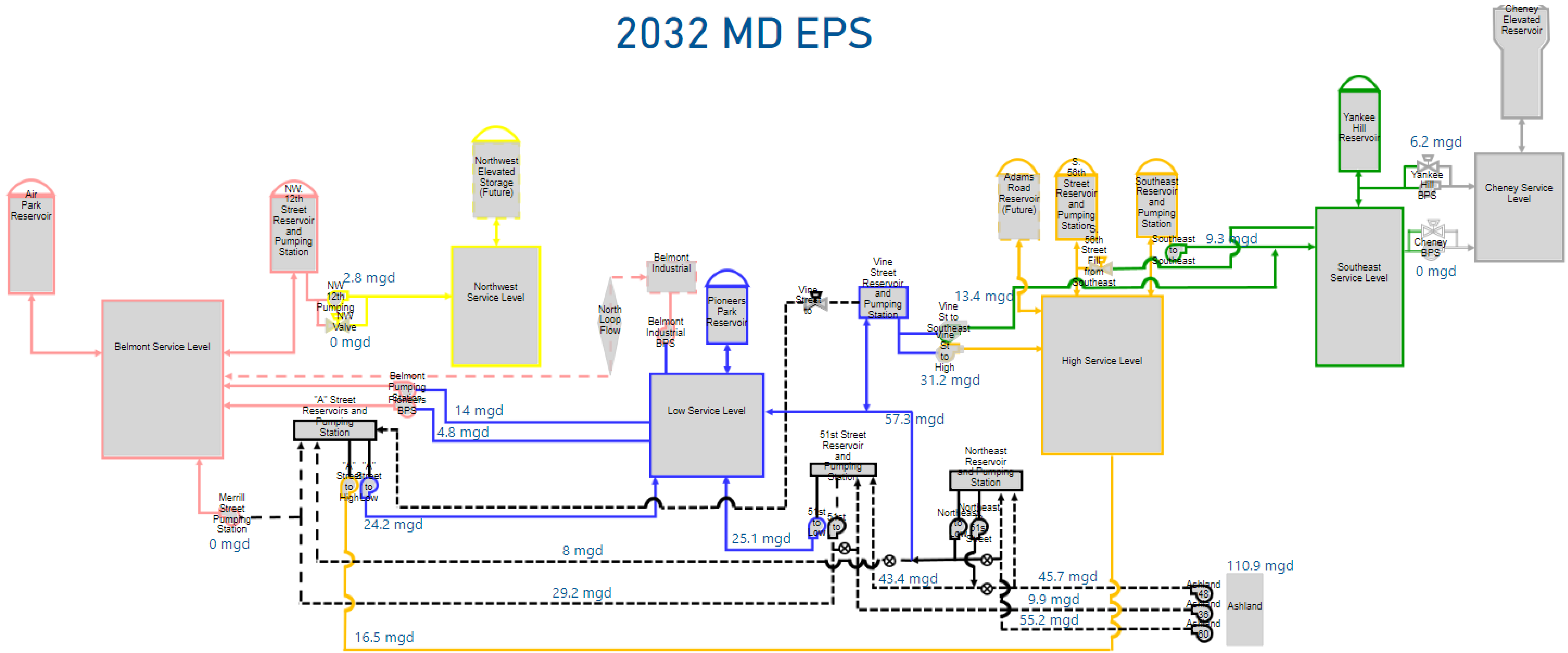


Figure 6-26 **Year 2032 Maximum Day EPS Scenario Schematic**

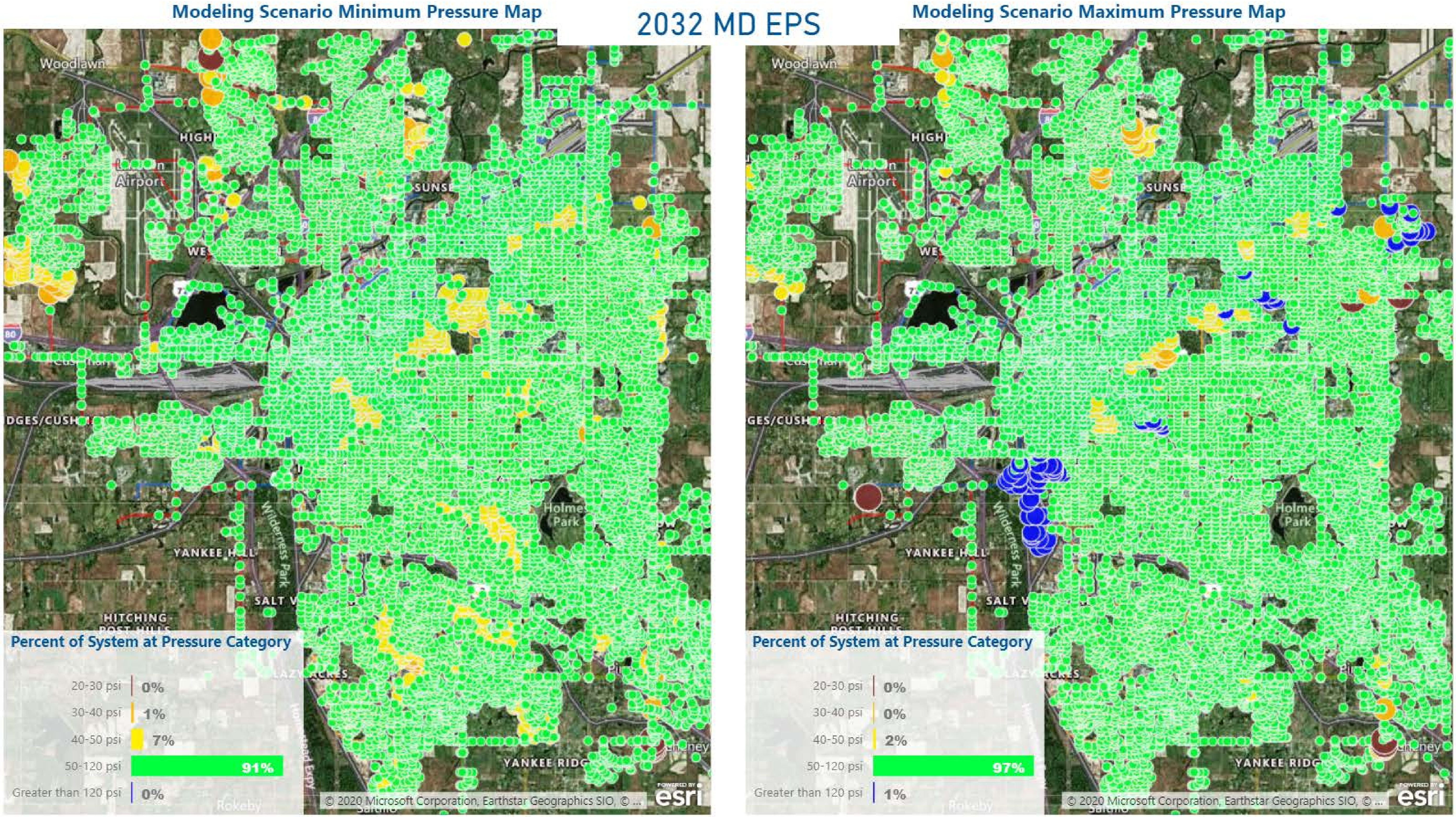


Figure 6-27 Year 2032 EPS Modeling Pressure Results

6.8 Other Modeling and Desktop Evaluations FOR THE 12-Year CIP

Several of the items in the CIP were answered through the 2020 EPS and 2032 EPS base modeling scenarios. Others were individually evaluated to determine their need and usefulness. Several additional scenarios were performed, unique to the improvement being evaluated. This section will discuss each project and any additional evaluations, whether desktop or through modeling, and reference supporting discussion related to each improvement if it has been provided in a previous section.

6.8.1 Valve Replacement and Automation at 51st Street PS

At the 51st Street Pumping Station and Reservoirs, there are some valves which LWS has identified as candidates for replacement. The current valves are manually operated and are at or near the end of their service life. LWS would like to automate the valves at this location to allow for remote operation and the potential bypassing of the 51st Street Pumping Station and Reservoirs.

6.8.2 NW 12th Street Pumping Station

The Northwest 12th Street Pumping Station has adequate capacity to provide the Northwest Service Level through 2032. However, it is noted in the *2014 Master Plan* that this is nearing the end of its useful life as it was intended as a temporary pumping station. A new Pumping Station should be constructed with an existing 5 mgd firm capacity, 8 mgd total. The ultimate capacity should be 8 mgd firm and 12 mgd total, but should be revisited with each Master Plan as growth occurs in the Northwest Service Level.

6.8.3 Vine Street Pumping Station East - Add Pump No. 8 w/ AFD

The addition of this pump was recognized and shown in the previous sections. This pump will increase the firm pumping capacity at Vine Street Pumping Station East to the Southeast Service Level and provide flexibility in operations. With the AFD, flow can be modulated into the Southeast Service Level which can have significant benefits during periods of lower demands in terms of energy and water age. Because there is an empty pump bay in this pumping station, rather than replacing the existing Pump No. 6, the first phase should be to install a new pump with a similar capacity as Pump No. 7.

6.8.4 Innovation Campus - Phase 1 - 16-inch Main

This improvement provides reliability and redundancy to the Innovation Campus once the Merrill Street Pumping Station is decommissioned.

6.8.5 I-80 & 56th Street Pumping Station - Supply Main and PS and Belmont Loop

This improvement has been evaluated and discussed in the focus area section for the North 56th Street and I-80. Much of the supply main has already been constructed up to the I-80 intersection along 56th Street. The Belmont Loop, connecting the area north of I-80 at 56th Street, will connect west then south to the existing area within Belmont at N. 14th Street and Alvo Road. This loop provides reliability and redundancy in case of an outage of the I-80 and N. 56th Street Booster Pumping Station.

6.8.6 16-inch Main on NW 56th Street, "O" St. to Partridge Lane

The need for this improvement and its benefits were discussed in the previous modeling sections.

6.8.7 Decommission Merrill Street Pumping Station

Due to its condition and lack of use, the Merrrill Street Pumping Station is recommended for decommissioning by 2022.

6.8.8 Rehabilitate Eddy Current Drive - Northeast #6

Pump No. 6 at the Northeast Pumping Station has been unusable for almost 20-years due to a faulty eddy current drive. A recent inspection was performed by the manufacturer which determined the drive is still viable but needs control components upgraded. The recommended plan for repair includes installation of a new EC-2000 controller along with a factory rehab and service of the drive and the motor since they have been sitting idle for a significant period of time.

6.8.9 31st and Randolph Valve Vault Relocation to "A" street

There is a 24-inch butterfly valve (No. 797 on the Foreman's Map, Sheet C-4W) located in a vault in the street at the intersection of 31st Street and Randolph Street used to transfer water from Vine Street to "A" Street. This valve is used to throttle gravity flows to "A" Street, which has caused the seat to wear so the valve will not close tight anymore. In addition, the working conditions in the vault are less than desirable with no head room to work. LWS would like to replace this valve with a buried butterfly valve strictly for shut-off purposes and a ball valve and electromagnetic meter installed near "A" Street Reservoirs Nos. 8 and 9 (30th Street and Capital Parkway) for throttling purposes. The vault should be removed from the street.

6.8.10 Add 20.9 mgd WTP South Pumping Station Pump No. 13

This pump was not shown to be needed for maximum day demands by Year 2032. However, it does provide additionally flexibility in operations of the WTP supply into the distribution system.

6.8.11 Add AFDs at Pioneers Pumping Station

The addition of AFDs at the Pioneers Pumping Station was a recommendation in the *2014 Master Plan* but was not evaluated under this master plan update. Prior to implementation of this improvement, we recommend further study and refinement of the concept.

Historically, in the Belmont and Southeast Service Levels, pressure variations are significant when pumps start up without AFD's. Some local industries have reported issues with their fire protection systems due to these pressure variations as pumps turn on and off. Additionally, Belmont and Southeast Pumping Stations discharge into large transmission mains, a 30-inch main in North 14th Street from the Belmont Pump Station and a 48-inch main in South 84th Street from the Southeast Pump Station, and there are cavitation issues. The pumps in these two stations are operating off their pump curves because of the reduced downstream head conditions. Therefore, operations at these two stations are limited to use of only the large pumps to control cavitation. The current operating procedures work around the cavitation issues but do not provide a long-term solution to be able to run the smaller pumps in the stations.

To start, the Pioneers Pumping Station is recommended for addition of AFD's. Although more expensive initially, AFDs are recommended instead of eddy current drives or discharge control valves due to their comparative inefficiencies. The AFDs would match pump curves to the existing and future system head curves. AFDs should be installed on all of the pumps in the pumping stations to maximum flexibility of operations and enable the smaller pumps to be used during lower flow conditions. At a minimum, AFDs should be added to Pump Nos. 1 and 2 at Pioneers Pumping Station as those are the only ones used at this time.

If the VSD installation is successful at Pioneers Pumping Station, VSD addition to Belmont and Southeast Pumping Stations should be evaluated and installed on the smaller pumps, if deemed cost- effective, so that they can be used again during lower flow conditions without cavitation.

6.8.12 Pressure Monitoring Stations

Four additional pressure monitoring stations are recommended within the 12-year CIP. Three of the locations identified in the *2014 Master Plan* as 2025 improvements are still ideal locations for additional pressure monitoring:

- Near Bridle Lane and S 58th Street in the Southeast Service Level where marginally low pressures occur
- Near Holdrege Street and N 57th Street along the Low/High Service Level boundary, in the High Service Level. Marginally high pressures occur at this location
- At the Low/High Service Level boundary in the Low Service Level near "O" Street and 33rd Street where marginally low pressures occur. This area was detailed in the 2020 modeling evaluations where a new PRV was tested.

The fourth additional pressure monitoring station recommended in the *2014 Master Plan* was at the high ground along Arbor Road. With the detailed evaluation of the I-80 and N 56th Street Pumping Station, it was recommended to locate the pumping station south of Arbor Road and convert this area to Belmont. If this improvement concept is followed, there will be no need for pressure monitoring at this location. An alternate location for this station would be at the high ground area near Laredo Drive and S 30th Street near the High/Southwest Service Level boundary.

6.8.13 Decommission South 56th Street PS

The South 56th Street Pumping Station is currently not operated and is impractical to operate as originally designed and built. Therefore, this pumping station is not used but is designed to boost pressures temporarily to the High Service Level from the South 56th Reservoir. When pumps are operated to utilize more of the reservoir volume, it has proven difficult to refill the tank and results in on-going low-pressure areas in the High Service Level. The Year 2032 maximum day EPS evaluations confirmed that rather than pump out of the S. 56th Street Reservoir during peak demand, it is necessary to transfer some supply from the Southeast Service Level and the Pumping Station is not expected to be run in the future. A capital improvement project has been included in the immediate improvements phase to remove the pumps and VSDs from the pumping station and to salvage them somewhere else in the system, if possible.

6.8.14 Northwest Reservoir (2 MG) and Pipeline

The need for storage within the Northwest Service Level for equalization was supported and discussed in the storage evaluation and the Year 2032 modeling evaluations. The previous recommended location of the new Northwest Reservoir was ¾ of a mile north of the existing NW 12th Street Reservoir because it is at high ground. However, putting a new storage facility this far away from the usage locations in the system and constructing almost a mile of 24-inch main would significantly increase water age and have detrimental impact in an area with existing high-water age. The additional cost of constructing the storage nearer to the existing NW 12th Street is likely a balanced alternative for the potential water quality impact that placing it much further away would create. Higher costs of constructing the storage facility at lower ground is also offset by the reduced pipeline costs with a much shorter distance needed. This facility should be as near to the usage customers within the Northwest Service Level as feasible, to mitigate excessive and unnecessary aging of water as it travels to and from the storage facility.

6.8.15 Belmont to Low PRV Station ("O" Street and NW 25th Street)

This improvement was recommended for fire flow considerations in the *2014 Master Plan*. The location of the valve (noted at "O" street and NW 12th Street) should be at the Belmont/Low Service Level boundary which is at "O" Street and about NW 25th Street. This may have just been a typo in the *2014 Master Plan* as it was previously modeled at the proper location. Fire flow evaluations were not performed in this update, but this area does occur at the periphery of the Low Service Level in an area where redundant flow paths are few. Though fire flow was not modeled in this update, from a visual review of the system this improvement for fire flow capacity is reasonable.

6.8.16 Decommission NW 12th Street Pumping Station

Decommissioning of the NW 12th Street Pumping Station, discussed in a previous section, should occur after the new Pumping Station is constructed.

6.8.17 Decommission Cheney Pumping Station

Decommissioning of the Cheney Pumping Station, currently in the 12-year CIP in Year 2027, can occur anytime subsequent to the addition of a pump at the Yankee Hill Pumping Station. If condition allows, this pumping station can continue to be used until the end of its useful life so a Year 2027 date could be deferred if efficient operations of the Station are still being recognized at that time.

6.8.18 Yankee Hill Pumping Station - Add 6 mgd Pump

Discussion of the addition of a 6 mgd pump at the Yankee Hill Pumping Station was provided in the pumping capacity desktop evaluations.

6.8.19 PRV Southeast SL to High SL - Vault near Southeast PS

This PRV station, discussed in the desktop storage section, will allow the transfer of water from the Southeast Service Level directly into the Southeast Storage Reservoir. This allows for the direct transfer of water from Vine Street Pumping Station East into the High Service Level at the Southeast Reservoir.

6.8.20 Innovation Campus - Phase 2 - 12-inch Main

This Phase 2 main is a second reliable feed to the Innovation Campus and will provide redundant fire protection as well as reliability in every day operations to supply the Innovation Campus.

6.8.21 Adams Street Reservoir and Pipelines for HSL (5 MG)

The Adams Street Reservoir and pipelines were discussed in the desktop storage evaluations and confirmed through the Year 2032 EPS modeling.

6.8.22 54-inch Main from Northeast PS to 88th and Holdrege

The existing transmission system has sufficient capacity to meet maximum day Year 2032 demands. However, the completion of this main will provide additional flexibility during all demand conditions, but especially during the bypass of Northeast for Winter Operations. To quantify the benefit that this main will have during maximum day conditions, the same control set was modeled for scenarios both with and without this improvement to make an apples-to-apples comparison of the benefit. Figure 6-28 provides this comparison. The difference between the operating water levels in the two scenarios shows a daily difference of about 8 feet in the levels of Vine Street. This roughly relates to a volume of 5 MG over the course of a day, or 5 mgd as a rate. This essentially means that for the same energy cost for the Northeast Pumping Station, with the 54-main completed, LWS can transfer an additional 5 mgd. During an average day or Winter Operations when Northeast Reservoir is being bypassed, the energy cost savings could be even greater. This improvement should be constructed towards the end of the 12-year CIP to provide operational flexibility and energy management benefits.

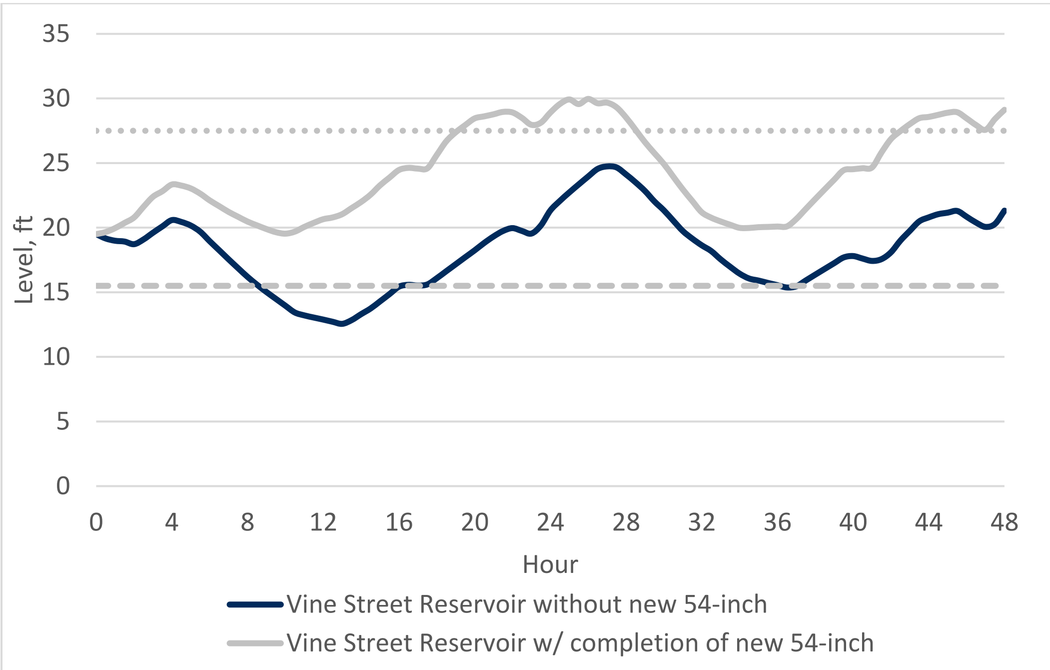


Figure 6-28 54-inch Main from Northeast PS to 88th and Holdrege Modeling Evaluation (Control Set Held Constant)

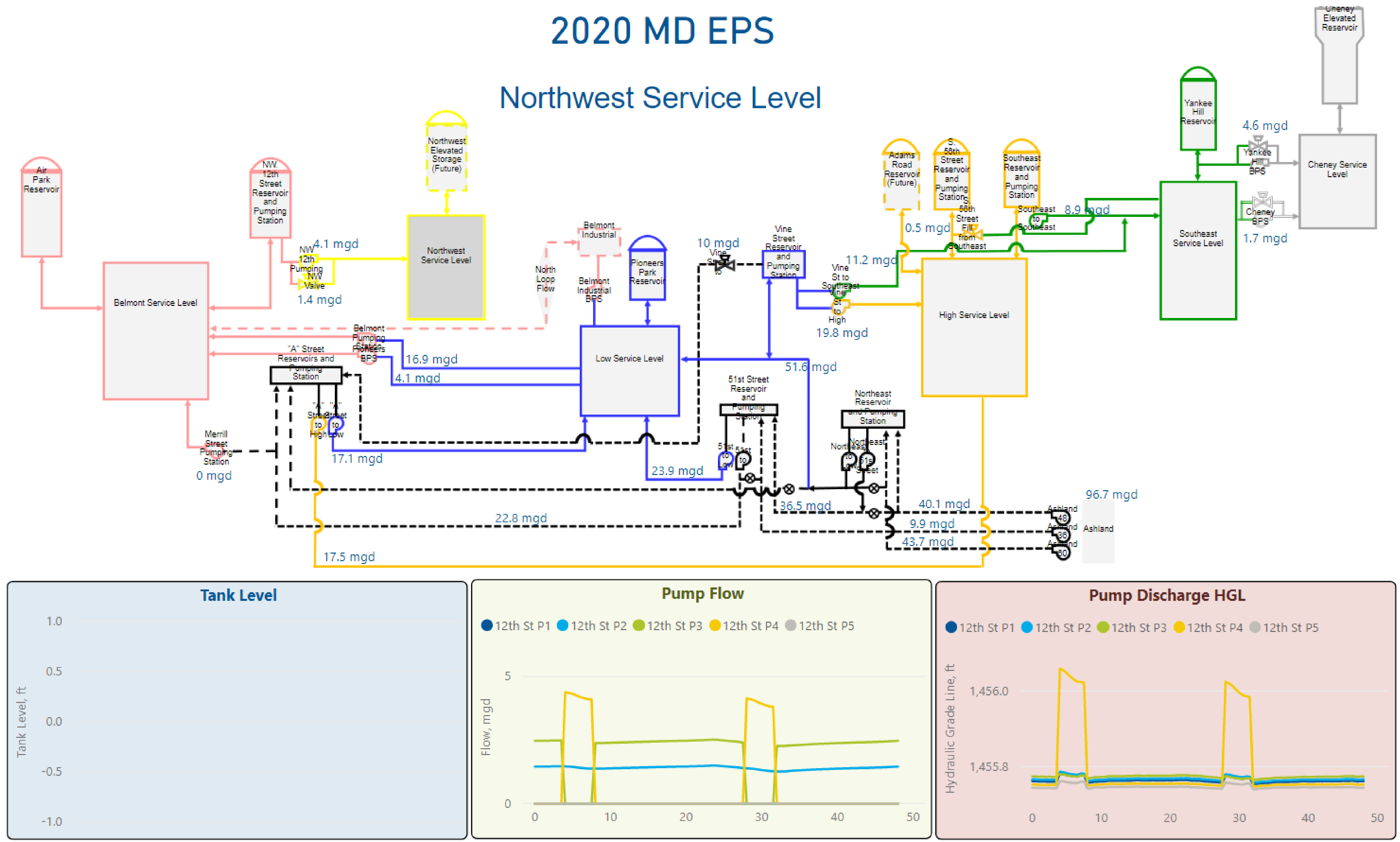


Figure 6-29 **2020 MD EPS Model Results – Northwest Service Level**

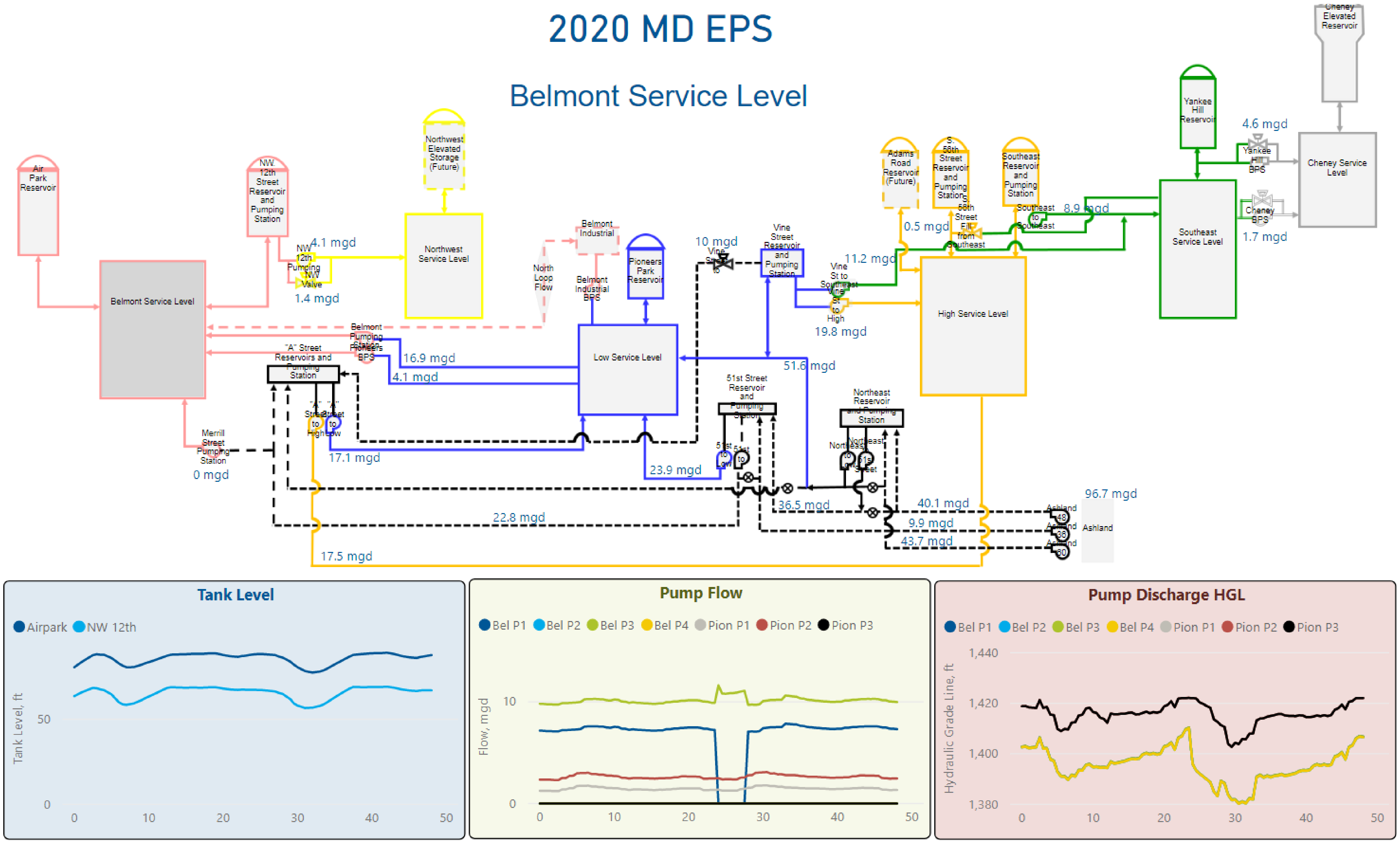


Figure 6-30 2020 MD EPS Model Results – Belmont Service Level

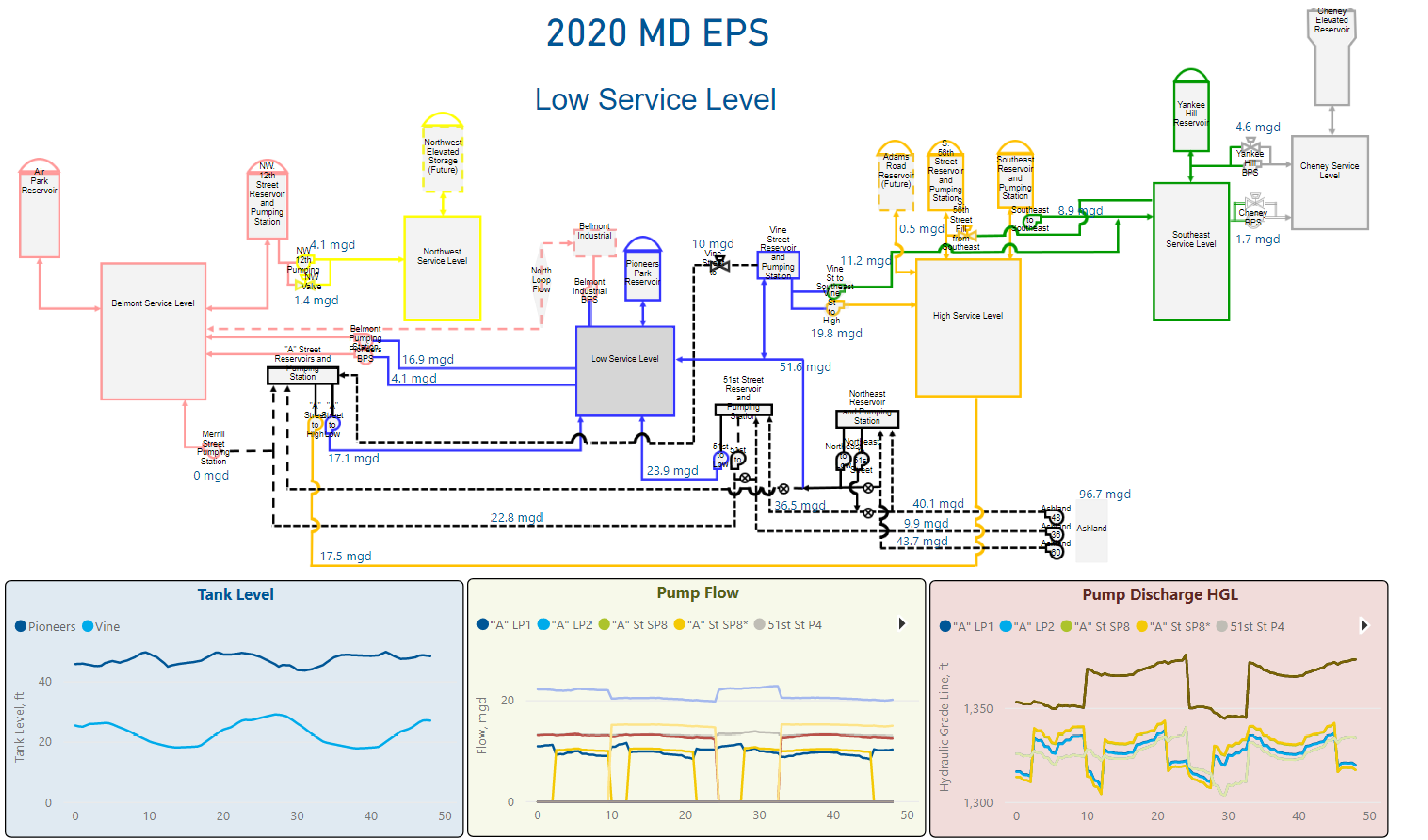


Figure 6-31 2020 MD EPS Model Results – Low Service Level

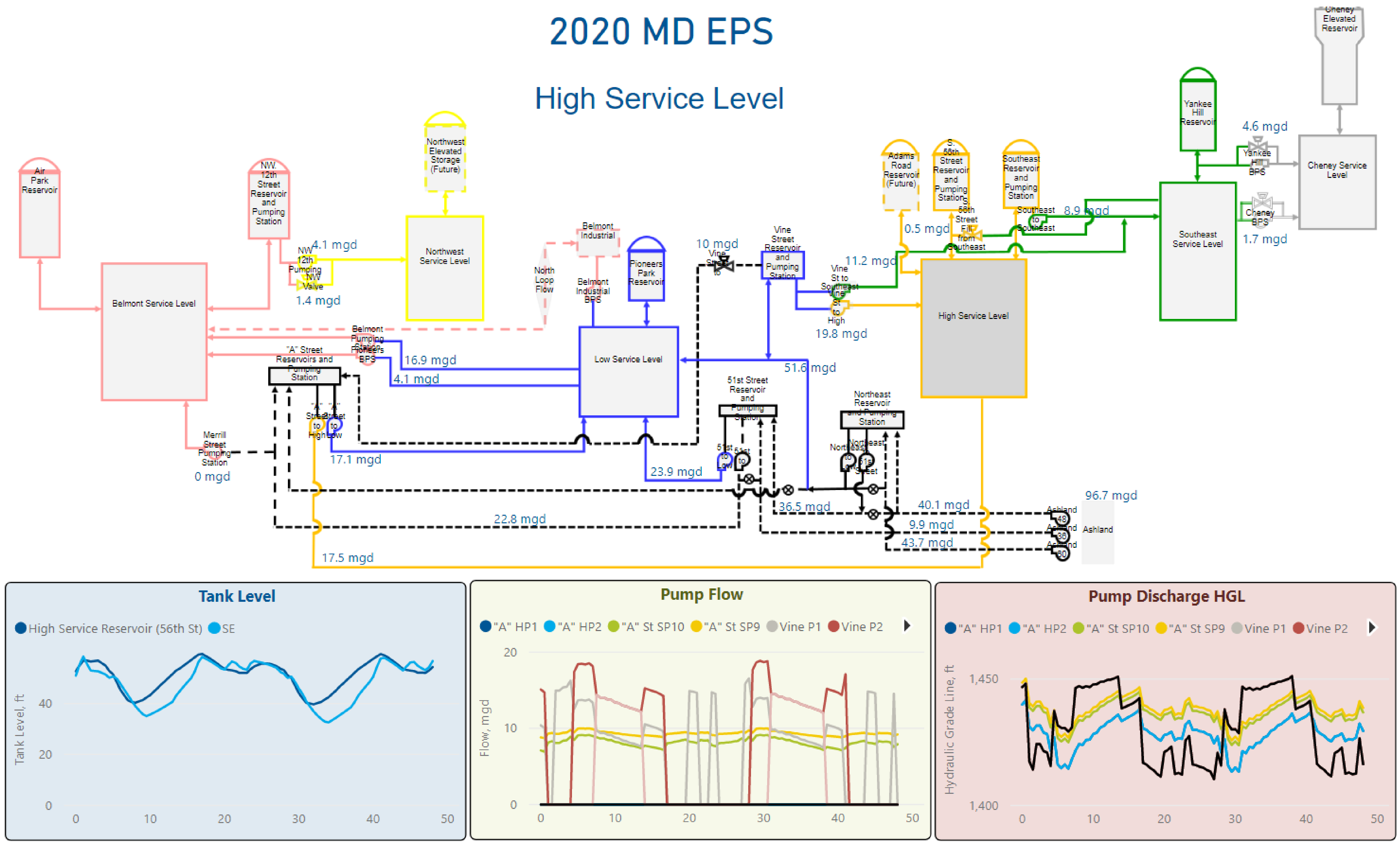


Figure 6-32 2020 MD EPS Model Results – High Service Level

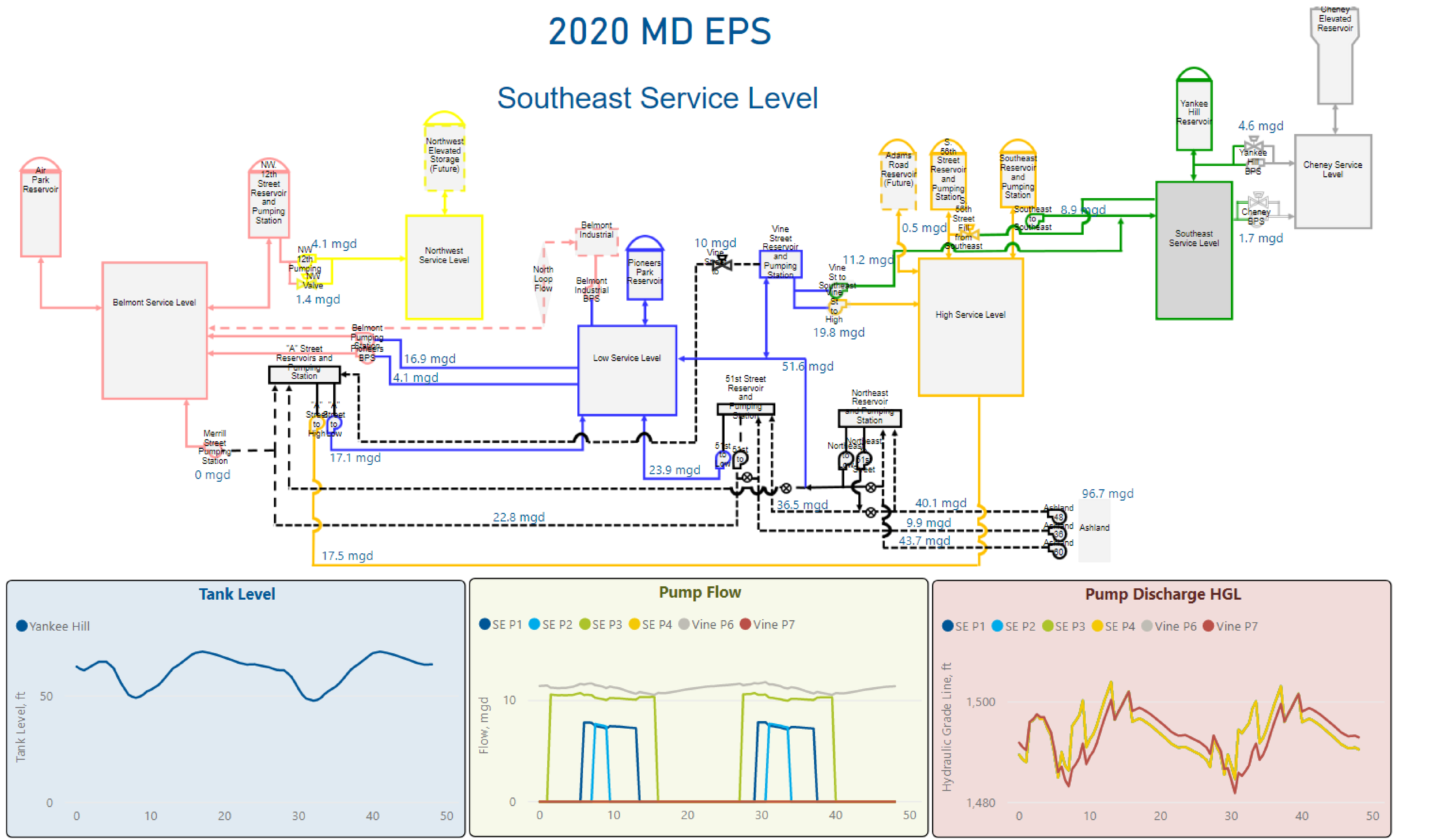


Figure 6-33 2020 MD EPS Model Results – Southeast Service Level

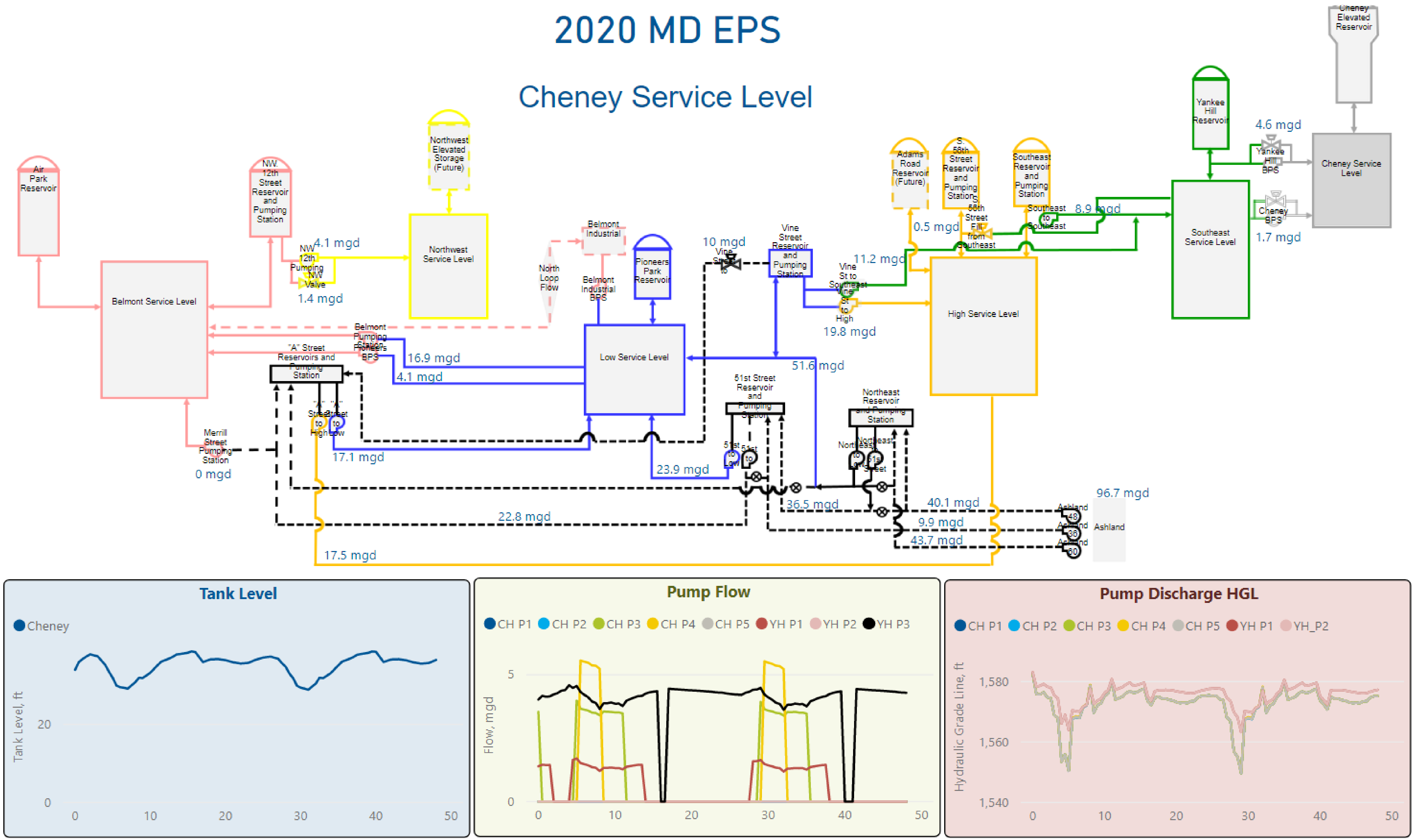
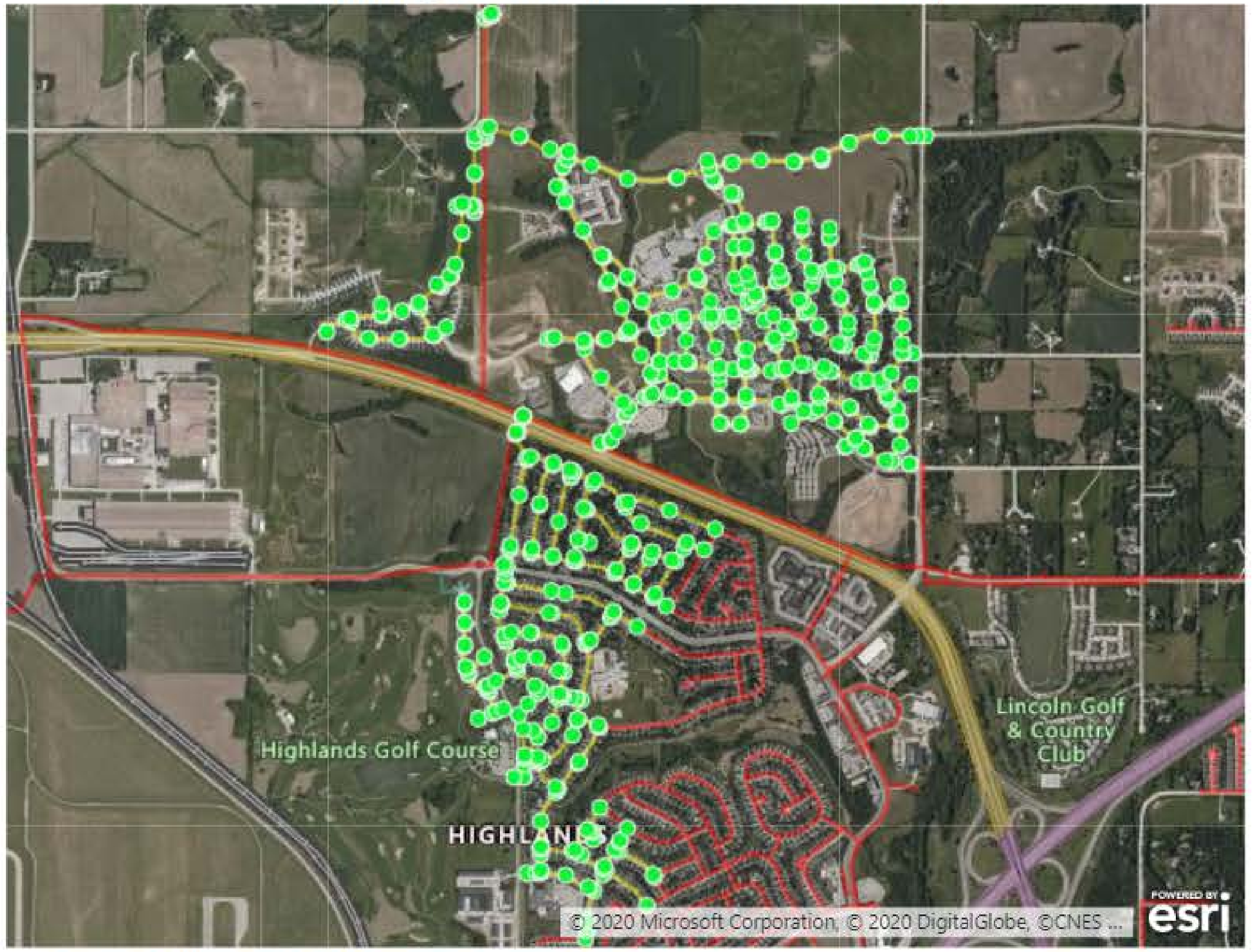
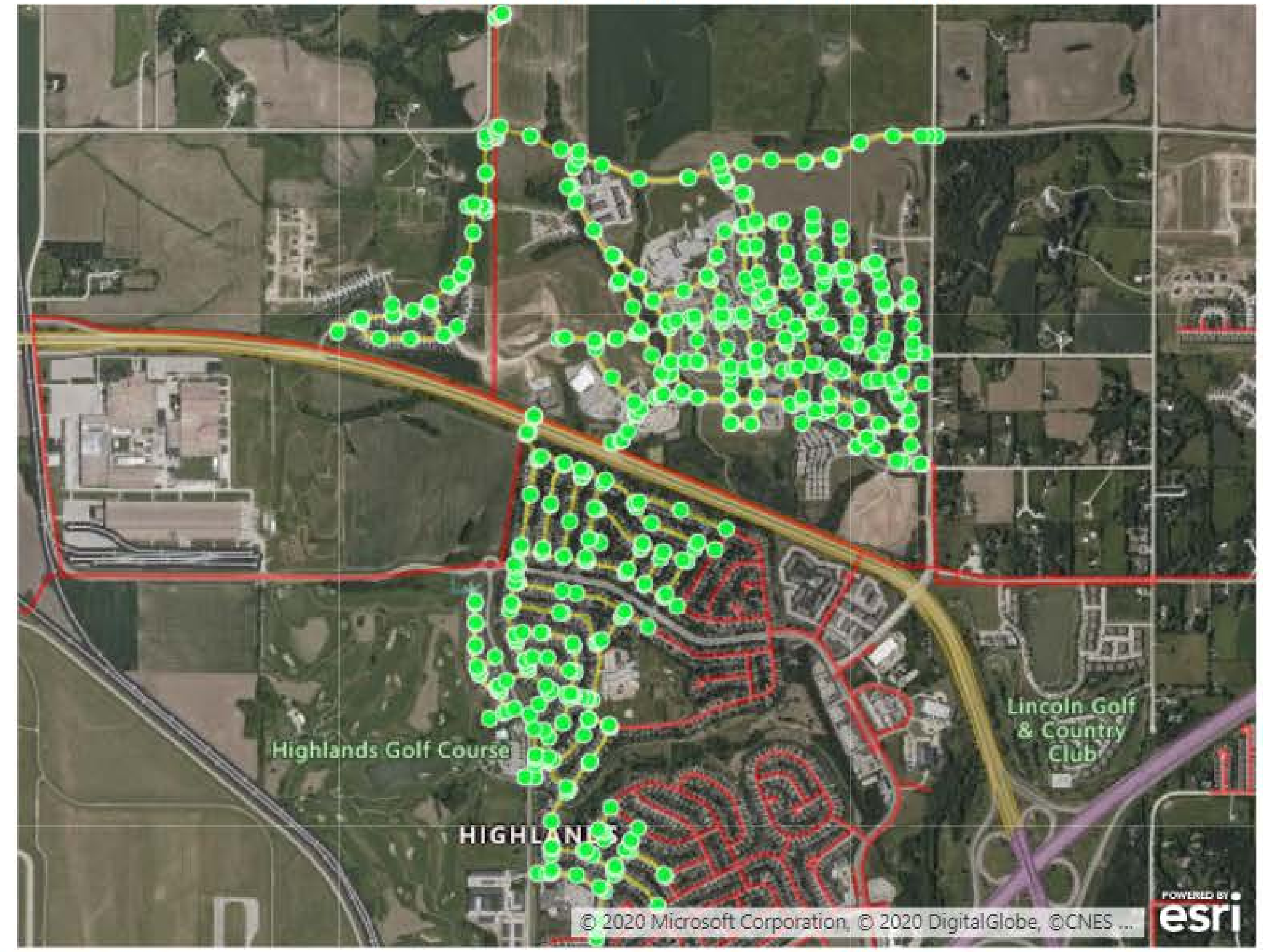


Figure 6-34 **2020 MD EPS Model Results - Cheney Service Level**

Modeling Scenario Minimum Pressure Map



Modeling Scenario Maximum Pressure Map



Count of Junctions by Minimum Pressure Cateogry

Category	Count
50-120 psi	688

Service Level Filter

- ☐ Belmont
- ☐ Cheney
- ☐ High
- ☐ Low
- ■ Northwest
- ☐ Southeast

Scenario Filter

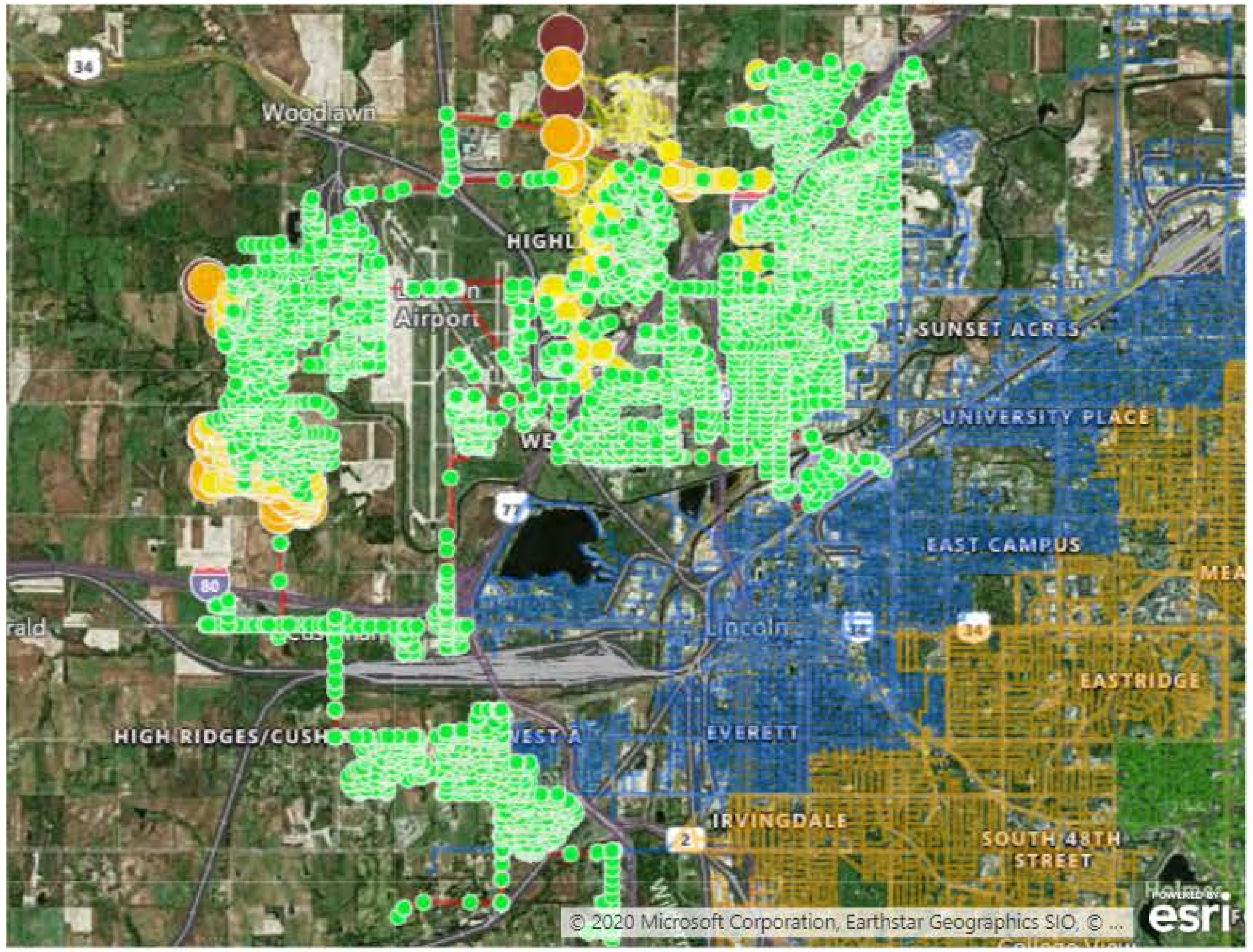
- ◉ 2020 MD EPS
- ○ 2032 MD EPS

Count of Junctions by Maximum Pressure Category

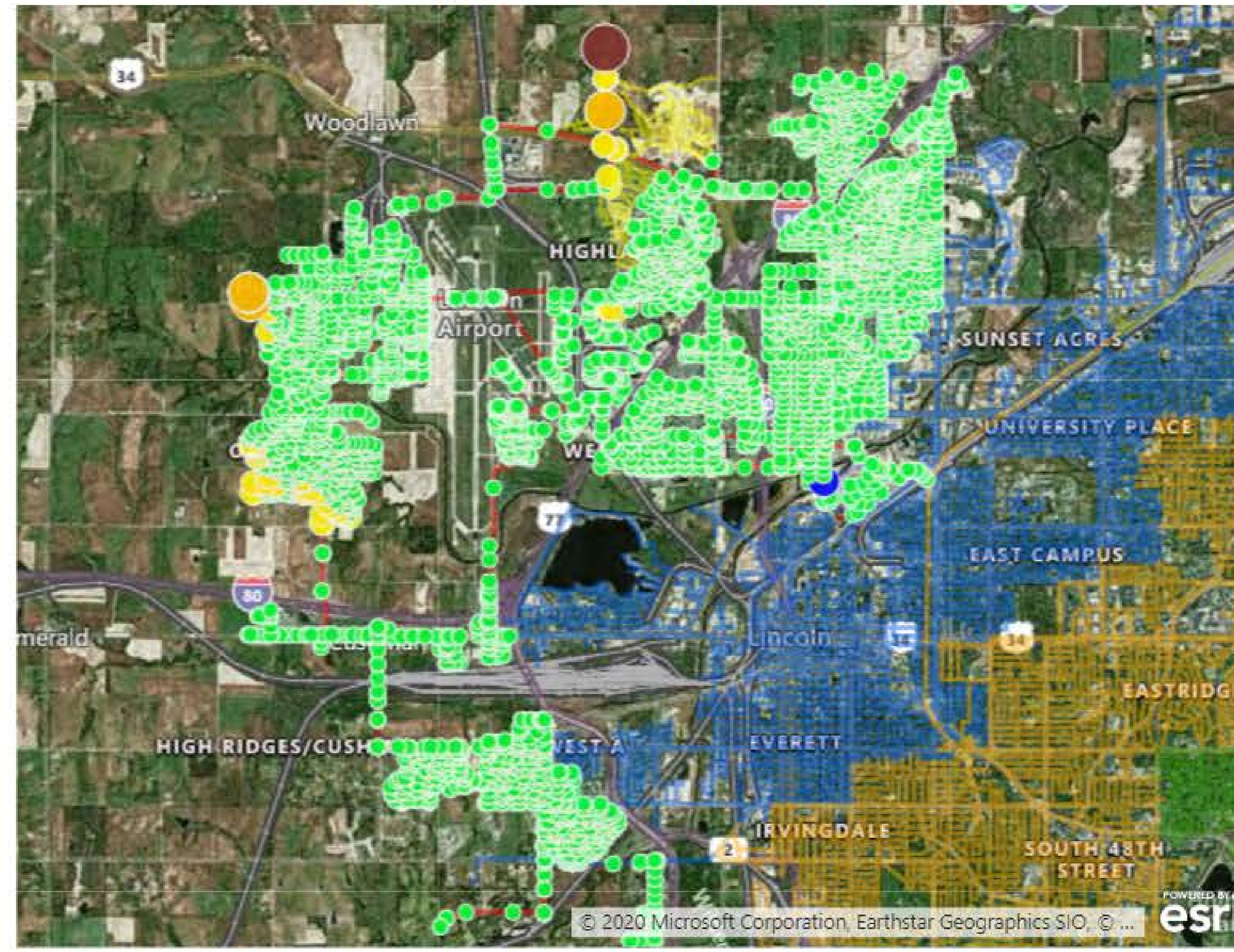
Category	Count
50-120 psi	688

Figure 6-35 2020 MD EPS Model Pressures – Northwest Service Level

Modeling Scenario Minimum Pressure Map



Modeling Scenario Maximum Pressure Map



Count of Junctions by Minimum Pressure Cateogry

Service Level Filter

- ■ Belmont
- ☐ Cheney
- ☐ High
- ☐ Low
- ☐ Northwest
- ☐ Southeast

Scenario Filter

- ◉ 2020 MD EPS
- ○ 2032 MD EPS

Count of Junctions by Maximum Pressure Category

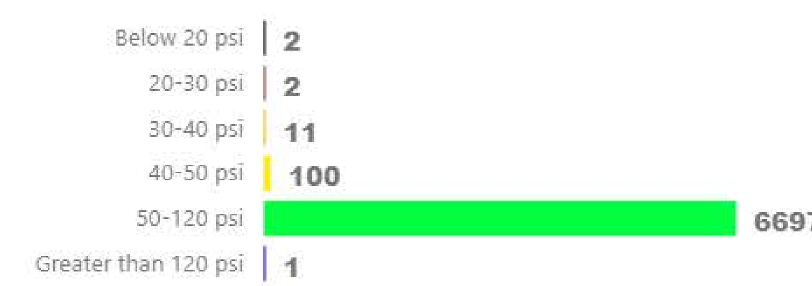
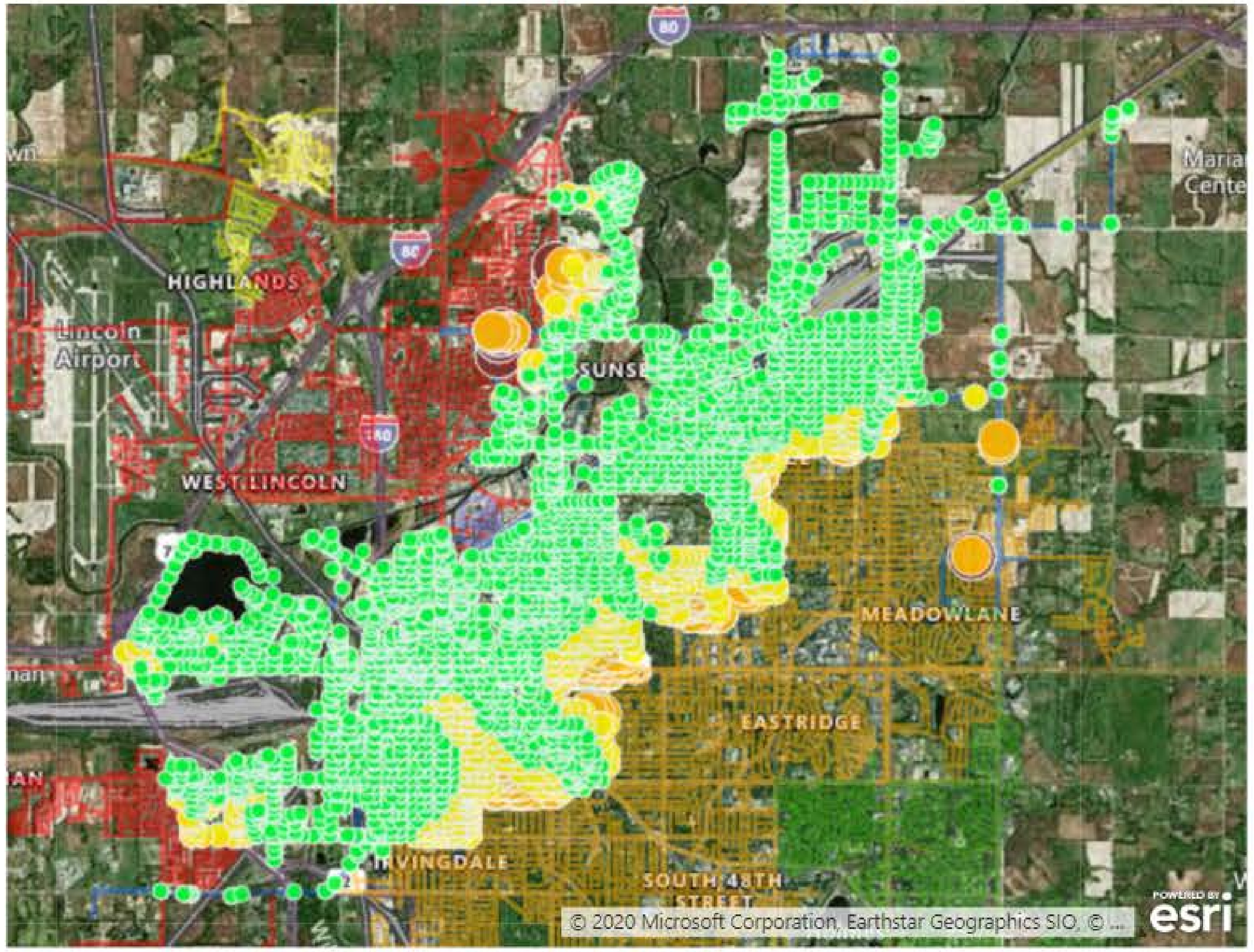
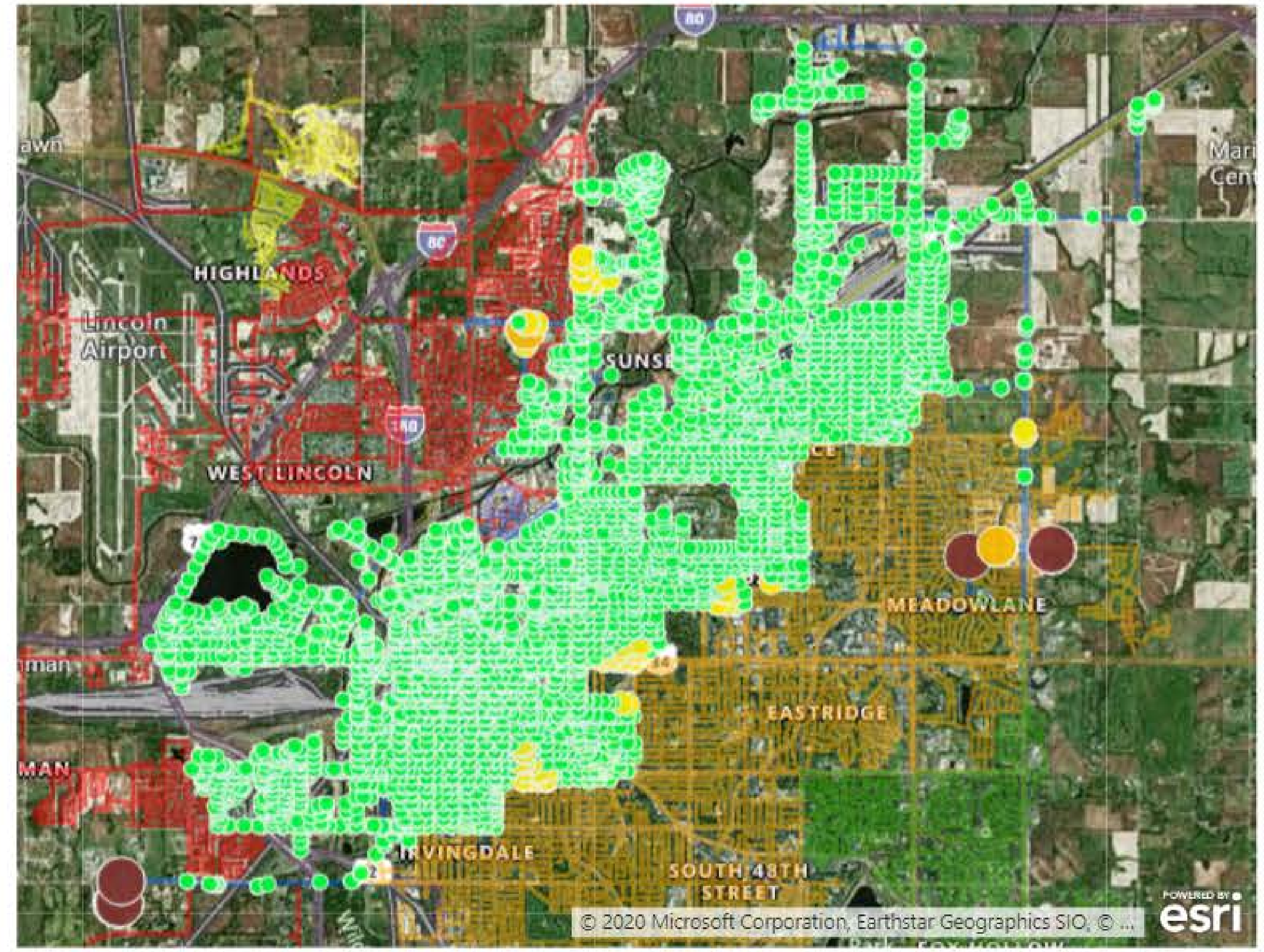


Figure 6-36 2020 MD EPS Model Pressures – Belmont Service Level

Modeling Scenario Minimum Pressure Map



Modeling Scenario Maximum Pressure Map



Count of Junctions by Minimum Pressure Cateogry

Service Level Filter

- Belmont
- Cheney
- High
- Low
- Northwest
- Southeast

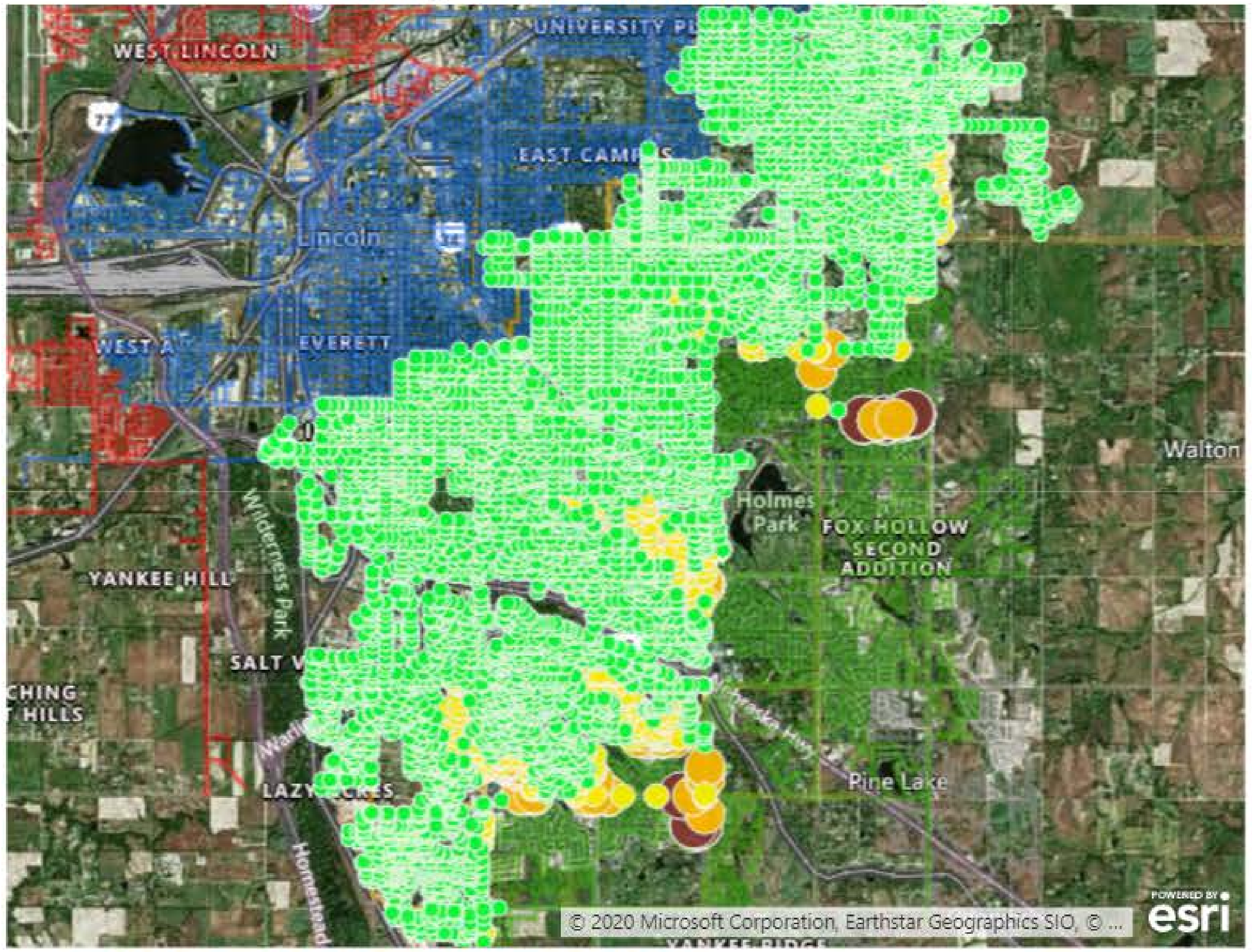
Scenario Filter

- 2020 MD EPS
- 2032 MD EPS

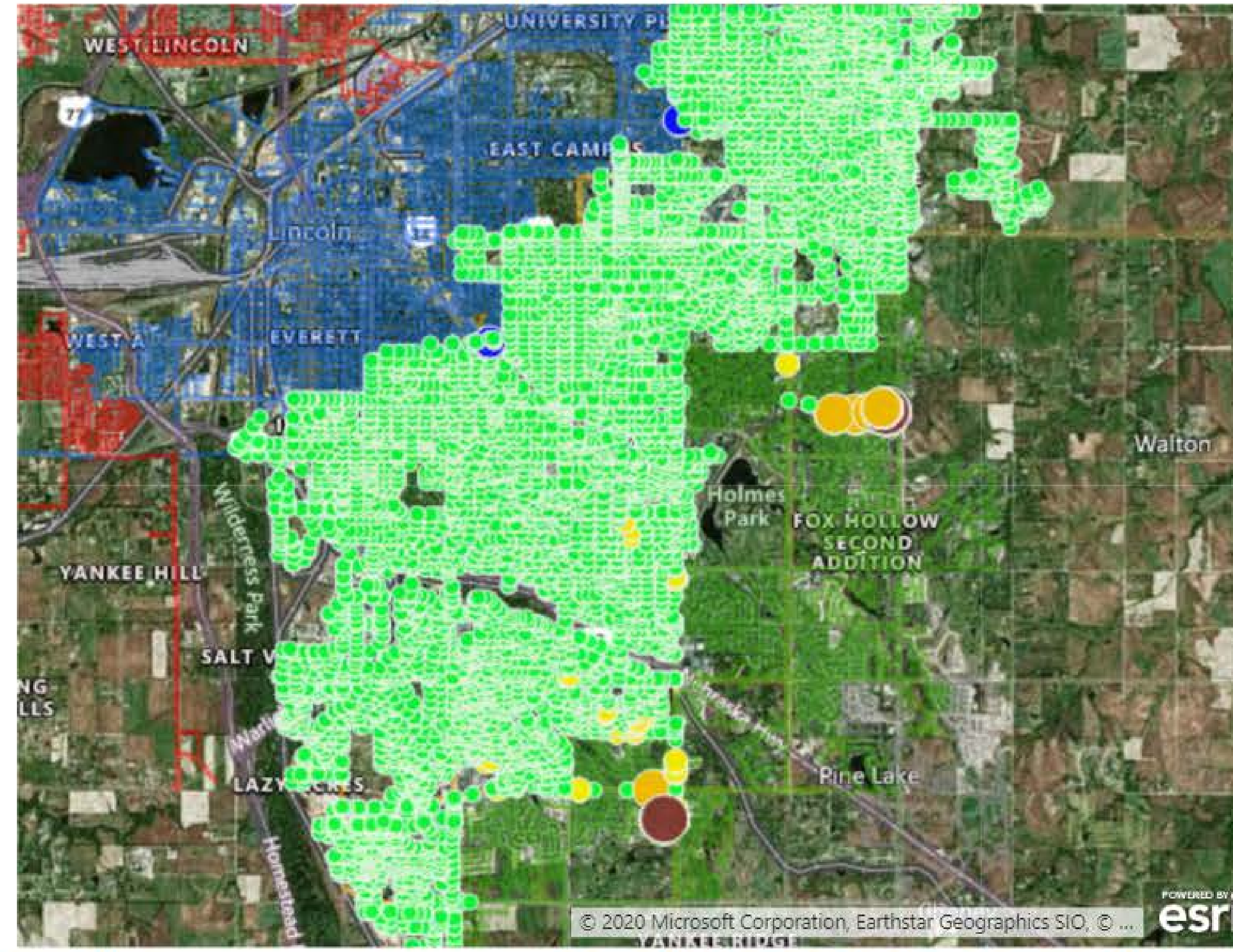
Count of Junctions by Maximum Pressure Category

Figure 6-37 2020 MD EPS Model Pressures – Low Service Level

Modeling Scenario Minimum Pressure Map



Modeling Scenario Maximum Pressure Map



Count of Junctions by Minimum Pressure Cateogry

Service Level Filter

- Belmont
- Cheney
- High
- Low
- Northwest
- Southeast

Scenario Filter

- 2020 MD EPS
- 2032 MD EPS

Count of Junctions by Maximum Pressure Category

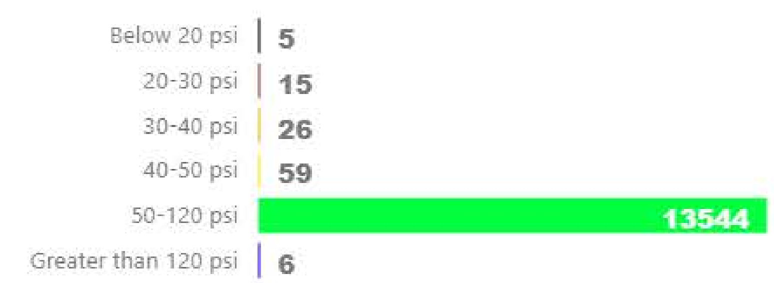


Figure 6-38 2020 MD EPS Model Pressures – High Service Level

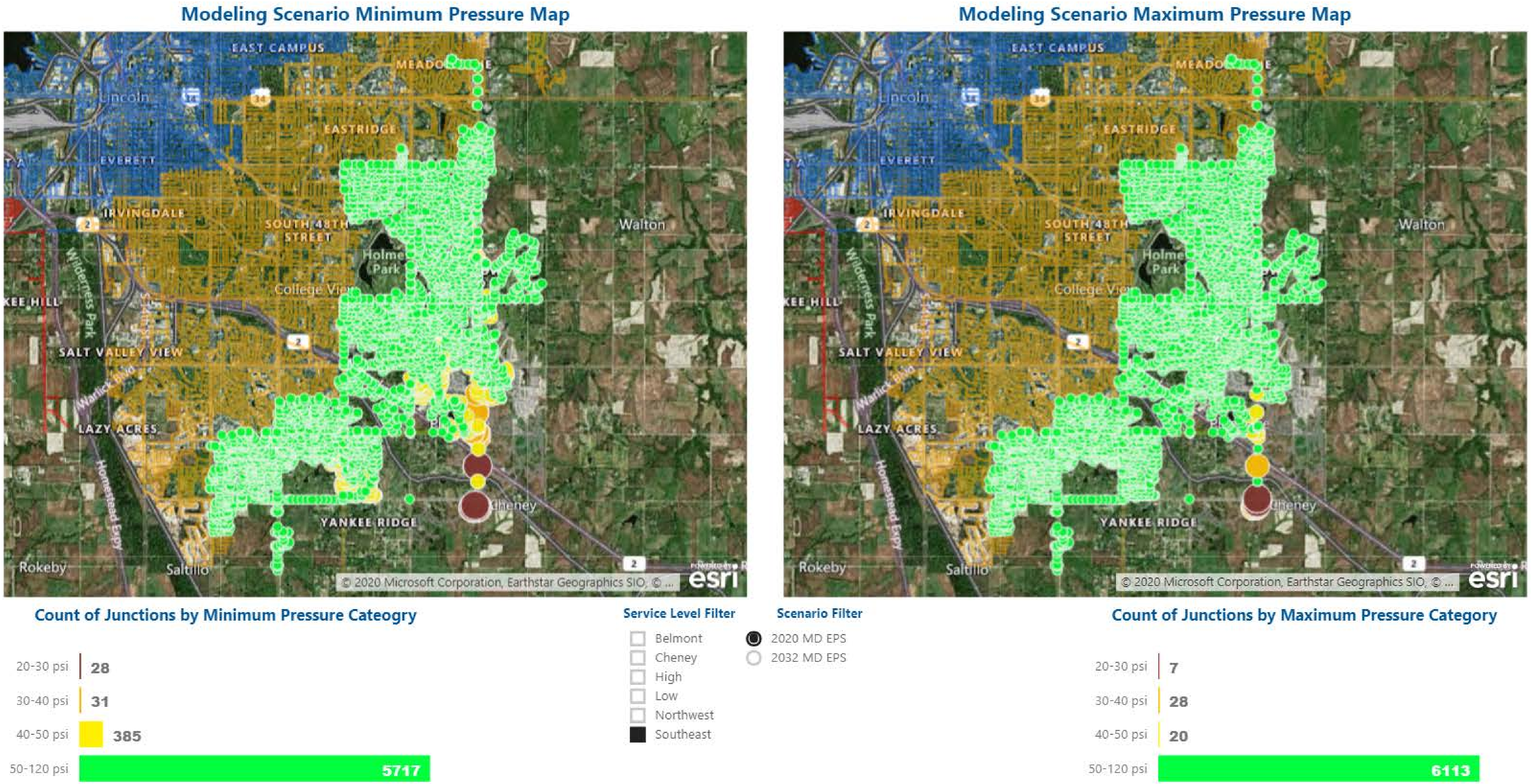
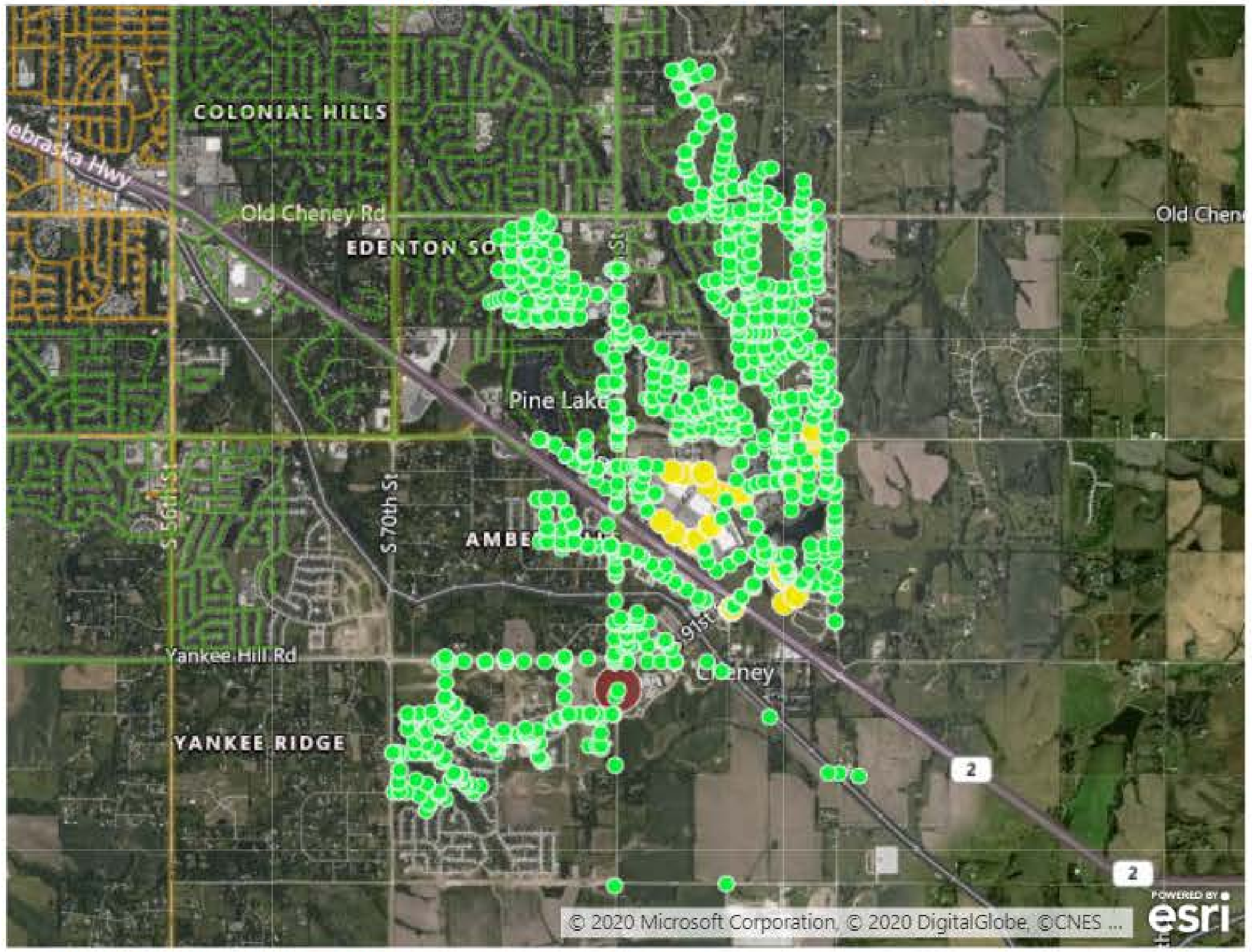
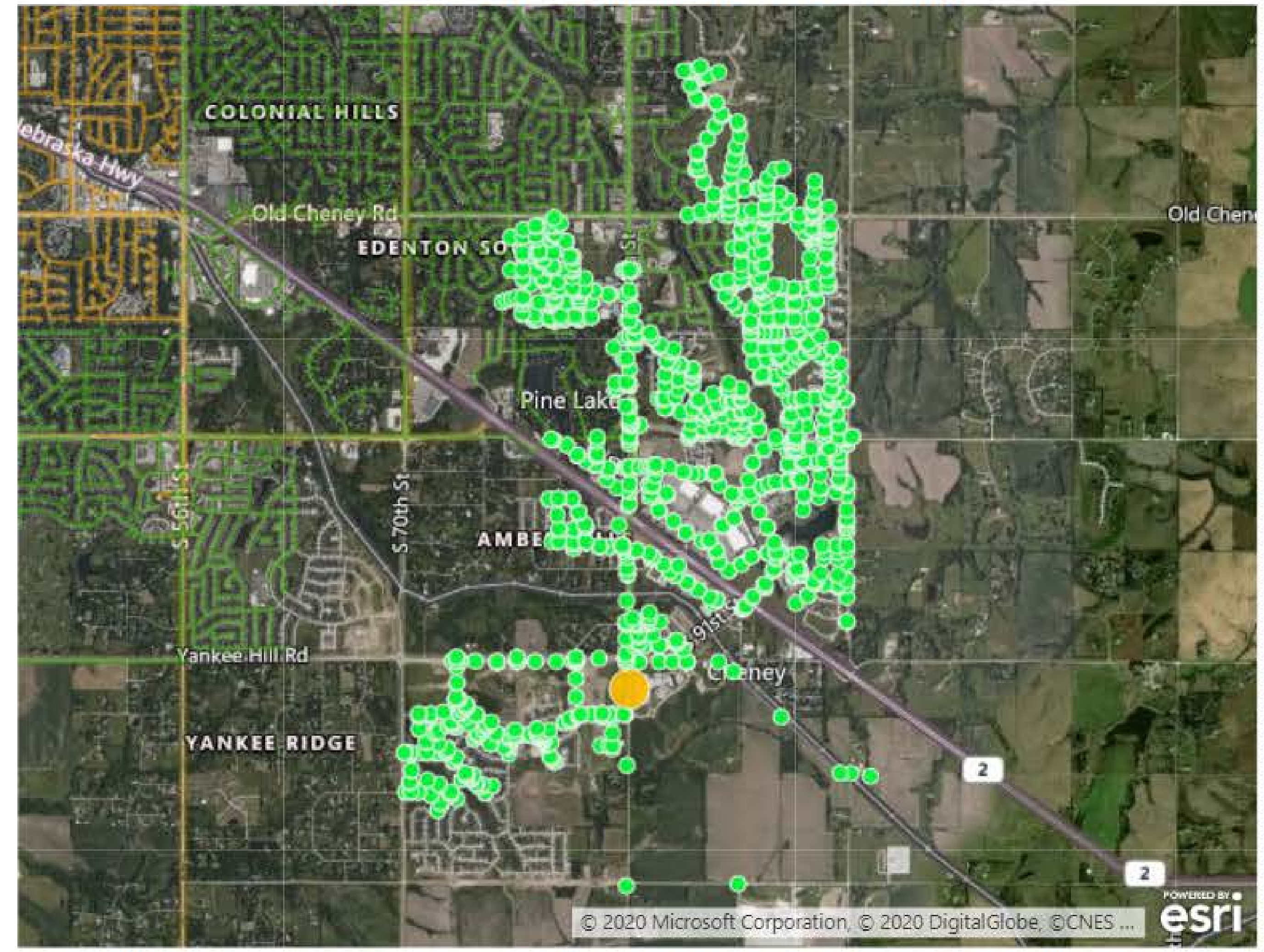


Figure 6-39 2020 MD EPS Model Pressures – Southeast Service Level

Modeling Scenario Minimum Pressure Map



Modeling Scenario Maximum Pressure Map



Count of Junctions by Minimum Pressure Cateogry

Service Level Filter

- Belmont
- Cheney
- High
- Low
- Northwest
- Southeast

Scenario Filter

- 2020 MD EPS
- 2032 MD EPS

Count of Junctions by Maximum Pressure Category

Figure 6-40 2020 MD EPS Model Pressures – Cheney Service Level

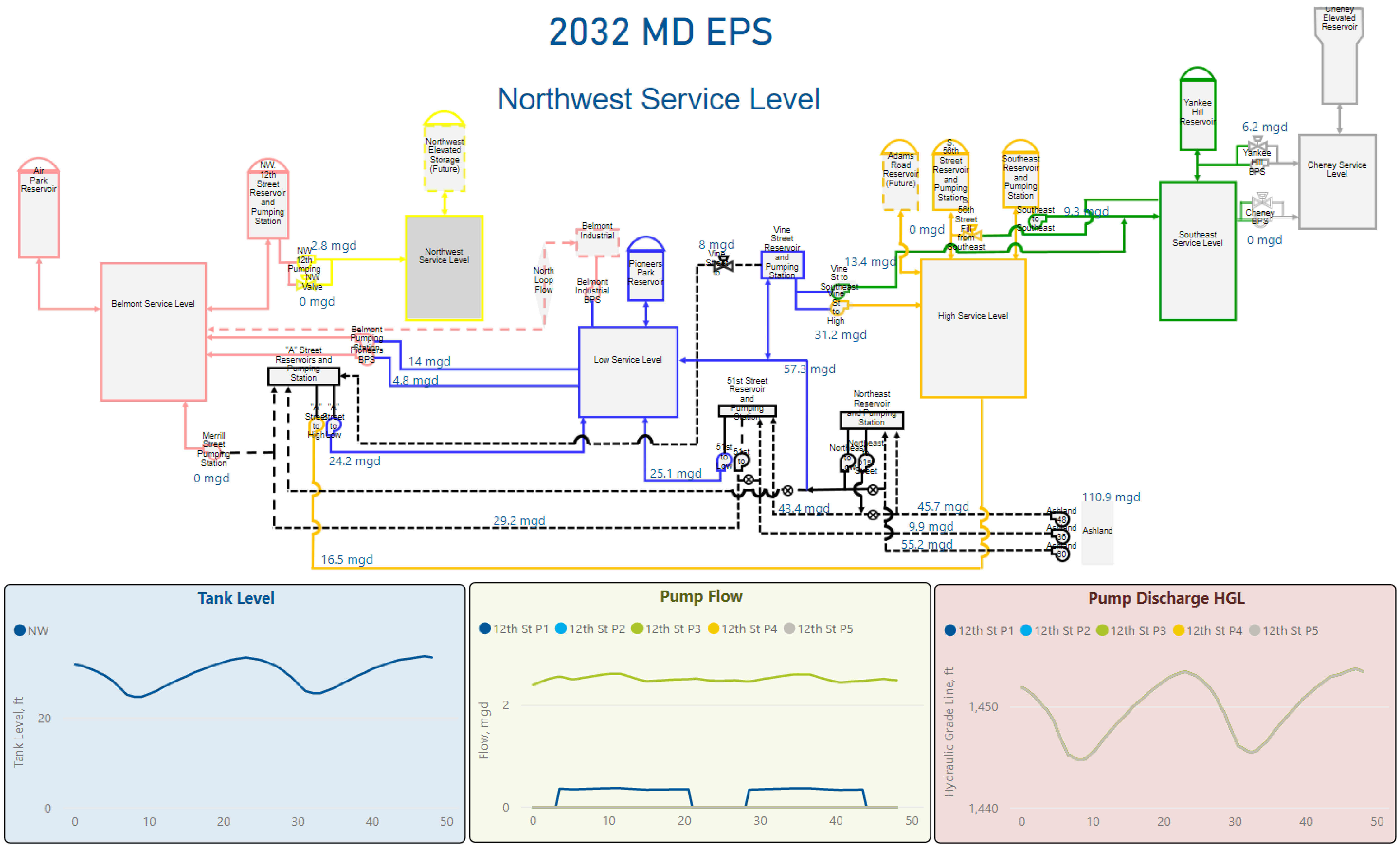


Figure 6-41 2032 MD EPS Model Results – Northwest Service Level

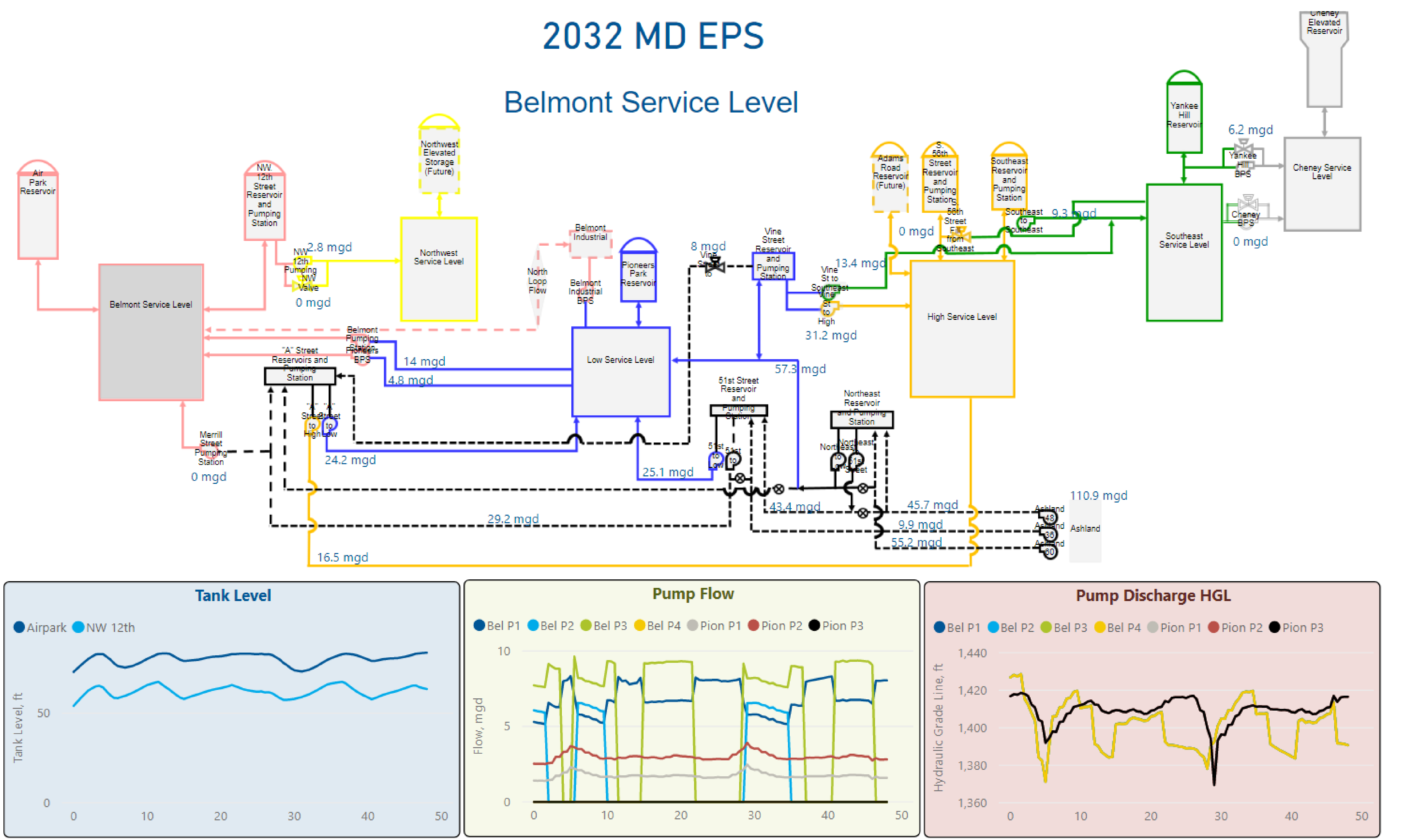


Figure 6-42 **2032 MD EPS Model Results – Belmont Service Level**

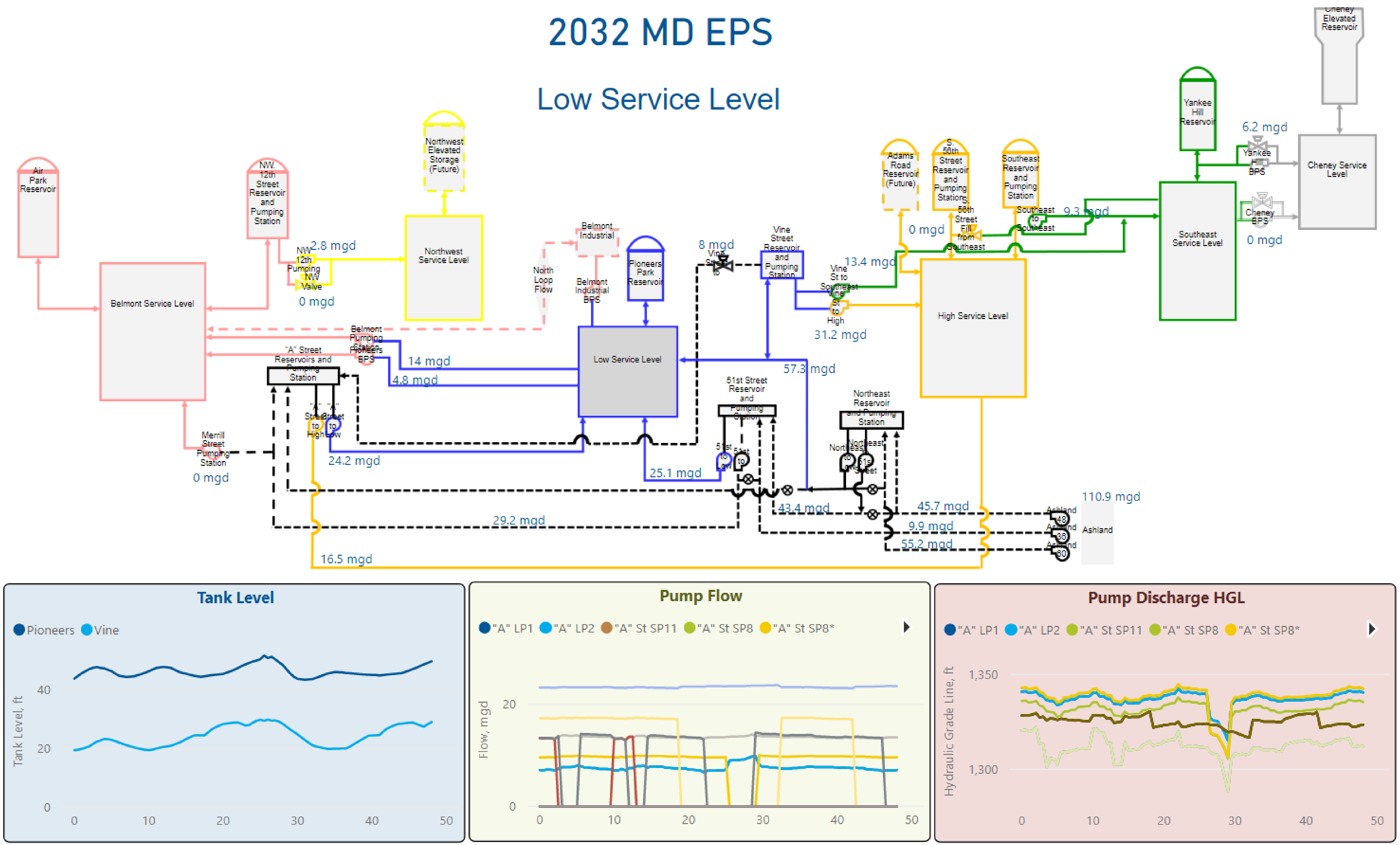


Figure 6-43 2032 MD EPS Model Results – Low Service Level

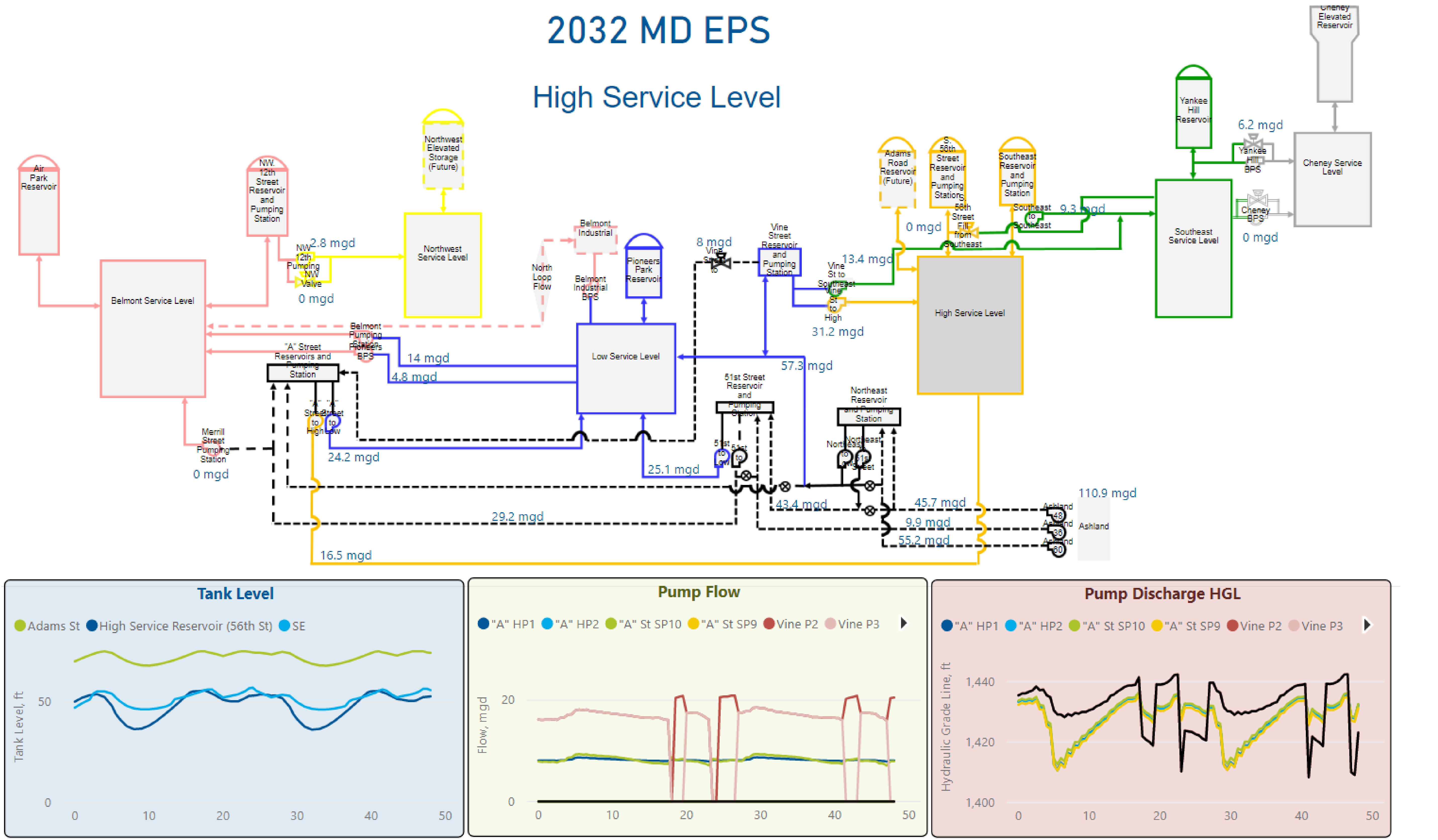


Figure 6-44 2032 MD EPS Model Results – High Service Level

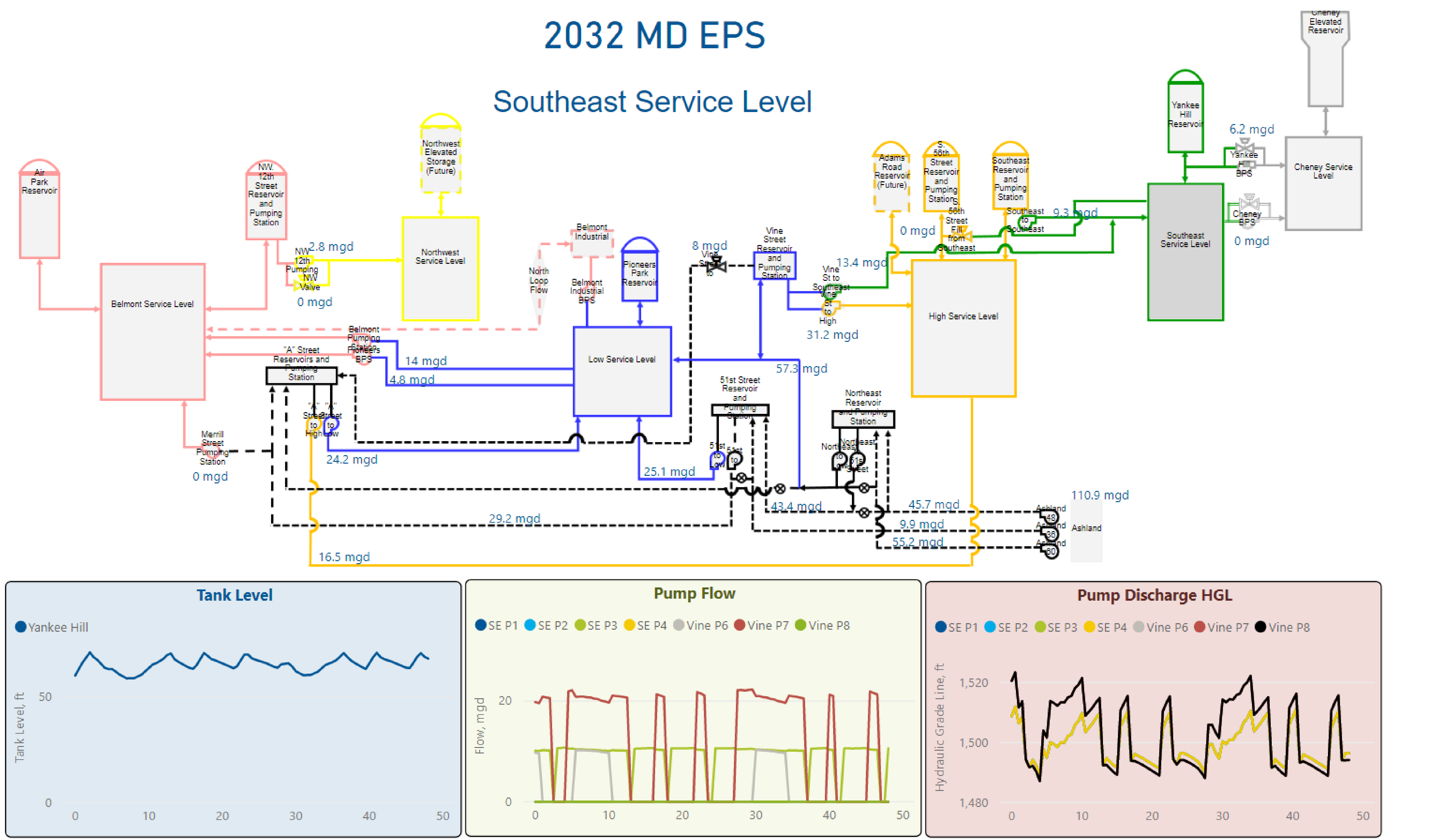


Figure 6-45 **2032 MD EPS Model Results – Southeast Service Level**

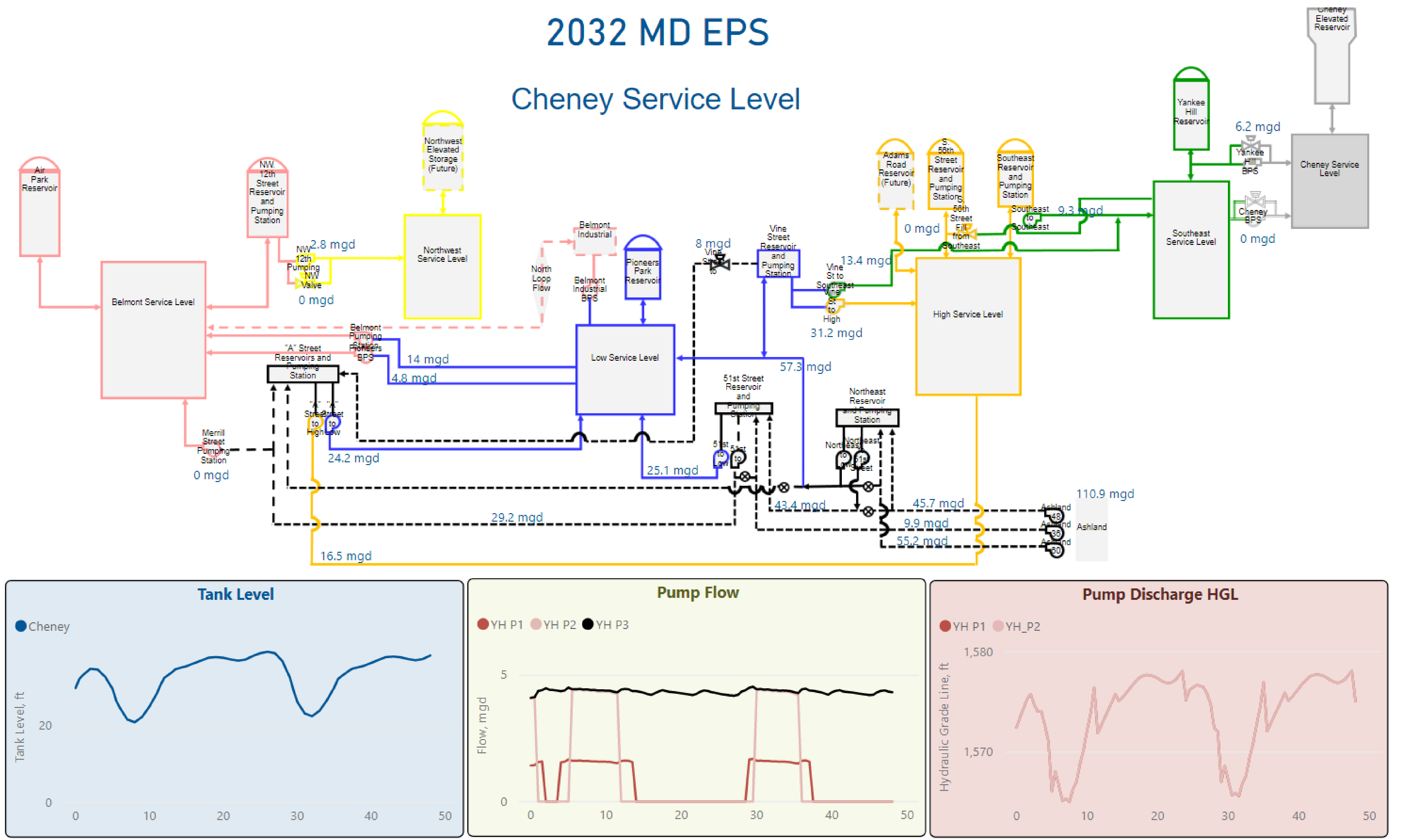


Figure 6-46 2032 MD EPS Model Results – Cheney Service Level

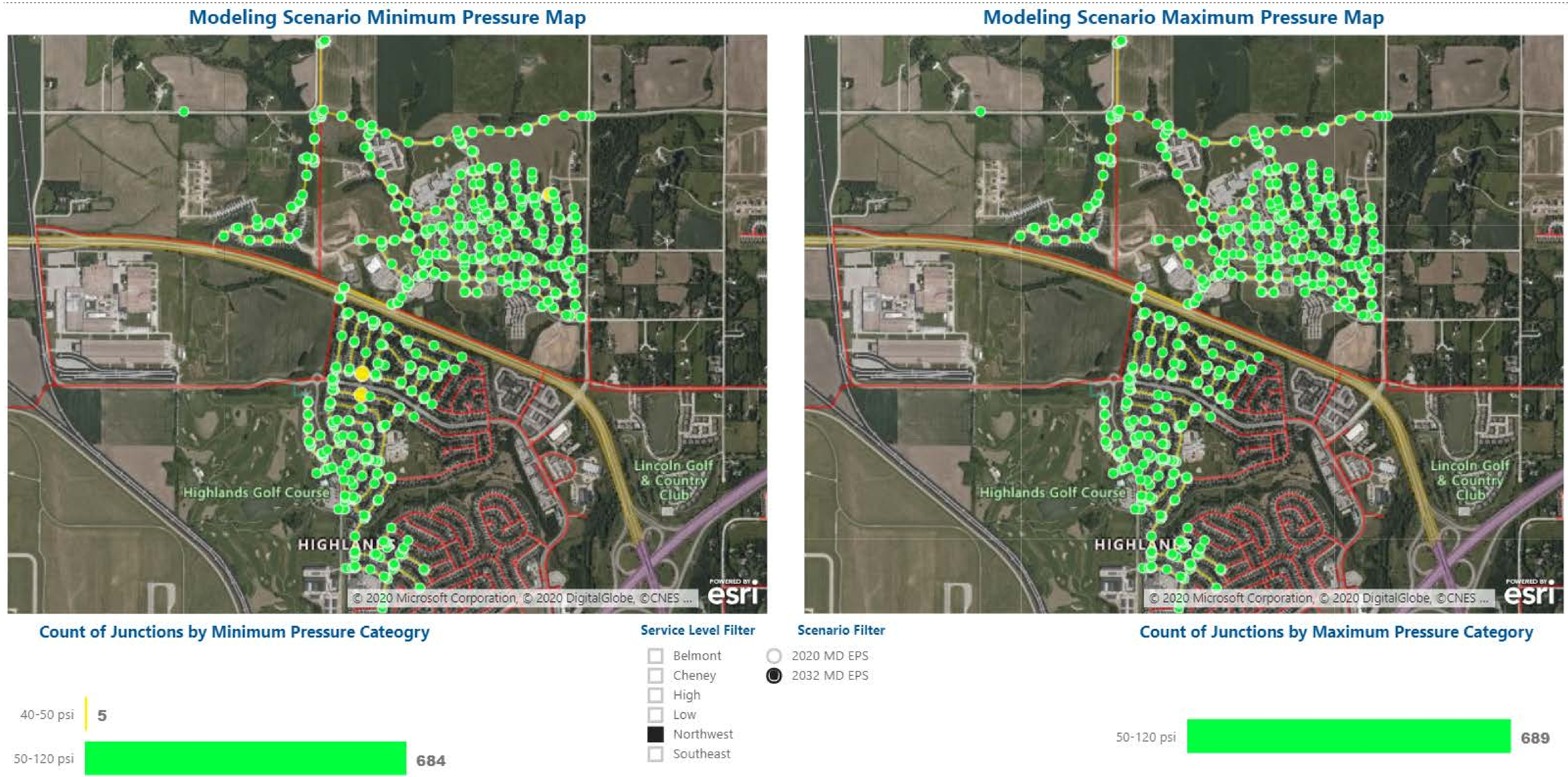
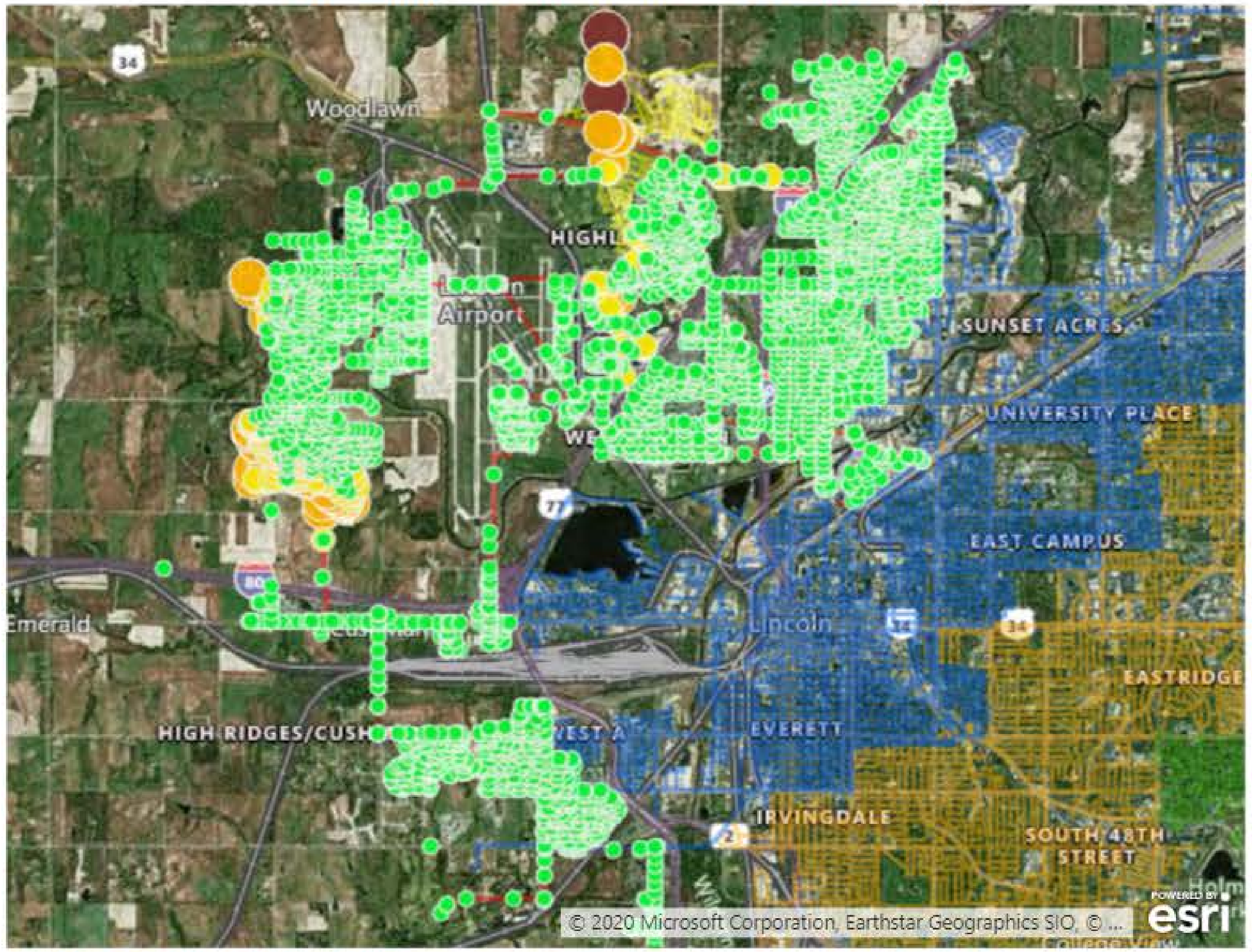
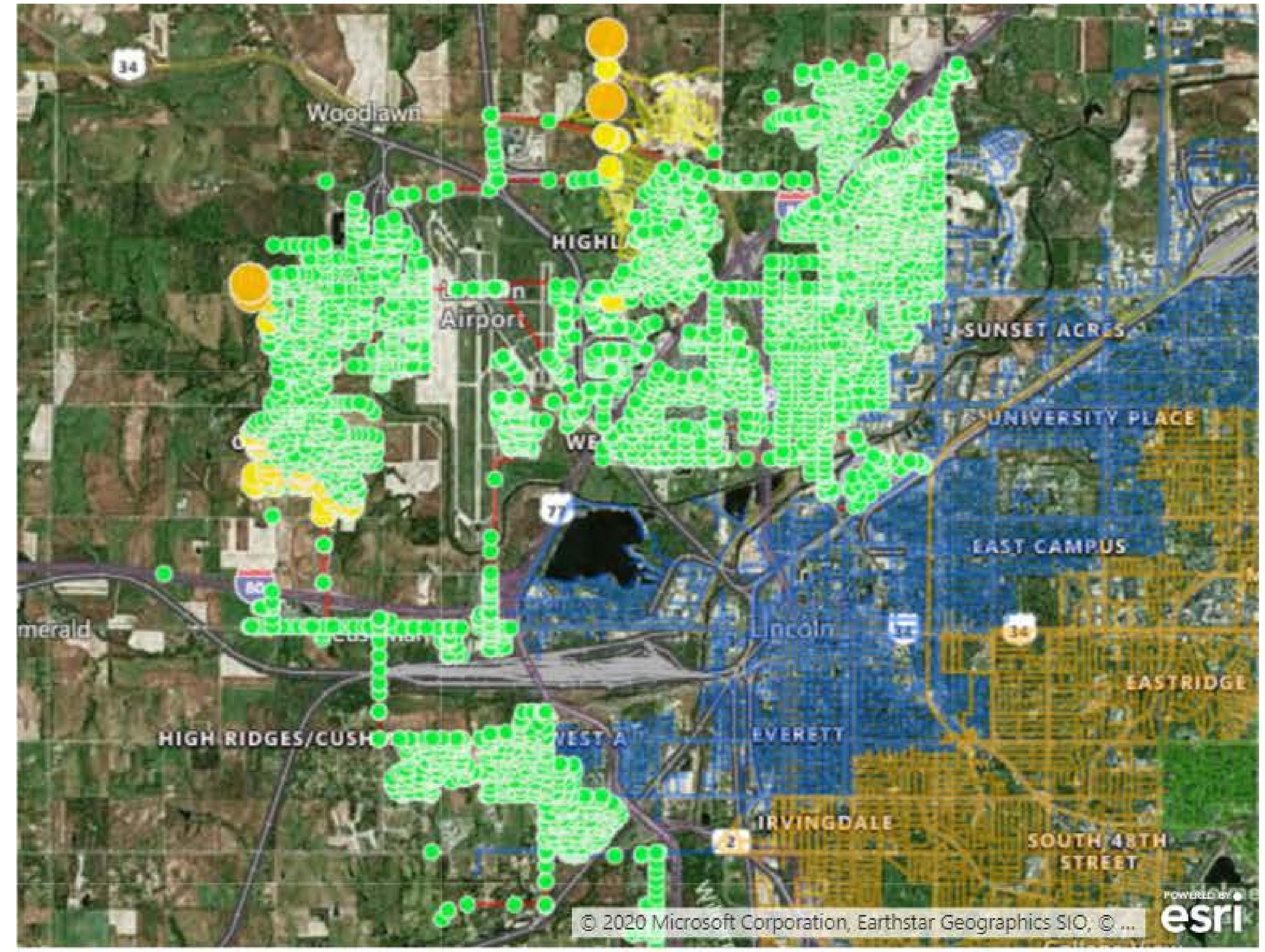


Figure 6-47 2032 MD EPS Model Pressures – Northwest Service Level

Modeling Scenario Minimum Pressure Map



Modeling Scenario Maximum Pressure Map



Count of Junctions by Minimum Pressure Cateogry

Service Level Filter

- Belmont
- Cheney
- High
- Low
- Northwest
- Southeast

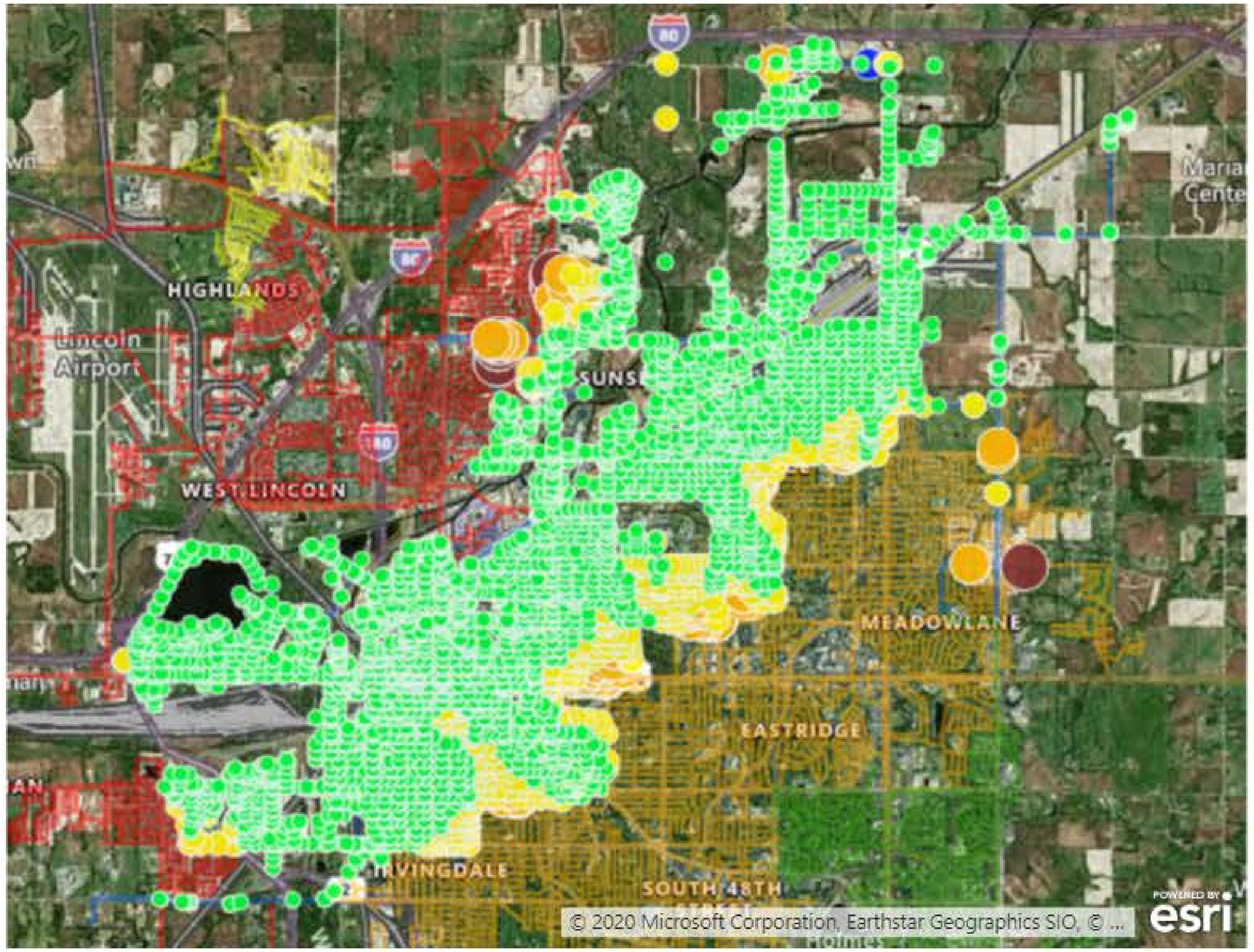
Scenario Filter

- 2020 MD EPS
- 2032 MD EPS

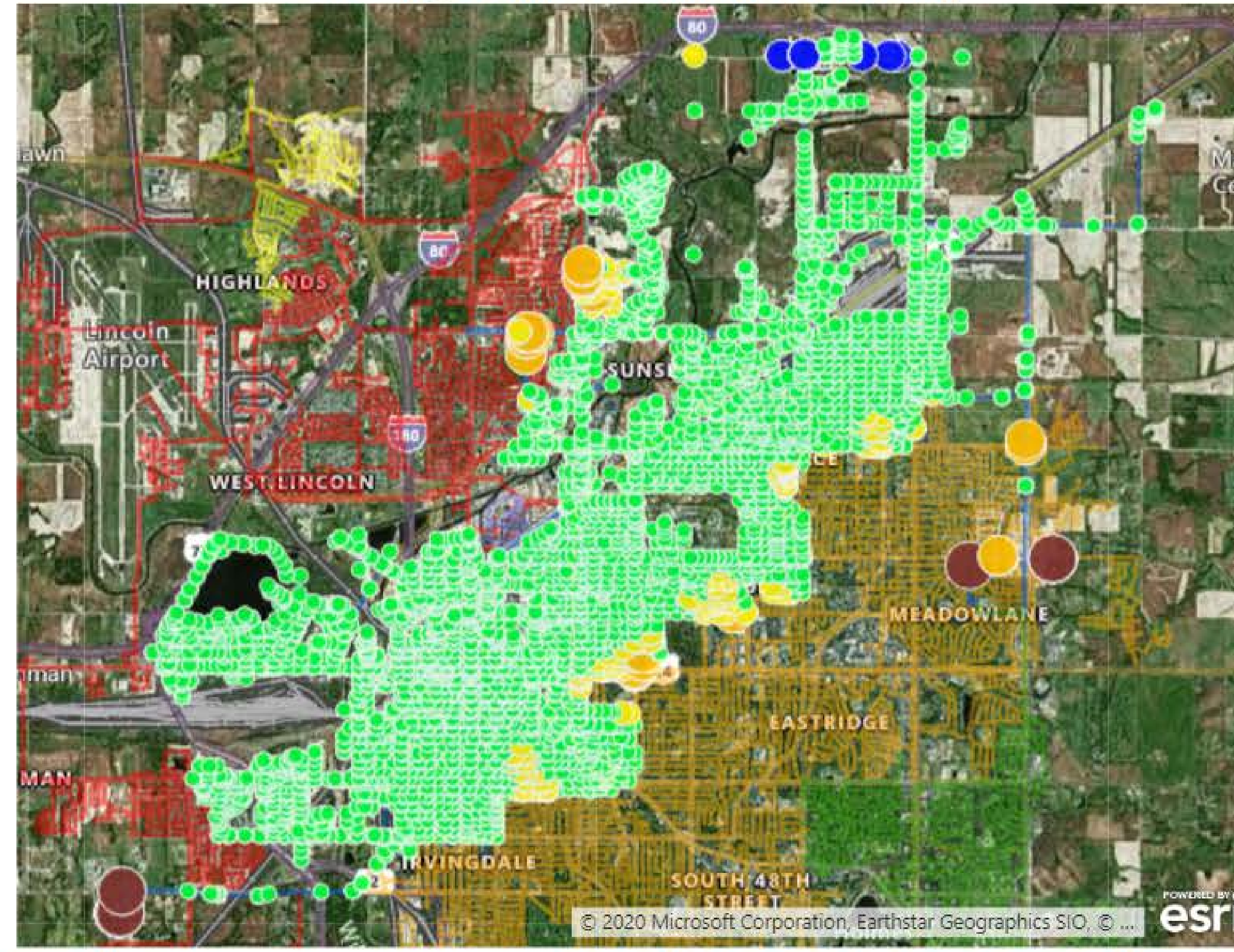
Count of Junctions by Maximum Pressure Category

Figure 6-48 2032 MD EPS Model Pressures – Belmont Service Level

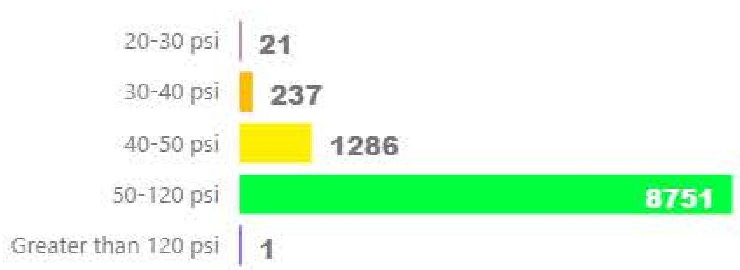
Modeling Scenario Minimum Pressure Map



Modeling Scenario Maximum Pressure Map



Count of Junctions by Minimum Pressure Cateogry



Service Level Filter

- ☐ Belmont
- ☐ Cheney
- ☐ High
- ■ Low
- ☐ Northwest
- ☐ Southeast

Scenario Filter

- ○ 2020 MD EPS
- ● 2032 MD EPS

Count of Junctions by Maximum Pressure Category

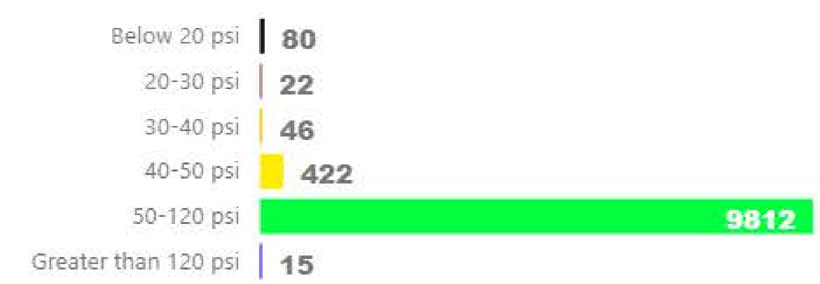


Figure 6-49 2032 MD EPS Model Pressures – Low Service Level

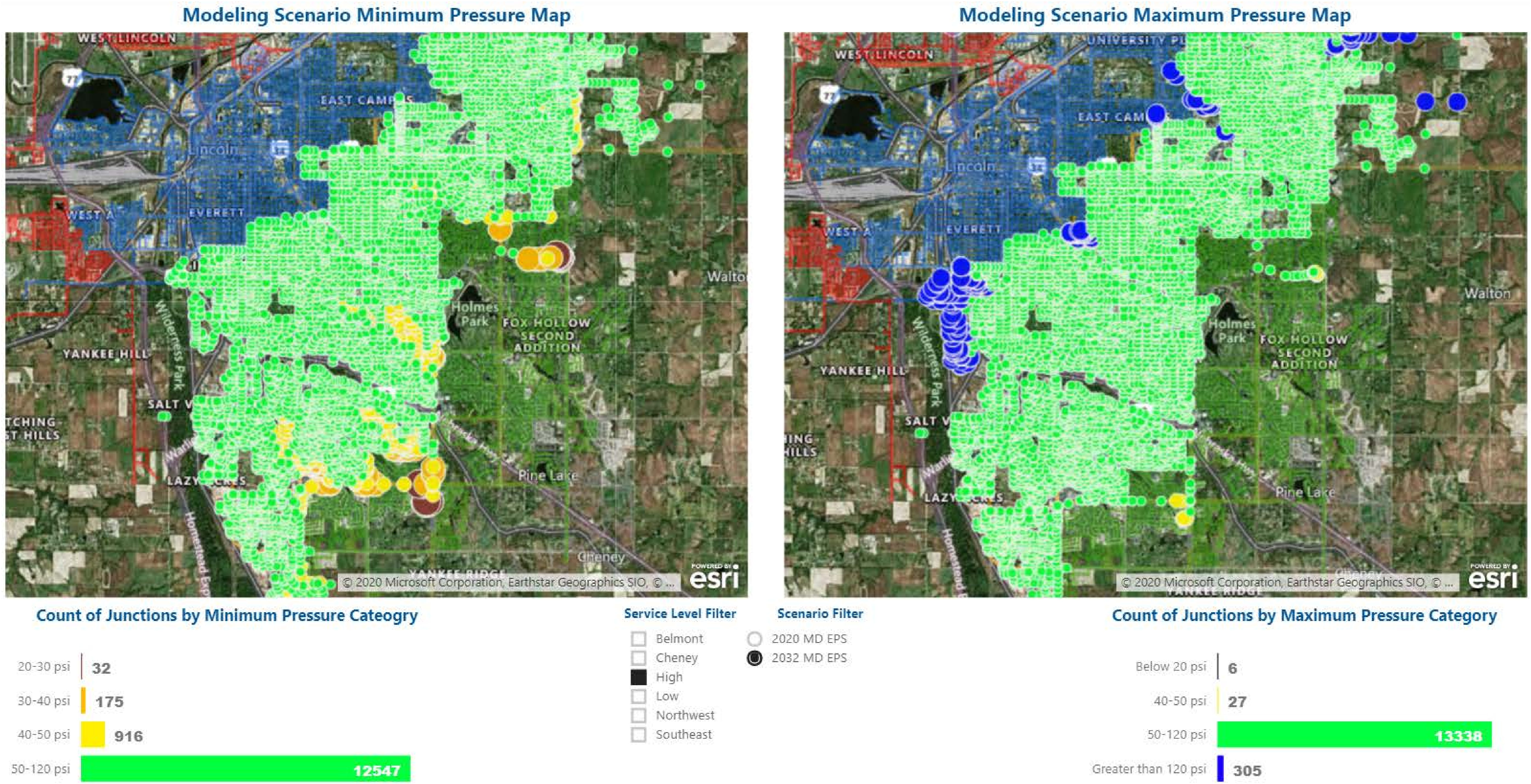


Figure 6-50 2032 MD EPS Model Pressures – High Service Level

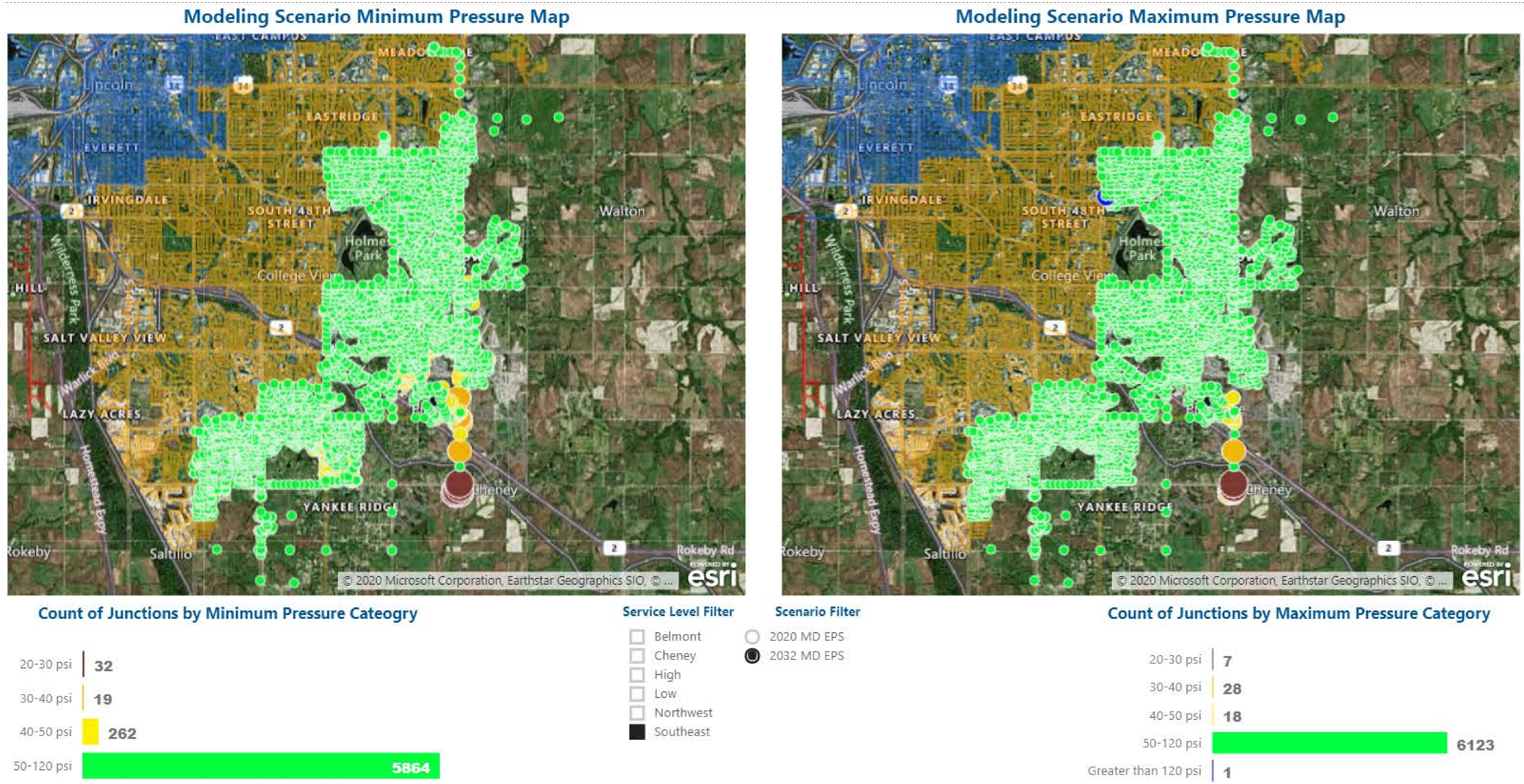
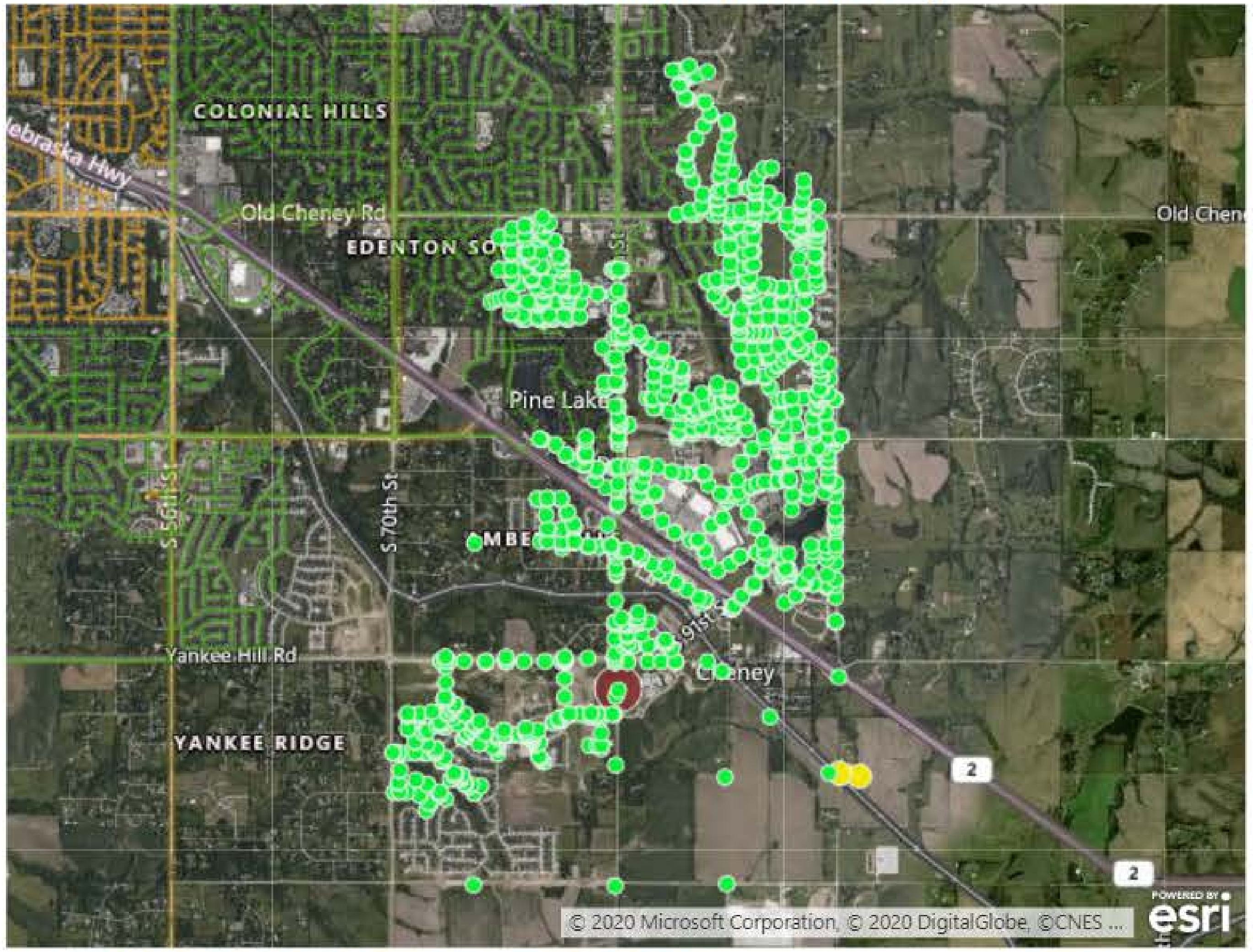
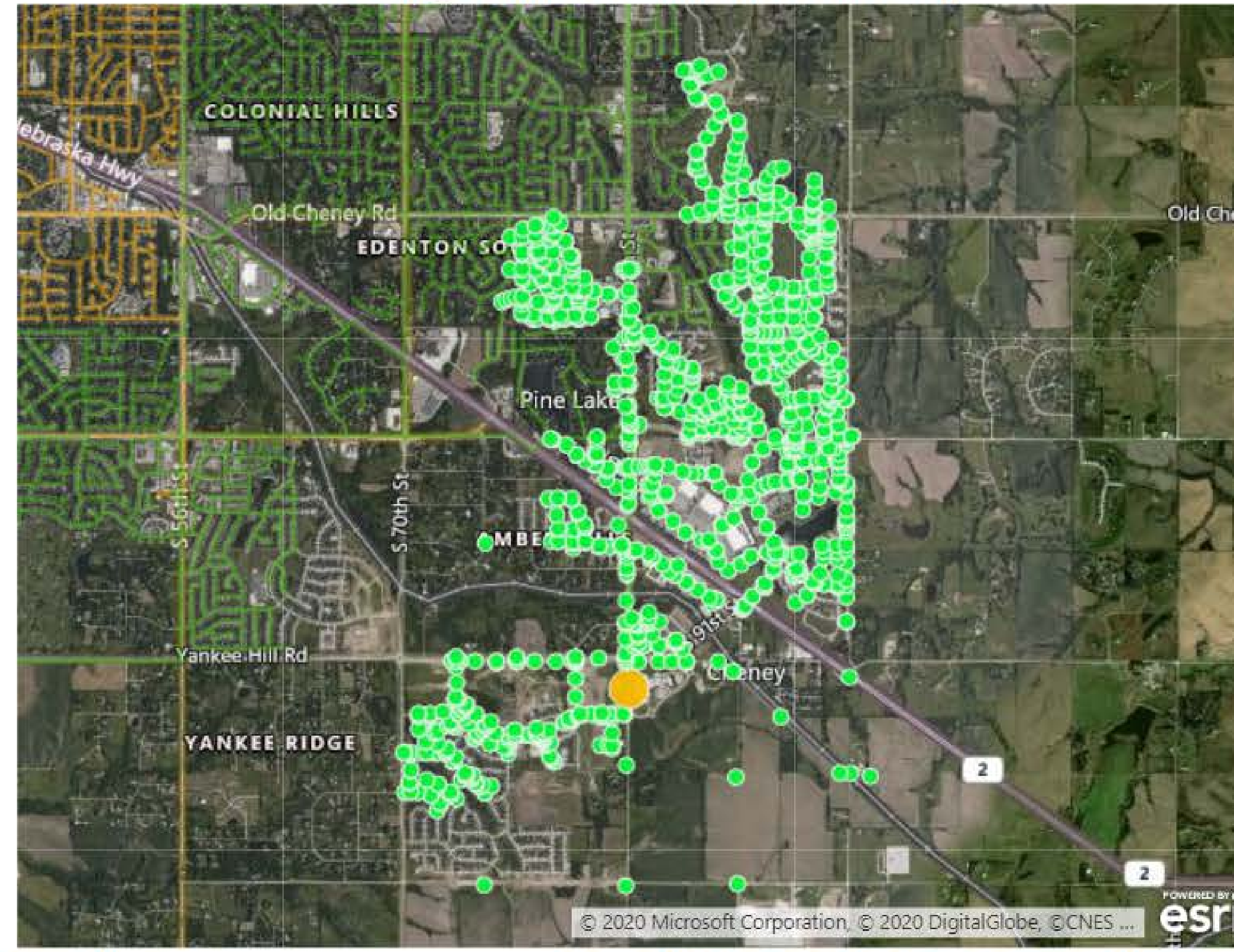


Figure 6-51 2032 MD EPS Model Pressures – Southeast Service Level

Modeling Scenario Minimum Pressure Map



Modeling Scenario Maximum Pressure Map



Count of Junctions by Minimum Pressure Cateogry

Service Level Filter

- Belmont
- Cheney
- High
- Low
- Northwest
- Southeast

Scenario Filter

- 2020 MD EPS
- 2032 MD EPS

Count of Junctions by Maximum Pressure Category

Figure 6-52 2032 MD EPS Model Pressures – Cheney Service Level