ATTACHMENT S: FIRE FLOW AVAILABILITY CERTIFICATES

BHC CONSULTANTS

TECHNICAL MEMORANDUM

Date: **August 08, 2018**

To: Denny Clouse

From: Noah Allen, PE

Subject: **TO 1520A Revised Hydraulic Analysis**

Background/Assumptions:

The north extension of Sound Transit's Light Rail passes through North City Water District's (District) service area. In 2016, an analysis of seven locations requiring fire flows to support the extension were completed. Upon receiving additional site layout information from Sound Transit, the District directed BHC to analyze an alternative configuration for the Task Order 1520A analysis. The revised analysis will look at the following scenario, illustrated in Figure 1:

- Add a pipe loop connecting to the existing 10-inch pipe located in 5th Ave NE onto the proposed development area to the west.
- Determine the required diameter to provide a 3,000 gpm fire flow at the proposed development area (assumed to be 14701 5th Ave NE).
- Determine the required diameter to provide a 4,000 gpm fire flow at the proposed development area (assumed to be 14701 5th Ave NE).

The analysis was completed using the current version of the NCWD's water distribution model and per the following conditions and assumptions:

- This analysis has been performed using the following demands:
  - 2010 Maximum Day Demand (MDD) with fire flow superimposed
- Analysis results indicate the capacity of the distribution system (as opposed to a given fire hydrant) to produce the required fire flow with a minimum residual pressure of 20 psi at all points throughout the distribution system (not including transmission piping). Actual fire flows may vary due to distribution system changes, variations in system demand and operational conditions. Maximum allowed velocity in the distribution system is 10 feet per second for existing pipes and 8 feet per second for new piping, during MDD plus fire flow conditions.
- Reservoir elevations were set at the level representing the depletion of operating, standby, and fire suppression storage. For all flow scenarios with a 3,000 gpm fire flow requirement the 3.7 million gallon 590 Zone Tank level is set at a depth of 55.6 feet (547.6' water surface elev.). For all flow scenarios with a 4,000 gpm fire flow requirement the 3.7 million gallon 590 Zone Tank level is set at a depth of 44.5 feet (536.5' water surface elev.).

- PRV stations, pump stations, and flow control valves are operating at current set-points, as identified in the current system model.
- Analyses for the 590 Zone were completed assuming 590 pressure zone Booster Station No. 1 is offline, which represents the booster pump station capable of delivering the greatest amount of flow.

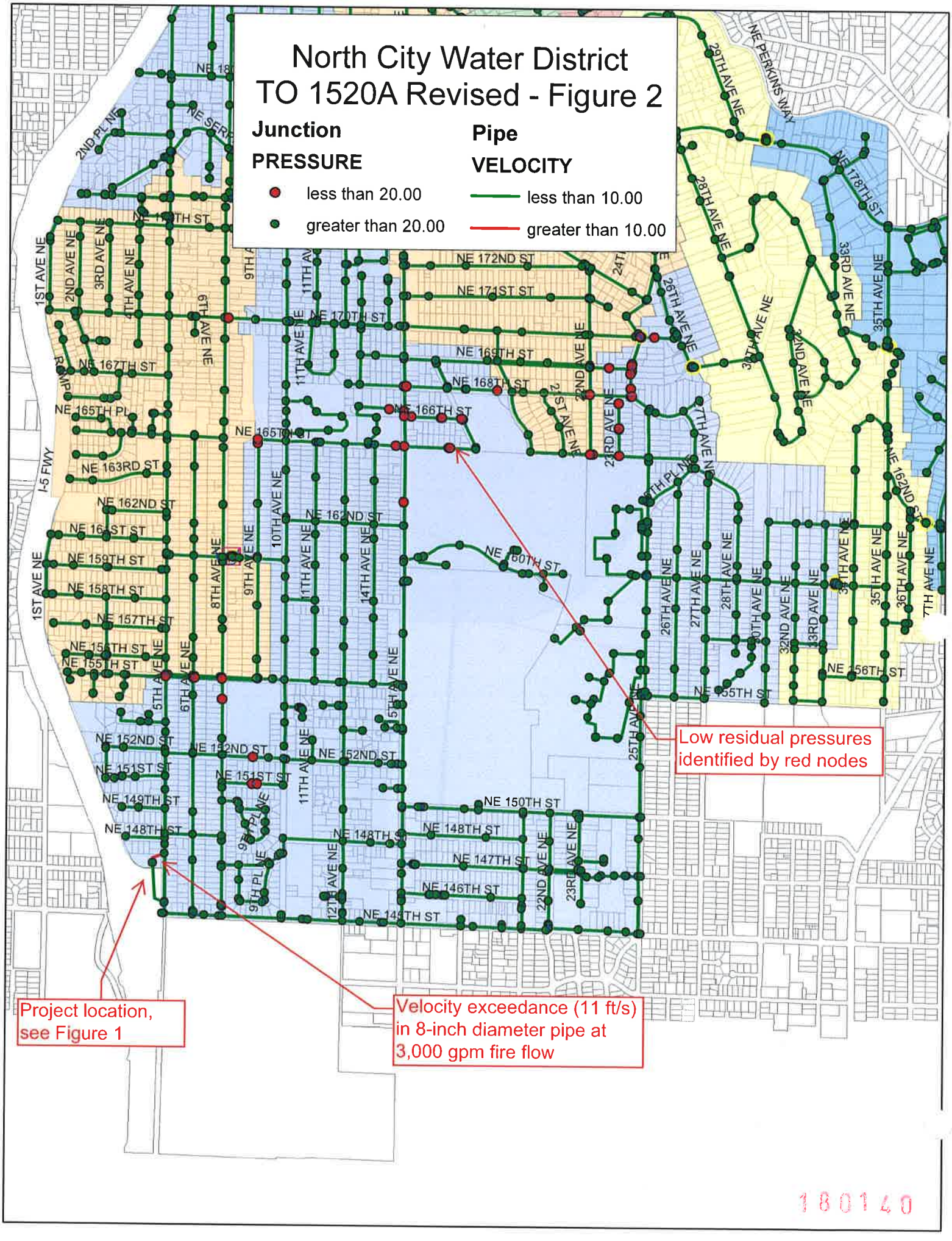
Analysis and Results:

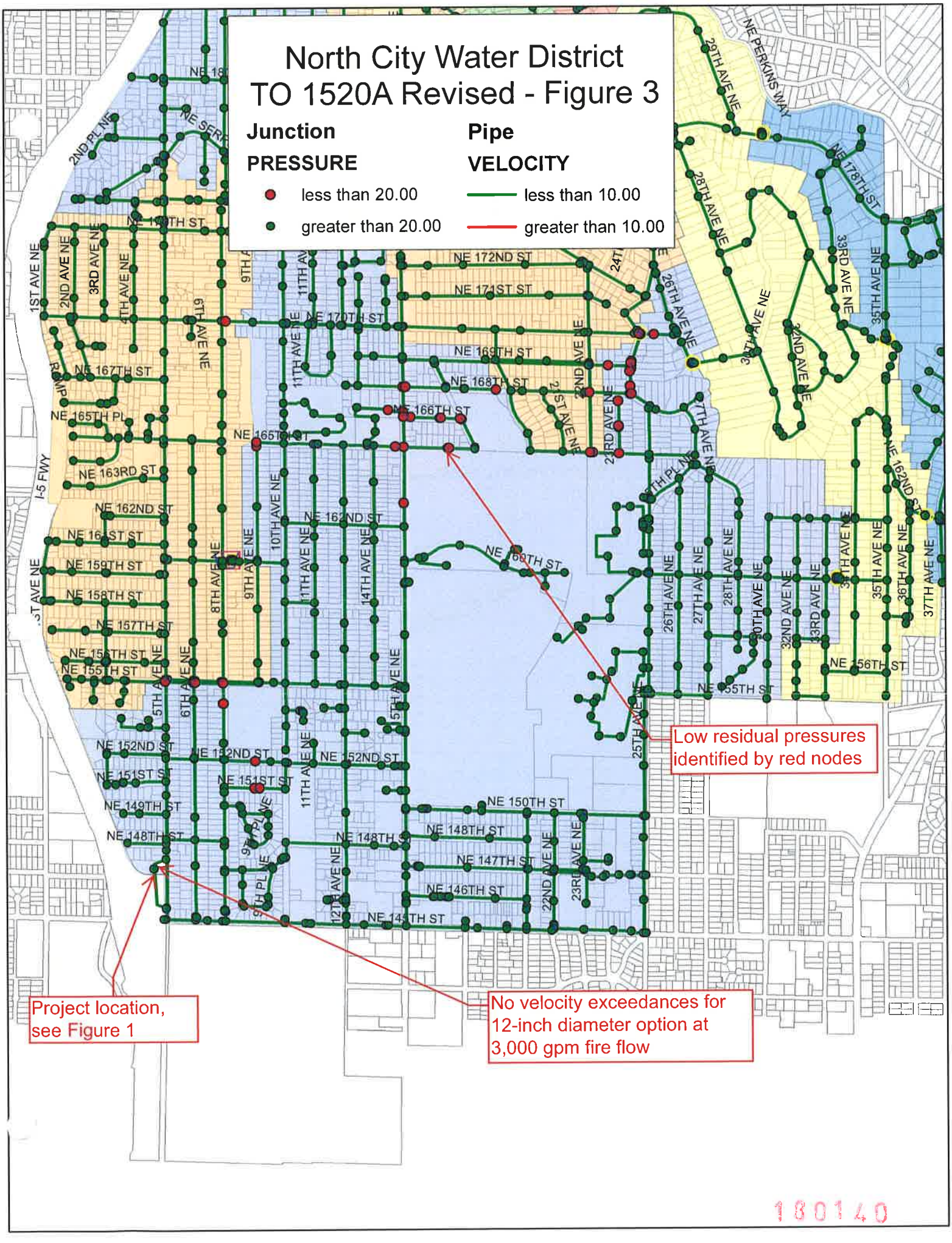
Flow analysis indicated that to supply a 3,000 gpm or 4,000 gpm fire flow a 12-inch diameter pipe would be required to maintain velocities below the required eight feet per second (ft/s).

The analysis for determining fire flow availability in the 590 Zone was completed following the standard fire flow availability method using differing pipe diameters. Results of the hydraulic analysis indicated that the limiting factor to providing a 3,000 gpm or 4,000 gpm fire flow to the proposed Sound Transit development is low residual pressure within the 590 Zone. Regardless of the looped pipe diameter, available fire flow is limited to 2,200 gpm. A fire flow of 3,000 gpm results in low residual pressures in significant portions of the 590 Zone. Increasing the fire flow to 4,000 gpm substantially increases the impacted area of low residual pressure in the 590 Zone and results in negative pressures at some locations. These low pressures are illustrated in Figure 2, Figure 3, and Figure 4.

At a flow of 2,200 gpm either an 8-inch or 12-inch diameter pipe can supply the proposed development if looped from the existing 10-inch pipe in 5th Ave NE. An 8-inch diameter pipe does not result in an exceedance of the eight ft/s velocity requirement. Based on the flow limitations due to low residual pressures in the 590 Zone and the understanding that the proposed development is the full build-out condition, an 8-inch diameter pipe provides capacity for the available flow at this location.


North City Water District
TO 1520A Revised - Figure 1
Junction
PRESSURE
less than 20.00
greater than 20.00
Pipe
VELOCITY
less than 10.00
greater than 10.00
8-inch or 12-inch looped service
Connection to existing 10-inch pipe
Proposed Project
Fire flow location
Connection to existing 10-inch pipe
NE 148TH ST
NE 145TH ST
5TH AVE NE
180140


North City Water District
TO 1520A Revised - Figure 2
Junction
PRESSURE
less than 20.00
greater than 20.00
Pipe
VELOCITY
less than 10.00
greater than 10.00
Low residual pressures identified by red nodes
Project location, see Figure 1
Velocity exceedance (11 ft/s) in 8-inch diameter pipe at 3,000 gpm fire flow
180140


North City Water District
TO 1520A Revised - Figure 3
Junction
PRESSURE
less than 20.00
greater than 20.00
Pipe
VELOCITY
less than 10.00
greater than 10.00
Low residual pressures identified by red nodes
Project location, see Figure 1
No velocity exceedances for 12-inch diameter option at 3,000 gpm fire flow
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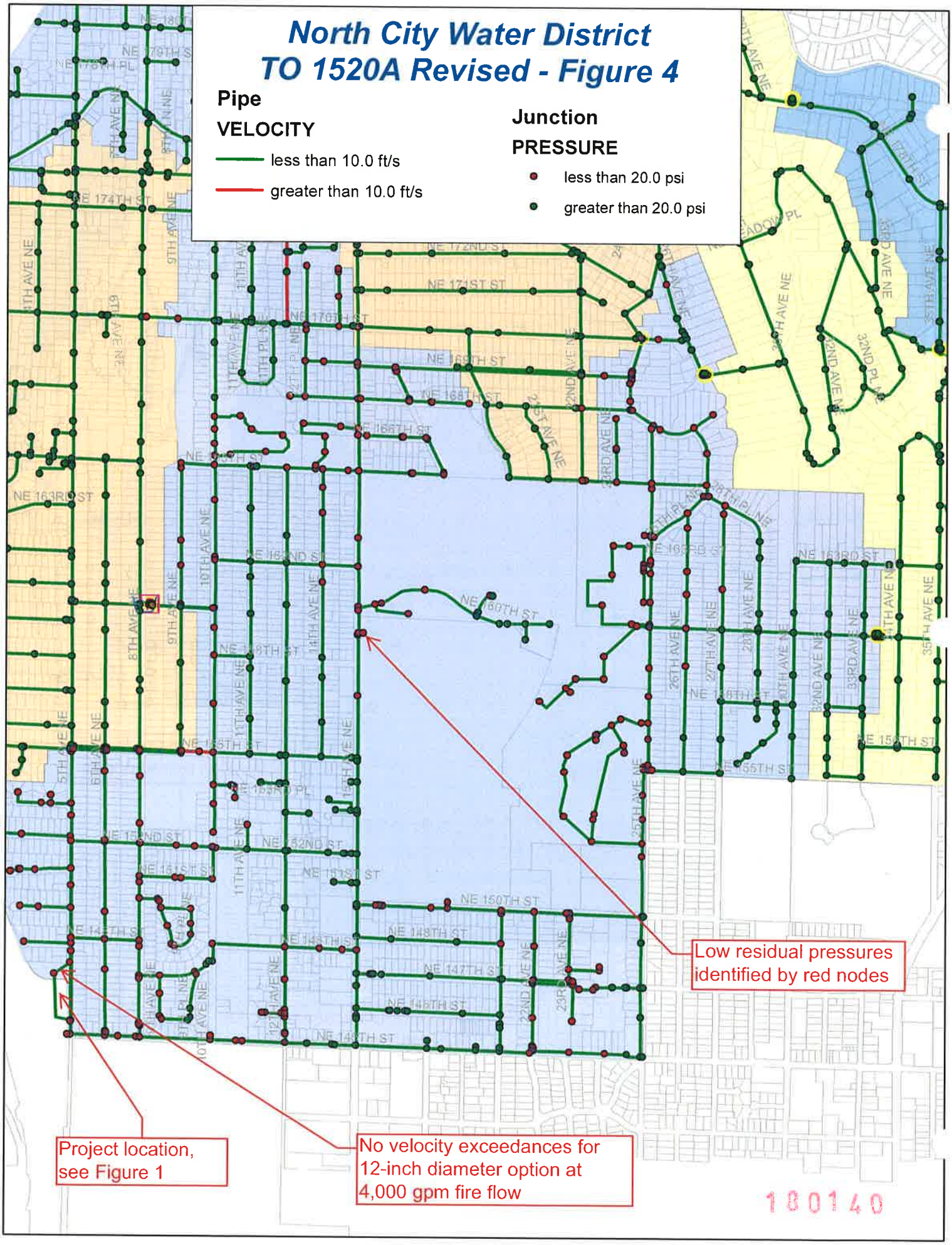
North City Water District
TO 1520A Revised - Figure 4
Pipe
VELOCITY
less than 10.0 ft/s
greater than 10.0 ft/s
Junction
PRESSURE
less than 20.0 psi
greater than 20.0 psi
Low residual pressures identified by red nodes
Project location, see Figure 1
No velocity exceedances for 12-inch diameter option at 4,000 gpm fire flow
100140

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NORTH CITY Water District

NORTH CITY WATER DISTRICT

FIRE FLOW ANALYSIS INFORMATION

Task Order No.: 1520B	Date: August 9, 2018
Applicant Name: Sound Transit	Project Location: NE 155th St at I-5, Shoreline
Proposed Use:	N/A
Static Pressure Range at Project Location:	120 psi (minimum); 121 psi (maximum)
Available Fire Flow (@ 20 psi min or 10 fps max):	2,150 GPM
Minimum Required Fire Flow:	N/A
Distance from Property to Fire Flow Hydrant(s):	Adjacent; refer to map
Location of Fire Hydrant(s) (Refer to Attached Map):	145 NE 155th St (Hydrant A10-33, 615 Zone)
Fire Flow Analysis Expiration Date:	*(one year from date of issuance)*

A hydraulic analysis of the District's water distribution system was performed to determine available fire flow at the above-referenced project location. The analysis was conducted in accordance with WAC 246-290-230. Specific analysis criteria and operational conditions are as follows:

- This analysis is based on the District's existing water distribution system configuration and includes improvements associated with expansion of the 615 pressure zone.
- One of the 615 Booster Pump Station fire flow pumps is out of service for this analysis, in accordance with Department of Health requirements.
- Analysis results indicate the capacity of the distribution system (as opposed to a given fire hydrant) to produce the required fire flow with a minimum residual pressure of 20 psi at all points throughout the distribution system (not including transmission piping). Actual fire flows may vary due to distribution system changes, variations in system demand and operational conditions.
- Fire hydrant distance is measured from the project line fronting the right-of-way, to the hydrant. Results of this analysis do not include potential new project site piping or hydrants.
- Minimum static pressure is based on Peak Hour Demand and reservoirs at the bottom of their respective equalizing ranges.
- Maximum static pressure is based on minimum system demand and reservoirs full.
- Fire flow demand is superimposed over existing Maximum Day Demand (MDD).
- Minimum required fire flow is based on Zoning/Land-Use type, as defined in the Comprehensive Plan and does not consider actual structures proposed by the applicant.
- Maximum allowed velocity in the distribution system is 10 feet per second for existing mains and 8 feet per second for new mains, during MDD plus fire flow conditions.
- The 3.7 million gallon 590 Zone Tank level is set at a depth of 64.8 feet (556.8' water surface elev.), representing depletion of operational, equalizing and fire suppression storage.
- All pressure reducing stations are operating at their normal set points.

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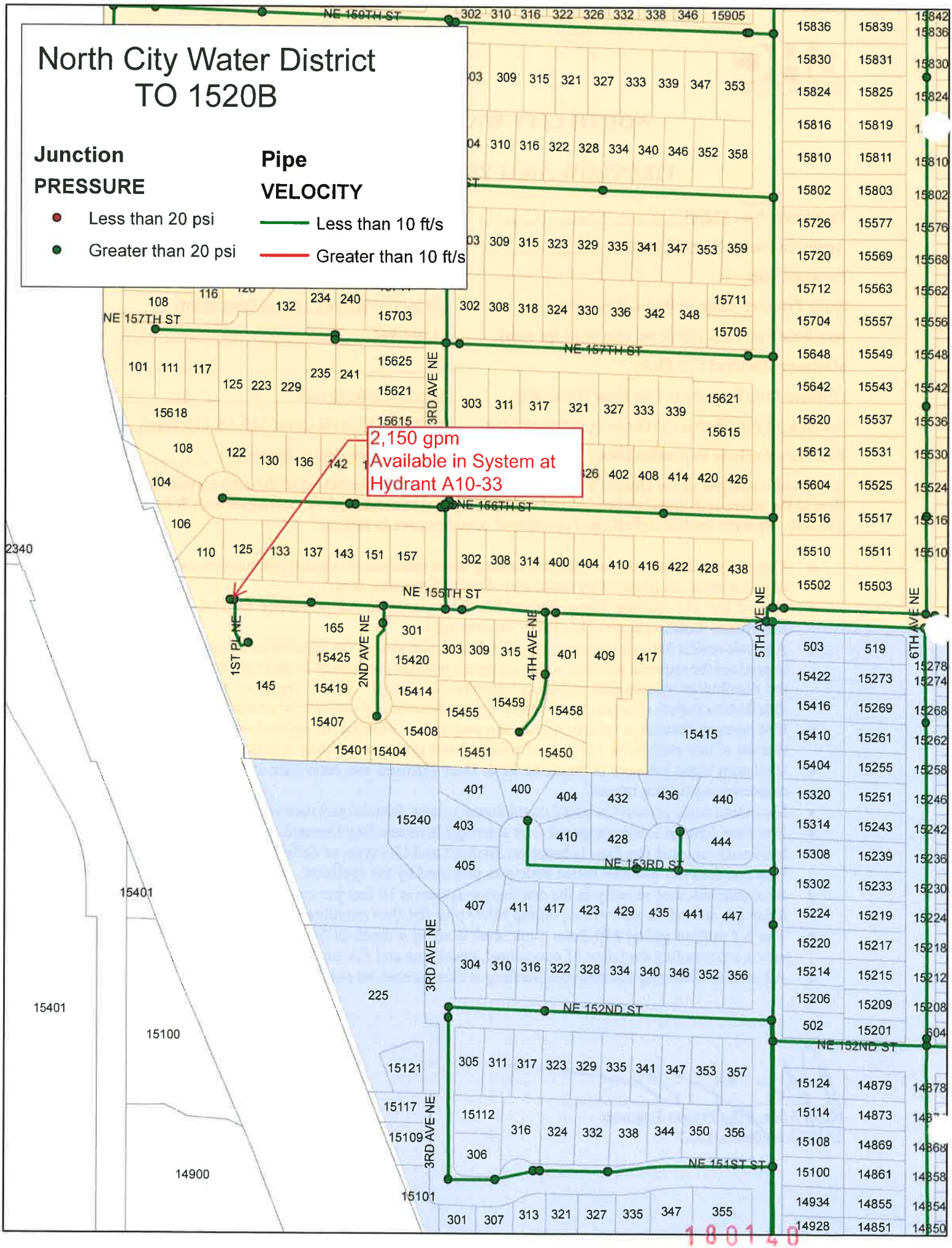
North City Water District
TO 1520B
Junction
PRESSURE
Less than 20 psi
Greater than 20 psi
Pipe
VELOCITY
Less than 10 ft/s
Greater than 10 ft/s
2,150 gpm
Available in System at
Hydrant A10-33
NE 159TH ST
NE 157TH ST
NE 156TH ST
NE 155TH ST
NE 153RD ST
NE 152ND ST
NE 151ST ST
1ST PL NE
2ND AVE NE
3RD AVE NE
4TH AVE NE
5TH AVE NE
6TH AVE NE
180140

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NORTH CITY WATER DISTRICT

FIRE FLOW ANALYSIS INFORMATION

Task Order No.: 1520C	Date: August 9, 2018
Applicant Name: Sound Transit	Project Location: 15918 1st Ave NE, Shoreline
Proposed Use:	N/A
Static Pressure Range at Project Location:	109 psi (minimum); 111 psi (maximum)
Available Fire Flow (@ 20 psi min or 10 fps max):	1,253 GPM
Minimum Required Fire Flow:	N/A
Distance from Property to Fire Flow Hydrant(s):	Refer to map
Location of Fire Hydrant(s) (Refer to Attached Map):	System; refer to map (615 Zone)
Fire Flow Analysis Expiration Date:	*(one year from date of issuance)*

A hydraulic analysis of the District's water distribution system was performed to determine available fire flow at the above-referenced project location. The analysis was conducted in accordance with WAC 246-290-230. Specific analysis criteria and operational conditions are as follows:

- This analysis is based on the District's existing water distribution system configuration and includes improvements associated with expansion of the 615 pressure zone.
- One of the 615 Booster Pump Station fire flow pumps is out of service for this analysis, in accordance with Department of Health requirements.
- Analysis results indicate the capacity of the distribution system (as opposed to a given fire hydrant) to produce the required fire flow with a minimum residual pressure of 20 psi at all points throughout the distribution system (not including transmission piping). Actual fire flows may vary due to distribution system changes, variations in system demand and operational conditions.
- Fire hydrant distance is measured from the project line fronting the right-of-way, to the hydrant. Results of this analysis do not include potential new project site piping or hydrants.
- Minimum static pressure is based on Peak Hour Demand and reservoirs at the bottom of their respective equalizing ranges.
- Maximum static pressure is based on minimum system demand and reservoirs full.
- Fire flow demand is superimposed over existing Maximum Day Demand (MDD).
- Minimum required fire flow is based on Zoning/Land-Use type, as defined in the Comprehensive Plan and does not consider actual structures proposed by the applicant.
- Maximum allowed velocity in the distribution system is 10 feet per second for existing mains and 8 feet per second for new mains, during MDD plus fire flow conditions.
- The 3.7 million gallon 590 Zone Tank level is set at a depth of 64.8 feet (556.8' water surface elev.), representing depletion of operational, equalizing and fire suppression storage.
- All pressure reducing stations are operating at their normal set points.

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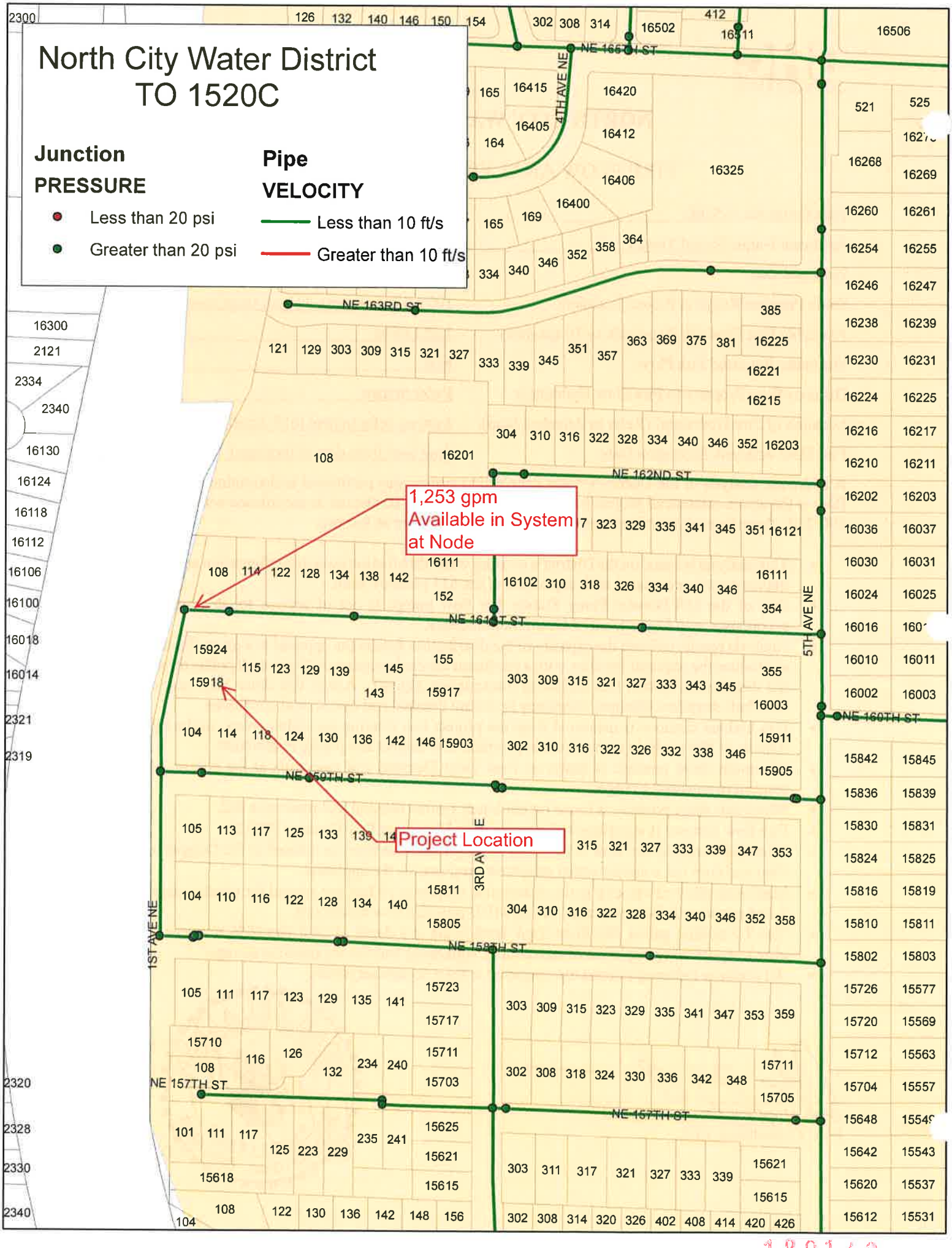
North City Water District
TO 1520C
Junction
PRESSURE
Less than 20 psi
Greater than 20 psi
Pipe
VELOCITY
Less than 10 ft/s
Greater than 10 ft/s
1,253 gpm
Available in System
at Node
Project Location
NE 163RD ST
NE 162ND ST
NE 161ST ST
NE 160TH ST
NE 159TH ST
NE 158TH ST
NE 157TH ST
4TH AVE NE
5TH AVE NE
3RD AVE NE
1ST AVE NE

180140

NORTH CITY WATER DISTRICT

FIRE FLOW ANALYSIS INFORMATION

Task Order No.: 1520D	Date: August 09, 2018
Applicant Name: Sound Transit	Project Location: 17222 1st Ave NE, Shoreline
Proposed Use:	N/A
Static Pressure Range at Project Location:	97 psi (minimum); 98 psi (maximum)
Available Fire Flow (@ 20 psi min or 10 fps max):	1,547 GPM
Minimum Required Fire Flow:	N/A
Distance from Property to Fire Flow Hydrant(s):	100 feet
Location of Fire Hydrant(s) (Refer to Attached Map):	17210 1st Ave NE (Hydrant A7-33, 615 Zone)
Fire Flow Analysis Expiration Date:	*(one year from date of issuance)*

A hydraulic analysis of the District's water distribution system was performed to determine available fire flow at the above-referenced project location. The analysis was conducted in accordance with WAC 246-290-230. Specific analysis criteria and operational conditions are as follows:

- This analysis is based on the District's existing water distribution system configuration and includes improvements associated with expansion of the 615 pressure zone.
- One of the 615 Booster Pump Station fire flow pumps is out of service for this analysis, in accordance with Department of Health requirements.
- Analysis results indicate the capacity of the distribution system (as opposed to a given fire hydrant) to produce the required fire flow with a minimum residual pressure of 20 psi at all points throughout the distribution system (not including transmission piping). Actual fire flows may vary due to distribution system changes, variations in system demand and operational conditions.
- Fire hydrant distance is measured from the project line fronting the right-of-way, to the hydrant. Results of this analysis do not include potential new project site piping or hydrants.
- Minimum static pressure is based on Peak Hour Demand and reservoirs at the bottom of their respective equalizing ranges.
- Maximum static pressure is based on minimum system demand and reservoirs full.
- Fire flow demand is superimposed over existing Maximum Day Demand (MDD).
- Minimum required fire flow is based on Zoning/Land-Use type, as defined in the Comprehensive Plan and does not consider actual structures proposed by the applicant.
- Maximum allowed velocity in the distribution system is 10 feet per second for existing mains and 8 feet per second for new mains, during MDD plus fire flow conditions.
- The 3.7 million gallon 590 Zone Tank level is set at a depth of 64.8 feet (556.8' water surface elev.), representing depletion of operational, equalizing and fire suppression storage.
- All pressure reducing stations are operating at their normal set points.

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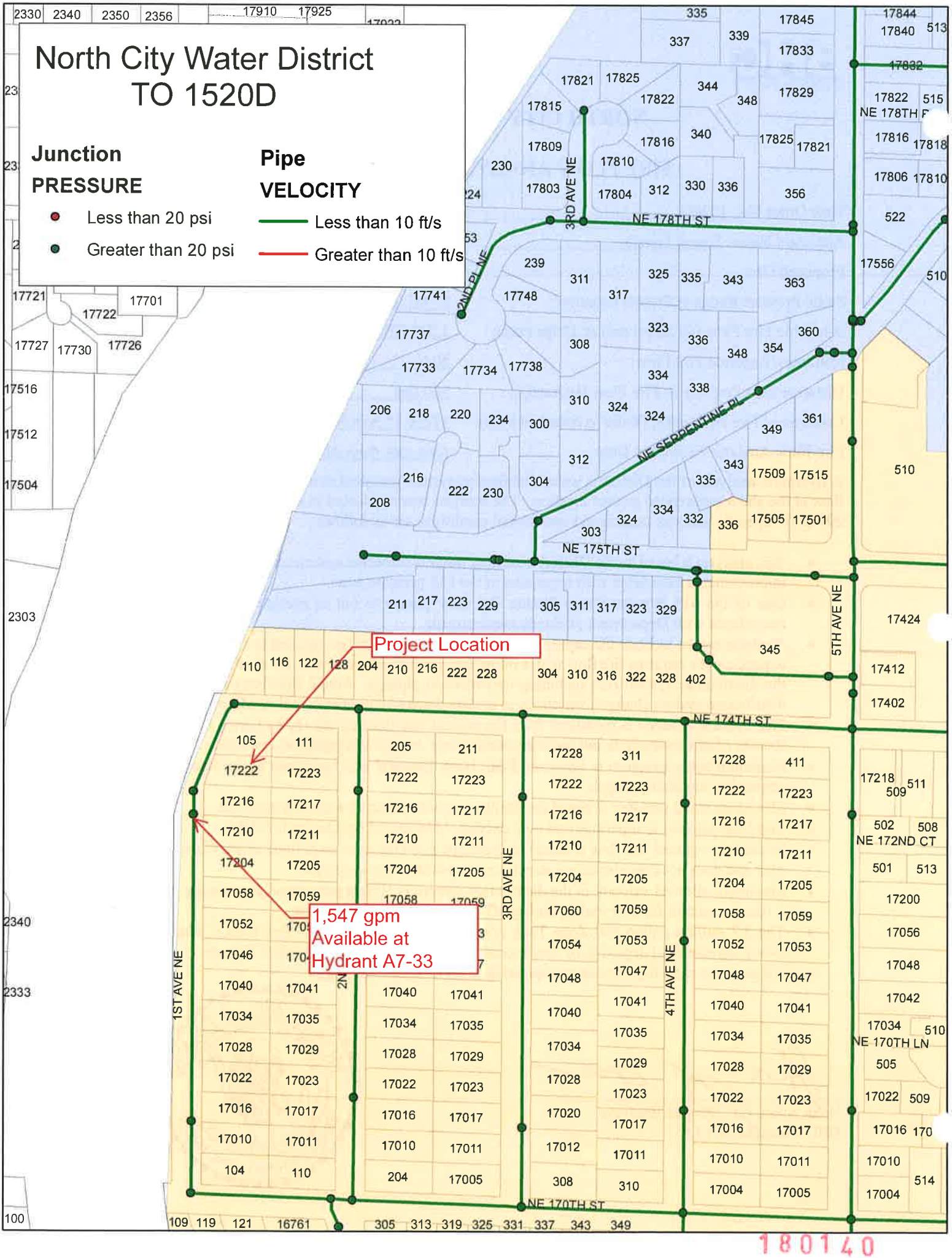
North City Water District
TO 1520D
Junction
PRESSURE
Less than 20 psi
Greater than 20 psi
Pipe
VELOCITY
Less than 10 ft/s
Greater than 10 ft/s
Project Location
1,547 gpm
Available at
Hydrant A7-33
NE 178TH ST
NE 175TH ST
NE 174TH ST
NE 170TH ST
NE SERPENTINE PL
3RD AVE NE
1ST AVE NE
2ND PL NE
4TH AVE NE
5TH AVE NE
NE 178TH PL
NE 172ND CT
NE 170TH LN
180140

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FIRE FLOW ANALYSIS INFORMATION

Task Order No.: 1520E	Date: August 09, 2018
Applicant Name: Sound Transit	Project Location: 18529 8th Ave NE, Shoreline
Proposed Use:	N/A
Static Pressure Range at Project Location:	81 psi (minimum); 88 psi (maximum)
Available Fire Flow (@ 20 psi min or 10 fps max):	4,600 GPM
Minimum Required Fire Flow:	N/A
Distance from Property to Fire Flow Hydrant(s):	275 feet
Location of Fire Hydrant(s) (Refer to Attached Map):	18559 8th Ave NE (Hydrant B4-17, 590 Zone)
Fire Flow Analysis Expiration Date:	*(one year from date of issuance)*

A hydraulic analysis of the District's water distribution system was performed to determine available fire flow at the above-referenced project location. The analysis was conducted in accordance with WAC 246-290-230. Specific analysis criteria and operational conditions are as follows:

- This analysis is based on the District's existing water distribution system configuration and includes improvements associated with expansion of the 615 pressure zone.
- Analysis results indicate the capacity of the distribution system (as opposed to a given fire hydrant) to produce the required fire flow with a minimum residual pressure of 20 psi at all points throughout the distribution system (not including transmission piping). Actual fire flows may vary due to distribution system changes, variations in system demand and operational conditions.
- Fire hydrant distance is measured from the project line fronting the right-of-way, to the hydrant. Results of this analysis do not include potential new project site piping or hydrants.
- Minimum static pressure is based on Peak Hour Demand and reservoirs at the bottom of their respective equalizing ranges.
- Maximum static pressure is based on minimum system demand and reservoirs full.
- Fire flow demand is superimposed over existing Maximum Day Demand (MDD).
- Minimum required fire flow is based on Zoning/Land-Use type, as defined in the Comprehensive Plan and does not consider actual structures proposed by the applicant.
- Maximum allowed velocity in the distribution system is 10 feet per second for existing mains and 8 feet per second for new mains, during MDD plus fire flow conditions.
- The 3.7 million gallon 590 Zone Tank level is set at a depth of 64.8 feet (556.8' water surface elev.), representing depletion of operational, equalizing and fire suppression storage.
- All pressure reducing stations are operating at their normal setpoints.

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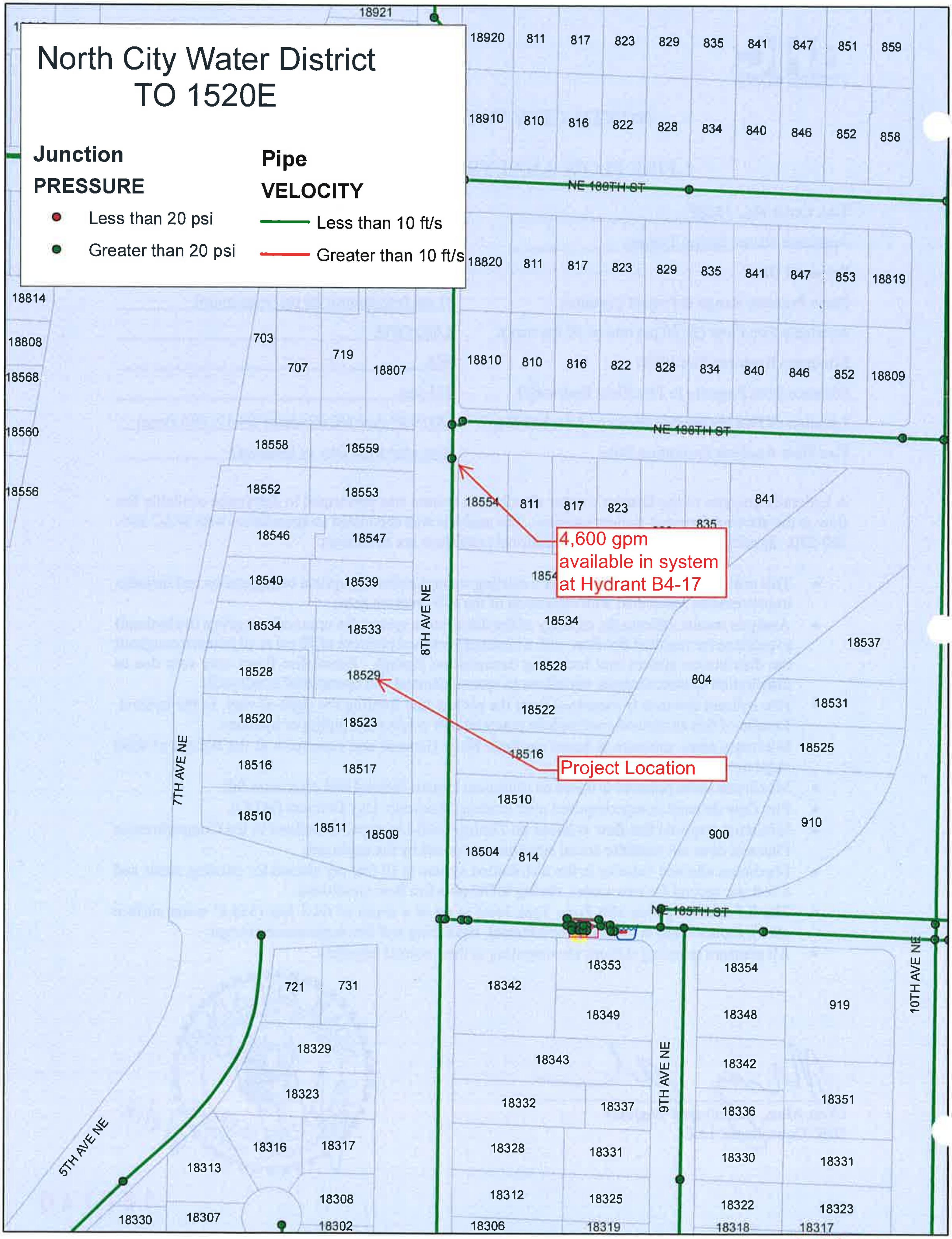
North City Water District
TO 1520E
Junction
PRESSURE
Less than 20 psi
Greater than 20 psi
Pipe
VELOCITY
Less than 10 ft/s
Greater than 10 ft/s
NE 189TH ST
NE 188TH ST
NE 185TH ST
8TH AVE NE
7TH AVE NE
9TH AVE NE
10TH AVE NE
5TH AVE NE
4,600 gpm available in system at Hydrant B4-17
Project Location

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NORTH CITY WATER DISTRICT

FIRE FLOW ANALYSIS INFORMATION

Task Order No.: 1520G	Date: August 09, 2018
Applicant Name: Sound Transit	Project Location: NE 195th St at I-5, Shoreline
Proposed Use:	N/A
Static Pressure Range at Project Location:	81 psi (minimum); 88 psi (maximum)
Available Fire Flow (@ 20 psi min or 10 fps max):	391 GPM at Hydrant; 3,523 GPM System
Minimum Required Fire Flow:	N/A
Distance from Property to Fire Flow Hydrant(s):	N/A
Location of Fire Hydrant(s) (Refer to Attached Map):	822 NE 195th St (Hydrant B2-12, 590 Zone)
Fire Flow Analysis Expiration Date:	*(one year from date of issuance)*

A hydraulic analysis of the District's water distribution system was performed to determine available fire flow at the above-referenced project location. The analysis was conducted in accordance with WAC 246-290-230. Specific analysis criteria and operational conditions are as follows:

- This analysis is based on the District's existing water distribution system configuration and includes improvements associated with expansion of the 615 pressure zone.
- Analysis results indicate the capacity of the distribution system (as opposed to a given fire hydrant) to produce the required fire flow with a minimum residual pressure of 20 psi at all points throughout the distribution system (not including transmission piping). Actual fire flows may vary due to distribution system changes, variations in system demand and operational conditions.
- Fire hydrant distance is measured from the project line fronting the right-of-way, to the hydrant. Results of this analysis do not include potential new project site piping or hydrants.
- Minimum static pressure is based on Peak Hour Demand and reservoirs at the bottom of their respective equalizing ranges.
- Maximum static pressure is based on minimum system demand and reservoirs full.
- Fire flow demand is superimposed over existing Maximum Day Demand (MDD).
- Minimum required fire flow is based on Zoning/Land-Use type, as defined in the Comprehensive Plan and does not consider actual structures proposed by the applicant.
- Maximum allowed velocity in the distribution system is 10 feet per second for existing mains and 8 feet per second for new mains, during MDD plus fire flow conditions.
- The 3.7 million gallon 590 Zone Tank level is set at a depth of 64.8 feet (556.8' water surface elev.), representing depletion of operational, equalizing and fire suppression storage.
- All pressure reducing stations are operating at their normal setpoints.

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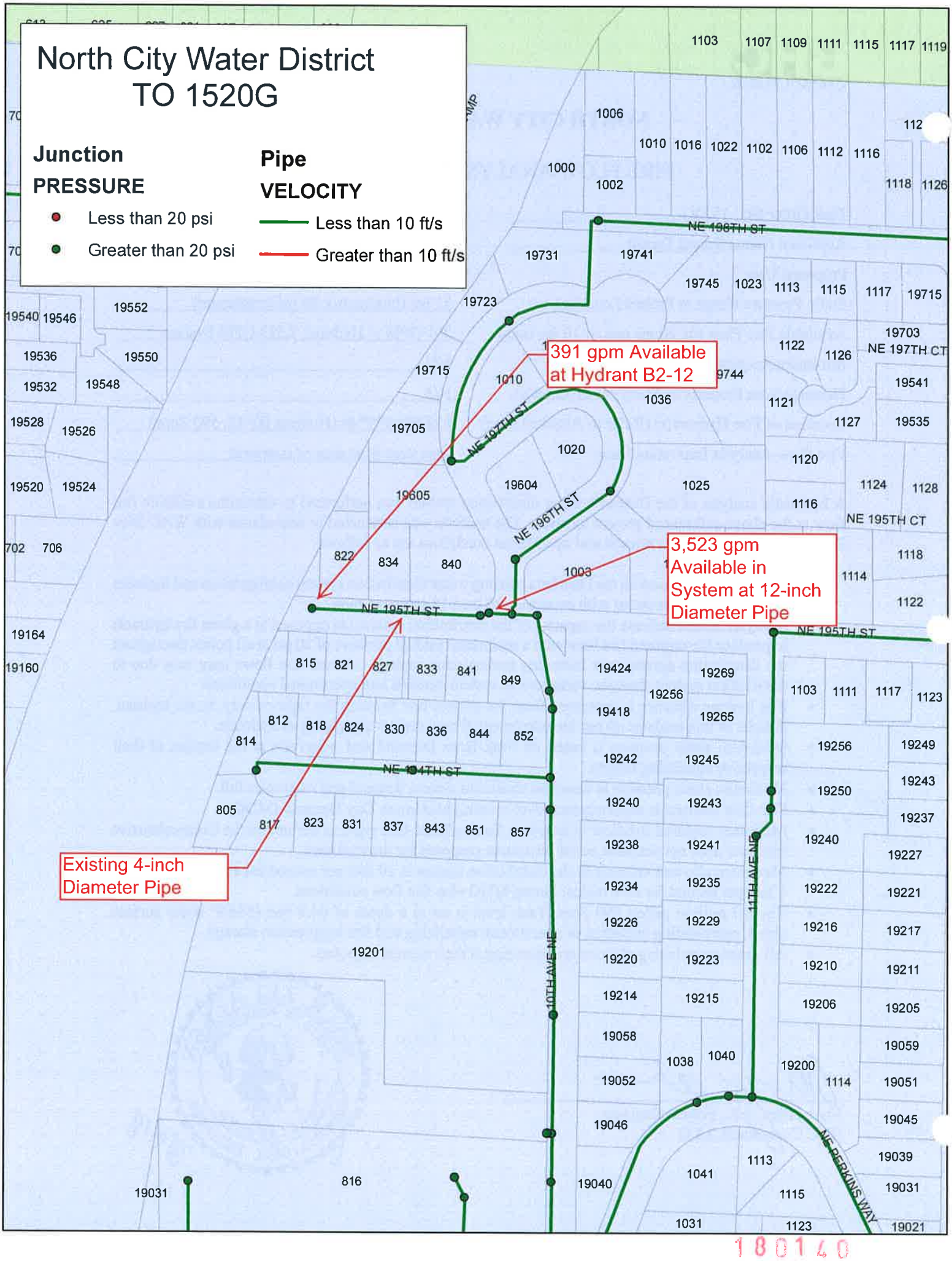
North City Water District
TO 1520G
Junction
PRESSURE
Less than 20 psi
Greater than 20 psi
Pipe
VELOCITY
Less than 10 ft/s
Greater than 10 ft/s
391 gpm Available at Hydrant B2-12
3,523 gpm Available in System at 12-inch Diameter Pipe
Existing 4-inch Diameter Pipe
NE 198TH ST
NE 197TH ST
NE 196TH ST
NE 195TH ST
NE 194TH ST
10TH AVE NE
11TH AVE NE
NE PERKINS WAY
NE 197TH CT
NE 195TH CT

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NORTH CITY WATER DISTRICT

FIRE FLOW ANALYSIS INFORMATION

Task Order No.: 1520F	Date: August 09, 2018
Applicant Name: Sound Transit	Project Location: NE 205th St at I-5
Proposed Use:	N/A
Static Pressure Range at Project Location:	85 psi (minimum); 87 psi (maximum)
Available Fire Flow (@ 20 psi min or 10 fps max):	2,150 GPM (refer to attached map)
Minimum Required Fire Flow (NCWD Comp Plan):	N/A
Distance from Property to Fire Flow Hydrant(s):	N/A
Location of Fire Hydrant(s) (Refer to Attached Map):	Refer to attached map
Fire Flow Analysis Expiration Date:	*(one year from date of issuance)*

A hydraulic analysis of the District's water distribution system was performed to determine available fire flow at the above-referenced project location. The analysis was conducted in accordance with WAC 246-290-230. Specific analysis criteria and operational conditions are as follows:

- This analysis is based on the District's existing water distribution system configuration and includes improvements associated with expansion of the 615 pressure zone.
- Analysis results indicate the capacity of the distribution system (as opposed to a given fire hydrant) to produce the required fire flow with a minimum residual pressure of 20 psi at all points throughout the distribution system (not including transmission piping). Actual fire flows may vary due to distribution system changes, variations in system demand and operational conditions.
- Fire hydrant distance is measured from the project line fronting the right-of-way, to the hydrant.
- Minimum static pressure is based on Peak Hour Demand and reservoirs at the bottom of their respective equalizing ranges; maximum static pressure is based on minimum system demand and reservoirs full.
- Fire flow demand is superimposed over existing Maximum Day Demand (MDD).
- Minimum required fire flow is based on Zoning/Land-Use type, as defined in the Comprehensive Plan and does not consider actual structures proposed by the applicant.
- Maximum allowed velocity in the distribution system is 10 feet per second for existing mains and 8 feet per second for new mains, during MDD plus fire flow conditions.
- The 590 to 502 zone PRV at the 3.7 tank site is offline for this analysis. Supply Stations 1 and 3 to the 502 zone are at their normal setpoints.
- All pressure reducing stations are operating at their normal setpoints.

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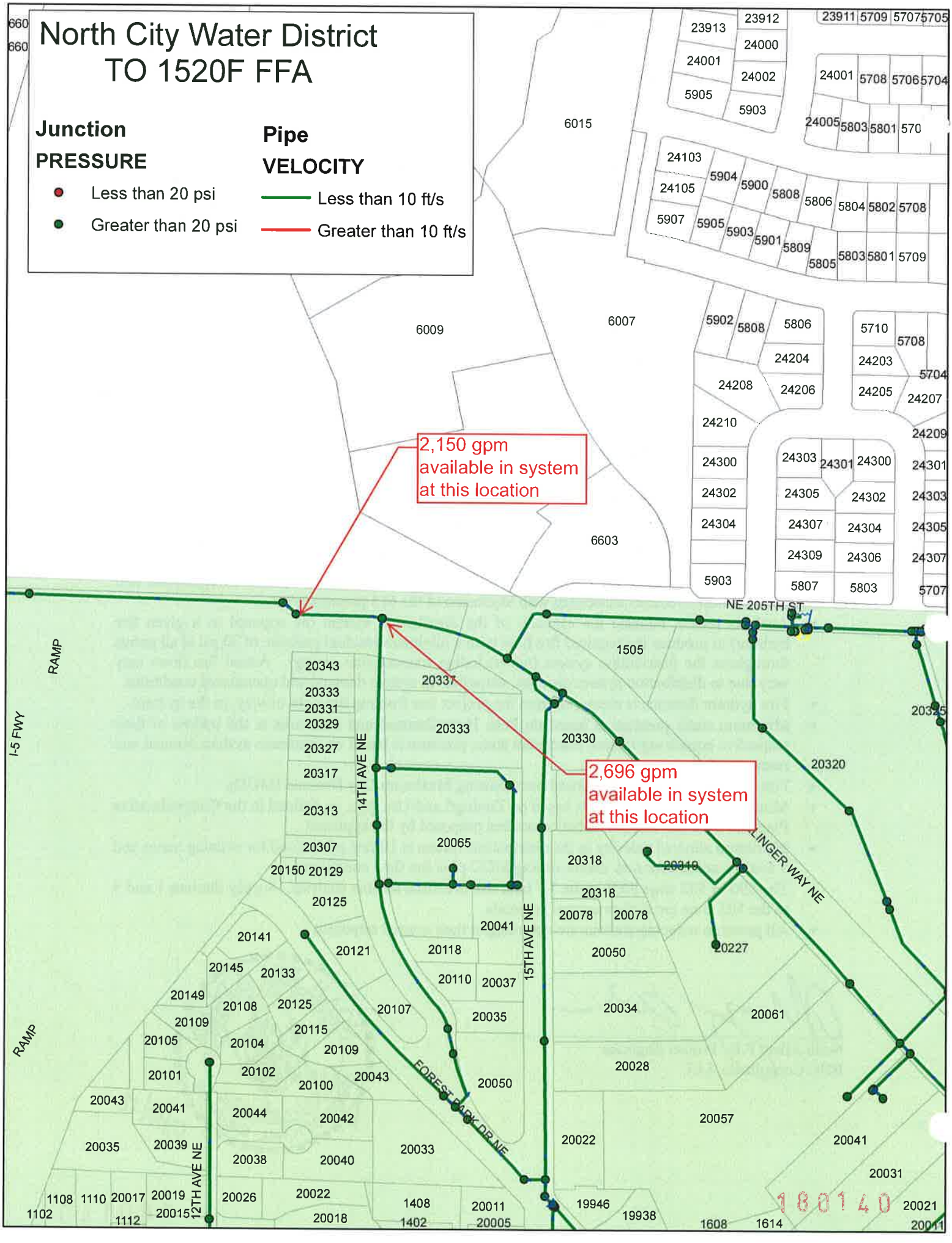
North City Water District
TO 1520F FFA
Junction
PRESSURE
Less than 20 psi
Greater than 20 psi
Pipe
VELOCITY
Less than 10 ft/s
Greater than 10 ft/s
2,150 gpm available in system at this location
2,696 gpm available in system at this location
NE 205TH ST
14TH AVE NE
15TH AVE NE
12TH AVE NE
FOREST PARK DR NE
I-5 FWY
RAMP
RAMP
6015
6009
6007
6603
1505
20320
20330
20333
20337
20343
20333
20331
20329
20327
20317
20313
20307
20150
20129
20125
20065
20141
20145
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20318
1108
1110
20017
20019
1102
1112
20015
5902
5808
5806
24204
24208
24206
24210
24300
24302
24304
5903
5710
5708
24203
5704
24205
24207
24209
24303
24301
24300
24305
24302
24307
24304
24309
24306
5807
5803
5707
24301
24303
24305
24307
23913
23912
24000
24001
24002
5905
5903
23911
5709
57075705
24001
5708
5706
5704
24005
5803
5801
570
24103
5904
5900
24105
5808
5806
5804
5802
5708
5907
5905
5903
5901
5809
5805
5803
5801
5709
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