GOVERNMENT OF YUKON

COPPER RIDGE LOT 519 & 520

MUNICIPAL SERVICING ASSESSMENT

SEPTEMBER 30, 2022

CONFIDENTIAL

COPPER RIDGE LOT 519 & 520

MUNICIPAL SERVICING ASSESSMENT

GOVERNMENT OF YUKON

CONFIDENTIAL

PROJECT NO.: 221-05315-00
DATE: SEPTEMBER 30, 2022

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1 INTRODUCTION

1.1 OVERVIEW

The Government of Yukon retained WSP Canada Inc. (WSP) to develop a municipal servicing assessment report for Copper Ridge Lot 519 & 520. The intent of this report is to determine the maximum additional residential density achievable with the existing infrastructure and to identify the threshold where feasible infrastructure upgrades would be required.

The project site is shown in **Figure 1-1** and is located in the southwest region of the City of Whitehorse. The site is bounded by Diamond Way and Copper Ridge Place to the north, Falcon Drive to the east and south, and Tigereye Crescent to the west. The site is surrounded by existing developments where existing utilities are present, and the proposed development would tie into these existing utilities.

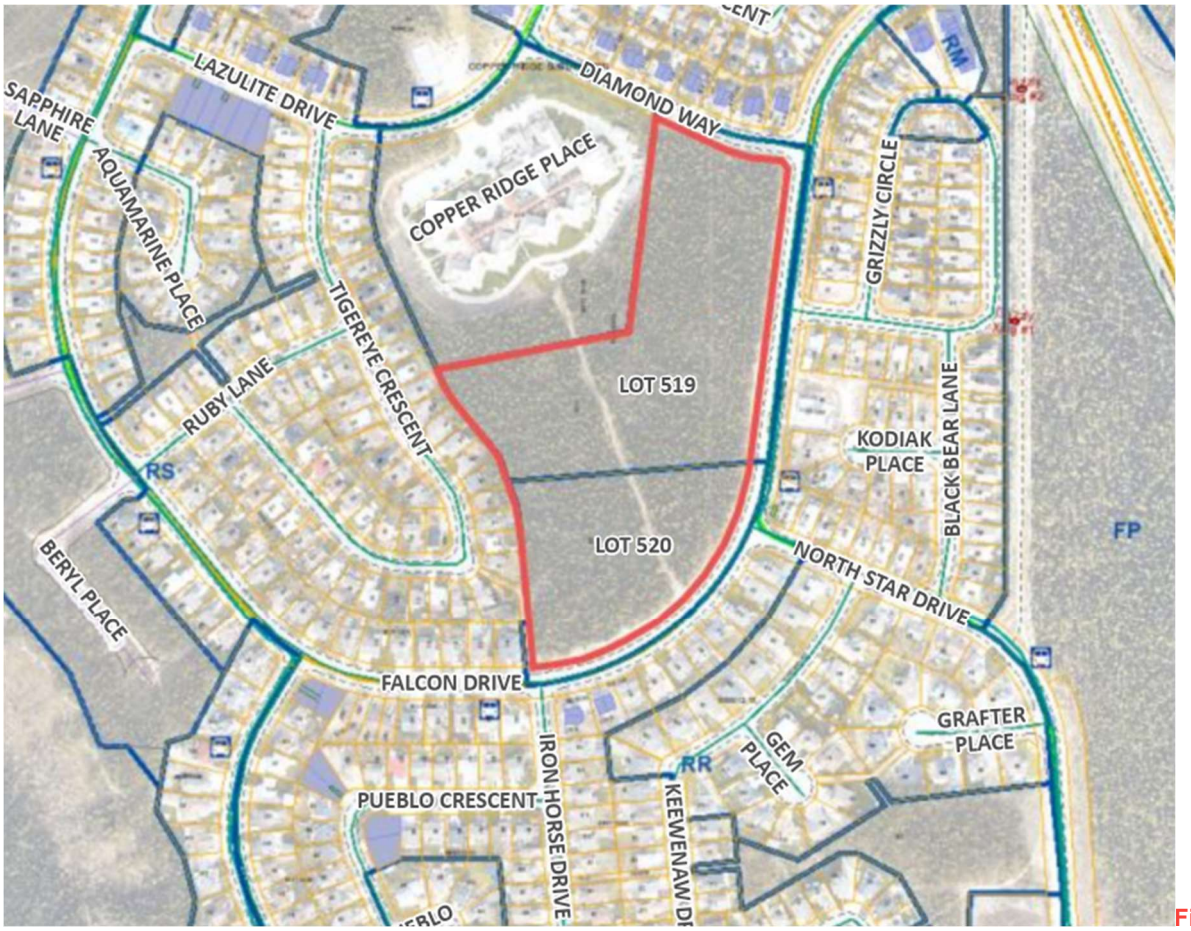


Figure 1-1 Copper Ridge Lot 519 & 520 (City of Whitehorse, 2022)

1.2 DATA COLLECTION AND BACKGROUND REVIEW

Various information including record drawings, studies, and datasets were provided by the City of Whitehorse, Yukon Government, ATCO Electric Yukon, and Northwestel, and are presented in **Table 1-1**.

Table 1-1 Data Summary

DATA	YEAR	DESCRIPTION
City of Whitehorse Open Data Portal Sanitary, Storm, and Water Datasets	2016	Shapefiles containing lines representing road centerlines, road right of ways; sanitary mains, manholes, outfalls, stations, valves; storm catchbasins, catchbasin manholes, culverts, ditches, mains, manholes, outfalls, stations; and water hydrants, mains, manholes, valves in the City of Whitehorse.
City of Whitehorse Open Data Portal LiDAR 1-meter data	2013	Point files of high-accuracy and high-resolution DEM processed into 1-meter post spacing within WH-67, 68, 77 and 78.
City of Whitehorse Servicing Standards Manual: Part 2 – Construction Design Criteria: Section 2.3 – Water Distribution System	2020	Design criteria for water distribution systems within the City of Whitehorse.
City of Whitehorse Servicing Standards Manual: Part 2 – Construction Design Criteria: Section 2.4 – Sanitary Sewer System	2020	Design criteria for sanitary sewer systems within the City of Whitehorse.
City of Whitehorse Servicing Standards Manual: Part 2 – Construction Design Criteria: Section 2.5 – Storm Drainage System	2020	Design criteria for storm sewer systems within the City of Whitehorse.
Government of Yukon Territory Predesign Report for Hillcrest Area "D" Subdivision in Whitehorse, Yukon – Final Report	1993	The Government of Yukon retained UMA Engineering Ltd. to prepare a detailed conceptual layout plan and pre-design engineering plan for the Hillcrest expansion area. The report discusses existing off-site infrastructure; design criteria for the proposed water distribution system, sanitary sewer system, roadways and drainage, shallow utilities; and a cost estimate.
City of Whitehorse Water Model	Year not provided	An EPANET model of the water distribution system within the City of Whitehorse.
Copper Ridge AutoCAD Drawing	Year not provided	AutoCAD drawing of lot lines, roadwork, sanitary sewer, storm sewer, and watermain infrastructure within the Copper Ridge subdivision.
Copper Ridge Infill Site Dataset	Year not provided	Shapefile containing lines representing the Copper Ridge Infill Site boundary.
Copper Ridge Existing Telecommunications Infrastructure Model	2022	PDF of existing telecommunications infrastructure within the Copper Ridge subdivision.
Copper Ridge Lot 519 & 520 Existing Power Infrastructure CAD Drawing	Year not provided	AutoCAD drawing of existing power infrastructure within the Copper Ridge subdivision.

Copper Ridge Subdivision Phase 2 – Stage 8 Utilities and Roadworks AutoCAD Drawing	1998	AutoCAD drawing of lot lines, roadwork, sanitary sewer, storm sewer, watermain, and electrical infrastructure within Phase 2 Stage 8 of the Copper Ridge subdivision.
Copper Ridge Subdivision Phase 2 – Stage 9 As-builts	2003	AutoCAD drawing of as-builts taken within Phase 2 Stage 9 of the Copper Ridge subdivision.
Copper Ridge Subdivision Phase 3 – Utilities & Roadworks Predesign AutoCAD Drawing	1998	AutoCAD drawing of lot lines, sanitary sewer, storm sewer, and watermain infrastructure within Phase 3 of the Copper Ridge subdivision.
Copper Ridge Subdivision Phase 5 AutoCAD Drawing	2000	AutoCAD drawing of lot lines within Phase 5 of the Copper Ridge subdivision.
Record Drawings	1994-2005	Record drawings of sanitary sewer, storm sewer and watermain infrastructure along Diamond Way, Falcon Drive, Grizzly Circle, Lazulite Drive, Tigereye Crescent, and within the Winze Place Lift Station.

1.3 ASSUMPTIONS AND LIMITATIONS

- All assessments are based on information provided by the City (no field visits or surveys conducted).
- The storm and sanitary sewer capacity will be assessed by analyzing the provided sewer models or flows and pipe information up to the nearest discharge location or trunk main (whichever is nearest).
- The proposed development will not be restricted to low density residential. If a higher density residential development on the proposed site is deemed feasible, any servicing restrictions and recommendations on infrastructure improvements will be provided. Condition assessment of the sanitary and storm sewer pipes is outside the scope of work. All pipes are assumed to be in good operating condition with no capacity limiting issues.
- The City's GIS water infrastructure datasets differed from the City's water distribution model. The model was assumed to be accurate.

2 EXISTING CONDITIONS

The regional topography, existing infrastructure, and existing land use within and surrounding the project site is illustrated in **Figure 2-1**, **Figure 2-2 to Figure 2-4**, and **Figure 2-5** respectively.

2.1 TOPOGRAPHY

Ground elevations within the project site range from 789 m in the south to 778 m in the north. This indicates that the topography within the project site slopes from south to north towards Diamond Way and Copper Ridge Place, a long-term care facility, then Lazulite Drive.

2.2 SANITARY SEWER SYSTEM

Upstream of the project site, the flows from lots to the south of North Star Drive discharge into the lift station on Winze Place. Based on the information provided by the City's Operations Team, the pumps in the lift station run alternatively after each pump cycle. The flows from the lift station continue north within the forcemain and discharge into the manhole at the North Star Drive & Drift Drive intersection. The flows from the lift station and the lots between North Star Drive and Falcon Drive discharge into Manhole S-86 and Manhole S-302 at the North Star Drive & Falcon Drive intersection and Manhole S-305 at the Iron Horse Drive & Falcon Drive intersection. From these manholes, the flows continue north along the 300 mm PE sanitary line on Falcon Drive and discharge into Manhole S-90. A 300 mm PE sanitary line runs northwest along Diamond Way from S-90 to S-92. The flows from Copper Ridge Place and the lots along Diamond Way discharge into this line. From S-92, a 350 mm PE sanitary trunk main runs northeast along Lazulite Drive. The contributing area to the lift station and trunk main, and the sanitary route described are shown in **Figure 3-1**.

2.3 STORMWATER SEWER SYSTEM

North of the project site, two catchbasins (CB-12A and CB-12B) are installed on each side of Diamond Way. 250 mm concrete CB leads connect the catchbasins to Manhole D-12 and from this manhole, a 300 mm concrete storm sewer runs northwest along Diamond Way and connects to Manhole D-11 at the Diamond Way & Lazulite Drive intersection. A 300 mm concrete storm line runs along Lazulite Drive, from Tigereye Crescent to Diamond Way, connecting to D-11. For Copper Ridge Place, a network of 150 to 250 mm storm sewers connect and discharge into the 300 mm concrete storm line along Lazulite Drive. A 300 mm CSP storm sewer stub connects to D-11 from the west. From D-11, a 450 mm HDPE storm trunk main runs northeast along Lazulite Drive.

2.4 WATER NETWORK

Key water distribution infrastructure in the area includes the Copper Ridge Pump Station, which is east of the proposed development site (across Falcon Drive). Additional existing infrastructure near the project site includes the following:

- A 200 mm ductile iron watermain on Diamond Way.
- Two (parallel) 250 mm ductile iron watermains on Falcon Drive between Iron Horse Drive and the Copper Ridge Pump Station (**Figure 2-2A**). The watermain nearest to the north/west end of Falcon Drive services the Tigereye Crescent and Ruby Lane area and includes one service ('Servicing Point 1') to the proposed development site approximately 15 m east of Iron Horse Drive. The other watermain (south/west end of Falcon Drive) services the area generally south of Falcon Drive (refer to **Section 3.3** for information on potential 'Servicing Point 3').
- A 250 mm ductile iron watermain on Falcon Drive approximately between the Copper Ridge Pump Station and Diamond Way. This watermain includes three services (considered as one service or 'Servicing Point 2') to the proposed development site, two of which are within 30 m of the Copper Ridge Pump Station and the final one, about 30 m south of Diamond Way.

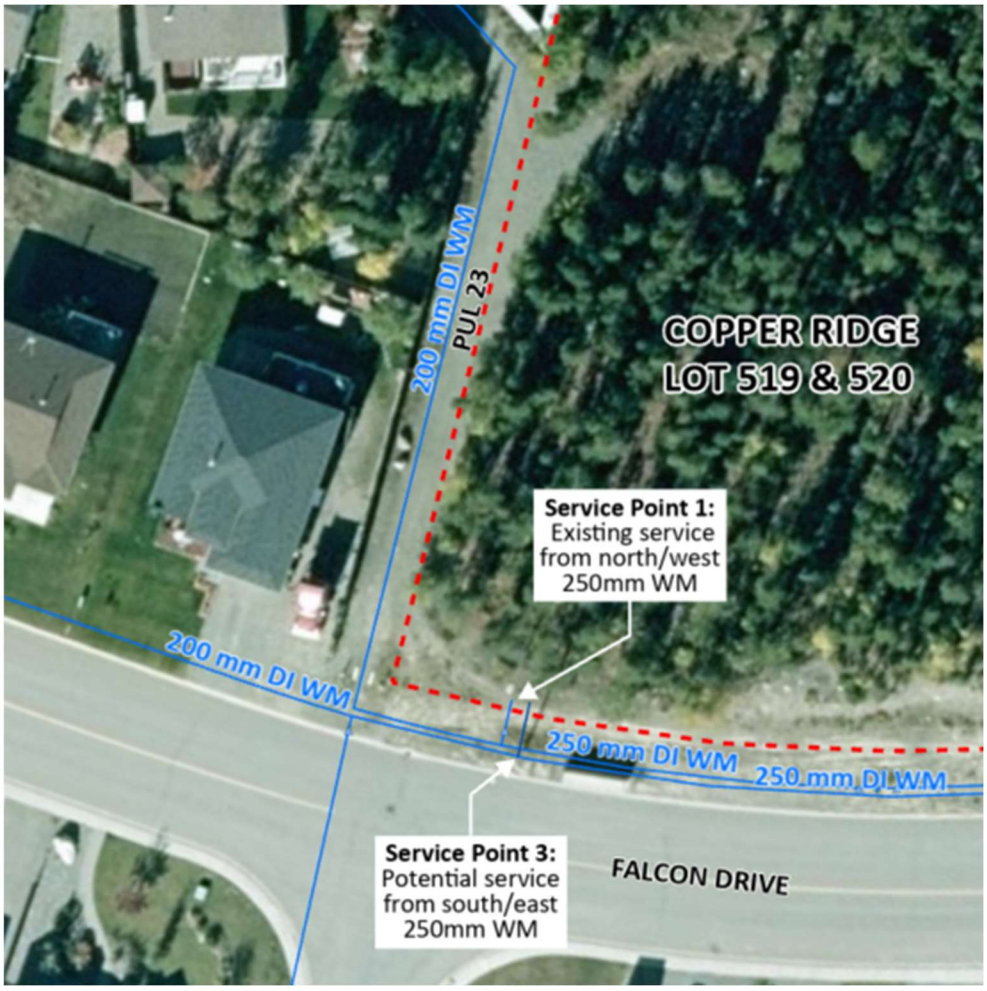


Figure 2-2A Existing watermains on Falcon Drive (between Iron Horse Drive and North Star Drive)

The City provided the current water distribution model for assessing the impact of the proposed development on the existing system. Model results for typical water demand scenarios (scenarios and design criteria explained in **Section 3**) under existing conditions are summarized in Table 2-1. Model screenshots showing results are also provided **Appendix C**.

Table 2-1 Existing conditions model results

MODEL NODE	APPROXIMATE LOCATION	SIMULATED PRESSURES (KPA)						
		ADD	MDD	MDD+100 L/S FF[1]	MDD+180 L/S FF[1]	PHD	NFD – FILLING	NFD – THERMAL
20700	Iron Horse Drive and Falcon Drive (south/east 250 mm watermain)	369.3	364.2	177.7	<0	358.8	371.6	373.3
20510	Iron Horse Drive and Falcon Drive (north/west 250 mm watermain)	405.2	385.6	111.7	<0	367.2	413.4	419.7
20010	Falcon Drive and Diamond Way (200 mm watermain)	322.3	290.1	<0	<0	259.7	335.8	346.3

Notes:

1 A fire flow of 100 or 180 L/s was applied at each model node evaluated.

The existing conditions model results indicate that the water distribution system could support up to a low-density residential development in the project site (subject to finished ground elevations within the project site). The 250 mm watermain on the south/east end of Falcon Drive provides the best alternative to service the project site (based on fire flow scenario results).

2.5 POWER

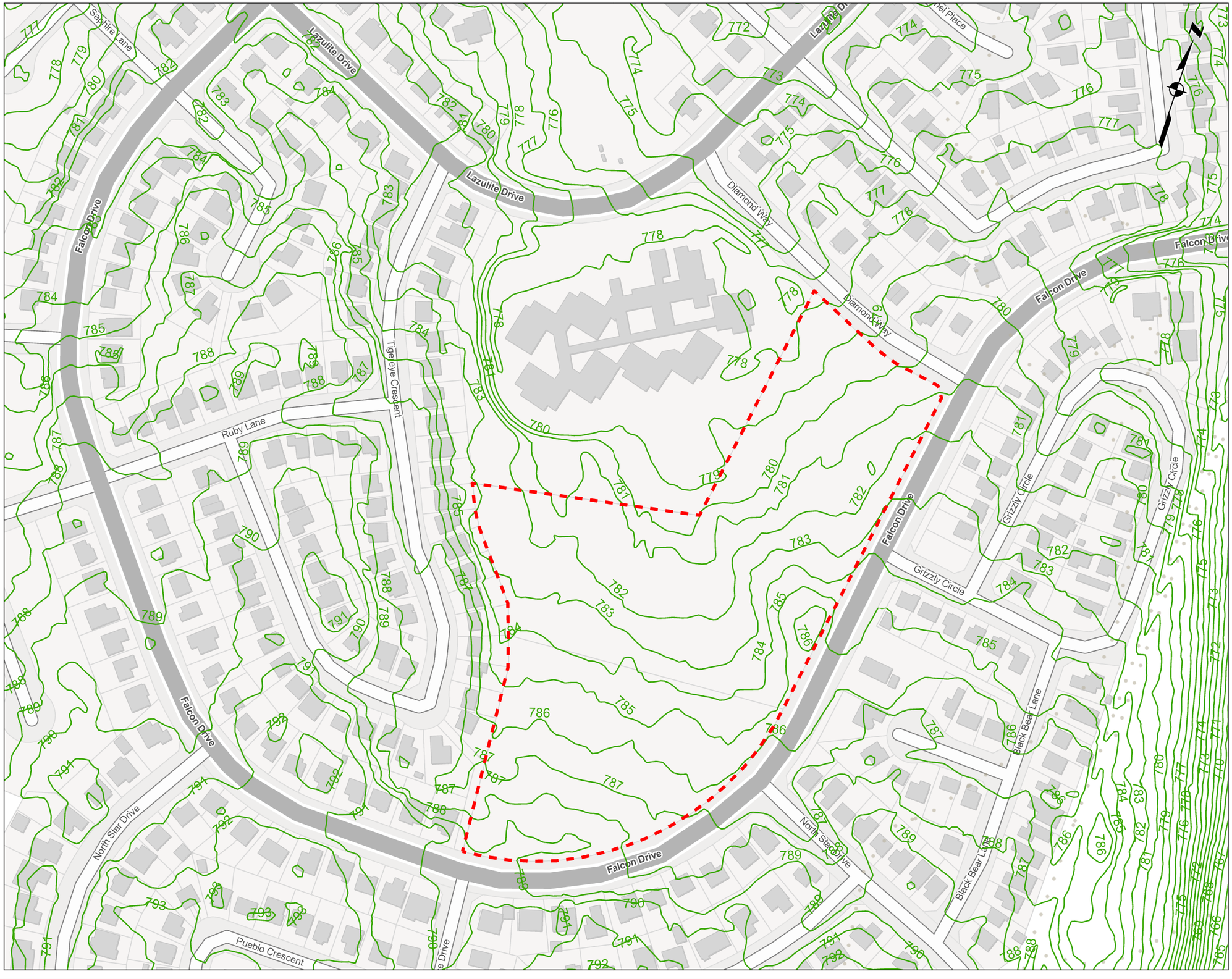
Figure 2-3 shows the existing power infrastructure in the surrounding neighborhood. Power is currently supplied by ATCO Electric Yukon in the surrounding neighborhood. The siteis located in an overhead rear lot serviced area. Services are not currently provided to the project site.

North of the project site, 25 kV numbered underground lines run along Lazulite Drive, and 14 kV underground lines and secondary underground lines run along Diamond Way. West of the project site, 25 kV underground lines and secondary underground lines run along Tigereye Crescent. East and south of the project site, 14 kV underground lines and secondary underground lines run along Grizzly Circle, Iron Horse Drive, Keewenaw Drive, and the southern portion of Falcon Drive. 25 kV underground lines and secondary underground lines run along North Star Drive and the northern portion of Falcon Drive.

Copper Ridge Place and the lots surrounding the project site are serviced by service drop underground lines.

2.6 TELECOMMUNICATIONS

Figure 2-4 shows the existing telecommunications infrastructure in the surrounding neighorhood. Telecommunications is currently supplied by Northwestel in the surrounding neighborhood. The existing infrastructure in the surrounding neighborhood is underground. Services are not currently provided to the project site.



Legend

- Project Boundary
- 1m Elevation Contour

Map Location

CITY OF WHITEHORSE

KEY MAP
1:500,000

Copper Ridge Lot 519 & 520
Municipal Servicing Assessment

Figure 2-1: Copper Ridge Lot 519 & 520 Regional Topography

City of Whitehorse
Yukon, Canada

Scale: 1:2,500

0 15 30 60 90 120 Meters

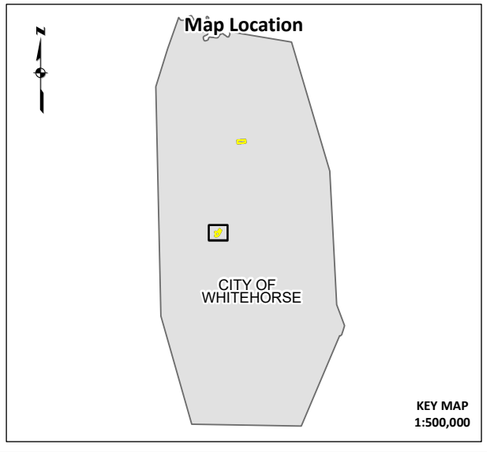
Universal Transverse Mercator (Zone 8N)
North American Datum (1983)

Report By: JC	WSP Job #: 221-05315-00
Drawn By: JC	Date: Sept 15, 2022
Reviewed By: GG, ES	Office: Edmonton

Notes: LiDAR Data provided by the City of Whitehorse Open Data Portal

Legend

- Project Boundary
- Water Mains
- Water Manholes
- Water Hydrants
- Water Valves
- Copper Ridge Pump House
- Storm Mains
- Storm Culverts
- Storm Ditches
- Storm Catch Basins
- Storm Catch Basin Manholes
- Storm Manholes
- Storm Outfalls
- Sanitary Mains
- Sanitary Manholes
- Sanitary Stations
- Figure 2-2A Detail



Copper Ridge Lot 519 & 520
Municipal Servicing Assessment

Figure 2-2: Copper Ridge Lot 519 & 520 Existing Infrastructure

City of Whitehorse
Yukon, Canada

Scale: 1:5,000

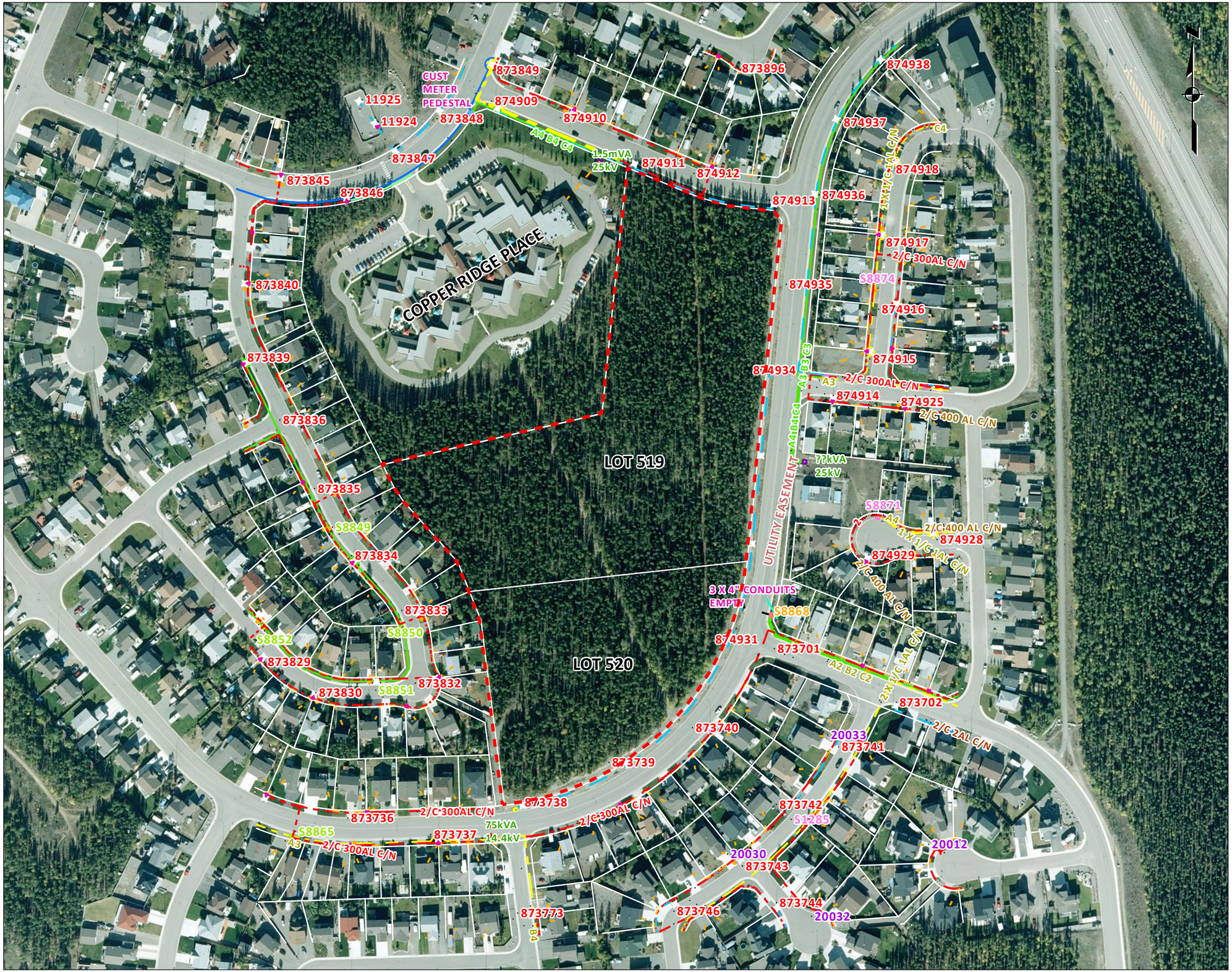
0 30 60 120 180 240 Meters

Universal Transverse Mercator (Zone 8N)
North American Datum (1983)

Report By: JC
Drawn by: JC
Reviewed By: GG, ES

WSP Job #: 221-05315-00
Date: Sept 19, 2022
Office: Edmonton

Notes: GIS data provided by the City of Whitehorse Open Data Portal



Legend

- Project Boundary
- 14 kV 1 Phase Underground Transformer
- 14 kV Underground Lines
- 25 kV 1 Phase Underground Transformer
- 25 kV 3 Phase Underground Transformer
- 25 kV 3 Phase Switch Cubicle
- 25 kV Numbered 3 Phase Switch Cubicle
- 25 kV Numbered Underground Lines
- 25 kV Underground Lines
- Conduit Only
- Easement
- HPS Steel
- Land Parcel
- Leader
- LED Steel Streetlight
- Pedestal
- Secondary Underground Isolation Point
- Secondary Underground Lines
- Service Drop Underground Lines
- Streetlight Abandoned Lines
- Streetlight Underground Lines
- Warning Lights

Copper Ridge Lot 519 & 520
Municipal Servicing Assessment

Figure 2-3: Copper Ridge Lot 519 & 520 Existing Power Infrastructure

City of Whitehorse
Yukon, Canada

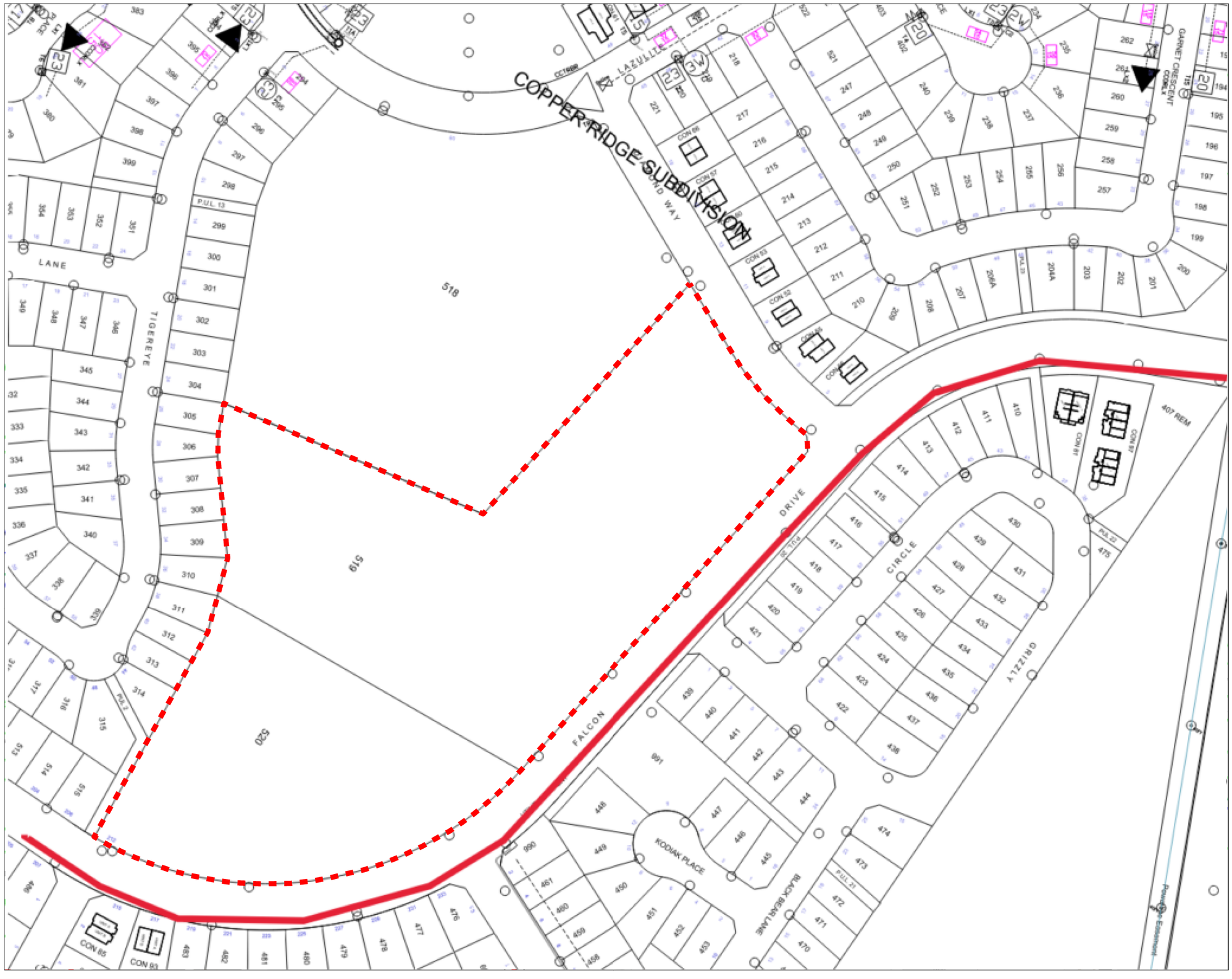
Scale: 1:2,500

0 15 30 60 90 120 Meters

Universal Transverse Mercator (Zone 8N)
North American Datum (1983)

Report By: JC	WSP Job #: 221-05315-00
Drawn by: JC	Date: Sept 22, 2022
Reviewed By: GG, ES	Off ce: Edmonton

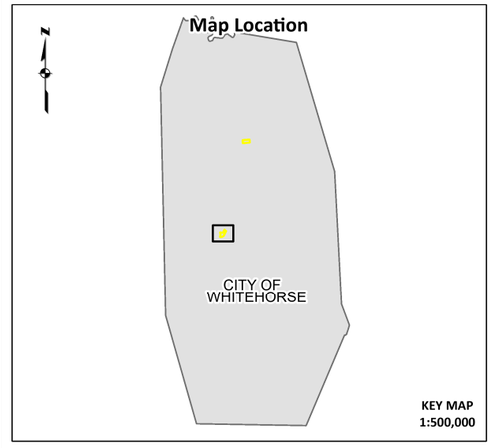
Notes: Shapef les provided by ATCO Electric Yukon



Legend

- Project Boundary
- Underground Infrastructure

Draft



Copper Ridge Lot 519 & 520
Municipal Servicing Assessment

Figure 2-4: Copper Ridge Lot 519 & 520
Existing Telecommunications Infrastructure

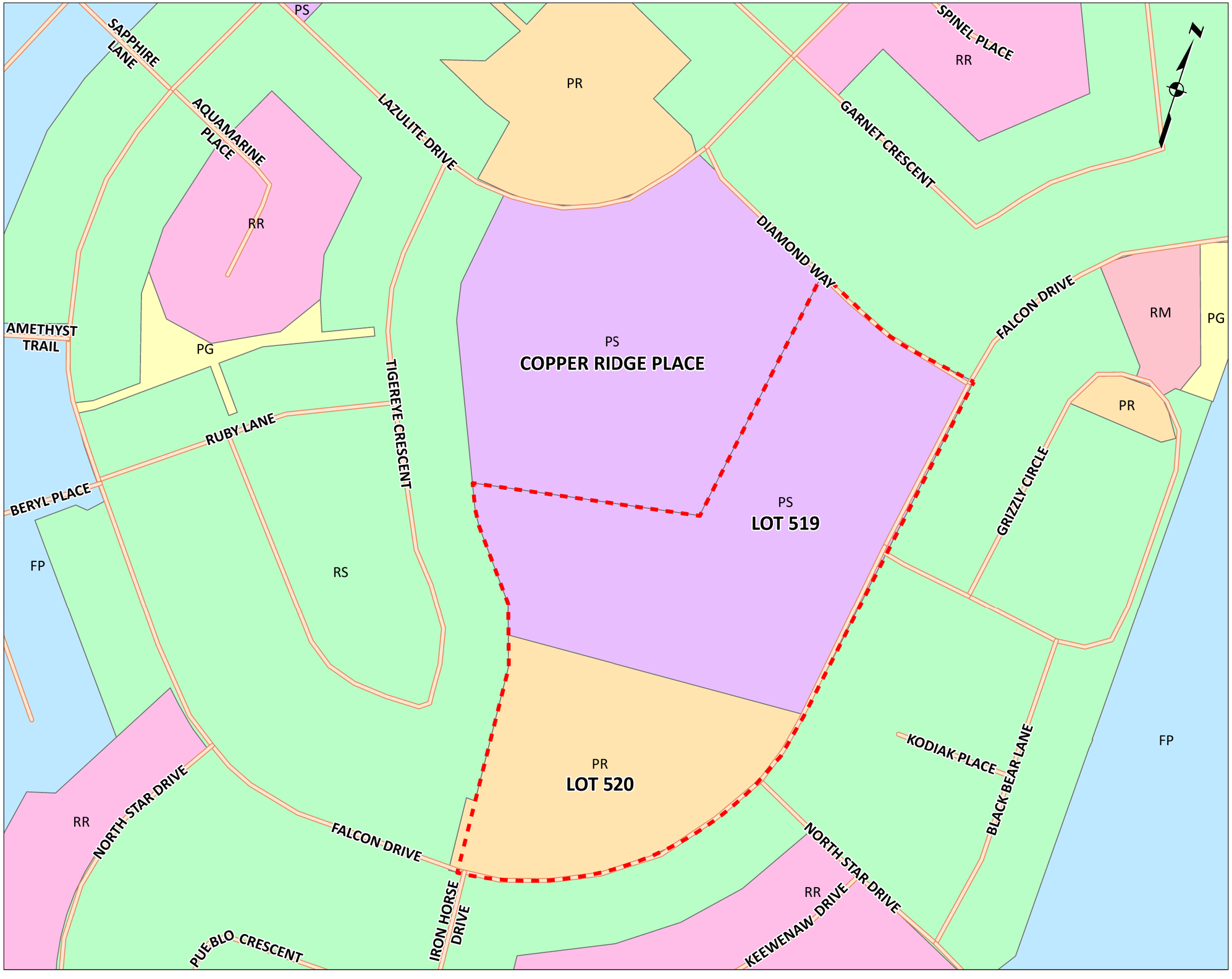
City of Whitehorse
Yukon, Canada

Scale: NTS

Universal Transverse Mercator (Zone 8N)
North American Datum (1983)

Report By: JC	WSP Job #: 221-05315-00
Drawn By: JC	Date: Sept 21, 2022
Reviewed By: GG, ES	Office: Edmonton

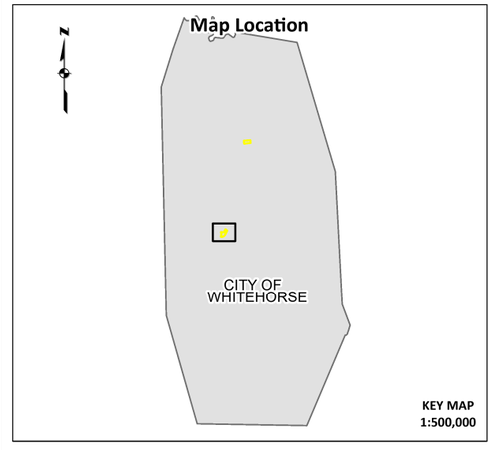
Notes: Figure provided by Northwestel



Legend

- Project Boundary
- FP (Future Planning)
- PG (Greenbelt)
- PR (Parks and Recreation)
- PS (Public Services)
- RM (Residential Multiple Housing)
- RR (Restricted Residential Detached)
- RS (Residential Single Detached)
- Roads

Draft



Copper Ridge Lot 519 & 520
Municipal Servicing Assessment

Figure 2-5: Copper Ridge Lot 519 & 520 Existing Land Use

City of Whitehorse
Yukon, Canada

Scale: 1:2,500

0 15 30 60 90 120 Meters

Universal Transverse Mercator (Zone 8N)
North American Datum (1983)

Report By: JC
Drawn By: JC
Reviewed By: GG, ES

WSP Job #: 221-05315-00
Date: Sept 20, 2022
Office: Edmonton

Notes: LiDAR Data provided by the City of Whitehorse Open Data Portal

3 ASSESSMENT

3.1 SANITARY SEWER SYSTEM

3.1.1 DESIGN CRITERIA

The scope of the sanitary sewer system assessment extends from upstream of the project site and up to the nearest downstream trunk main which is assumed to be the 350 mm PE sanitary sewer running along Lazulite Drive from S-108. It is assumed that the Copper Ridge Lot 519 & 520 sanitary sewer system will tie into S-91, and that the sanitary sewer system downstream of S-108 has the capacity to handle additional flows from the post-development condition of the project site. Flow monitoring can be conducted downstream of Manhole S-108 to confirm flow rates within the downstream system in order to validate this assumption.

The following parameters were used in the assessment and sourced from Section 2.3 and Section 2.4 of the City of Whitehorse Servicing Standards Manual:

- Capacity of Winze Place Lift Station Sewage Pump — 15 L/s
- Population Density (Residential) — 40 persons/ha
- Average Flow (90% of water consumption rate) — 450 L/c/d
- Peaking Factor (Residential) — 4.0
- Peaking Factor (Commercial, Industrial, Institutional) — 3.0
- Infiltration Allowance — 6000 L/ha/d

As per Kishchuk (2018), the average number of persons per dwelling within the City of Whitehorse averaged 2.34 persons in 2016. We used a conservative population density of 3 persons/home to determine the flows contributed by the existing residential lots.

3.1.2 RESULTS

Detailed calculations for the sanitary sewer system capacity can be found in **Appendix A**. Capacity calculations were completed for two downstream pipes: the 300 mm PE sanitary sewer running from S-91 to S-92 and the 300 mm PE sanitary sewer running from S-92 to S-108 (**Table 3-1**).

As per the Winze Place Lift Station record drawing and based on the assumption that one pump is running at a time, the capacity of the lift station equates the capacity of the sewage pump which discharges at a rate of 15 L/s. Therefore, the capacity of the lift station is considered to be 15 L/s which is below the calculated peak inflow rate of 17.22 L/s. To be conservative, 17.22 L/s was used in the calculations. The City's Operations Team noted that the pump at the lift station is running at capacity. The pump outflow rate could not be confirmed with the City's Operations Team as the flow is not monitored at the lift station. It is recommended that the City's Operations Team install temporary flow monitoring to determine the peak outflow rate prior to development of the project site.

The flows discharging from the residential lots downstream of the lift station and upstream of the project site, and contributing to the downstream pipes was considered (referred to as the Downstream Pipe Basin Boundary in **Figure 3-1**). Peak flows and inflow & infiltration were accounted for in the calculations. The total peak flow contributed by the lots is 18.20 L/s.

The flows discharging from Copper Ridge Place and contributing to the pipe section from S-92 to S-108 was also considered. As per the Government of Yukon (2022), there are 96 service beds in Copper Ridge Place. A maximum capacity of 96 persons was assumed and an allowance of 20 persons was included for staffing. Peak flows and

inflow & infiltration were accounted for in the calculations. The total peak flow contributed by Copper Ridge Place is 5.05 L/s.

The capacity of the pipe section from S-91 to S-92 was determined using the Manning Equation. The full flow capacity of the downstream pipe is 174.58 L/s. The remaining capacity in the downstream pipe was determined by subtracting the flows contributed by the lift station and residential lots from the capacity of the downstream pipe. The remaining capacity in the downstream pipe is 139.16 L/s which yields a population potential of 6,659 persons for Copper Ridge Lot 519 & 520.

The capacity of the pipe section from S-92 to S-108 was determined using the Manning Equation. The full flow capacity of the downstream pipe is 166.30 L/s. The remaining capacity in the downstream pipe was determined by subtracting the flows contributed by the lift station, residential lots, and Copper Ridge Place from the capacity of the downstream pipe. The remaining capacity in the downstream pipe is 125.83 L/s which yields a population potential of 6,019 persons for Copper Ridge Lot 519 & 520.

Table 3-1 Summary of Downstream Pipe Capacities

PIPE SECTION		SIZE	SLOPE	FULL FLOW CAPACITY	CONTRIBUTING FLOW	REMAINING CAPACITY	POPULATION POTENTIAL
FROM MH	TO MH	(MM)	(%)	(L/S)	(L/S)	(L/S)	(PERSONS)
S-91	S-92	300	3.78	174.58	35.42	139.16	6,659
S-92	S-108	300	3.43	166.30	40.47	125.83	6,019

The pipe section from S-92 to S-108 is the limiting pipe as it has a lower slope and a higher contributing flow, resulting in lower capacity. Therefore, the population potential of Copper Ridge Lot 519 & 520 is 6,019 persons based on the available pipe capacities calculated. This does not mean that the site or the downstream trunk sewer system can accommodate a population of 6,019 people. It more identifies that the existing sanitary sewer system from Manhole S-91 to the 375 mm trunk sewer is not the limiting factor for the site development potential.

The total capacity of the limiting pipe section from Manhole S-92 to S-108 is 166.30 L/s. The pre-design flow is 40.47 L/s, which results in a remaining capacity of 125.83 L/s. Based on a population density of 40 persons/ha and an area of 6.20 ha, Copper Ridge Lot 519 & 520 could accommodate a population of 248 persons. The 248 persons would contribute an additional flow of 5.59 L/s to the downstream pipe, resulting in a post-design flow of 46.07 L/s and a remaining capacity of 120.23 L/s.

As Copper Ridge Lot 519 & 520 is sloping towards Diamond Way, the implementation of an on-site gravity sanitary sewer system will be required and will tie into Manhole S-91. The implementation of a new lift station on the project site will likely not be required.

3.2 STORMWATER SEWER SYSTEM

3.2.1 DESIGN CRITERIA

The scope of the storm sewer system assessment extends from the project site and up to the nearest trunk main which is assumed to be the 450 mm HDPE storm sewer on Lazulite Drive running from D-11. It is assumed that the storm sewer system currently handles runoff from the pre-development condition of the project site during a 1:5 year rainfall event.

The following parameters were used in the assessment and sourced from the City of Whitehorse Rainfall Intensity Duration Data and Section 2.5 of the City of Whitehorse Servicing Standards Manual:

- Land Use of Copper Ridge Lot 519 & 520 — Open Space
- Runoff Coefficient — 0.15
- Time of Concentration (Inlet Time) — 15 min

- Intensity 19.41 mm/h

3.2.2 RESULTS

Detailed calculations for the storm sewer system capacity can be found in **Appendix B**.

From the LiDAR data, runoff from the site will flow towards Diamond Way, and will enter the storm sewer system via CB-12A. It is assumed that there is no cross-lot drainage so that the stormwater runoff from Copper Ridge Lot 519 & 520 will not flow into the Copper Ridge Place lot. The implementation of a swale between Lot 519 & the Copper Ridge Place lot may be required to direct the runoff from the project site to Diamond Way.

It is assumed that the post-development release rate will be required to match the pre-development flow rate for the 1:5 year rainfall event. The pre-development flow rate of the project site runoff was determined using the Rational Method. The pre-development flow rate for Copper Ridge Lot 519 & 520 is calculated at 50 L/s; therefore, the post-development release rate for Copper Ridge Lot 519 & 520 will need to be restricted to 50 L/s. Onsite stormwater sewer infrastructure, including stormwater management and storage, will likely be required in order to maintain pre-development flow rates. The implementation of an onsite sewer and storage system will likely require a storm sewer main extension along Diamond Way from Manhole D-11 to the project site. These sewer infrastructure upgrades may eliminate or lessen the need for the swale between Lot 519 & the Copper Ridge Place lot. Specific stormwater management and storm sewer extension requirements should be reviewed and confirmed to meet the post-development release rate during detailed design of the site.

It is not recommended to tie a portion of the onsite storm sewer system to the existing infrastructure in Grizzly Circle as the natural drainage patterns of the Copper Ridge site flow towards the Copper Ridge Place lot and Diamond Way. By tying a portion of the system to Grizzly Circle, an increase of flows would be introduced to the infrastructure along Grizzly Circle which were likely not accounted for in its original design. Additionally, as the site currently has significant crossfall to the northwest, a large amount of grading revisions would be required to redirect flow to Grizzly Place and would lead to challenges with pipe inverts.

The City noted that there is a history of drainage issues in the Copper Ridge Lot 519 & 520 area. The implementation of onsite storm sewer infrastructure will need to be reviewed during detailed design to ensure that the area is protected from flooding.

The City's Operations Team also noted that two rock pits are located along the west side of the development and that it receives runoff from dwellings along this side. The implementation or modification of storm services will need to be reviewed during detailed design to ensure that the dwellings are protected from flooding. It was also noted that there is a monitoring well used for groundwater surveillance located at the southwest corner of the site and that this well needs to be kept post-development.

3.3 WATER NETWORK

3.3.1 DESIGN CRITERIA

Section 2.3 of the City of Whitehorse Servicing Standards Manual was referenced for evaluating the impact of the proposed development on the existing water distribution system. The City standards require that analyses are conducted for Average Day Demand (ADD), Maximum Day Demand (MDD), Peak Hour Demand (PHD), MDD plus fire flow and Night Filling Demand (NFD). Relevant design criteria from the City standards are listed below:

- Average Daily Demand (ADD) 500 L/c/d
- Maximum Daily Demand (MDD) 2 x ADD
- Peak Hour Demand (PHD) 3 x ADD
- Fire Flow Low Density Residential (Single 100 L/s

Family, Duplex and Triplex)

- Fire Flow Medium Density Residential (Multiple Housing) — 180 L/s
- Fire Flow High Density Residential (Multiple Housing – 50 or more units) — 225 L/s
- Minimum Allowable Velocity — 0.15 m/s
- Maximum Allowable Velocity — 3.50 m/s
- Maximum Allowable Operating Pressure — 550 kPa
- Minimum Residual Pressure (PHD) — 280 kPa
- Minimum Residual Pressure (MDD + FF) — 140 kPa

The NFD scenarios represent the lowest system demand period (highest system pressures) and are usually simulated to analyze reservoir filling capabilities and flow circulation. These scenarios were configured based on Stantec Consulting Ltd. (2005) and are summarized below:

- NFD – Reservoir Filling — 0.6 x ADD
- NFD – Thermal Analysis — 0.3 x ADD

3.3.2 APPROACH

The impact of the proposed development on the existing system was evaluated using the City's current model, last updated on January 25, 2022. The model was used without modification except for splitting pipes at the approximate servicing points (described in **Section 2.4**) to add the water demands for the proposed development. In addition to the existing water services to the project site, a new servicing point ('Servicing Point 3' in **Figure 2-2A**) from the 250 mm watermain on the south/east end of Falcon Drive was also evaluated. A new watermain (also 250 mm) was added between the 250 mm watermains on Falcon Drive to assess the impact of looping the system through the project site. Parameters for the proposed infrastructure were based on the existing topography, model scale (for pipe lengths) and an assumed pipe roughness (Hazen-Williams C factor) of 150 (typical for PVC and HDPE pipe).

Water consumption areas, population values, and demands for the proposed development under various scenarios are summarized in **Table 3-2**. The assumed finished ground elevation in the project site was 789 m, about the same elevations at the south end of Falcon Drive and up to 9 m higher than at Falcon Drive and Diamond Way.

Table 3-2 Water Demands for the proposed development

ZONING	AREA (HA)	POP'N (PEOPLE)[1]	ADD (L/S)	MDD (L/S)	PHD (L/S)	NFD – FILLING (L/S)	NFD – THERMAL (L/S)
R	6.20	248	1.435	2.870	4.305	0.861	0.431

Notes:

1 Based on a population density of 40 persons/ha as outlined in Section 2.4 of the City of Whitehorse Servicing Standards.

3.3.3 MODEL RESULTS

Table 3-3 presents the model results for each servicing point evaluated for the proposed development. Screenshots of the model results are provided in **Appendix C**, and a digital file of the water model, including the new watermain and development demands, will be provided separately.

Table 3-3 Model results

SERVICING POINT	SIMULATED PRESSURES (KPA)							
	ADD	MDD	MDD+100 L/S FF[2]	MDD+180 L/S FF[2]	MDD+225 L/S FF[2]	PHD	NFD – FILLING	NFD – THERMAL[1]
1	409.0	387.2	115.8	<0	<0	366.4	418.2	425.3
2	230.4	193.1	<0	<0	<0	159.4	245.9	258.3
3	372.0	364.7	169.2	<0	<0	356.9	374.9	377.3
3 & south/east 250 mm watermain on Falcon Drive	394.3	385.1	288.4	160.7[3]	70.4	375.6	398.0[4]	400.7[4]

Notes:

1 Pipe velocities for the NFD – Thermal Analysis scenario were greater than 0.15 m/s near the proposed development site.
2 Pipe velocities were below 3.5 m/s near the proposed development site.
3 A model node (20010) near Falcon Drive and Diamond Way experienced pressures less than 140 kPa under this scenario.
4 Looping the system through the site leads to the areas generally around Valerie Crescent, Grizzly Circle and North Star Drive, now experiencing pipe velocities less than 0.15 m/s in low-demand scenarios.

Based on the model results, a medium-density residential development could be supported by the existing network by looping the system between Servicing Point 3 (south/end 250 mm watermain on Falcon Drive) and the north/west 250 mm watermain also on Falcon Drive. Although under the 180 L/s fire flow demand scenario, the system experiences pressures under 140 kPa at Falcon Drive and Diamond Way. The existing system can supply approximately up to about 170 L/s of fire flow at the project site such that pressures elsewhere are above 140 kPa. Looping the system through the project site does lead to pipe velocities less than 0.15 m/s around Valerie Crescent, Grizzly Circle and North Star Drive under low-demand scenarios.

A high-density residential development fire flow demand of 225 L/s was also evaluated with the new system loop. However, the existing system could not supply the required flows.

Model results should be updated when the proposed development zoning, road and lot layout, and rough grading are in more advanced stages. Fire hydrant flow testing is recommended to confirm model results.

3.3.4 EXISTING SYSTEM IMPROVEMENTS

System pressures and minimum pipe velocities could be improved if the Copper Ridge Pumphouse infrastructure is reconfigured or a direct feed from the station is provided to the project site. The system could also support a high-density residential development if these updates were implemented. However, changes to the pumphouse infrastructure were not evaluated as it requires a detailed review of the existing facility and coordination with City operations staff. Reconfiguration of the pumphouse infrastructure should be evaluated in future stages depending on the preferred type of residential development at the project site.

3.4 POWER

Based on a population density of 40 persons/ha and an area of 6.20 ha, Copper Ridge Lot 519 & 520 could accommodate a population of 248 persons. Assuming a population of 248 persons, an average of 3 residents per building, and zoning of single family, duplex or triplex lots, ATCO Electric Yukon would be able to service the site with front lot underground servicing. This servicing would include, but would not be limited to the installation of new single phase padmount transformers, single phase pedestals, street lights, switch cubicles, primary underground wires, and secondary underground wires. This work would not include individual servicing to each building. ATCO Electric Yukon would provide a single conduit stub to each lot that has the potential to be serviced with secondary voltage (120/240V single phase) from new pedestals in the area. This servicing would be consistent with the surrounding existing development and would require a utility corridor in the road right of way before any infrastructure is installed.

The required upgrades for a higher density residential development cannot be confirmed until specific details of the proposed development have been established and provided to ATCO Electric Yukon. This would depend on the proposed lot layout and if the utility corridor supplied meets the requirements for the servicing styles described in the previous paragraph.

3.5 TELECOMMUNICATIONS

Based on a population density of 40 persons/ha and an area of 6.20 ha, Copper Ridge Lot 519 & 520 could accommodate a population of 248 persons. Assuming a population of 248 persons, there is currently no capacity to service the project site at a low density residential development. To service the site at a low density, utility extensions and upgrades would be required for the existing telecommunications infrastructure. This may include a conduit fiber build which consists of ground level duct pedestals, as well as the addition of electronic equipment and joint trench shallow utilities to service the lots. The conduit system would tie into the existing infrastructure along Falcon Drive.

The required upgrades for a higher density residential development cannot be confirmed until specific details of the proposed development have been established and provided to Northwestel.

3.6 TRANSPORTATION

Figure 3-2 and **Figure 3-3** shows the proposed access points for Copper Ridge Lot 519 & 520. There are potentially two layouts for the access points.

The first layout would shift the existing intersections along Falcon Drive from three-legged to four-legged, both of which are generally preferred. The proposed four-legged intersections along Falcon Drive would meet the typical minimum spacing of 60 m between adjacent intersections along a collector road (i.e. Falcon Drive), a road on which traffic movement and access have similar importance.

The second option includes the implementation of three-legged intersections along Falcon Drive. The proposed intersections along Falcon Drive would meet the typical minimum spacing of 60 m between adjacent intersections along a collector road (i.e. Falcon Drive).

Both options include an access point along Diamond Way. This three-legged intersection meets the typical minimum spacing of 60 m between adjacent intersections along a collector road (i.e. Diamond Way).

A minimum of two points of ingress and egress should be provided in order to meet emergency servicing requirements. The City's Fire Department also requires that National Building Code of Canada and National Fire Code of Canada considerations and minimum are factored into the development.

At the time of application, the development will be assessed for compliance through a Development Review Process lead by the City's Land and Building Services Division. As part of this process, consultation with the City's Transportation Maintenance team will be required to ensure that access and street maintenance (if public) is captured with their operational envelope.

Basic data related to location, user volumes (e.g., vehicular, cyclist, and pedestrian), design speed, and posted speed should be assembled, and function characteristics should be determined prior to detailed design (Transportation Association of Canada, 2017). The feasibility of the access points will need to be further reviewed against the City of Whitehorse policies and confirmed during detailed design of the site.

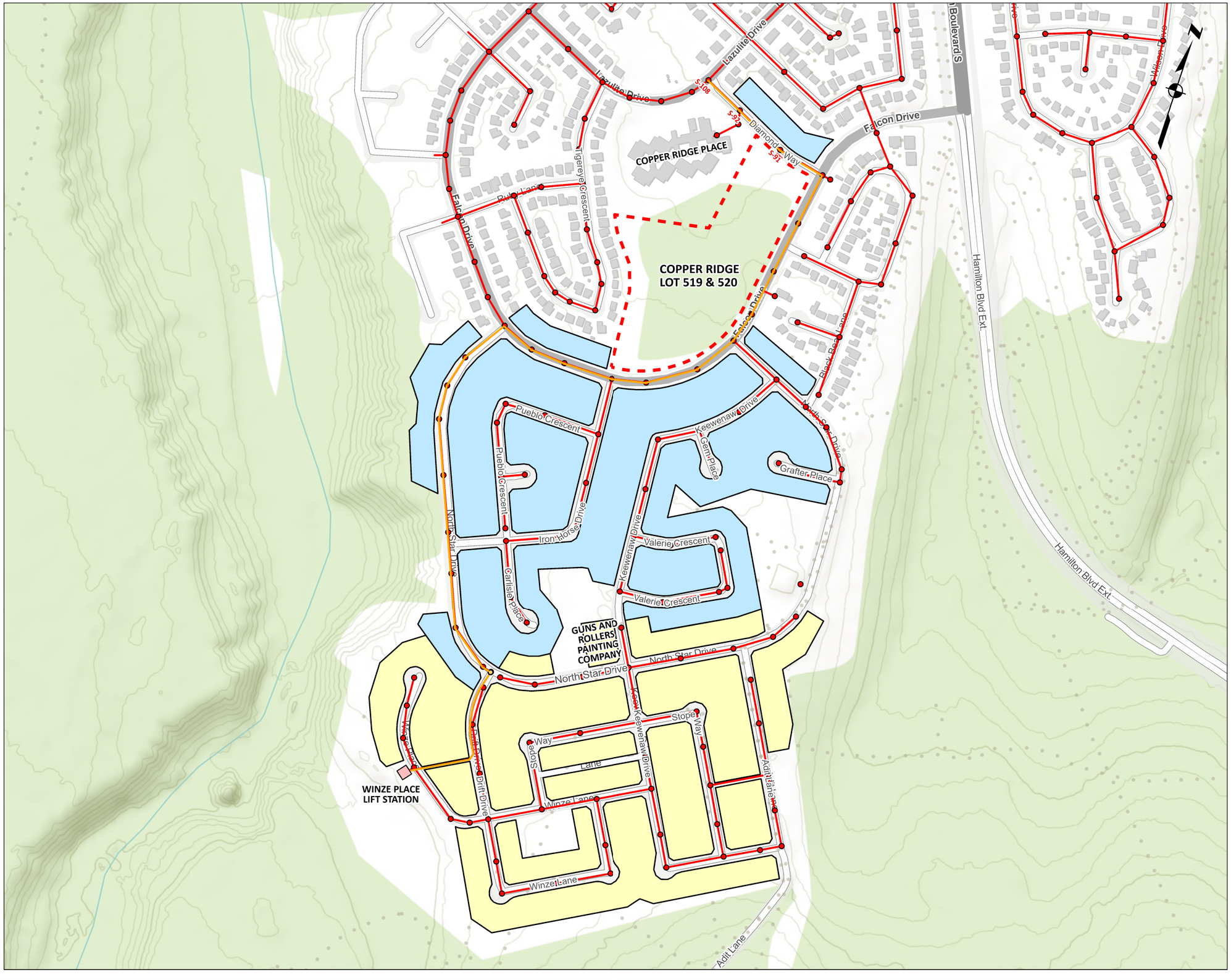
3.7 COST ESTIMATE

An order of magnitude cost estimate was completed for the development of Copper Ridge Lot 519 & 520 and is summarized in **Table 3-4**. Due to the level of information provided, a few assumptions were made:

- Approximately 500m of sewermain, watermain, and road would be installed across the project site. This is assuming a low density residential development.
- The extended price for sanitary sewer infrastructure is all inclusive (pipes, service pipes, tie-in to existing, manholes).
- The extended price for storm sewer infrastructure is all inclusive (pipes, service pipes, tie-in to existing, catchbasins, catchbasin manholes, manholes).
- The extended price for water infrastructure is all inclusive (pipes, service pipe, tie-in to existing, gate valves, curb stops, fire hydrants).
- The extended price for road infrastructure is all inclusive (excavation, reshaping, subbase, base, asphalt)
- The unit prices used for the cost estimate were taken from a City of Whitehorse project completed in 2021, and a 50% contingency was provided for the recent rise in material pricing.

Table 3-4 Cost Estimate for Copper Ridge Lot 519 & 520 Development

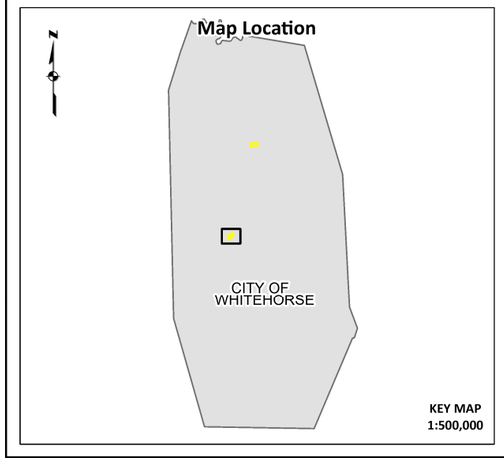
ITEM DESCRIPTION	EXTENDED PRICE
Mobilization	$300,000
Sanitary Sewer	$1,000,000
Storm Sewer	$1,000,000
Watermain	$1,000,000
Roads	$500,000
SUB-TOTAL	**$3,800,000**
50% Contingency	$1,900,000
TOTAL	**$5,700,000**



Legend

- Project Boundary
- Sanitary Manholes
- Sanitary Mains
- Sanitary Outfalls
- Sanitary Valves
- Sanitary Stations
- Downstream Pipe Basin Boundary
- Lift Station Basin Boundary
- Main Sanitary Route
- Forcemain Discharge Point

Draft



Copper Ridge Lot 519 & 520
Municipal Servicing Assessment

Figure 3-1: Copper Ridge Lot 519 & 520 Basin Boundaries

City of Whitehorse
Yukon, Canada

Scale: 1:6,000

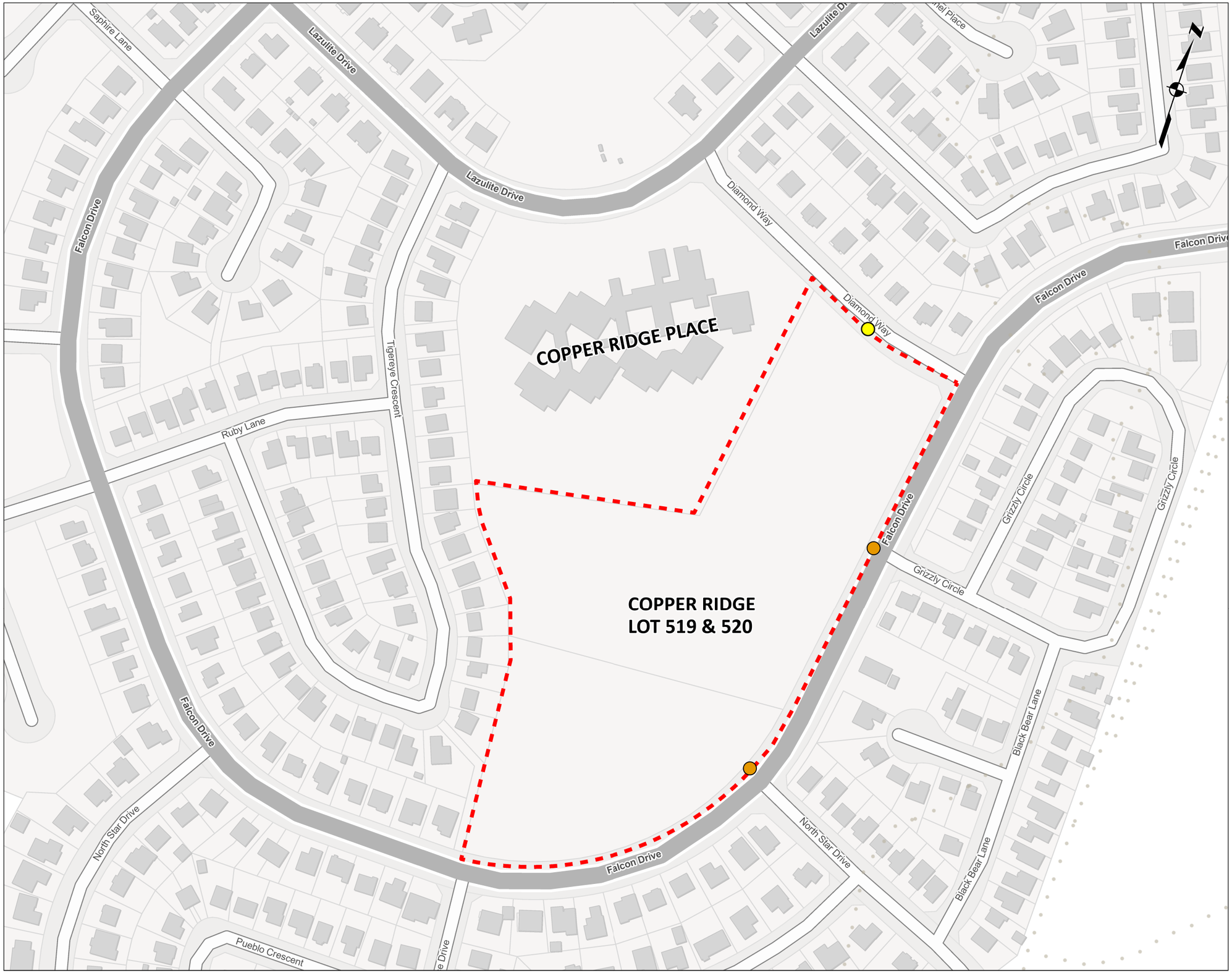
0 40 80 160 240 320 Meters

Universal Transverse Mercator (Zone 8N)
North American Datum (1983)

Report By: JC
Drawn by: JC
Reviewed By: GG, ES

WSP Job #: 221-05315-00
Date: Sept 19, 2022
Office: Edmonton

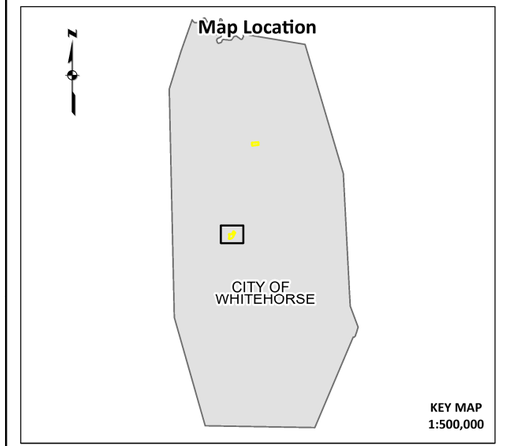
Notes: GIS data provided by the City of Whitehorse Open Data Portal



Legend

- Project Boundary
- Proposed Three-Legged Intersection
- Proposed Four-Legged Intersection

Draft



Copper Ridge Lot 519 & 520
Municipal Servicing Assessment

Figure 3-2: Copper Ridge Lot 519 & 520 Proposed Access Points - Option #1

City of Whitehorse
Yukon, Canada

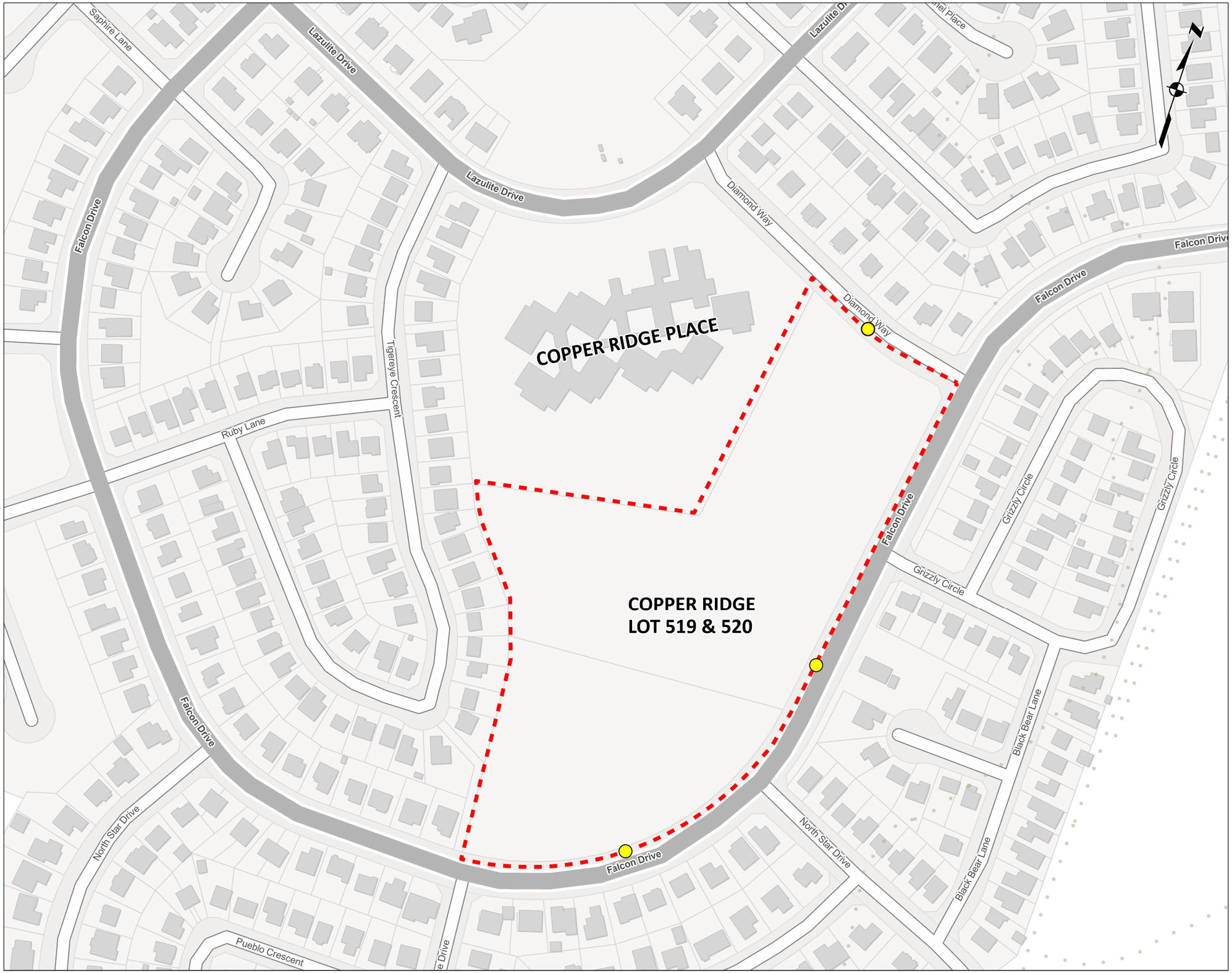
Scale: 1:2,500

0 15 30 60 90 120 Meters

Universal Transverse Mercator (Zone 8N)
North American Datum (1983)

Report By: JC	WSP Job #: 221-05315-00
Drawn By: JC	Date: Sept 21, 2022
Reviewed By: GG, ES	Office: Edmonton

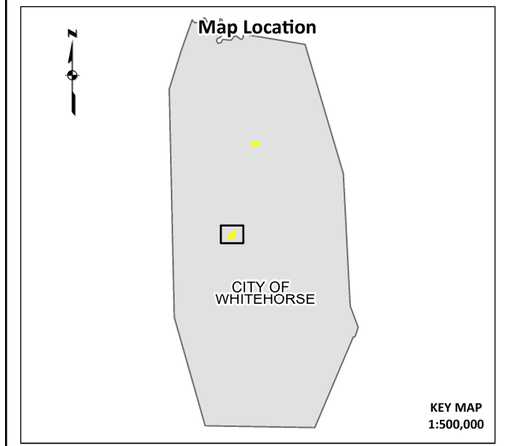
Notes: LiDAR Data provided by the City of Whitehorse Open Data Portal



Legend

- Project Boundary
- Proposed Three-Legged Intersection

Draft



Copper Ridge Lot 519 & 520
Municipal Servicing Assessment

Figure 3-3: Copper Ridge Lot 519 & 520
Proposed Access Points - Option #2

City of Whitehorse
Yukon, Canada

Scale: 1:2,500

0 15 30 60 90 120 Meters

Universal Transverse Mercator (Zone 8N)
North American Datum (1983)

Report By: JC	WSP Job #: 221-05315-00
Drawn By: JC	Date: Sept 21, 2022
Reviewed By: GG, ES	Office: Edmonton

Notes: LiDAR Data provided by the City of Whitehorse Open Data Portal

4 SUMMARY

The following section provides a summary of the results of the assessment completed for Copper Ridge Lot 519 & 520.

4.1 SANITARY SEWER SYSTEM

- The site is limited by the 300 mm PE sanitary sewer from S-92 to S-108. The remaining capacity of this pipe section yields a population potential of 6,019 persons for Copper Ridge Lot 519 & 520. While it is highly unlikely that the physical site or the larger downstream trunk sewer system can accommodate a population of 6,019 people, it does confirm that the existing sanitary sewer system from S-91 to the 375 mm trunk sewer main is not the limiting factor for site development potential.
- As Copper Ridge Lot 519 & 520 is sloping towards Diamond Way, the implementation of an on-site gravity sanitary sewer system will be required and will tie into Manhole S-91. The implementation of a new lift station on the project site will likely not be required.

4.2 STORMWATER SEWER SYSTEM

- There is currently no stormwater sewer system on the project site.
- The implementation of onsite stormwater sewer infrastructure, including a stormwater management/storage system, will be required to address the likely increase in post development runoff rate. This will also likely require a storm sewer main extension along Diamond Way from Manhole D-11 to the project site.

4.3 WATER NETWORK

- The City's current water model was used for the water network assessment based on design criteria outlined in the standards.
- Based on the model results, the existing water distribution system can support up to a low-density residential development (fire flow demand of 100 L/s) on the project site.
- A new watermain was assumed to be required through the project site with connections to both watermains on Falcon Drive. A 250 mm watermain can provide the required fire flows for a medium-density residential development at the project site. However, this leads to residual pressures of less than 140 kPa near Falcon Drive and Diamond Way. Furthermore, under low-demand scenarios, pipe velocities are less than 0.15 m/s around Valerie Crescent, Grizzly Circle and North Star Drive. Model results should be updated when the proposed development zoning and population, road and lot layout, and rough grading are in more advanced stages. Fire hydrant flow testing is recommended to confirm model results.
- System pressures and pipe velocities could be improved By reconfiguring the Copper Ridge Pumphouse infrastructure or providing a direct feed from the station to the project site. The system could also support a high-density residential development if these updates were implemented. Changes to the pumphouse infrastructure were not evaluated as this requires a detailed review of the existing facility and coordination with City operations staff.

4.4 POWER

- WSP did not assess power servicing at the project site but liaised with ATCO Electric Yukon to seek the necessary information and confirm requirements.

- Based on a population of 248 persons, an average of 3 residents per building, and zoning of single family, duplex or triplex lots, ATCO Electric Yukon would be able to service the site with front lot underground servicing and provide a single conduit stub to each lot that has the potential to be serviced with secondary voltage.
- The required upgrades for a higher density cannot be confirmed until specific details of the proposed development have been established and provided to ATCO Electric Yukon.

4.5 TELECOMMUNICATIONS

- WSP did not access telecommunications servicing at the project site but liaised with Northwestel to seek the necessary information and confirm requirements.
- Utility extensions and upgrades would be required such as a conduit fiber build and joint trench shallow utilities.
- The required upgrades for a higher density cannot be confirmed until specific details of the proposed development have been established and provided to Northwestel.

4.6 TRANSPORTATION

- Two options were considered for the proposed access points. The first option considers four-legged intersections along Falcon Drive, and the second option considers three-legged intersections along Falcon Drive.
- A minimum of two points of ingress and egress should be provided to the site in order to meet emergency servicing requirements.
- The City's Fire Department requires that National Building Code of Canada and National Fire Code of Canada considerations and minimums are factored into the development.

4.7 COST ESTIMATE

- The total of the cost estimate for the development of Copper Ridge Lot 519 & 520 is $5,700,000.

4.8 CONCLUSION

Based on the assessments completed for the sanitary, storm, and water system, the limiting factor for the site is the water network and the availability of fire flows. The site would be limited to low density residential development as the existing system is not be able to provide the fire flow demand of 180 L/s for medium density residential development without improvements (or lowering of the fire flow requirements). Based on a population density of 40 persons/ha for a low density residential development, and an area of 6.20 ha, Copper Ridge Lot 519 & 520 could accommodate a population of 248 persons.

5 REFERENCES

City of Whitehorse. (2022). *GIS Interactive Maps*. Retrieved from External Planning Theme: https://gisext.whitehorse.ca/Html5Viewer/index.html?viewer=PlanningViewer

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APPENDIX

A SANITARY SEWER CALCULATIONS

SANITARY SEWER CAPACITY SAMPLE CALCULATIONS (S-92 TO S-108)

FLOW FROM GUNS AND ROLLERS PAINTING COMPANY

Assuming a maximum service capacity of 25 persons based on the parking stalls in Google Maps, the **Population** of Guns and Rollers Painting Company is 25 persons, and the **Average Flow** is 450 L/c/d [1] which is 90% of the water consumption rate of 500 L/c/d [2]. To determine the **Average Sewage Flow**:

$$Average\ Sewage\ Flow = Population \times Average\ Flow = \frac{25\ persons \times 450\ L/c/d}{24 \times 60 \times 60} = 0.13\ L/s$$

The **Peaking Factor** is 3.0 [1]. To determine **Peak Sewage Flow (Peak Dry Weather Flow)**:

$$Peak\ Sewage\ Flow = Peaking\ Factor \times Average\ Sewage\ Flow = 3.0 \times 0.13\ L/s = 0.39\ L/s$$

The **Area** of the Guns and Rollers Painting Company lot is 0.37 ha, and the **Infiltration Allowance** is 6000 L/ha/d [1]. To determine **Inflow/Infiltration (I/I)**:

$$I/I = Area \times 6000\ L/ha/d = \frac{0.37\ ha \times 6000\ L/ha/d}{24 \times 60 \times 60} = 0.03\ L/s$$

To determine **Total Peak Flow (Peak Wet Weather Flow)**:

$$Total\ Peak\ Flow = Peak\ Sewage\ Flow + I/I = 0.39\ L/s + 0.03\ L/s = 0.42\ L/s$$

FLOW FROM LOTS (LIFT STATION BASIN BOUNDARY)

The **Number of Homes** contributing flow to the lift station is 249 (within the lift station basin boundary in **Figure 2-4**) and the **Population Density** is assumed to be 3 persons/home. To determine **Population:**

$$Population = Number\ of\ Homes \times Population\ Density = 249\ homes \times 3\ persons/home = 747\ persons$$

The **Average Flow** is 450 L/c/d [1] which is 90% of the water consumption rate of 500 L/c/d [2]. To determine the **Average Sewage Flow**:

$$Average\ Sewage\ Flow = Population \times Average\ Flow = \frac{747\ persons \times 450\ L/c/d}{24 \times 60 \times 60} = 3.89\ L/s$$

The **Peaking Factor** is 4.0 [1]. To determine **Peak Sewage Flow (Peak Dry Weather Flow)**:

$$Peak\ Sewage\ Flow = Peaking\ Factor \times Average\ Sewage\ Flow = 4.0 \times 3.89\ L/s = 15.56\ L/s$$

The **Area** of the lots contributing flow to the downstream pipe is 17.91 ha. The **Infiltration Allowance** is 6000 L/ha/d [1]. To determine **Inflow/Infiltration (I/I)**:

$$I/I = Area \times 6000\ L/ha/d = \frac{17.91\ ha \times 6000\ L/ha/d}{24 \times 60 \times 60} = 1.24\ L/s$$

To determine **Total Peak Flow (Peak Wet Weather Flow)**:

$$Total\ Peak\ Flow = Peak\ Sewage\ Flow + I/I = 15.56\ L/s + 1.24\ L/s = 16.81\ L/s$$

FLOW FROM WINZE PLACE LIFT STATION

As per the Winze Place Lift Station record drawing and based on the assumption that one pump is running at a time, the capacity of the lift station equates the capacity of the sewage pump which discharges at a rate of 15 L/s [3]. The capacity of the lift station is considered to be 15 L/s and the calculated peak inflow rate is 17.22 L/s (sum of **Flow from Lots** and **Flow from Guns and Rollers Painting Company**). To be conservative, 17.22 L/s was used for **Flow from Winze Place Lift Station**.

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[1] City of Whitehorse (2020). *City of Whitehorse Servicing Standards Manual: Part 2 – Construction Design Criteria: Section 2.4 – Sanitary Sewer System.*
[2] City of Whitehorse (2020). *City of Whitehorse Servicing Standards Manual: Part 2 – Construction Design Criteria: Section 2.3 – Water Distribution System.*
[3] Quest Engineering Group Inc. (2006). *Copper Ridge Subdivision Phase 2 – Stage 11 Lift Station & Standby Generator.*

FLOW FROM COPPER RIDGE PLACE

Assuming a maximum service capacity of 96 persons and an allowance of 20 persons for staffing, the **Population** of Copper Ridge Place is 116 persons, and the **Average Flow** is 450 L/c/d [1] which is 90% of the water consumption rate of 500 L/c/d [2]. To determine the **Average Sewage Flow**:

$$Average\ Sewage\ Flow = Population \times Average\ Flow = \frac{116\ persons \times 450\ L/c/d}{24 \times 60 \times 60} = 0.60\ L/s$$

The **Peaking Factor** is 4.0 [1]. To determine **Peak Sewage Flow (Peak Dry Weather Flow)**:

$$Peak\ Sewage\ Flow = Peaking\ Factor \times Average\ Sewage\ Flow = 4.0 \times 0.60\ L/s = 2.42\ L/s$$

The **Area** of the Copper Ridge Place lot is 37.93 ha, and the **Infiltration Allowance** is 6000 L/ha/d [1]. To determine **Inflow/Infiltration (I/I)**:

$$I/I = Area \times 6000\ L/ha/d = \frac{37.93\ ha \times 6000\ L/ha/d}{24 \times 60 \times 60} = 2.63\ L/s$$

To determine **Total Peak Flow (Peak Wet Weather Flow)**:

$$Total\ Peak\ Flow = Peak\ Sewage\ Flow + I/I = 2.42\ L/s + 2.63\ L/s = 5.05\ L/s$$

FLOW FROM LOTS (DOWNSTREAM PIPE BASIN BOUNDARY)

The **Number of Homes** contributing flow to the downstream pipe is 269 (within the downstream pipe basin boundary in **Figure 2-4**) and the **Population Density** is assumed to be 3 persons/home. To determine **Population:**

$$Population = Number\ of\ Homes \times Population\ Density = 269\ homes \times 3\ persons/home = 807\ persons$$

The **Average Flow** is 450 L/c/d [1] which is 90% of the water consumption rate of 500 L/c/d [2]. To determine the **Average Sewage Flow**:

$$Average\ Sewage\ Flow = Population \times Average\ Flow = \frac{807\ persons \times 450\ L/c/d}{24 \times 60 \times 60} = 4.20\ L/s$$

The **Peaking Factor** is 4.0 [1]. To determine **Peak Sewage Flow (Peak Dry Weather Flow)**:

$$Peak\ Sewage\ Flow = Peaking\ Factor \times Average\ Sewage\ Flow = 4.0 \times 4.20\ L/s = 16.81\ L/s$$

The **Area** of the lots contributing flow to the downstream pipe is 19.93 ha. The **Infiltration Allowance** is 6000 L/ha/d [1]. To determine **Inflow/Infiltration (I/I)**:

$$I/I = Area \times 6000\ L/ha/d = \frac{19.93\ ha \times 6000\ L/ha/d}{24 \times 60 \times 60} = 1.38\ L/s$$

To determine **Total Peak Flow (Peak Wet Weather Flow)**:

$$Total\ Peak\ Flow = Peak\ Sewage\ Flow + I/I = 16.81\ L/s + 1.38\ L/s = 18.20\ L/s$$

DOWNSTREAM PIPE CAPACITY (FROM S-92 TO S-108)

The **Diameter** of the downstream pipe is 300 mm [4]. To determine the **Area** of the pipe:

$$Area = \frac{\pi \times Diameter^2}{4} = \frac{\pi \times (0.300\ m)^2}{4} = 0.071 m^2$$

It is assumed that the pipe is flowing at full capacity, meaning that θ is 180 degrees and 2θ is 360 degrees. To determine the **Wetted Perimeter** of the pipe:

$$Wetted\ Perimeter = Diameter \times \theta = 0.300\ m \times 180 \times \frac{\pi}{180} = 0.942\ m$$

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[4] Yukon Government Engineering & Development (1995). *Plan/Profile Diamond Way STA. 0-011.25 to STA 0+227.691.*

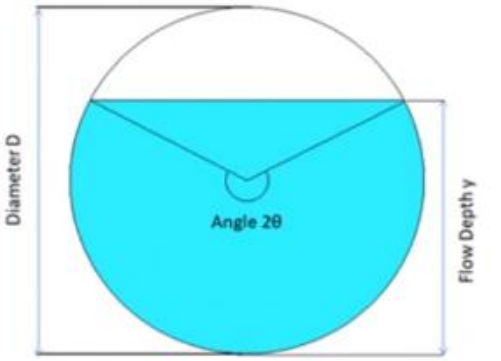


Figure 1 Manning's Equation Full Pipe [5]

To determine the **Hydraulic Radius** of the pipe:

$$Hydraulic\ Radius = \frac{Area}{Wetted\ Perimeter} = \frac{0.071m^2}{0.942m} = 0.075m$$

The **Slope** and **Manning's n** of the downstream pipe is 3.43% [4] and 0.014 [1], respectively. To determine the **Velocity** through the pipe:

$$Velocity = \frac{Hydraulic\ Radius^{2/3} \times Slope^{1/2}}{n} = \frac{(0.075\ m^2)^{2/3} \times (0.0343\ m/m)^{1/2}}{0.014} = 2.353\ m/s$$

To determine the **Discharge** through the pipe:

$$Discharge = Velocity \times Area = 2.353\ m/s \times 0.071\ m^2 \times \frac{1000\ L}{1\ m^3} = 166.30\ L/s$$

POPULATION POTENTIAL OF COPPER RIDGE LOT 519 & 520

To determine the **Remaining Capacity** in the downstream pipe:

$$\begin{aligned} Remaining\ Capacity \\ &= Downstream\ Pipe\ Capacity - Flow\ from\ Winze\ Place\ Lift\ Station \\ &- Flow\ from\ Copper\ Ridge\ Place \\ &- Flow\ from\ Lots\ (Downstream\ Pipe\ Basin\ Boundary) \\ &= 166.30\ L/s - 17.22\ L/s - 5.05\ L/s - 18.20\ L/s = 125.83\ L/s \end{aligned}$$

The **Area** of Copper Ridge Lot 519 & 520 is 6.20 ha, and the **Infiltration Allowance** is 6000 L/ha/d [1]. To determine **Inflow/Infiltration (I/I)**:

$$I/I = Area \times 6000\ L/ha/d = \frac{6.20\ ha \times 6000\ L/ha/d}{24 \times 60 \times 60} = 0.43\ L/s$$

To determine **Peak Sewage Flow (Peak Dry Weather Flow)**:

$$Peak\ Sewage\ Flow = Remaining\ Capacity - I/I = 125.83\ L/s - 0.43\ L/s = 125.40\ L/s$$

The **Peaking Factor** is 4.0 [1]. To determine **Average Sewage Flow**:

$$Average\ Sewage\ Flow = \frac{Peak\ Sewage\ Flow}{Peaking\ Factor} = \frac{125.40\ L/s}{4.0} = 31.35\ L/s$$

The **Average Flow** is 450 L/c/d [1] which is 90% of the water consumption rate of 500 L/c/d [2]. To determine the **Population Potential**:

---

[5] Dwivedi, Dhaval (2020). *Flow through a circular channel using Manning's formula*. https://www.youtube.com/watch?v=Rcnr8qhtvMs.

$$Population\ Potential = \frac{Average\ Sewage\ Flow}{Average\ Flow} = \frac{31.35\ L/s \times 24 \times 60 \times 60}{450\ L/c/d} = 6{,}019\ persons$$

FLOW FROM COPPER RIDGE LOT 519 & 520

Based on a population density of 40 persons/ha and an area of 6.20 ha, the **Population** is:

$$Population = Area \times Population\ Density = 6.20\ ha \times 40\ persons/ha = 248\ persons$$

The **Average Flow** is 450 L/c/d [1] which is 90% of the water consumption rate of 500 L/c/d [2]. To determine the **Average Sewage Flow**:

$$Average\ Sewage\ Flow = Population \times Average\ Flow = \frac{248\ persons \times 450\ L/c/d}{24 \times 60 \times 60} = 1.29\ L/s$$

The **Peaking Factor** is 4.0 [1]. To determine **Peak Sewage Flow (Peak Dry Weather Flow)**:

$$Peak\ Sewage\ Flow = Peaking\ Factor \times Average\ Sewage\ Flow = 4.0 \times 1.29\ L/s = 5.16\ L/s$$

The **Area** of Copper Ridge Lot 519 & 520 is 6.20 ha. The **Infiltration Allowance** is 6000 L/ha/d [1]. To determine **Inflow/Infiltration (I/I)**:

$$I/I = Area \times 6000\ L/ha/d = \frac{6.20\ ha \times 6000\ L/ha/d}{24 \times 60 \times 60} = 0.43\ L/s$$

To determine **Total Peak Flow (Peak Wet Weather Flow)**:

$$Total\ Peak\ Flow = Peak\ Sewage\ Flow + I/I = 5.16\ L/s + 0.43\ L/s = 5.59\ L/s$$

To determine **Total Post-Design Flow**:

$$\begin{aligned} Total\ Post\ Design\ Flow \\ &= Flow\ from\ Winze\ Place\ Lift\ Station + Flow\ from\ Copper\ Ridge\ Place \\ &+ Flow\ from\ CopperRidge\ Lot\ 519\ \&\ 520 = 17.22\ L/s + 5.05\ L/s + 5.59\ L/s = 46.07\ L/s \end{aligned}$$

To determine **Remaining Capacity**:

$$\begin{aligned} Remaining\ Capacity &= Downstream\ Pipe\ Capacity - Total\ Post\ Design\ Flow = 166.30\ L/s - 46.07\ L/s \\ &= 120.23\ L/s \end{aligned}$$

Table A-1 *Copper Ridge Lot 519 & 520 Sanitary Sewer Capacity* (S-91 to S-92)

FLOW FROM GUNS AND ROLLERS PAINTING COMPANY		
Population	25	Persons
Average Flow	450	L/c/d
Average Sewage Flow	0.13	L/s
Peaking Factor	3.0	
Peak Sewage Flow (PDWF)	0.39	L/s
Area	0.37	ha
Inflow / Infiltration @ 6000 L/ha/d	0.03	L/s
Total Peak Flow (PWWF)	0.42	L/s
FLOW FROM LOTS (LIFT STATION BASIN BOUNDARY)		
Number of Homes	249	Homes
Population Density	3	Persons/home
Population	747	Persons
Average Flow	450	L/c/d
Average Sewage Flow	3.89	L/s
Peaking Factor	4.0	
Peak Sewage Flow (PDWF)	15.56	L/s
Area	17.91	ha
Inflow / Infiltration @ 6000 L/ha/d	1.24	L/s
Total Peak Flow (PWWF)	16.81	L/s
FLOW FROM WINZE PLACE LIFT STATION		
Capacity (Given)	15.00	L/s
Capacity (Calculated)	17.22	L/s
FLOW FROM LOTS (DOWNSTREAM PIPE BASIN BOUNDARY)		
Number of Homes	269	Homes
Population Density	3	Persons/home
Population	807	Persons
Average Flow	450	L/c/d
Average Sewage Flow	4.20	L/s
Peaking Factor	4.0	
Peak Sewage Flow (PDWF)	16.81	L/s
Area	19.93	ha
Inflow / Infiltration @ 6000 L/ha/d	1.38	L/s
Total Peak Flow (PWWF)	18.20	L/s
DOWNSTREAM PIPE CAPACITY (FROM S-91 TO S-92)		
Diameter	0.300	m
Area	0.071	m^2
θ	3.142	radians
Wetted Perimeter	0.942	m
Hydraulic Radius	0.075	m
Slope	0.0378	m/m
Manning's n	0.014	
Velocity	2.470	m/s
Discharge	0.175	m^3/s
Discharge	174.58	L/s
POPULATION POTENTIAL OF COPPER RIDGE LOT 519 & 520		
Remaining Capacity	139.16	L/s
Area	6.20	ha
Inflow / Infiltration @ 6000 L/ha/d	0.43	L/s
Peak Sewage Flow (PDWF)	138.73	L/s
Peaking Factor	4.0	
Average Sewage Flow	34.68	L/s
Average Flow	450	L/c/d
Population Potential	6659	Persons

Table A-2 *Copper Ridge Lot 519 & 520 Sanitary Sewer Capacity* (S-92 to S-108)

FLOW FROM GUNS AND ROLLERS PAINTING COMPANY		
Population	25	Persons
Average Flow	450	L/c/d
Average Sewage Flow	0.13	L/s
Peaking Factor	3.0	
Peak Sewage Flow (PDWF)	0.39	L/s
Area	0.37	ha
Inflow / Infiltration @ 6000 L/ha/d	0.03	L/s
Total Peak Flow (PWWF)	0.42	L/s
FLOW FROM LOTS (LIFT STATION BASIN BOUNDARY)		
Number of Homes	249	Homes
Population Density	3	Persons/home
Population	747	Persons
Average Flow	450	L/c/d
Average Sewage Flow	3.89	L/s
Peaking Factor	4.0	
Peak Sewage Flow (PDWF)	15.56	L/s
Area	17.91	ha
Inflow / Infiltration @ 6000 L/ha/d	1.24	L/s
Total Peak Flow (PWWF)	16.81	L/s
FLOW FROM WINZE PLACE LIFT STATION		
Capacity (given)	15.00	L/s
Capacity (calculated)	17.22	L/s
FLOW FROM COPPER RIDGE PLACE		
Population	116	Persons
Average Flow	450	L/c/d
Average Sewage Flow	0.60	L/s
Peaking Factor	4.0	
Peak Sewage Flow (PDWF)	2.42	L/s
Area	37.93	ha
Inflow / Infiltration @ 6000 L/ha/d	2.63	L/s
Total Peak Flow (PWWF)	5.05	L/s
FLOW FROM LOTS (DOWNSTREAM PIPE BASIN BOUNDARY)		
Number of Homes	269	Homes
Population Density	3	Persons/home
Population	807	Persons
Average Flow	450	L/c/d
Average Sewage Flow	4.20	L/s
Peaking Factor	4.0	
Peak Sewage Flow (PDWF)	16.81	L/s
Area	19.93	ha
Inflow / Infiltration @ 6000 L/ha/d	1.38	L/s
Total Peak Flow (PWWF)	18.20	L/s
DOWNSTREAM PIPE CAPACITY (FROM S-92 TO S-108)		
Diameter	0.300	m
Area	0.071	m^2
θ	3.142	radians
Wetted Perimeter	0.942	m
Hydraulic Radius	0.075	m
Slope	0.0343	m/m
Manning's n	0.014	
Velocity	2.353	m/s
Discharge	0.166	m^3/s
Discharge	166.30	L/s
POPULATION POTENTIAL OF COPPER RIDGE LOT 519 & 520		
Remaining Capacity	125.83	L/s
Area	6.20	ha
Inflow / Infiltration @ 6000 L/ha/d	0.43	L/s
Peak Sewage Flow (PDWF)	125.40	L/s
Peaking Factor	4.0	
Average Sewage Flow	31.35	L/s
Average Flow	450	L/c/d
Population Potential	6019	Persons
FLOW FROM COPPER RIDGE LOT 519 & 520		
Area	6.20	ha
Population Density	40	Persons/ha
Population	248	Persons
Average Flow	450	L/c/d
Average Sewage Flow	1.29	L/s
Peaking Factor	4.0	
Peak Sewage Flow (PDWF)	5.16	L/s
Inflow / Infiltration @ 6000 L/ha/d	0.43	L/s
Total Peak Flow (PWWF)	5.59	L/s
Total Post-Design Flow	46.07	L/s
Remaining Capacity	120.23	L/s

APPENDIX

B STORM SEWER CALCULATIONS

STORM SEWER CAPACITY SAMPLE CALCULATIONS

The **Land Use, Area (A), and Runoff Coefficient (C)** of Copper Ridge Lot 519 & 520 is Open Space, 6.20 ha, and 0.15, respectively [1]. To determine **AxC**:

$$A \times C = 6.20\ ha \times 0.15 = 0.93\ ha$$

To determine **Sum AxC**:

$$Sum\ A \times C = 0.93\ ha$$

The **Time of Concentration** at CB-12A is the inlet time of 15 minutes [1]. The **Intensity** was selected when the corresponding value for the **Duration** (i.e., Time of Concentration) lands on the line for the 5-year return period. Therefore, an **Intensity** of 19.41 mm/h was determined from **Figure 1**.

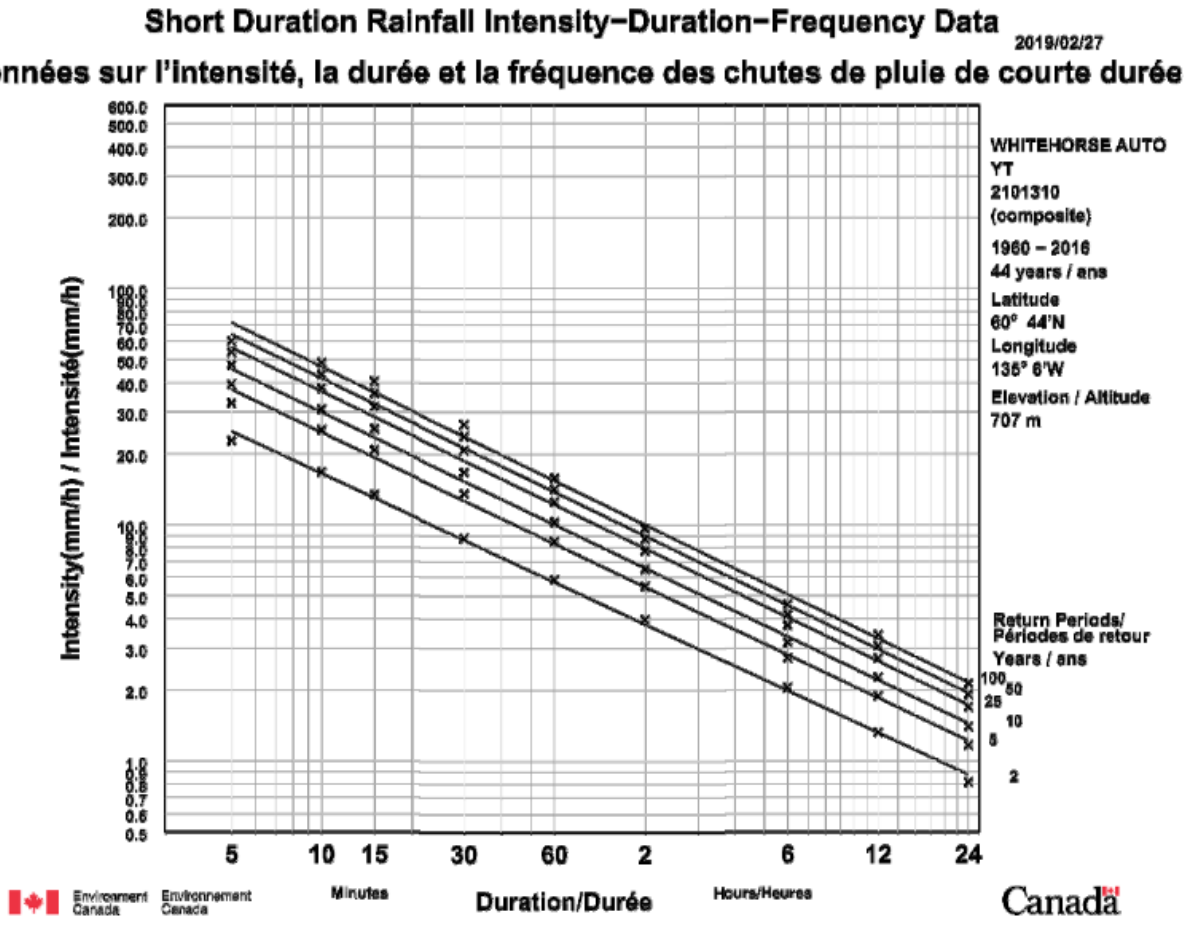


Figure 1 Short Duration Rainfall IDF Data [2]

To determine the **Pre-development Flow Rate (Q)**:

$$Q = \frac{(Sum\ A \times C) \times i}{360} = \frac{0.93 \times 19.41\ mm/h}{360} = 0.050\ m^3/s = 50\ L/s$$

---

[1] City of Whitehorse (2020). *City of Whitehorse Servicing Standards Manual: Part 2 – Construction Design Criteria: Section 2.5 – Storm Drainage System.*

[2] City of Whitehorse (2020). *Rainfall Intensity – Duration Data. Whitehorse, Yukon.*

Table B-1 *Copper Ridge Lot 519 & 520 Storm Sewer Capacity*

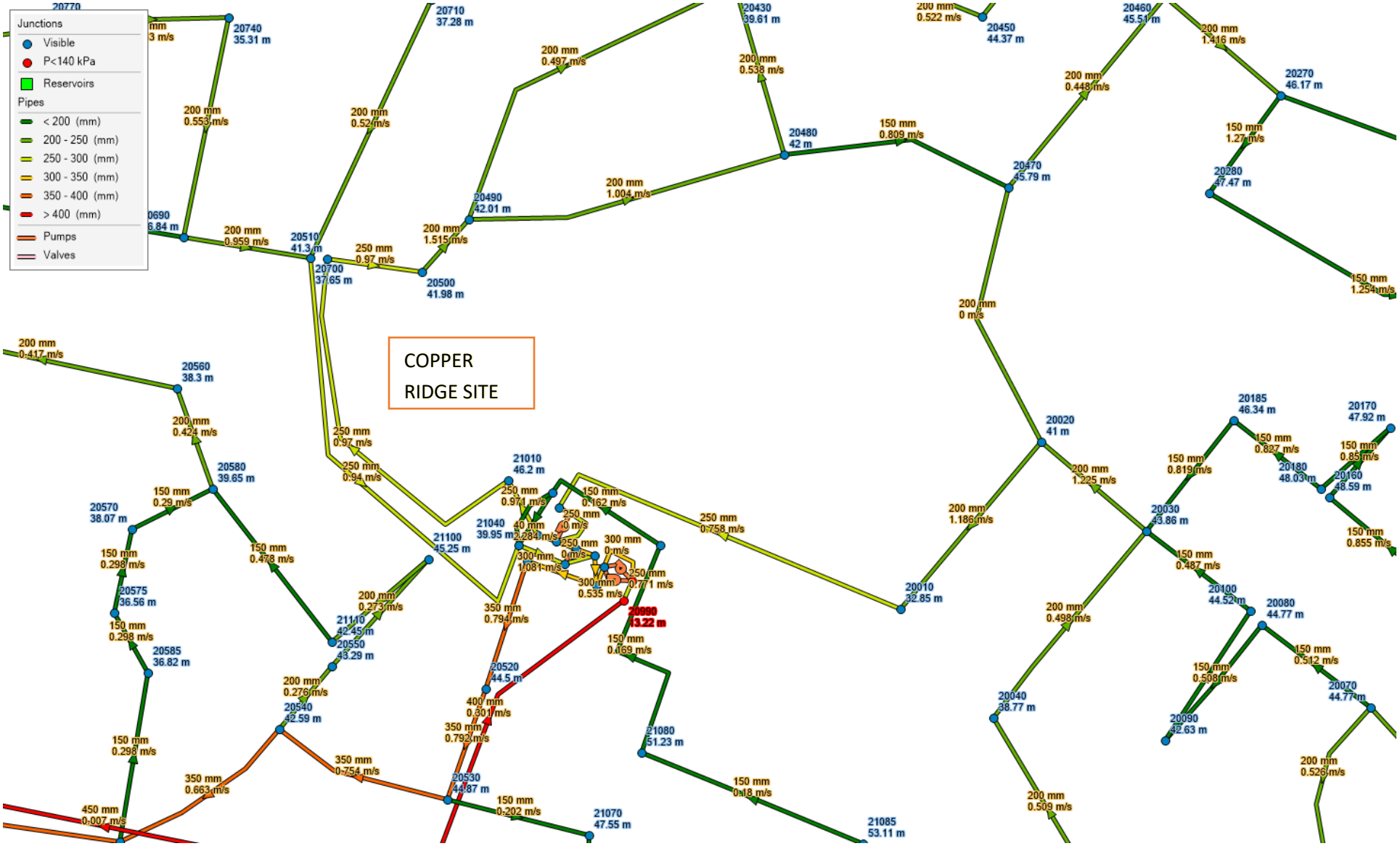
FROM MH	TO MH	LAND USE	AREA ADDED, A (HA)	C	AxC (HA)	SUM AxC (HA)	TIME OF CONC (MIN)	i (mm/hr)
CB-12A	D-12	Open Space	6.20	0.15	0.93	0.93	15.00	19.41

APPENDIX

C WATER MODEL RESULTS

MODEL RESULTS FOR EXISTING CONDITIONS

ADD



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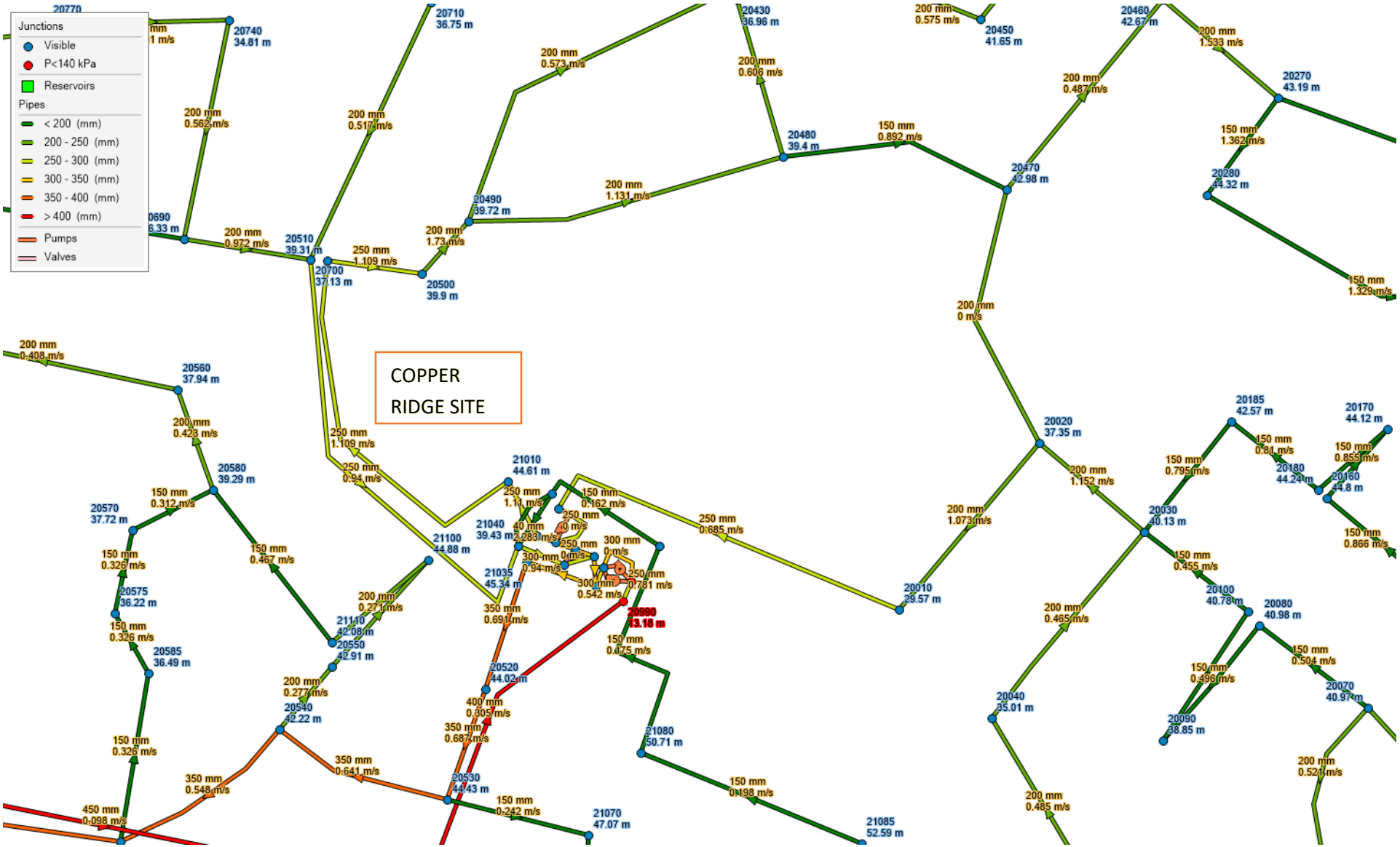
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Reservoirs
Pipes
< 200 (mm)
200 - 250 (mm)
250 - 300 (mm)
300 - 350 (mm)
350 - 400 (mm)
> 400 (mm)
Pumps
Valves
COPPER
RIDGE SITE
20740
34.81 m
20710
36.75 m
20430
36.96 m
20450
41.65 m
20460
42.67 m
20270
43.19 m
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44.32 m
20480
39.4 m
20470
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20510
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20700
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20500
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20560
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20580
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20570
37.72 m
20575
36.22 m
20585
36.49 m
20540
42.22 m
20550
42.91 m
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21100
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21010
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21070
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21085
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20010
29.57 m
20020
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20030
40.13 m
20185
42.57 m
20170
44.12 m
20180
44.24 m
20160
44.8 m
20100
40.78 m
20080
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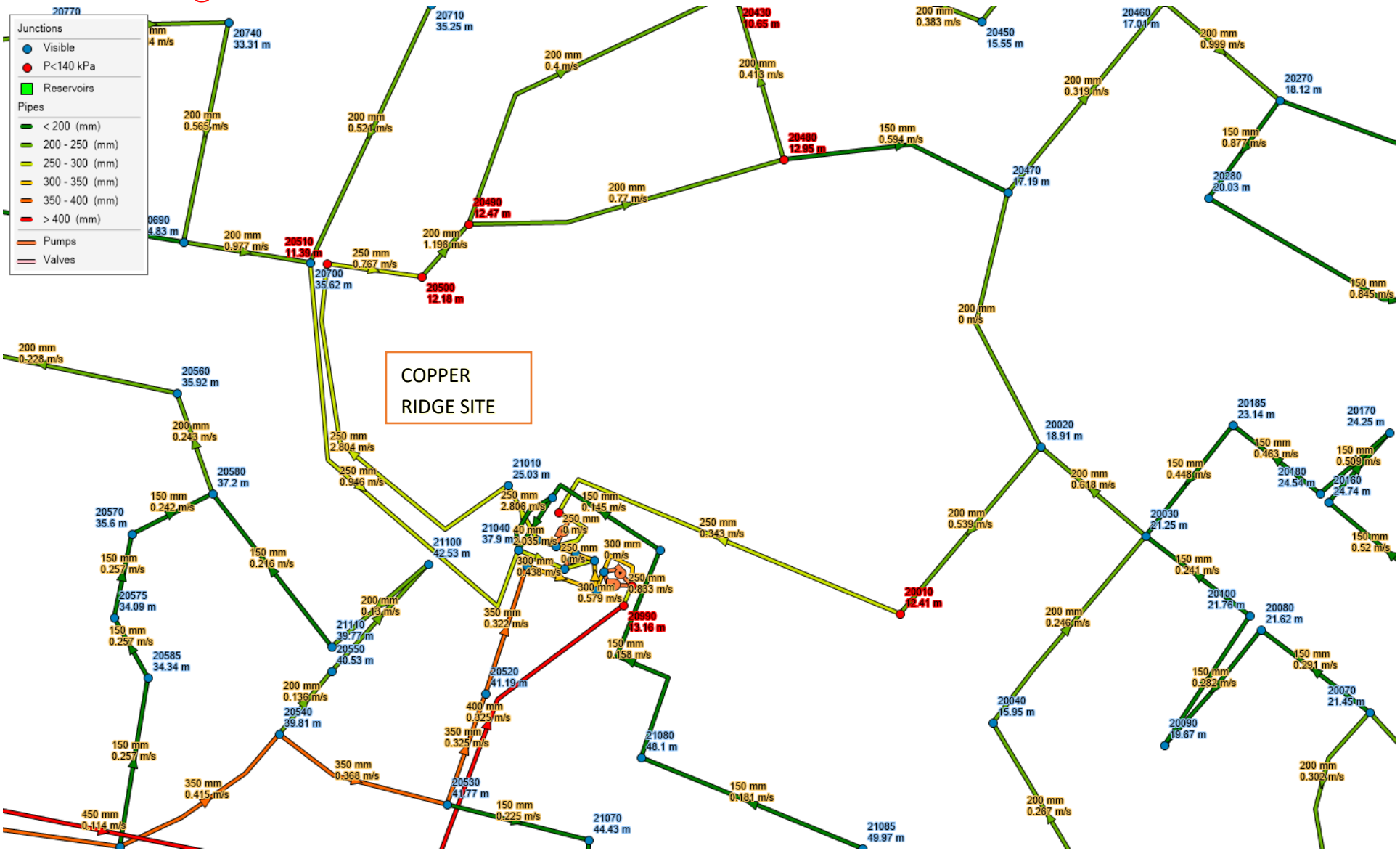
20070
40.97 m
20990
43.18 m

MDD+100 L/S FF @ MODEL NODE 20510



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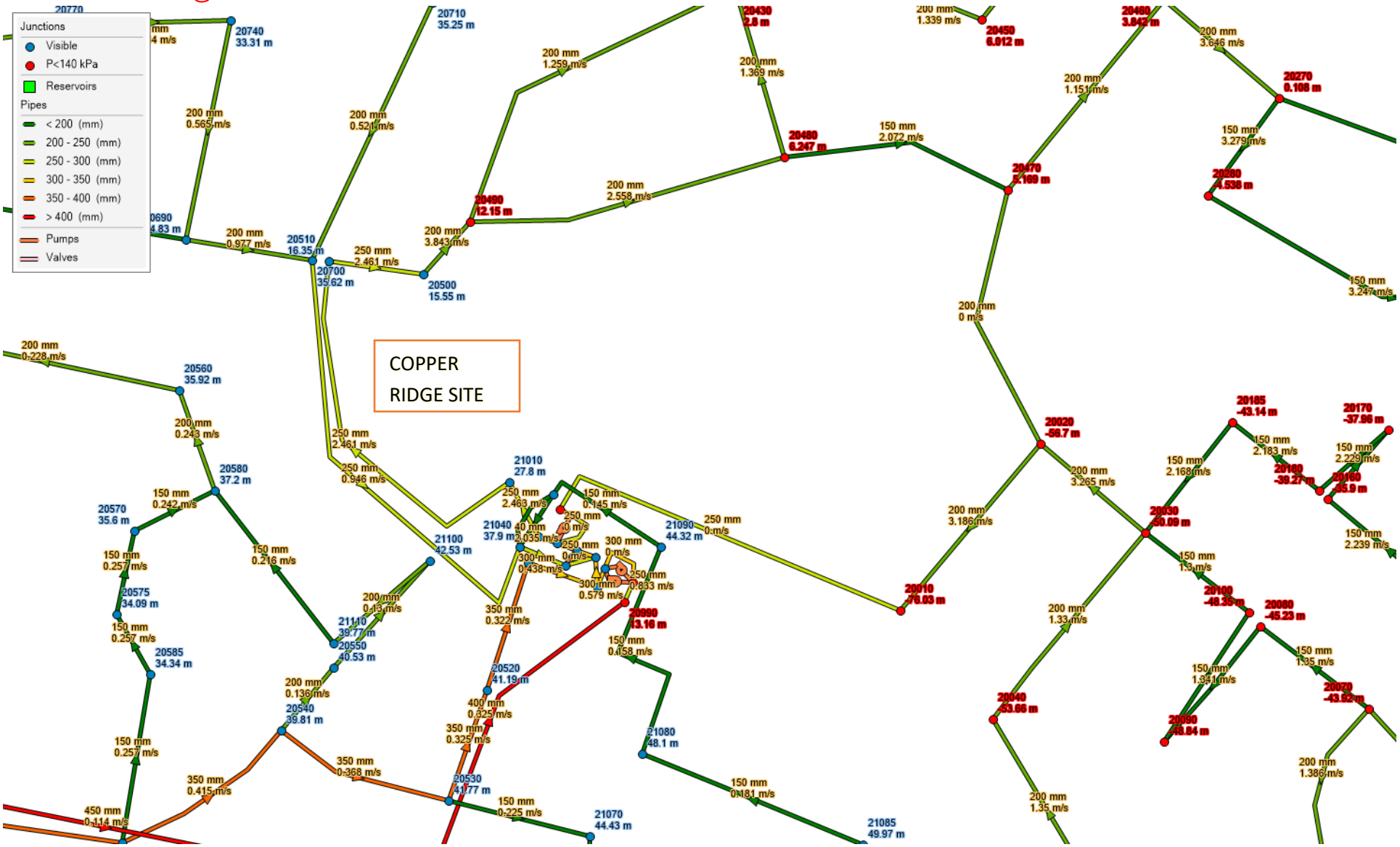

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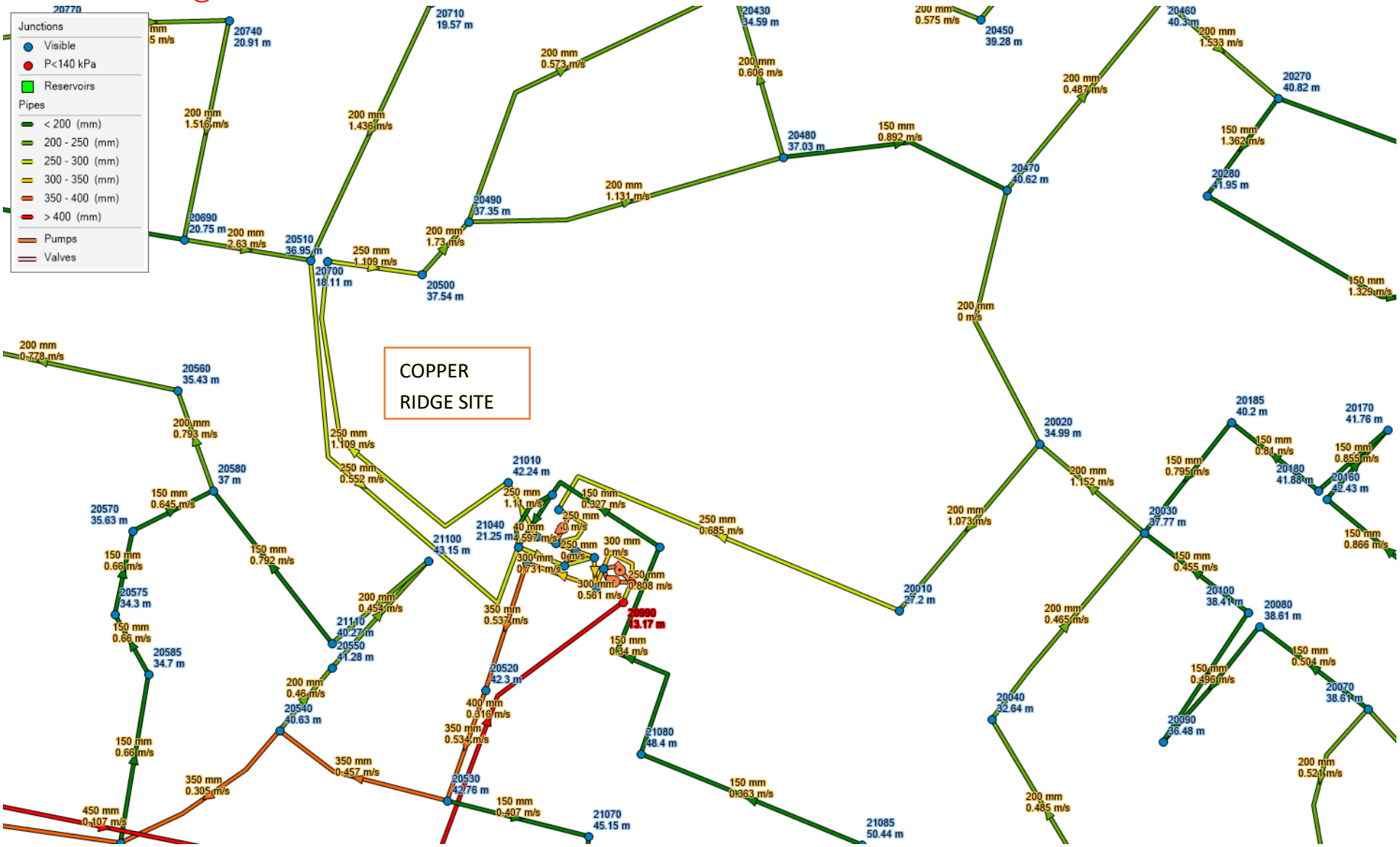
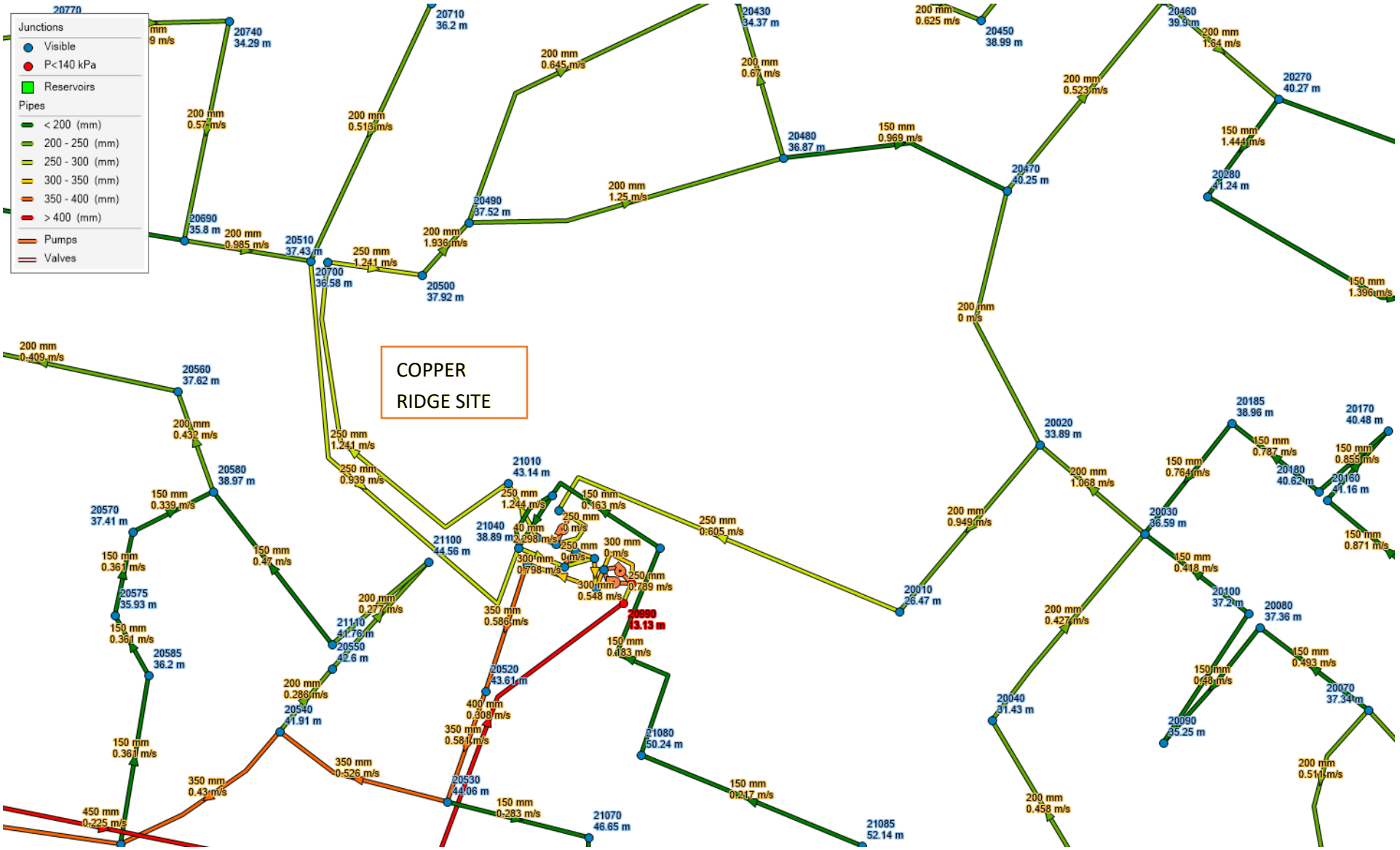


PHD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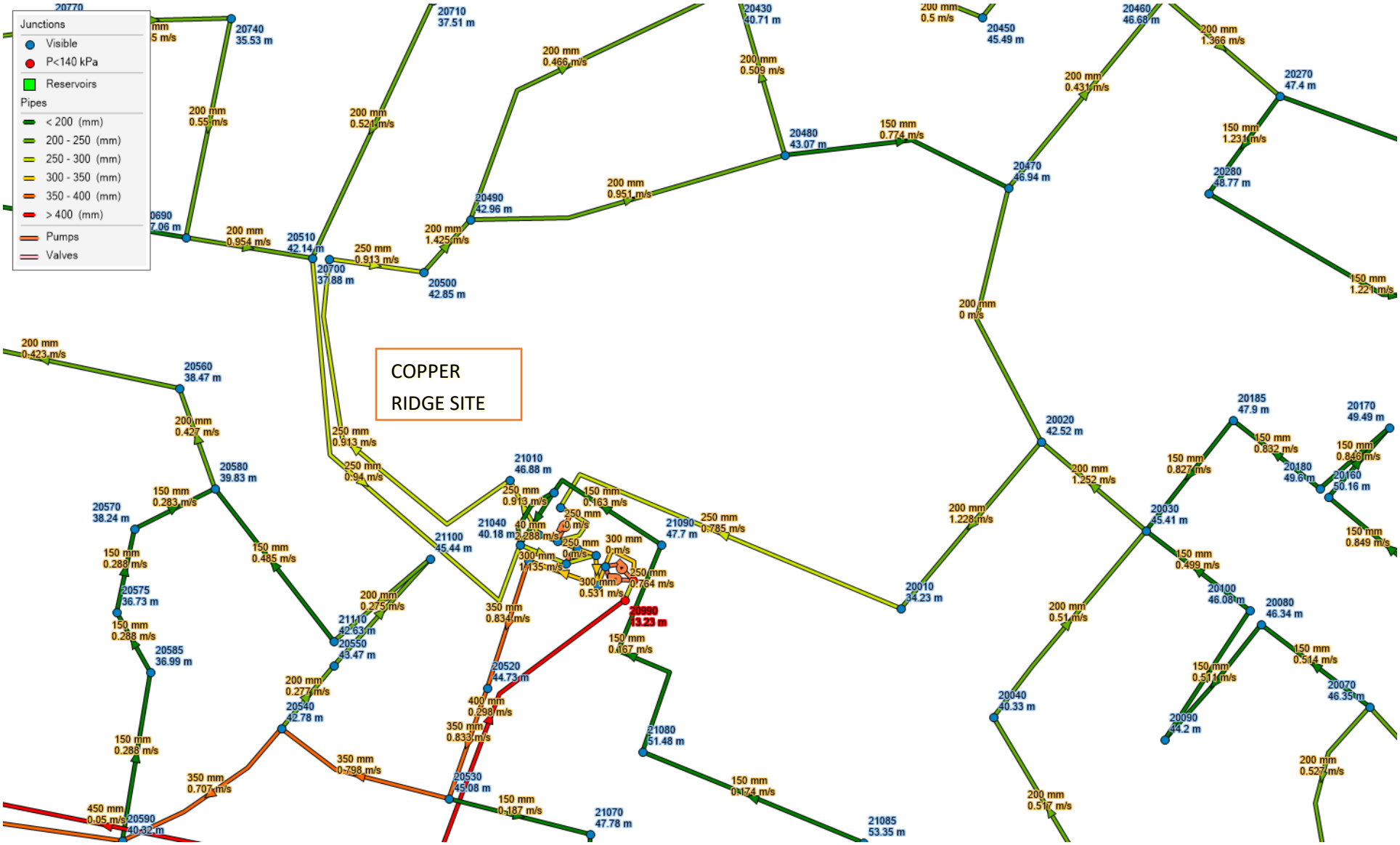
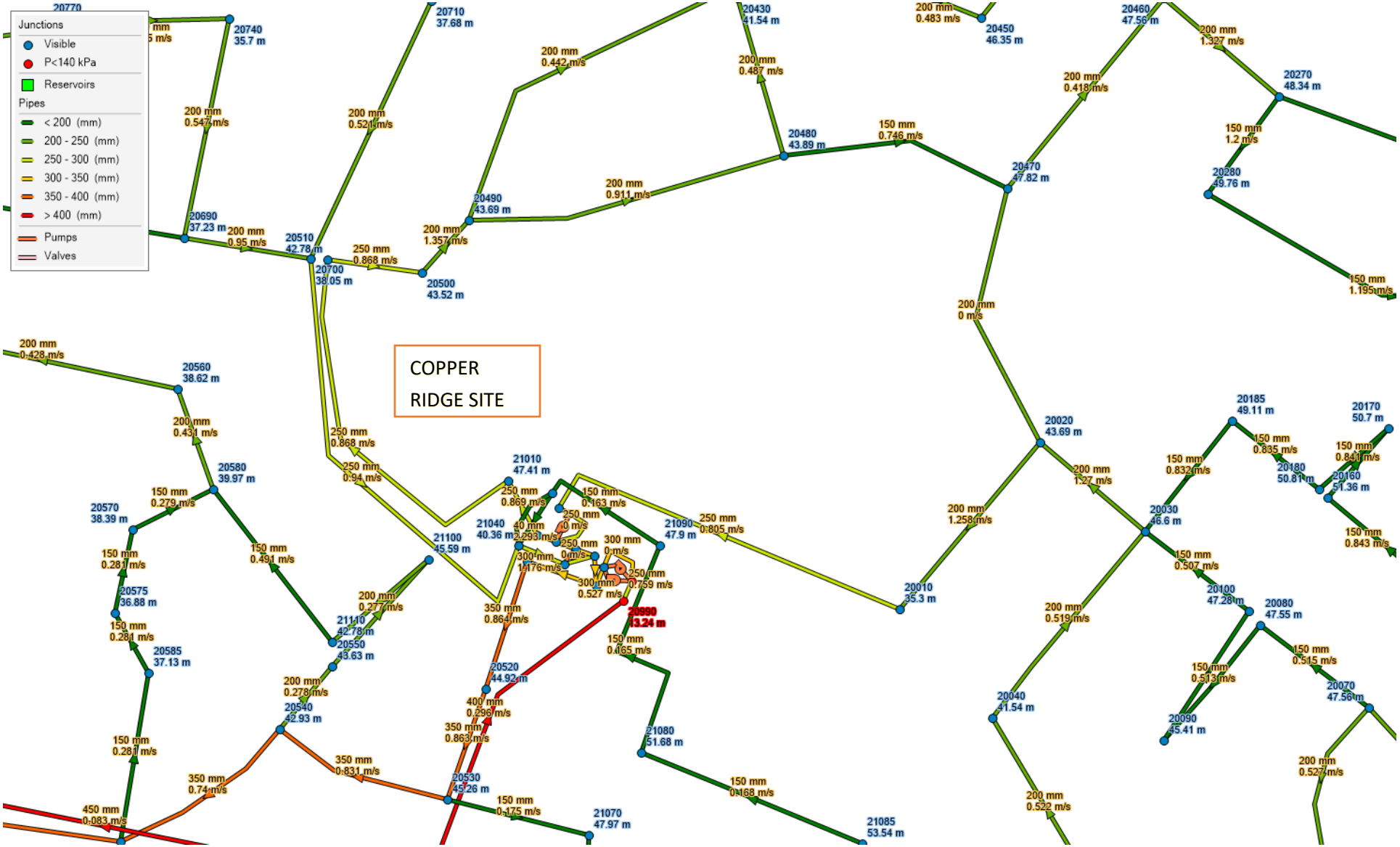
Visible
P<140 kPa
Reservoirs
Pipes
< 200 (mm)
200 - 250 (mm)
250 - 300 (mm)
300 - 350 (mm)
350 - 400 (mm)
> 400 (mm)
Pumps
Valves
COPPER
RIDGE SITE

NFD – RESERVOIR FILLING ANALYSIS



NFD – THERMAL ANALYSIS



MODEL RESULTS FOR CONNECTION TO SERVICING POINT 1

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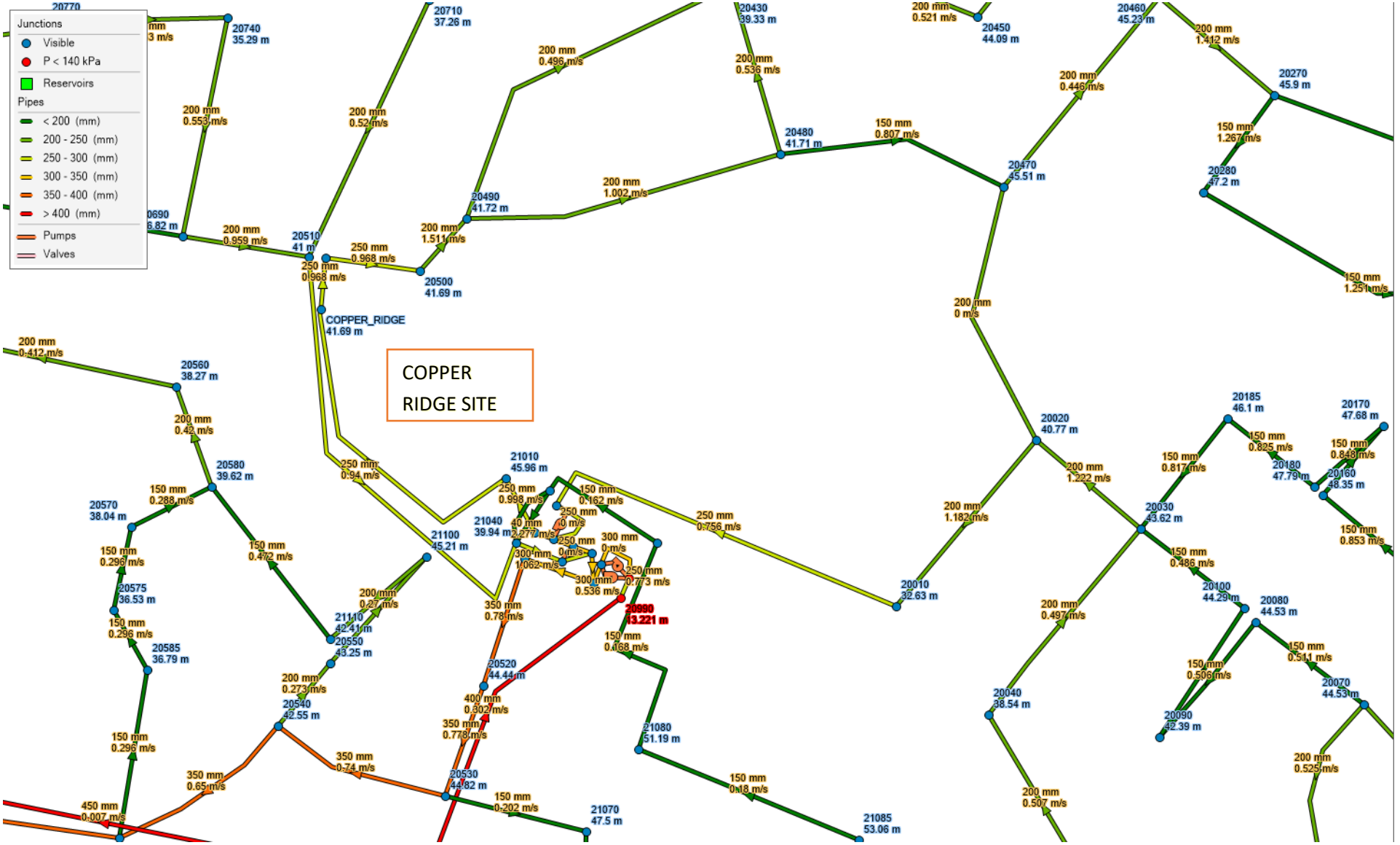

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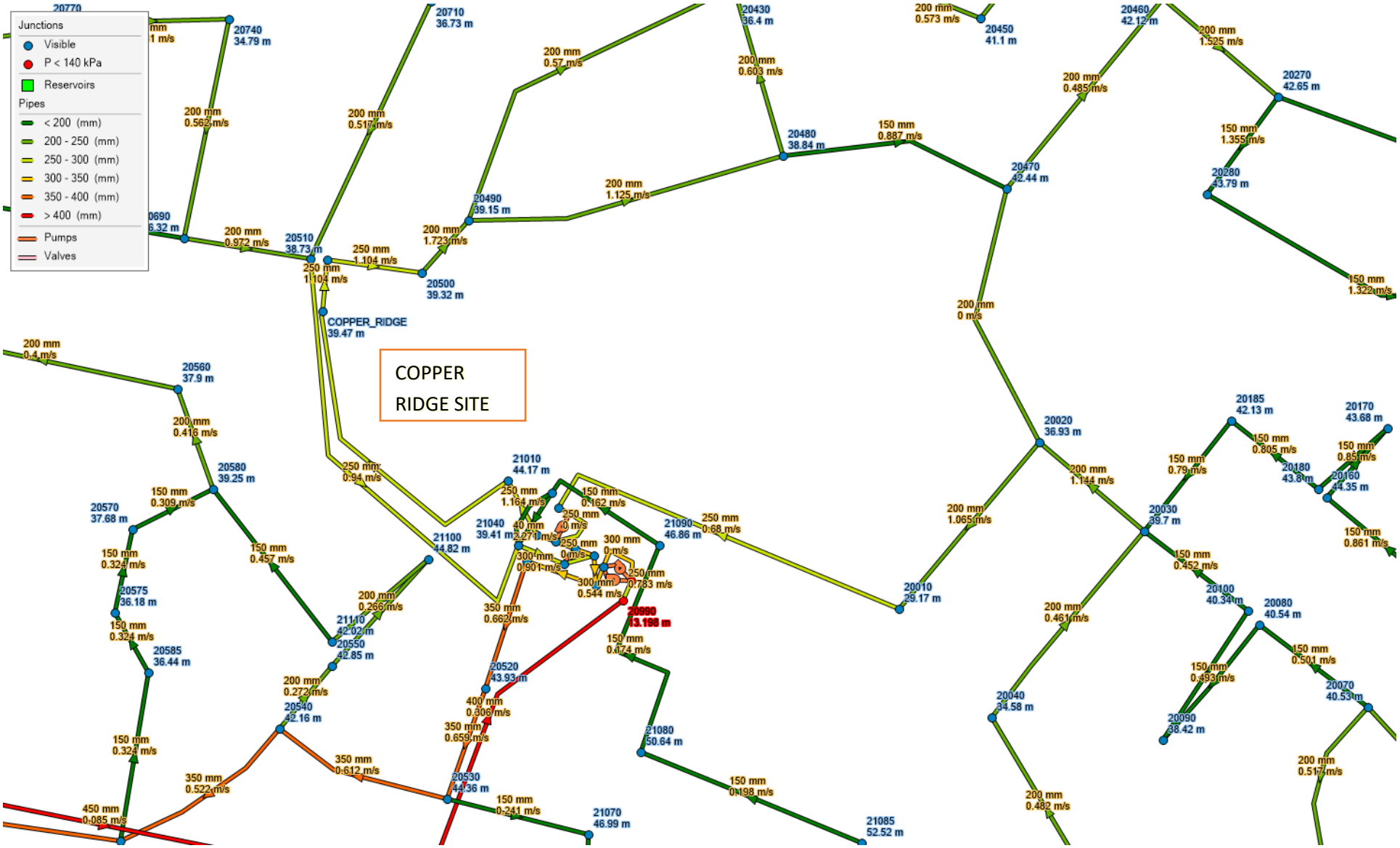
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P < 140 kPa
Reservoirs
Pipes
< 200 (mm)
200 - 250 (mm)
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300 - 350 (mm)
350 - 400 (mm)
> 400 (mm)
Pumps
Valves
COPPER RIDGE SITE
COPPER_RIDGE
39.47 m
20710
36.73 m
20740
34.79 m
20430
36.4 m
20450
41.1 m
20460
42.12 m
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20585
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20185
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20170
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20180
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20160
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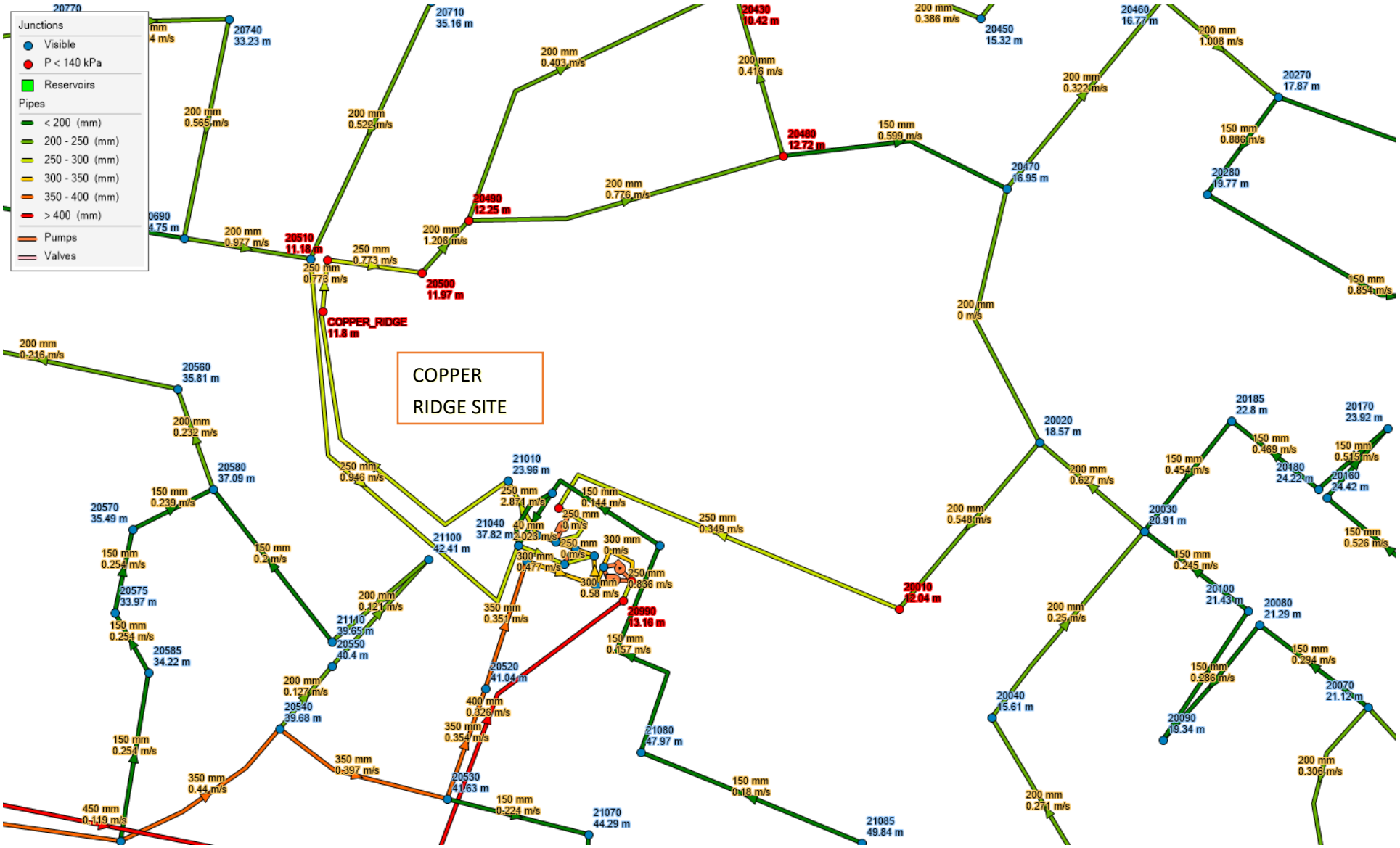
MDD+100 L/S FF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Visible
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Reservoirs
Pipes
< 200 (mm)
200 - 250 (mm)
250 - 300 (mm)
300 - 350 (mm)
350 - 400 (mm)
> 400 (mm)
Pumps
Valves
COPPER RIDGE SITE
COPPER_RIDGE
11.8 m
20510
11.18 m
20500
11.97 m
20490
12.25 m
20480
12.72 m
20430
10.42 m
20010
12.04 m
20990
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20710
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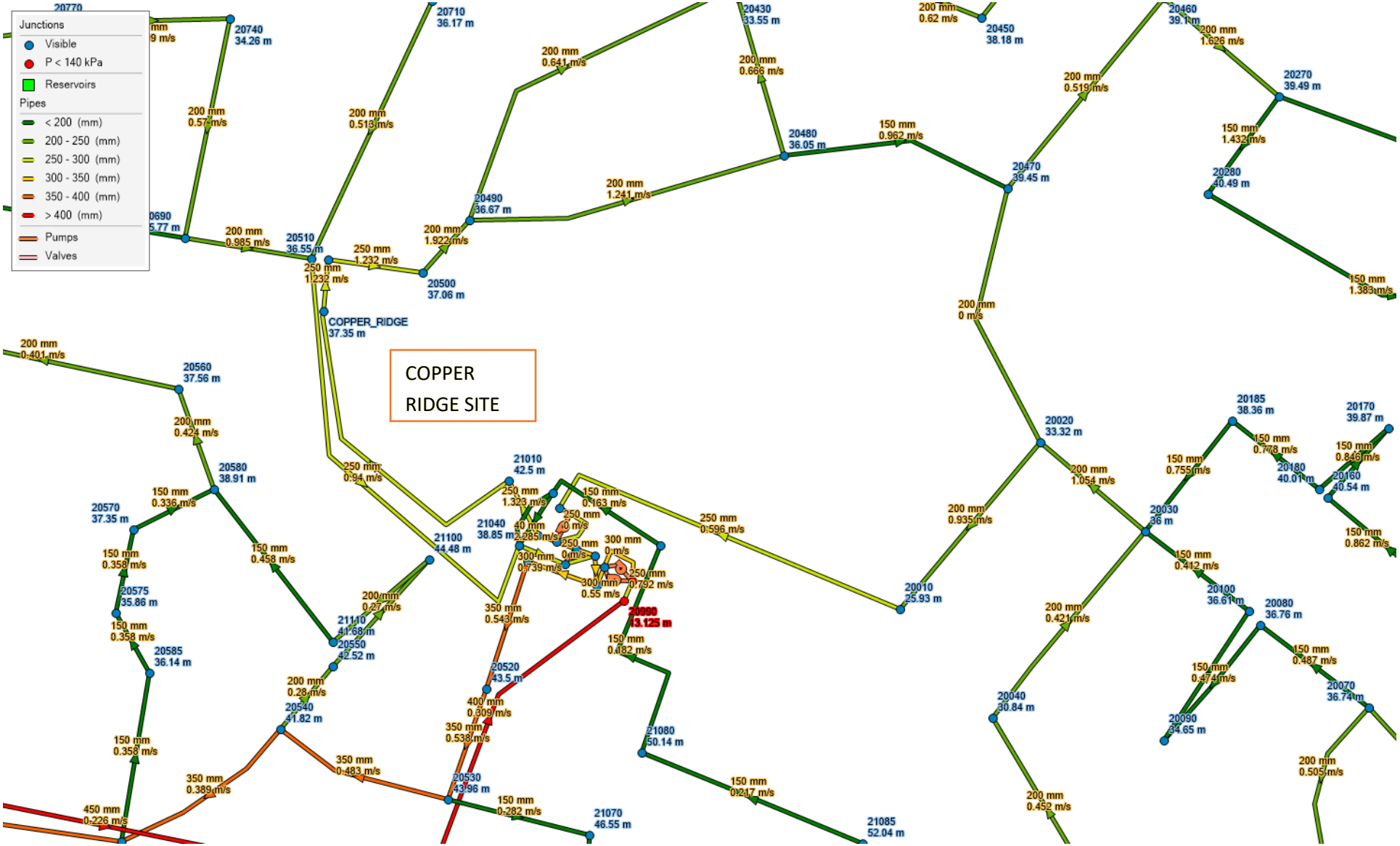
PHD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Reservoirs
Pipes
< 200 (mm)
200 - 250 (mm)
250 - 300 (mm)
300 - 350 (mm)
350 - 400 (mm)
> 400 (mm)
Pumps
Valves
COPPER RIDGE SITE
COPPER_RIDGE
37.35 m
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20520
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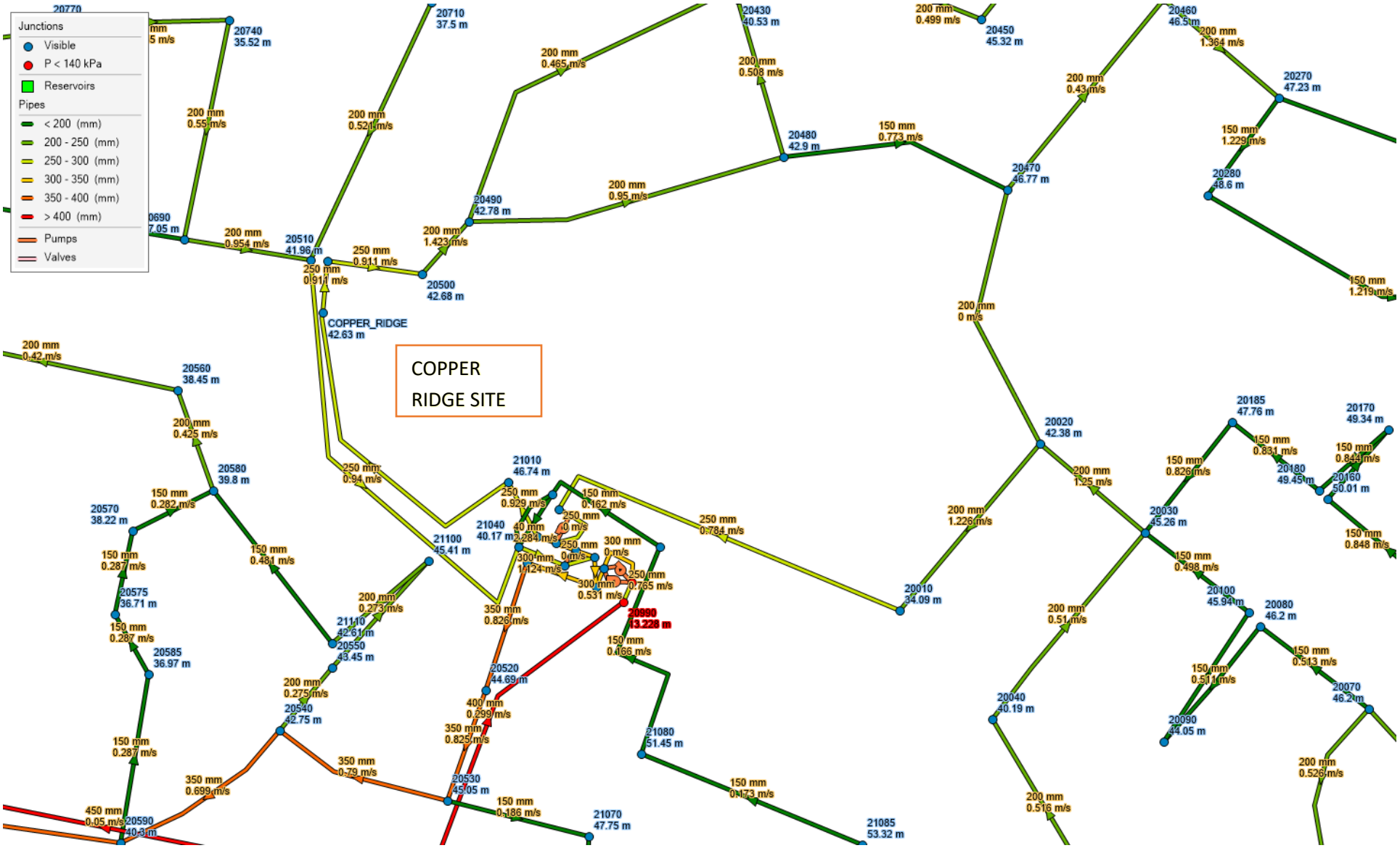
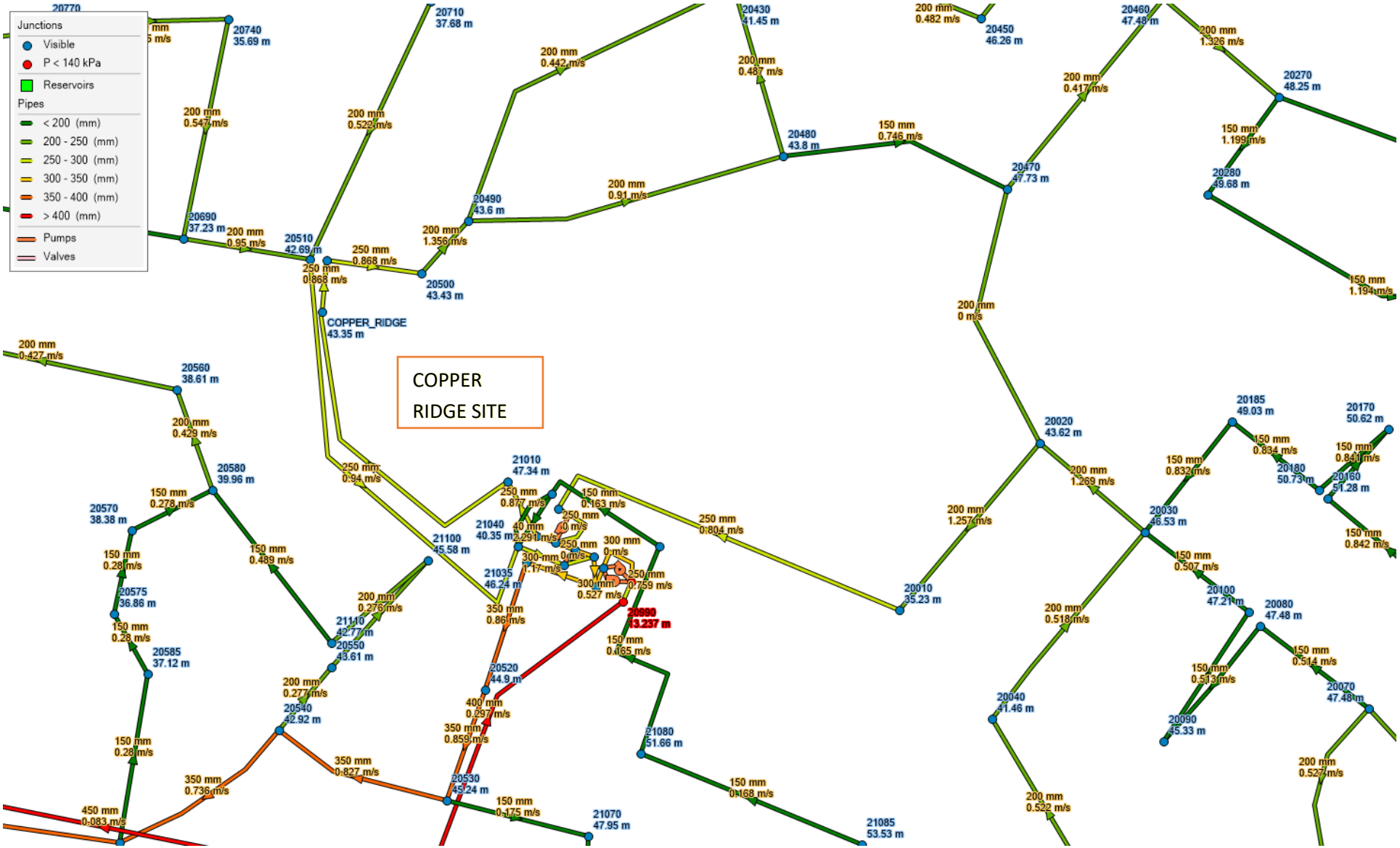
NFD – RESERVOIR FILLING ANALYSIS



NFD – THERMAL ANALYSIS



MODEL RESULTS FOR CONNECTION TO SERVICING POINT 2

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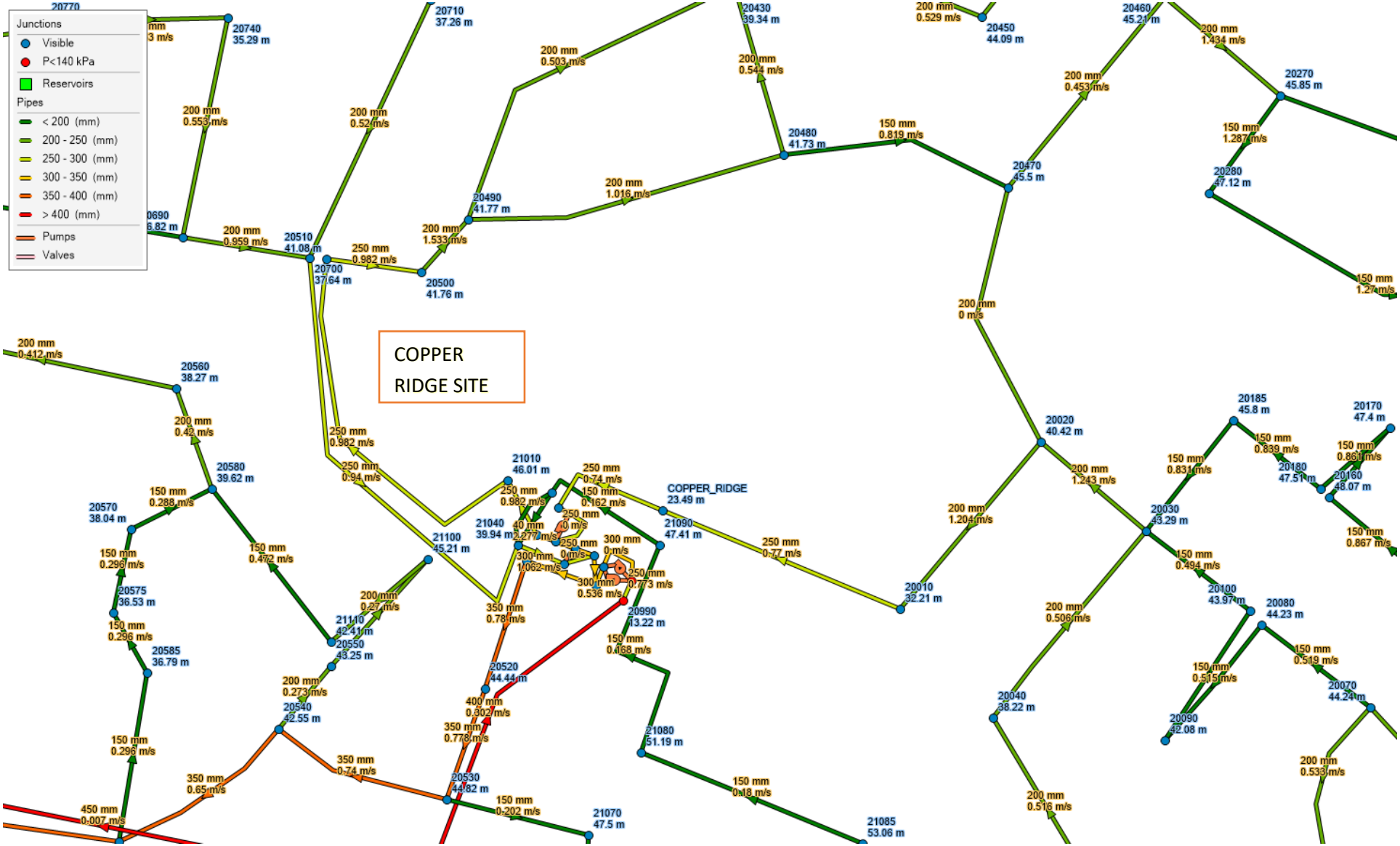

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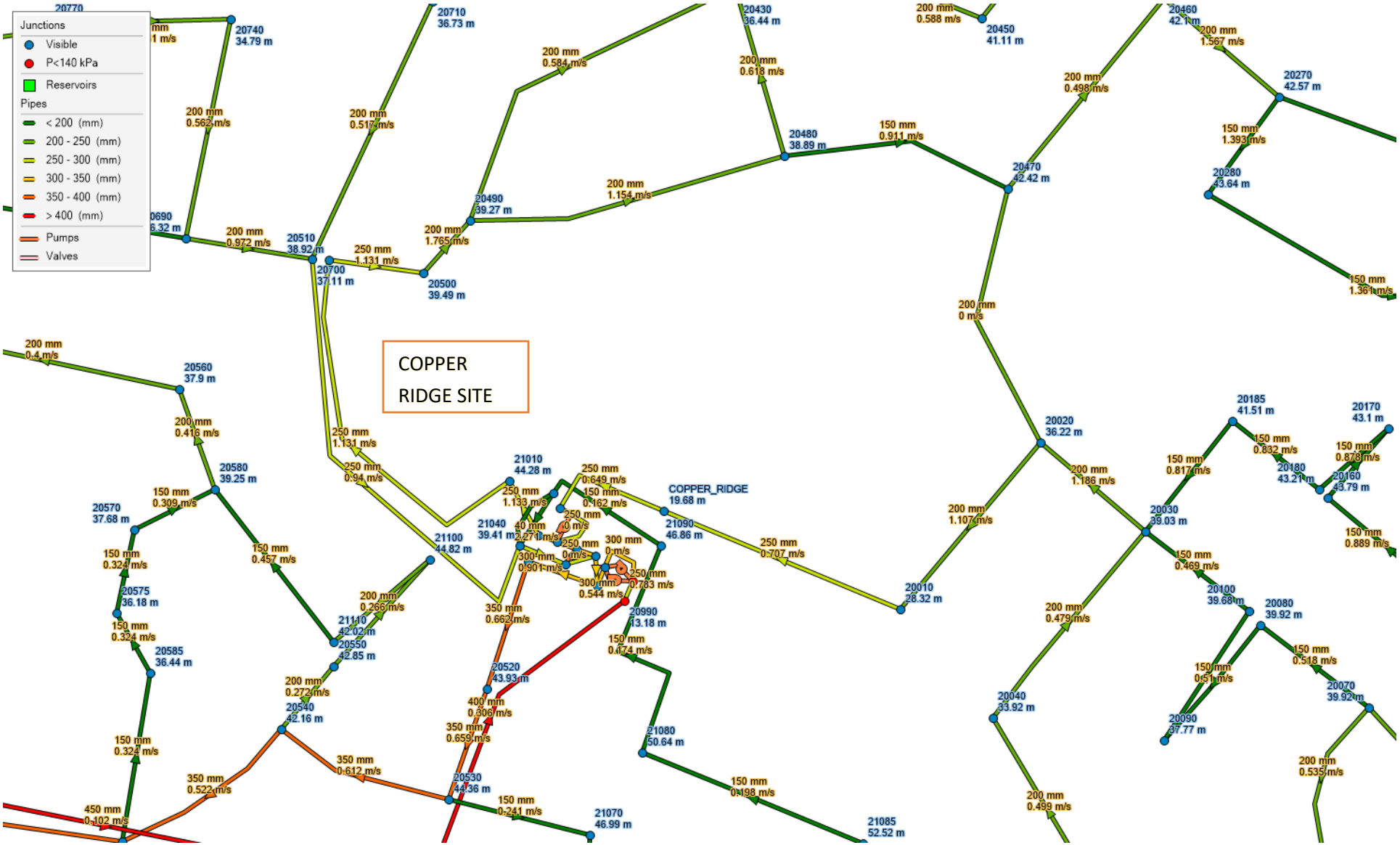
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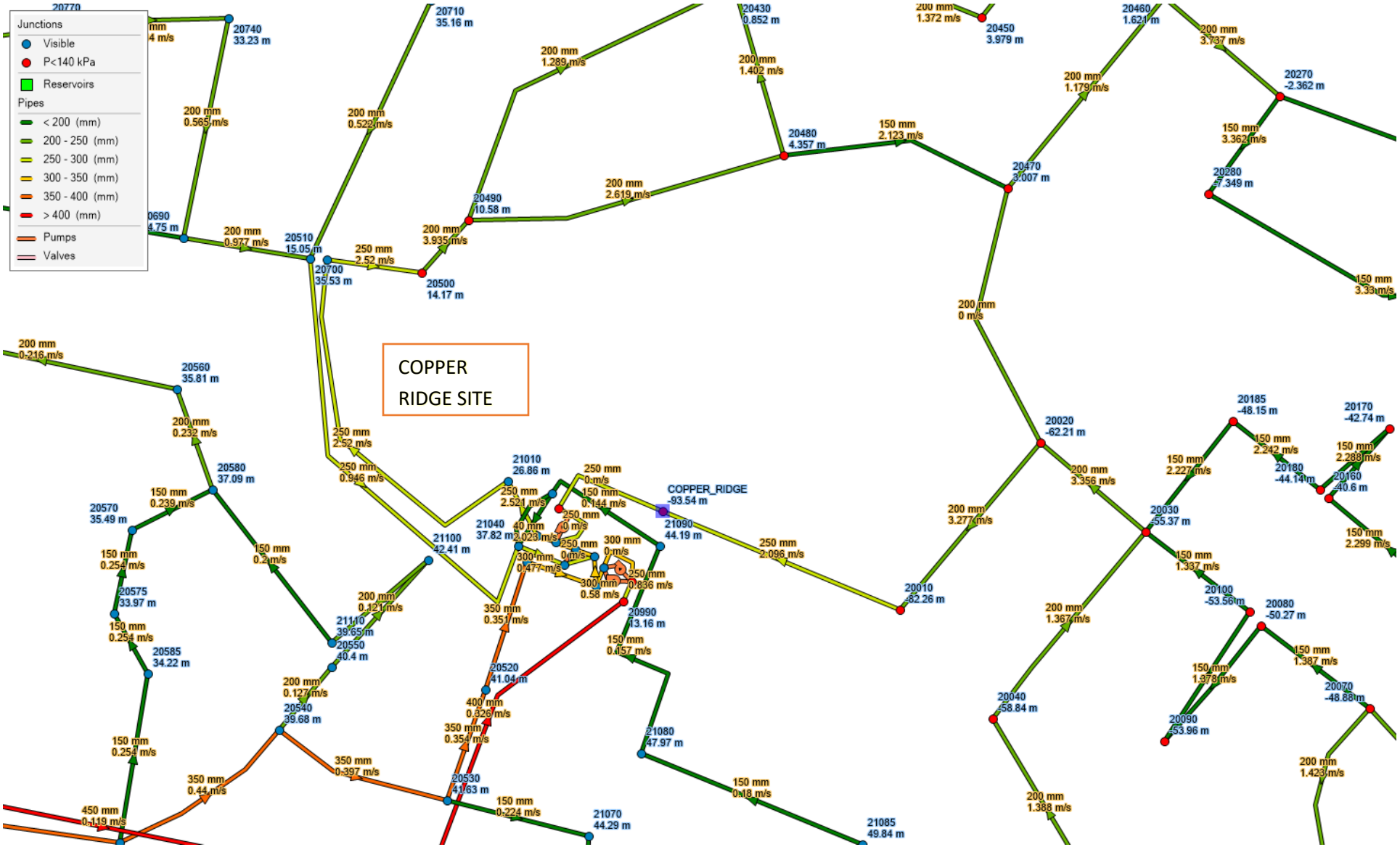
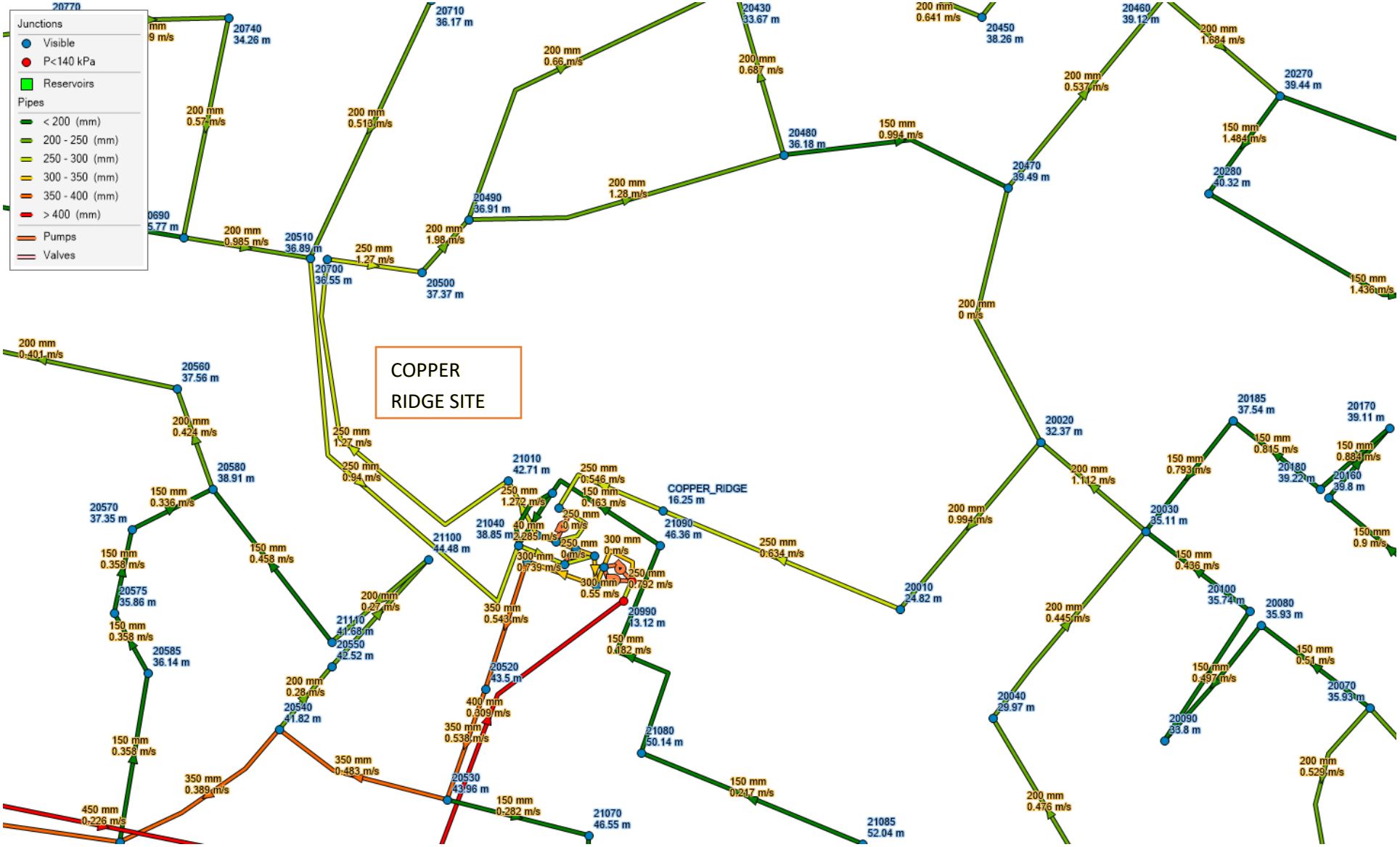
P<140 kPa
Reservoirs
Pipes
< 200 (mm)
200 - 250 (mm)
250 - 300 (mm)
300 - 350 (mm)
350 - 400 (mm)
> 400 (mm)
Pumps
Valves
COPPER
RIDGE SITE
COPPER_RIDGE
19.68 m
20740
34.79 m
20710
36.73 m
20430
36.44 m
20450
41.11 m
20460
42.1 m
20270
42.57 m
20280
43.64 m
20480
38.89 m
20490
39.27 m
20510
38.92 m
20700
37.11 m
20500
39.49 m
20470
42.42 m
20560
37.9 m
20580
39.25 m
20570
37.68 m
20575
36.18 m
20585
36.44 m
20540
42.16 m
21100
44.82 m
21040
39.41 m
21010
44.28 m
21090
46.86 m
20010
28.32 m
20020
36.22 m
20185
41.51 m
20170
43.1 m
20180
43.21 m
20160
43.79 m
20030
39.03 m
20100
39.68 m
20080
39.92 m
20070
39.92 m
20090
37.77 m
20040
33.92 m
21110
42.02 m
20550
42.85 m
20520
43.93 m
20990
43.18 m
21080
50.64 m
20530
44.36 m
21070
46.99 m
21085
52.52 m

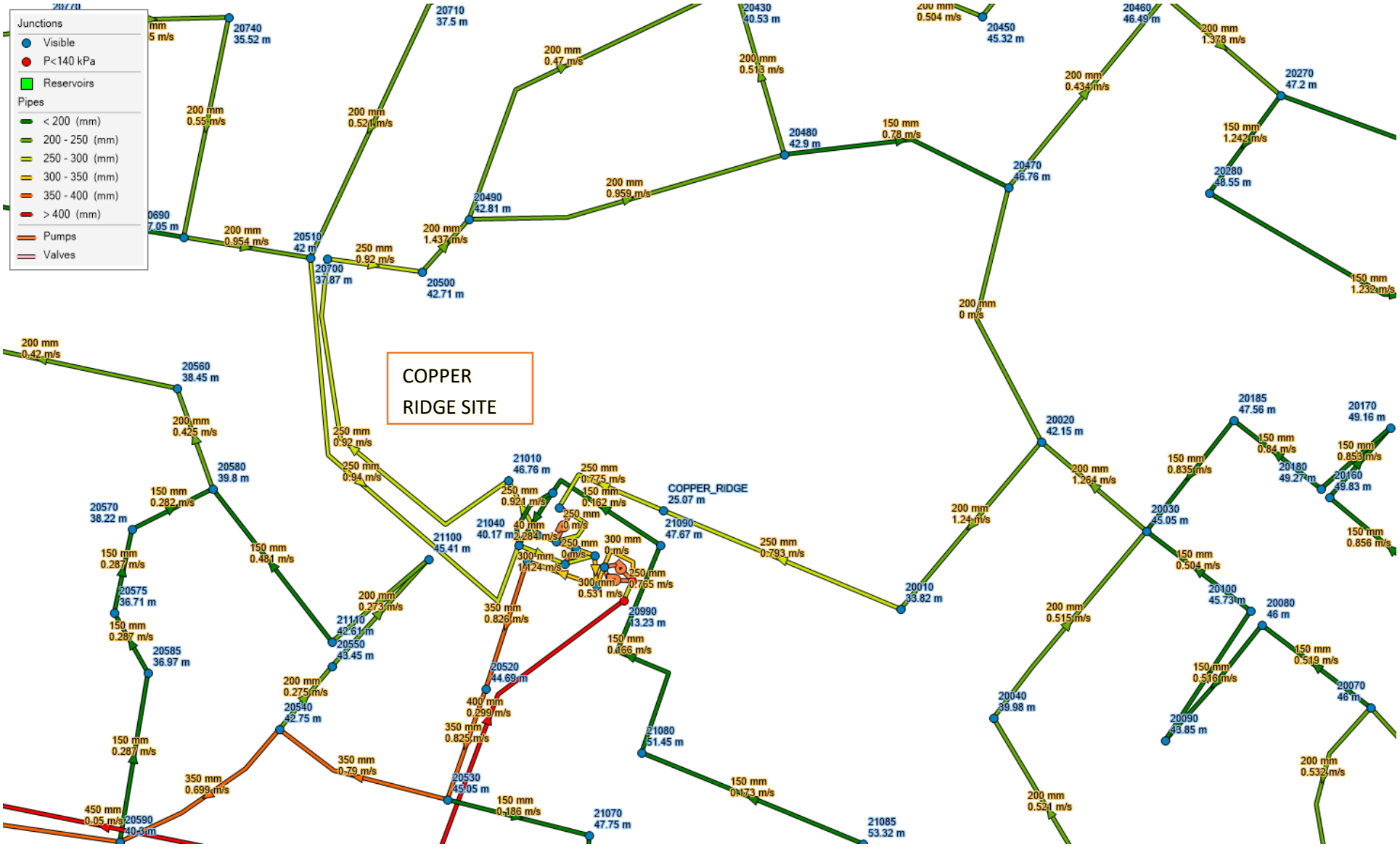
MDD+100 L/S FF


Junctions
Visible
P<140 kPa
Reservoirs
Pipes
< 200 (mm)
200 - 250 (mm)
250 - 300 (mm)
300 - 350 (mm)
350 - 400 (mm)
> 400 (mm)
Pumps
Valves
COPPER
RIDGE SITE
COPPER_RIDGE
-93.54 m
20710
35.16 m
20740
33.23 m
20430
0.852 m
20450
3.979 m
20460
1.621 m
20270
-2.362 m
20280
-7.349 m
20480
4.357 m
20470
3.007 m
20490
10.58 m
20510
15.05 m
20700
35.53 m
20500
14.17 m
20560
35.81 m
20580
37.09 m
20570
35.49 m
20575
33.97 m
20585
34.22 m
20550
40.4 m
20540
39.68 m
20530
41.63 m
21010
26.86 m
21040
37.82 m
21100
42.41 m
21110
39.65 m
20520
41.04 m
20990
43.16 m
21080
47.97 m
21070
44.29 m
21085
49.84 m
20020
-62.21 m
20010
-82.26 m
20185
-48.15 m
20170
-42.74 m
20180
-44.14 m
20160
-40.6 m
20030
-55.37 m
20100
-53.56 m
20080
-50.27 m
20040
-58.84 m
20070
-48.88 m
20090
-53.96 m
21090
44.19 m

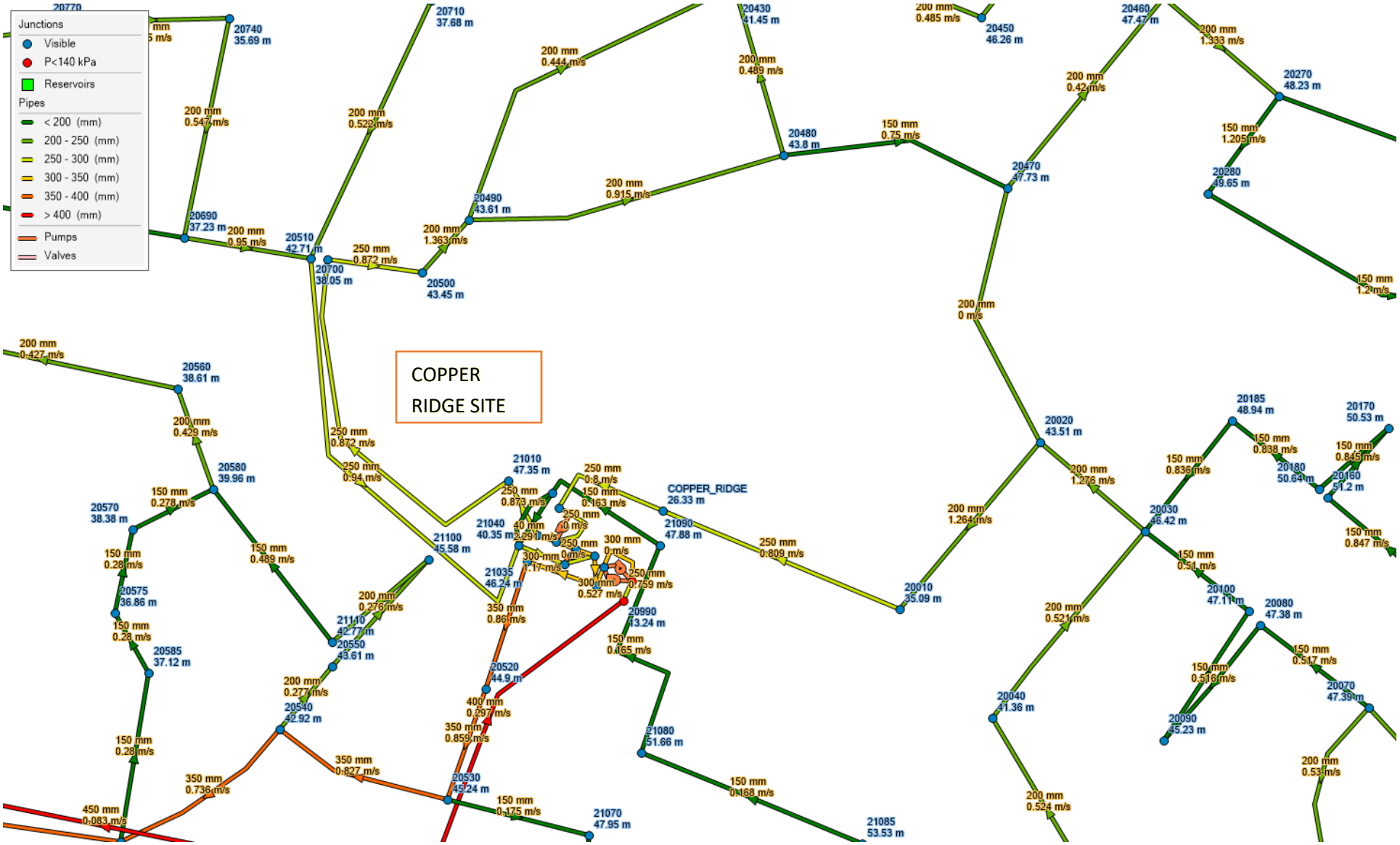
PHD


Junctions
Visible
P<140 kPa
Reservoirs
Pipes
< 200 (mm)
200 - 250 (mm)
250 - 300 (mm)
300 - 350 (mm)
350 - 400 (mm)
> 400 (mm)
Pumps
Valves
COPPER
RIDGE SITE
COPPER_RIDGE
16.25 m
20740
34.26 m
20710
36.17 m
20430
33.67 m
20450
38.26 m
20460
39.12 m
20270
39.44 m
20280
40.32 m
20480
36.18 m
20470
39.49 m
20490
36.91 m
20510
36.89 m
20700
36.55 m
20500
37.37 m
20560
37.56 m
20580
38.91 m
20570
37.35 m
20575
35.86 m
20585
36.14 m
20540
41.82 m
20550
42.52 m
21110
41.68 m
21100
44.48 m
21010
42.71 m
21040
38.85 m
21090
46.36 m
20010
24.82 m
20990
43.12 m
20520
43.5 m
20530
43.96 m
21080
50.14 m
21070
46.55 m
21085
52.04 m
20020
32.37 m
20185
37.54 m
20170
39.11 m
20180
39.22 m
20160
39.8 m
20030
35.11 m
20100
35.74 m
20080
35.93 m
20070
35.93 m
20040
29.97 m
20090
33.8 m
200 mm 0.574 m/s
200 mm 0.518 m/s
200 mm 0.66 m/s
200 mm 0.687 m/s
200 mm 0.641 m/s
200 mm 0.537 m/s
200 mm 1.684 m/s
150 mm 0.994 m/s
150 mm 1.484 m/s
200 mm 1.28 m/s
200 mm 0.985 m/s
200 mm 1.98 m/s
250 mm 1.27 m/s
150 mm 1.436 m/s
200 mm 0 m/s
200 mm 0.401 m/s
200 mm 0.424 m/s
250 mm 1.27 m/s
250 mm 0.94 m/s
250 mm 0.546 m/s
150 mm 0.163 m/s
250 mm 1.272 m/s
250 mm 0 m/s
40 mm 2.285 m/s
250 mm 0 m/s
300 mm 0 m/s
300 mm 0.739 m/s
250 mm 0.792 m/s
300 mm 0.55 m/s
250 mm 0.634 m/s
200 mm 0.994 m/s
200 mm 1.112 m/s
150 mm 0.793 m/s
150 mm 0.815 m/s
150 mm 0.884 m/s
150 mm 0.9 m/s
150 mm 0.336 m/s
150 mm 0.458 m/s
150 mm 0.358 m/s
150 mm 0.358 m/s
200 mm 0.27 m/s
350 mm 0.543 m/s
150 mm 0.482 m/s
200 mm 0.28 m/s
400 mm 0.309 m/s
350 mm 0.538 m/s
350 mm 0.483 m/s
350 mm 0.389 m/s
150 mm 0.358 m/s
450 mm 0.226 m/s
150 mm 0.282 m/s
150 mm 0.247 m/s
200 mm 0.445 m/s
150 mm 0.436 m/s
150 mm 0.497 m/s
150 mm 0.51 m/s
200 mm 0.529 m/s
200 mm 0.476 m/s

NFD – RESERVOIR FILLING ANALYSIS

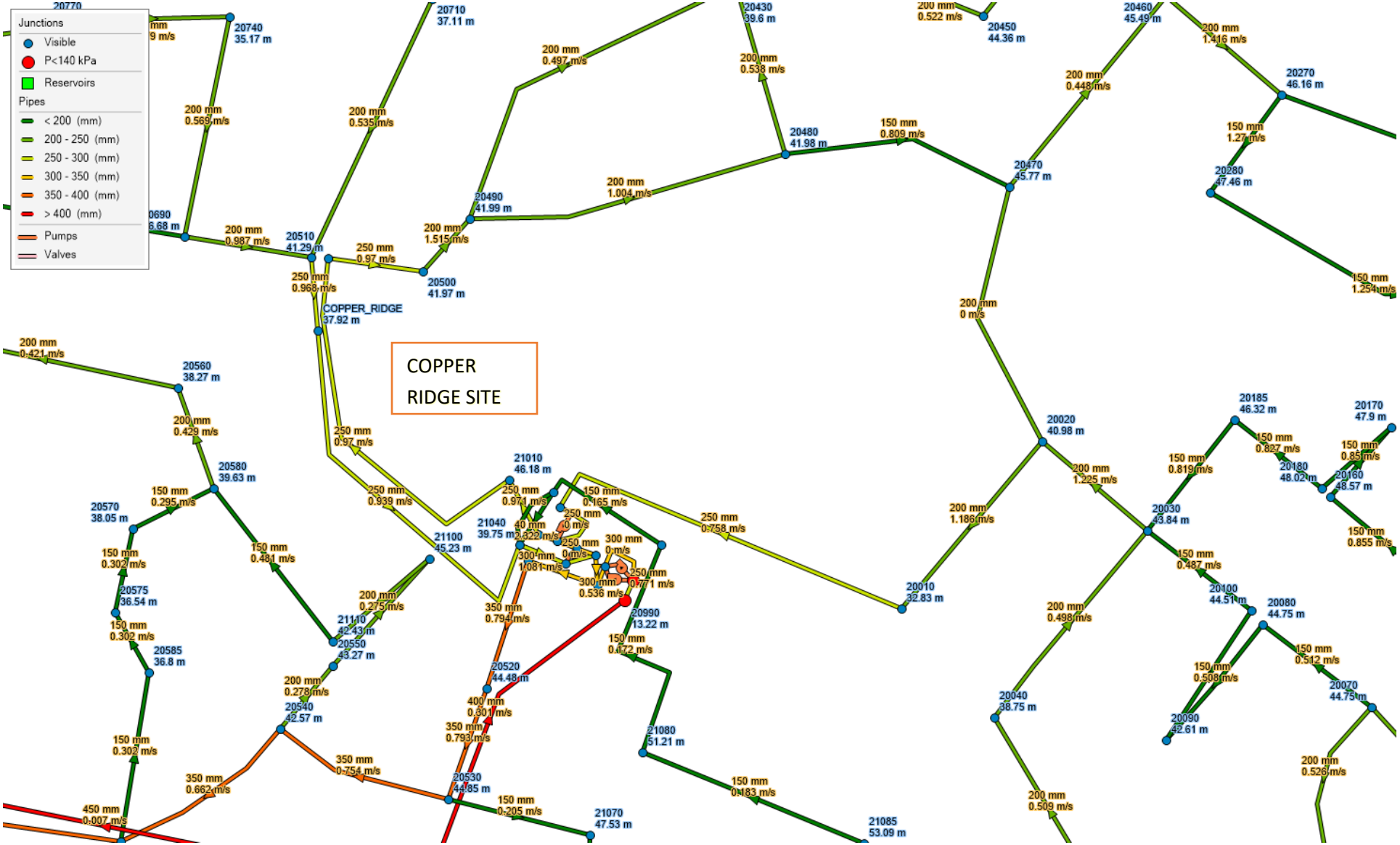


NFD – THERMAL ANALYSIS

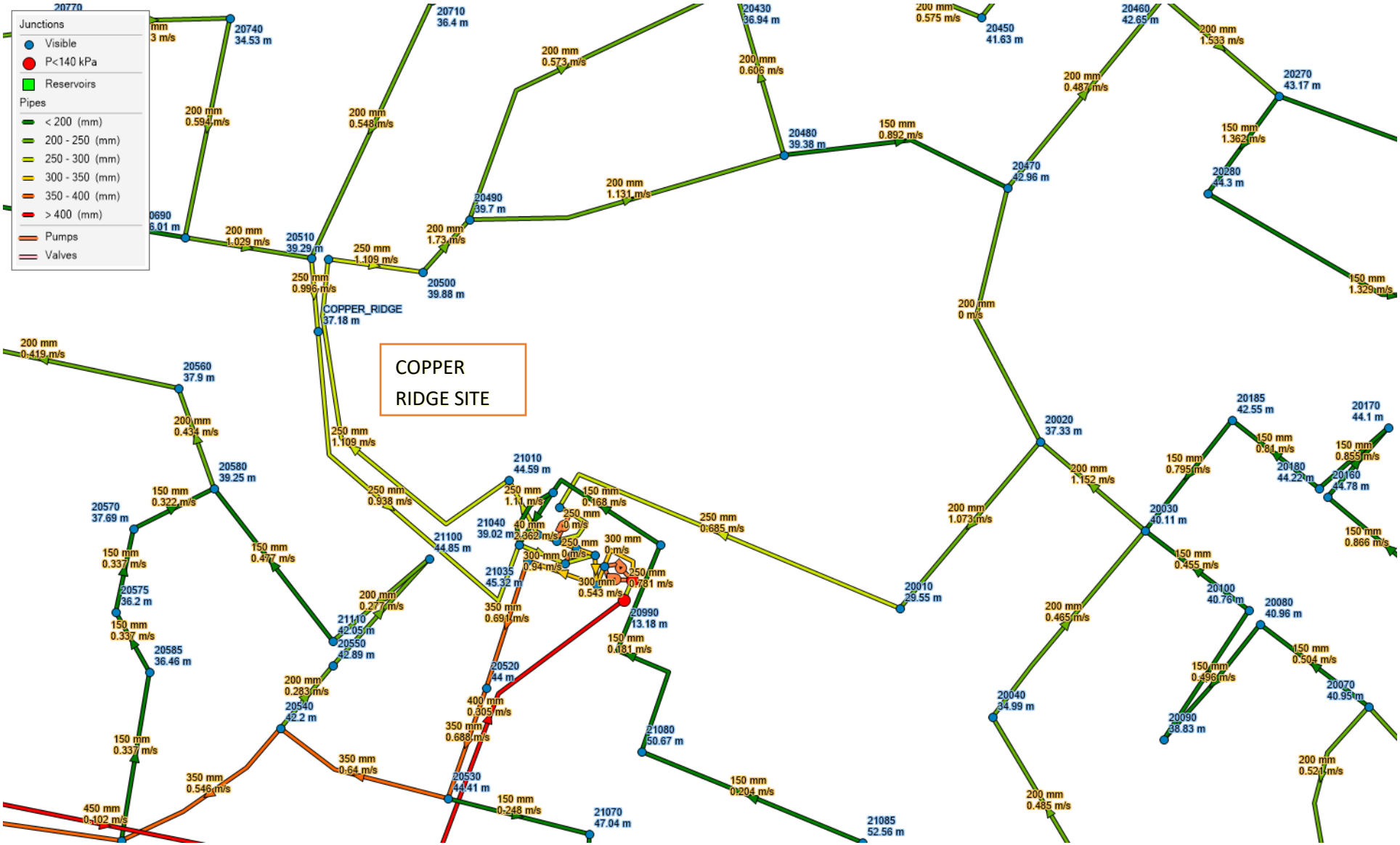


MODEL RESULTS FOR CONNECTION TO SERVICING POINT 3

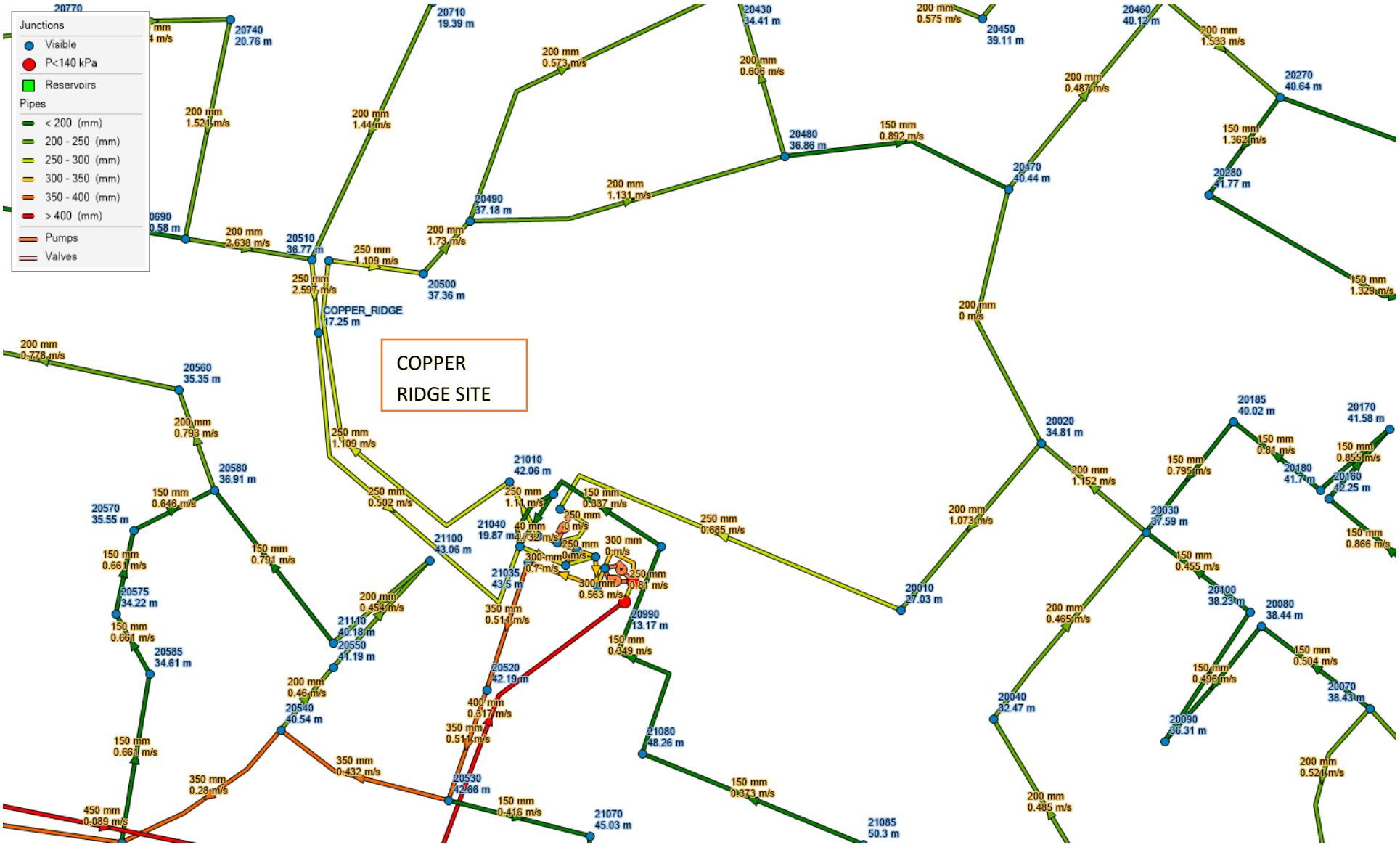
ADD



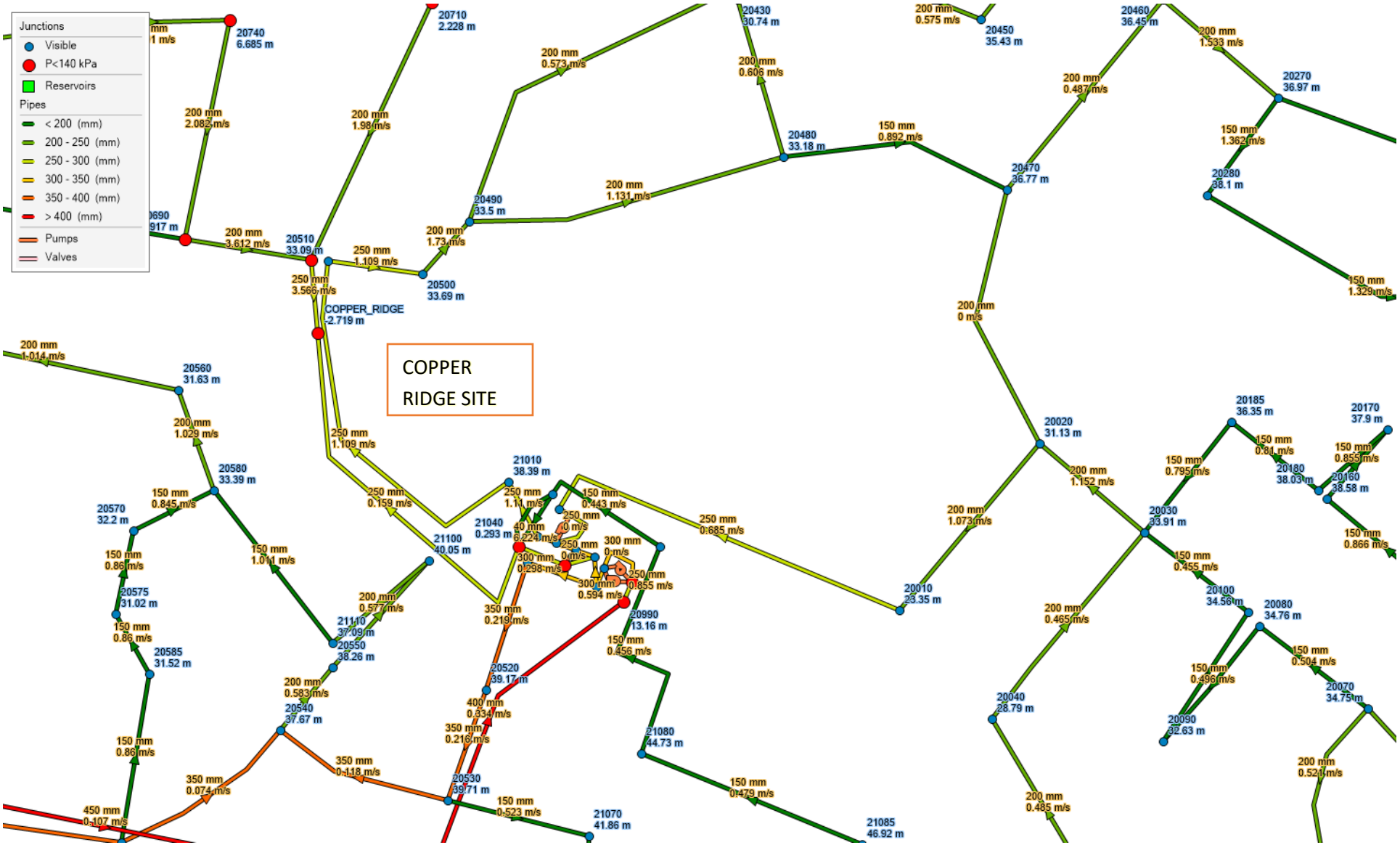
MDD


Junctions
Visible
P<140 kPa
Reservoirs
Pipes
< 200 (mm)
200 - 250 (mm)
250 - 300 (mm)
300 - 350 (mm)
350 - 400 (mm)
> 400 (mm)
Pumps
Valves
COPPER_RIDGE
37.18 m
COPPER
RIDGE SITE
20770
20740
34.53 m
20710
36.4 m
20430
36.94 m
20450
41.63 m
20460
42.65 m
20270
43.17 m
20280
44.3 m
20480
39.38 m
20490
39.7 m
20510
39.29 m
20500
39.88 m
20470
42.96 m
20560
37.9 m
20580
39.25 m
20570
37.69 m
20575
36.2 m
20585
36.46 m
20540
42.2 m
20550
42.89 m
21110
42.05 m
21100
44.85 m
21040
39.02 m
21035
45.32 m
21010
44.59 m
20520
44 m
20530
44.41 m
20990
13.18 m
21080
50.67 m
21070
47.04 m
21085
52.56 m
20010
29.55 m
20020
37.33 m
20185
42.55 m
20170
44.1 m
20180
44.22 m
20160
44.78 m
20030
40.11 m
20100
40.76 m
20080
40.96 m
20040
34.99 m
20090
38.83 m
20070
40.95 m

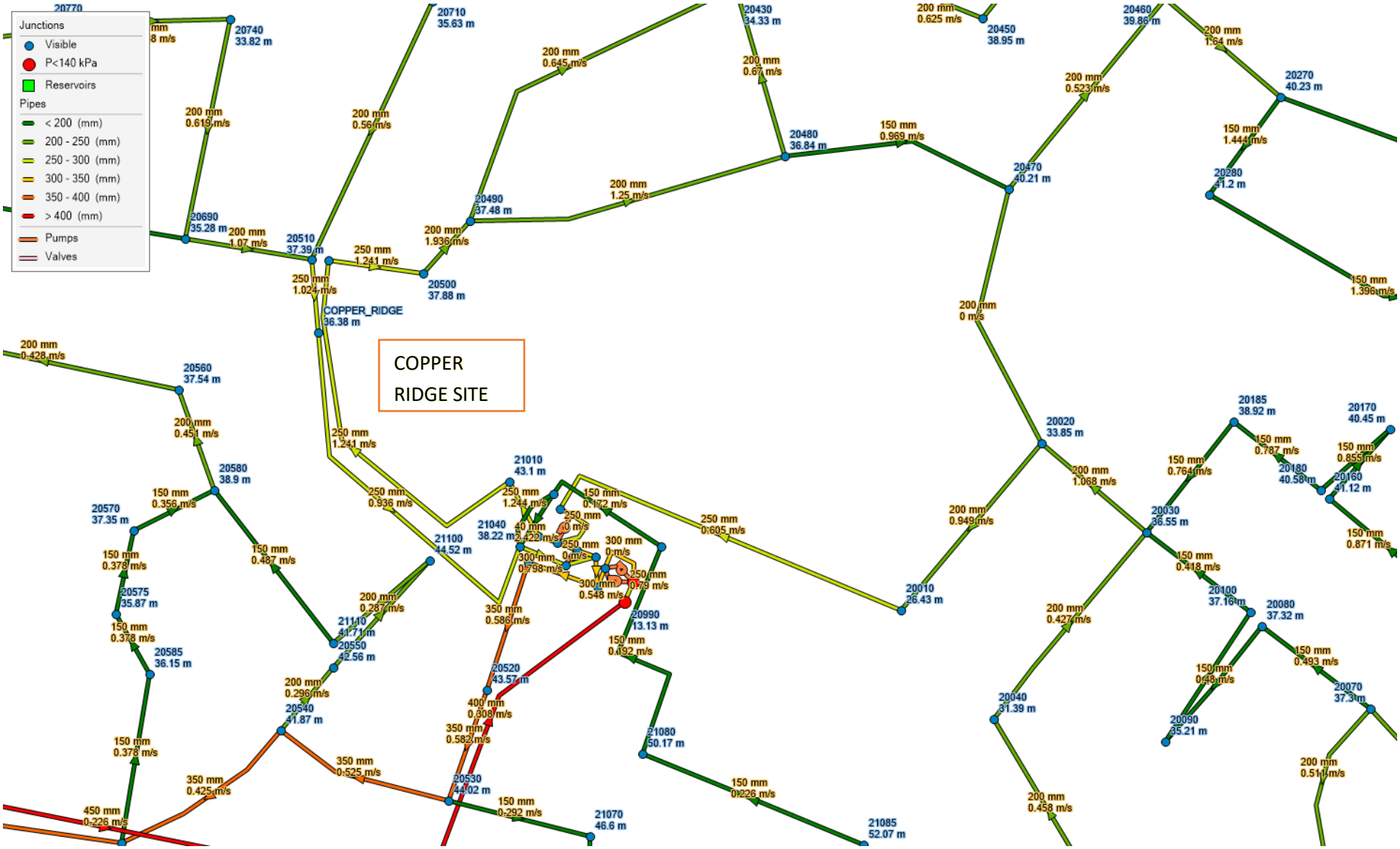
MDD+100 L/S FF


Junctions
Visible
P<140 kPa
Reservoirs
Pipes
< 200 (mm)
200 - 250 (mm)
250 - 300 (mm)
300 - 350 (mm)
350 - 400 (mm)
> 400 (mm)
Pumps
Valves
COPPER_RIDGE
17.25 m
COPPER
RIDGE SITE
20740
20.76 m
20710
19.39 m
20430
34.41 m
20450
39.11 m
20460
40.12 m
20270
40.64 m
20280
41.77 m
20480
36.86 m
20490
37.18 m
20510
36.77 m
20500
37.36 m
20470
40.44 m
20020
34.81 m
20185
40.02 m
20170
41.58 m
20180
41.7 m
20160
42.25 m
20030
37.59 m
20100
38.23 m
20080
38.44 m
20070
38.43 m
20090
36.31 m
20040
32.47 m
20010
27.03 m
20560
35.35 m
20580
36.91 m
20570
35.55 m
20575
34.22 m
20585
34.61 m
20550
41.19 m
20540
40.54 m
20530
42.66 m
21010
42.06 m
21040
19.87 m
21100
43.06 m
21035
43.5 m
20520
42.19 m
20990
43.17 m
21080
48.26 m
21070
45.03 m
21085
50.3 m
21110
40.18 m

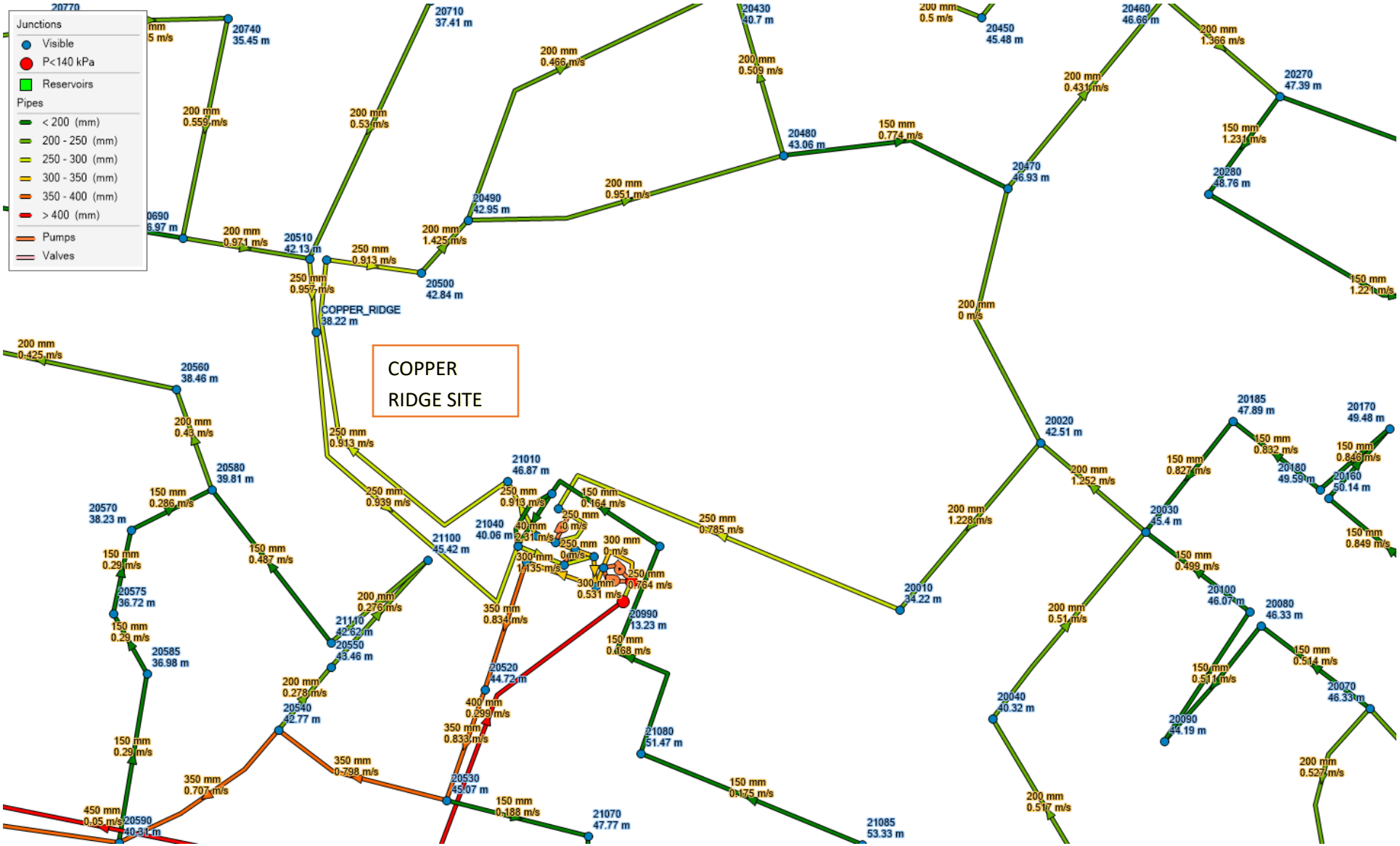
MDD+180 L/S FF


Junctions
Visible
P<140 kPa
Reservoirs
Pipes
< 200 (mm)
200 - 250 (mm)
250 - 300 (mm)
300 - 350 (mm)
350 - 400 (mm)
> 400 (mm)
Pumps
Valves
COPPER RIDGE SITE
COPPER_RIDGE
-2.719 m
20740
6.685 m
20710
2.228 m
20430
30.74 m
20450
35.43 m
20460
36.45 m
20270
36.97 m
20280
38.1 m
20470
36.77 m
20480
33.18 m
20490
33.5 m
20510
33.09 m
20500
33.69 m
20560
31.63 m
20580
33.39 m
20570
32.2 m
20575
31.02 m
20585
31.52 m
20550
38.26 m
20540
37.67 m
20530
39.71 m
21010
38.39 m
21040
0.293 m
21100
40.05 m
21110
37.09 m
20520
39.17 m
20990
13.16 m
21080
44.73 m
21070
41.86 m
21085
46.92 m
20010
23.35 m
20020
31.13 m
20185
36.35 m
20170
37.9 m
20180
38.03 m
20160
38.58 m
20030
33.91 m
20100
34.56 m
20080
34.76 m
20040
28.79 m
20090
32.63 m
20070
34.75 m

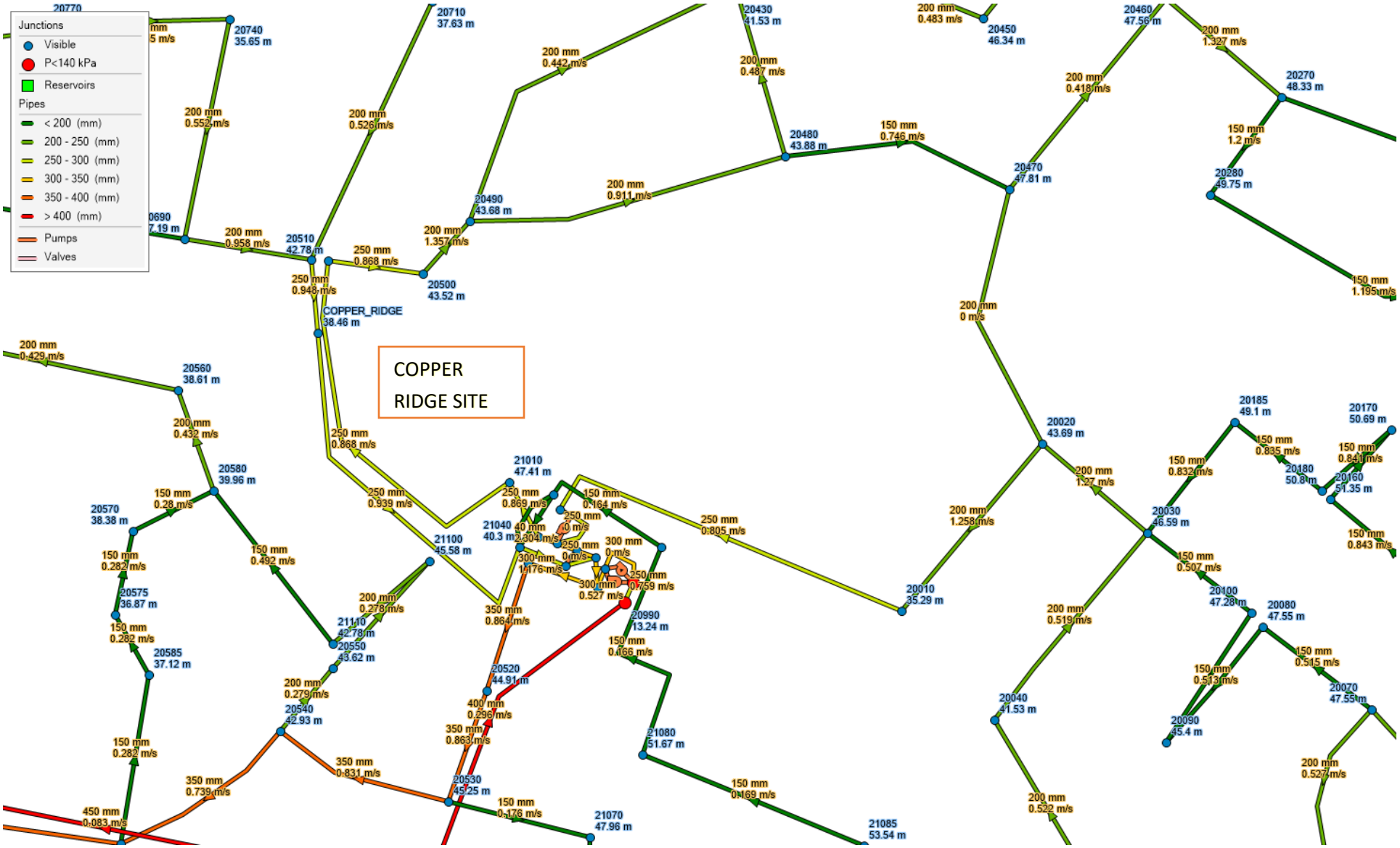
PHD


Junctions
Visible
P<140 kPa
Reservoirs
Pipes
< 200 (mm)
200 - 250 (mm)
250 - 300 (mm)
300 - 350 (mm)
350 - 400 (mm)
> 400 (mm)
Pumps
Valves
COPPER RIDGE SITE
COPPER_RIDGE
36.38 m
20510
37.39 m
20500
37.88 m
20490
37.48 m
20480
36.84 m
20470
40.21 m
20460
39.86 m
20450
38.95 m
20430
34.33 m
20710
35.63 m
20740
33.82 m
20690
35.28 m
20270
40.23 m
20280
41.2 m
20560
37.54 m
20580
38.9 m
20570
37.35 m
20575
35.87 m
20585
36.15 m
20540
41.87 m
20550
42.56 m
21110
41.71 m
21100
44.52 m
21040
38.22 m
21010
43.1 m
20520
43.57 m
20530
44.02 m
20990
13.13 m
21080
50.17 m
21070
46.6 m
21085
52.07 m
20010
26.43 m
20020
33.85 m
20030
36.55 m
20185
38.92 m
20170
40.45 m
20180
40.58 m
20160
41.12 m
20100
37.16 m
20080
37.32 m
20070
37.3 m
20090
35.21 m
20040
31.39 m

NFD – RESERVOIR FILLING ANALYSIS

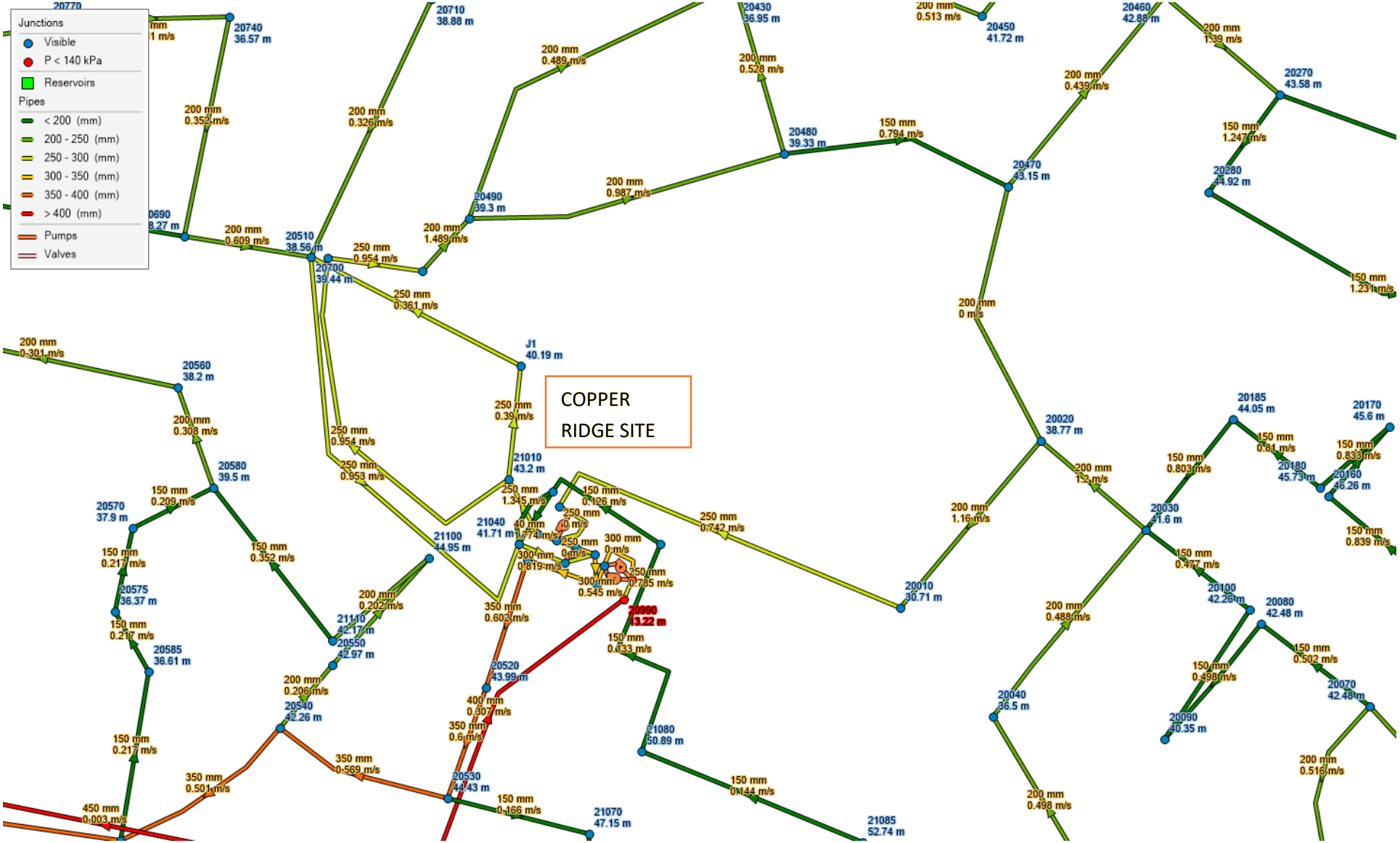


NFD – THERMAL ANALYSIS

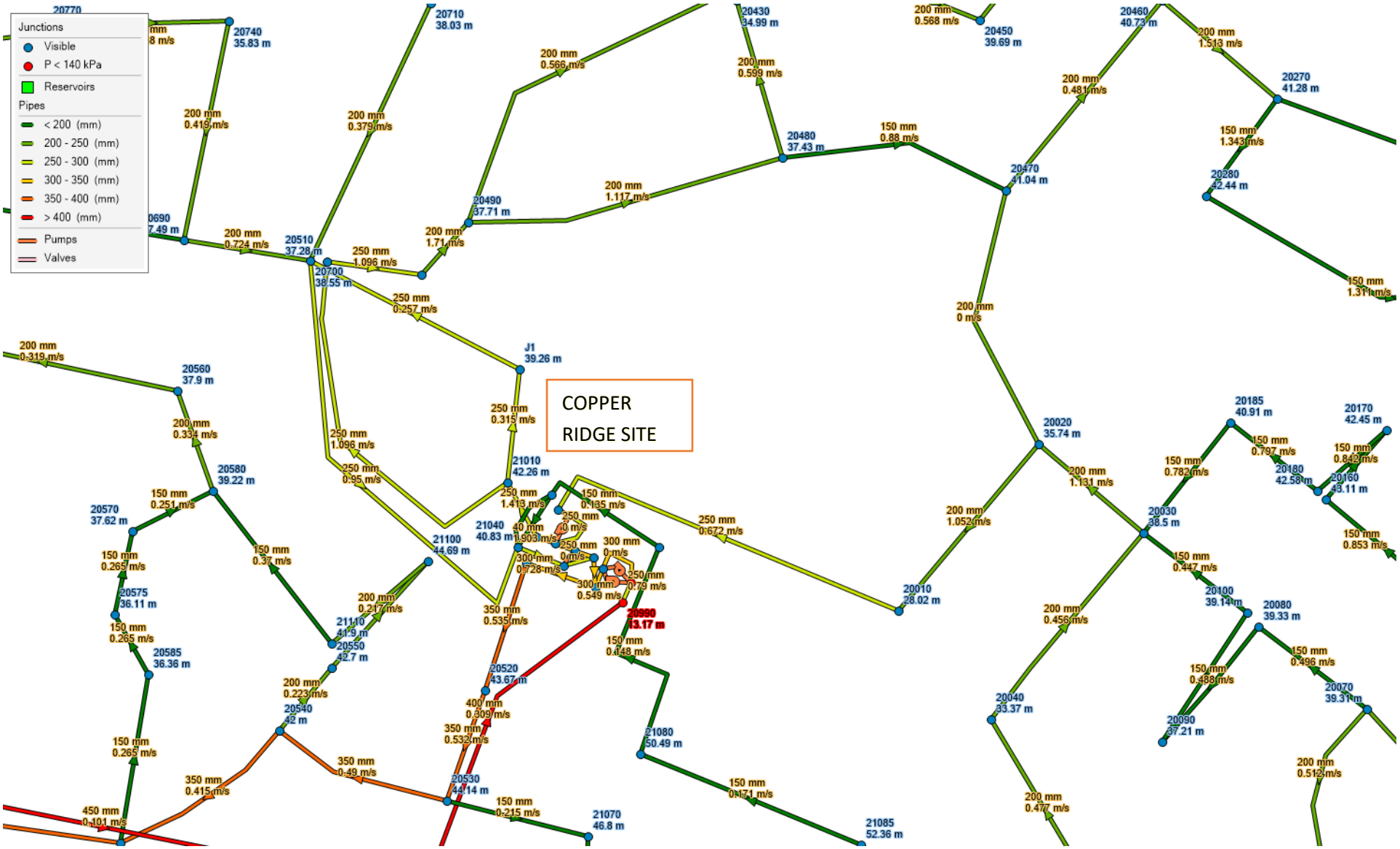


MODEL RESULTS FOR CONNECTION TO SERVICING POINT 3 AND SOUTH/EAST 250 MM WM ON FALCON

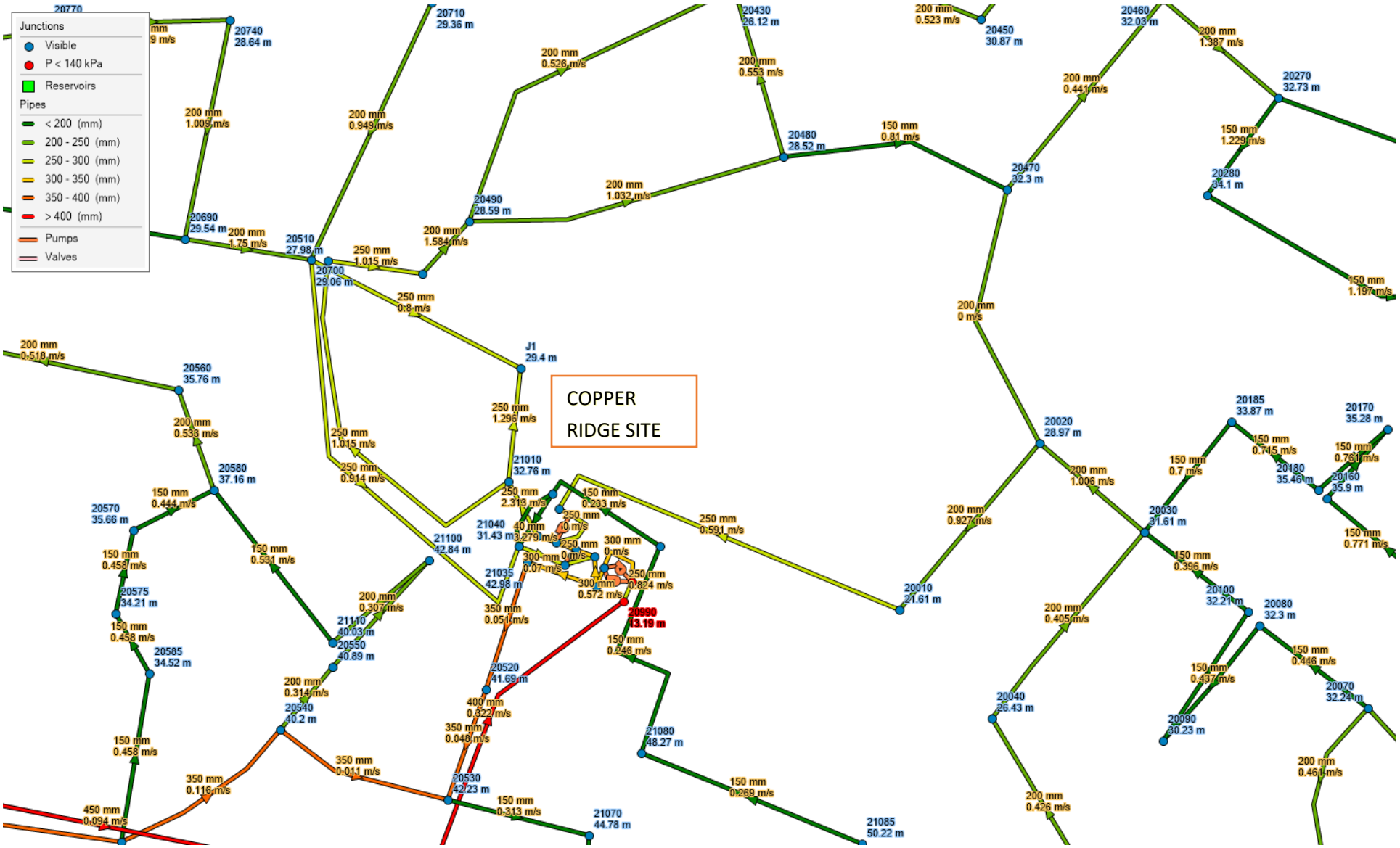
ADD



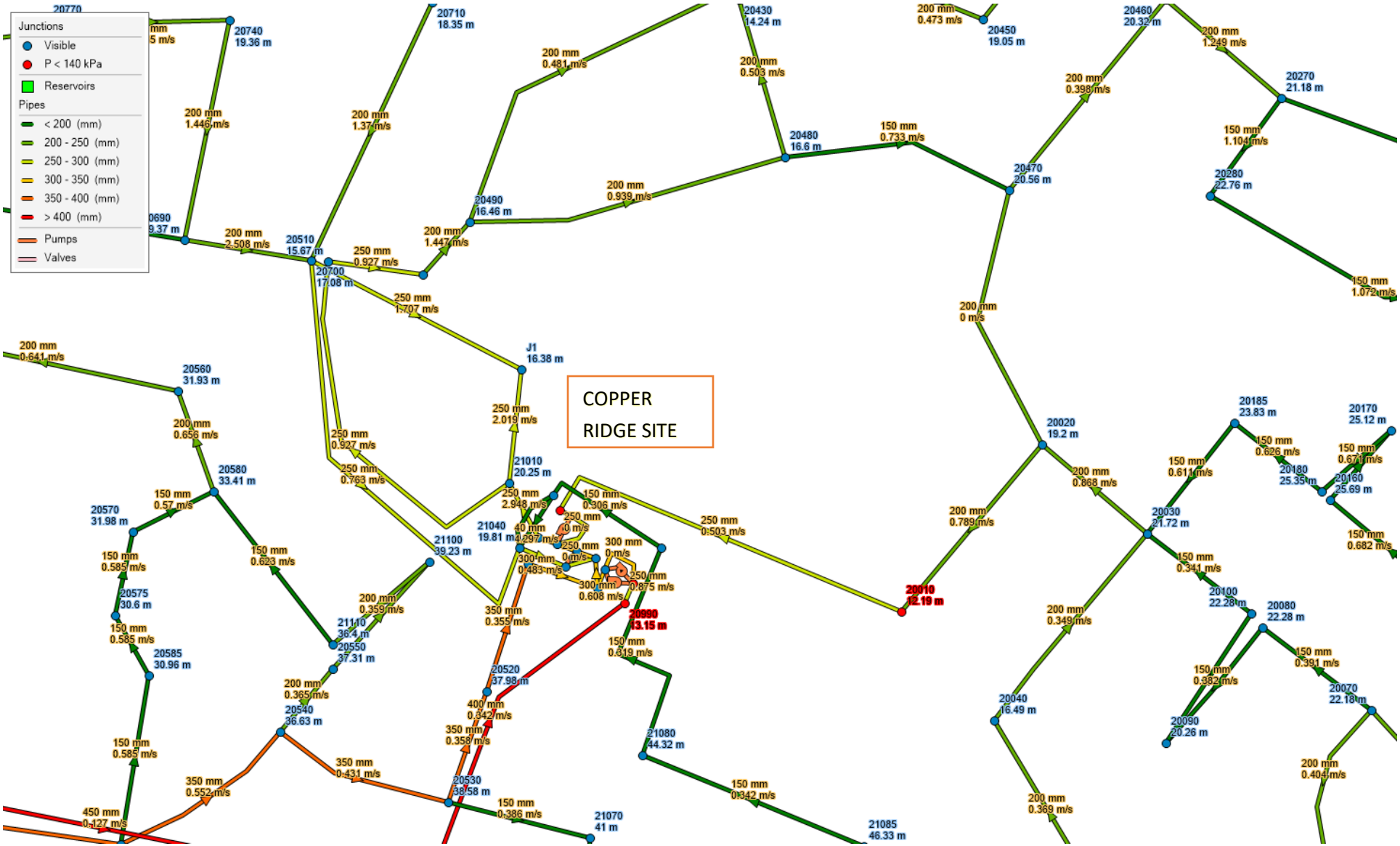
MDD


Junctions
Visible
P < 140 kPa
Reservoirs
Pipes
< 200 (mm)
200 - 250 (mm)
250 - 300 (mm)
300 - 350 (mm)
350 - 400 (mm)
> 400 (mm)
Pumps
Valves
COPPER
RIDGE SITE
20710
38.03 m
20740
35.83 m
20430
34.99 m
20450
39.69 m
20460
40.73 m
20270
41.28 m
20280
42.44 m
20480
37.43 m
20470
41.04 m
20490
37.71 m
20510
37.28 m
20700
38.55 m
J1
39.26 m
20560
37.9 m
20580
39.22 m
20570
37.62 m
20575
36.11 m
20585
36.36 m
21010
42.26 m
21040
40.83 m
21100
44.69 m
21110
41.9 m
20550
42.7 m
20540
42 m
20520
43.67 m
20530
44.14 m
21070
46.8 m
21080
50.49 m
21085
52.36 m
20010
28.02 m
20020
35.74 m
20185
40.91 m
20170
42.45 m
20180
42.58 m
20160
43.11 m
20030
38.5 m
20100
39.14 m
20080
39.33 m
20070
39.31 m
20090
37.21 m
20040
33.37 m
20990
43.17 m

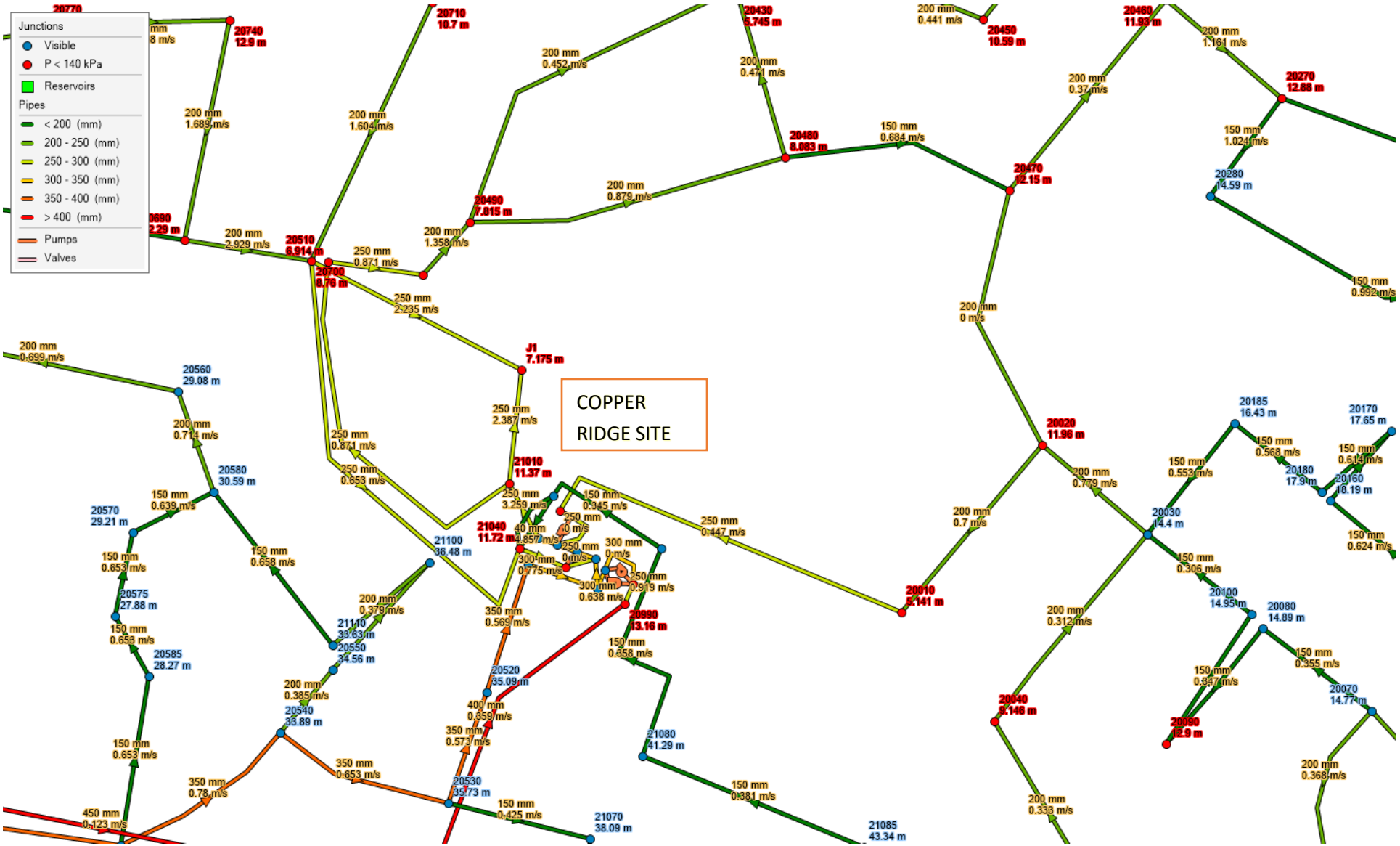
MDD+100 L/S


Junctions
Visible
P < 140 kPa
Reservoirs
Pipes
< 200 (mm)
200 - 250 (mm)
250 - 300 (mm)
300 - 350 (mm)
350 - 400 (mm)
> 400 (mm)
Pumps
Valves
COPPER
RIDGE SITE
20740 28.64 m
20710 29.36 m
20430 26.12 m
20450 30.87 m
20460 32.03 m
20270 32.73 m
20280 34.1 m
20690 29.54 m
20510 27.98 m
20700 29.06 m
20490 28.59 m
20480 28.52 m
20470 32.3 m
J1 29.4 m
20560 35.76 m
20580 37.16 m
20570 35.66 m
20575 34.21 m
20585 34.52 m
21100 42.84 m
21040 31.43 m
21035 42.98 m
21010 32.76 m
21110 40.03 m
20550 40.89 m
20540 40.2 m
20520 41.69 m
20530 42.23 m
21080 48.27 m
21070 44.78 m
21085 50.22 m
20010 21.61 m
20020 28.97 m
20030 31.61 m
20185 33.87 m
20170 35.28 m
20180 35.46 m
20160 35.9 m
20100 32.21 m
20080 32.3 m
20040 26.43 m
20090 30.23 m
20070 32.24 m
20990 13.19 m

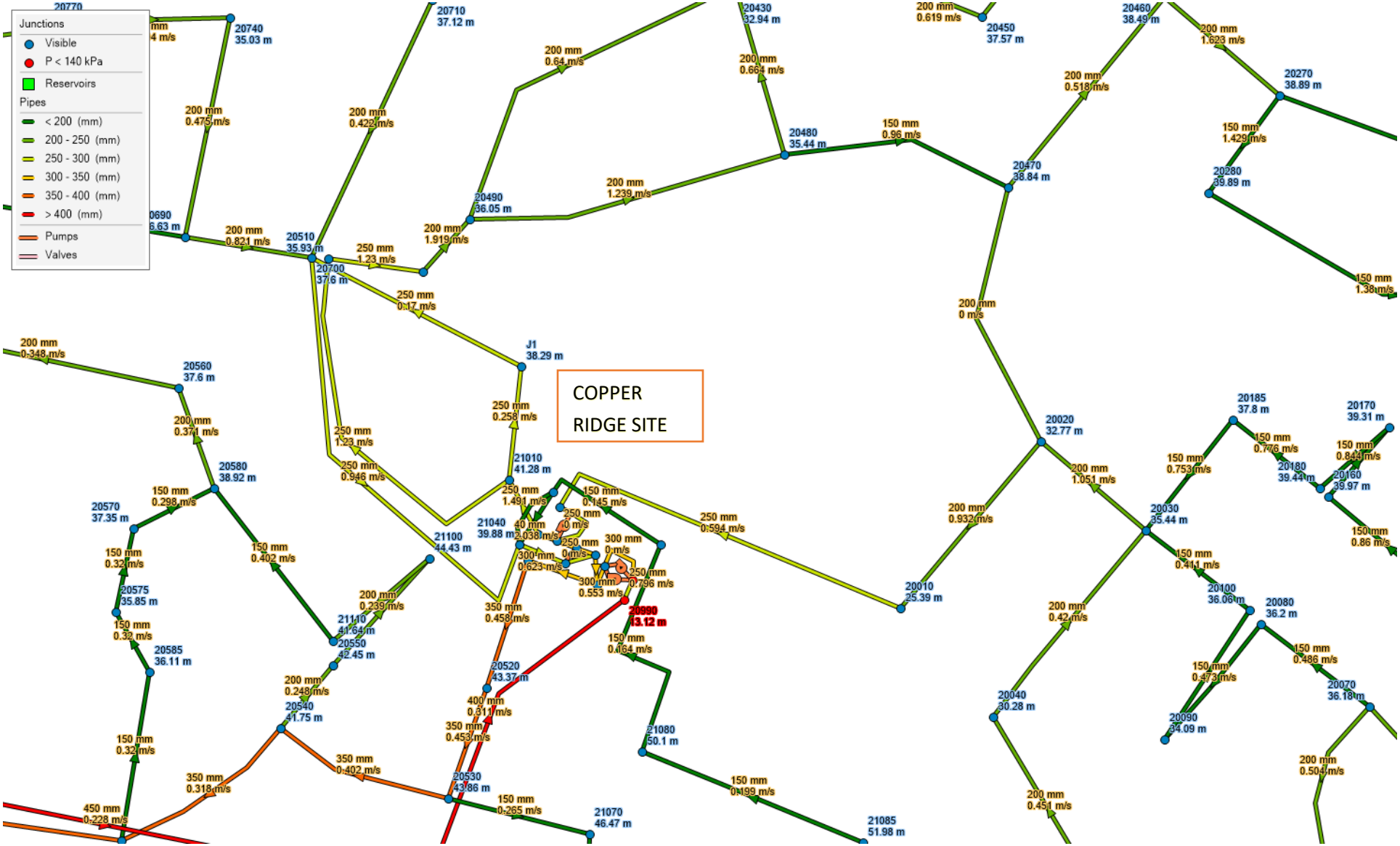
MDD+180 L/S


Junctions
Visible
P < 140 kPa
Reservoirs
Pipes
< 200 (mm)
200 - 250 (mm)
250 - 300 (mm)
300 - 350 (mm)
350 - 400 (mm)
> 400 (mm)
Pumps
Valves
COPPER
RIDGE SITE
20770
20740 19.36 m
20710 18.35 m
20430 14.24 m
20450 19.05 m
20460 20.32 m
20270 21.18 m
20280 22.76 m
20480 16.6 m
20470 20.56 m
20490 16.46 m
20510 15.67 m
20700 17.08 m
J1 16.38 m
21010 20.25 m
21040 19.81 m
21100 39.23 m
20010 12.19 m
20990 13.15 m
20560 31.93 m
20580 33.41 m
20570 31.98 m
20575 30.6 m
20585 30.96 m
20550 37.31 m
21110 36.4 m
20540 36.63 m
20520 37.98 m
20530 38.58 m
21070 41 m
21080 44.32 m
21085 46.33 m
20020 19.2 m
20030 21.72 m
20185 23.83 m
20170 25.12 m
20180 25.35 m
20160 25.69 m
20100 22.28 m
20080 22.28 m
20040 16.49 m
20090 20.26 m
20070 22.18 m
200 mm 1.446 m/s
200 mm 1.37 m/s
200 mm 0.481 m/s
200 mm 0.503 m/s
200 mm 0.473 m/s
200 mm 0.398 m/s
200 mm 1.249 m/s
150 mm 0.733 m/s
150 mm 1.104 m/s
200 mm 0.939 m/s
200 mm 2.508 m/s
200 mm 1.447 m/s
250 mm 0.927 m/s
250 mm 1.707 m/s
150 mm 1.072 m/s
200 mm 0 m/s
200 mm 0.641 m/s
250 mm 2.019 m/s
250 mm 0.927 m/s
250 mm 0.763 m/s
200 mm 0.656 m/s
150 mm 0.57 m/s
250 mm 2.948 m/s
150 mm 0.306 m/s
250 mm 0 m/s
40 mm 4.297 m/s
250 mm 0 m/s
300 mm 0 m/s
300 mm 0.483 m/s
250 mm 0.875 m/s
300 mm 0.608 m/s
250 mm 0.503 m/s
200 mm 0.789 m/s
200 mm 0.868 m/s
150 mm 0.626 m/s
150 mm 0.611 m/s
150 mm 0.671 m/s
150 mm 0.682 m/s
150 mm 0.585 m/s
150 mm 0.623 m/s
200 mm 0.359 m/s
350 mm 0.355 m/s
150 mm 0.619 m/s
150 mm 0.341 m/s
200 mm 0.349 m/s
150 mm 0.391 m/s
150 mm 0.882 m/s
200 mm 0.365 m/s
400 mm 0.342 m/s
350 mm 0.358 m/s
350 mm 0.431 m/s
350 mm 0.552 m/s
150 mm 0.386 m/s
150 mm 0.342 m/s
200 mm 0.404 m/s
200 mm 0.369 m/s
450 mm 0.127 m/s

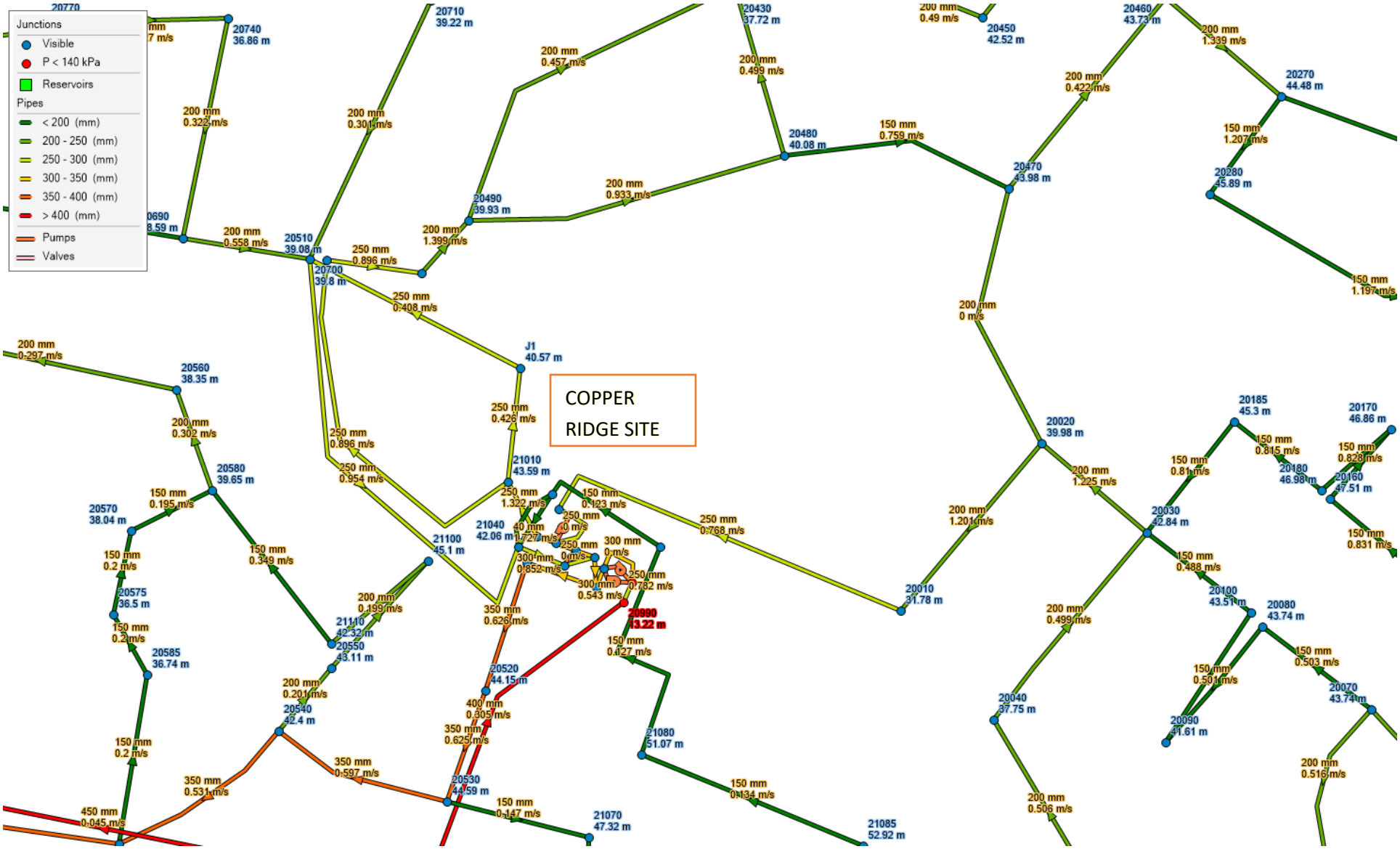
MDD+225 L/S


Junctions
Visible
P < 140 kPa
Reservoirs
Pipes
< 200 (mm)
200 - 250 (mm)
250 - 300 (mm)
300 - 350 (mm)
350 - 400 (mm)
> 400 (mm)
Pumps
Valves
COPPER
RIDGE SITE

PHD


Junctions
Visible
P < 140 kPa
Reservoirs
Pipes
< 200 (mm)
200 - 250 (mm)
250 - 300 (mm)
300 - 350 (mm)
350 - 400 (mm)
> 400 (mm)
Pumps
Valves
COPPER
RIDGE SITE
20710 37.12 m
20740 35.03 m
20430 32.94 m
20450 37.57 m
20460 38.49 m
20270 38.89 m
20280 39.89 m
20480 35.44 m
20490 36.05 m
20510 35.93 m
20700 37.6 m
20470 38.84 m
J1 38.29 m
20560 37.6 m
20580 38.92 m
20570 37.35 m
20575 35.85 m
20585 36.11 m
21010 41.28 m
21040 39.88 m
21100 44.43 m
21110 41.64 m
20550 42.45 m
20540 41.75 m
20520 43.37 m
20530 43.86 m
20990 43.12 m
21080 50.1 m
21070 46.47 m
21085 51.98 m
20010 25.39 m
20020 32.77 m
20185 37.8 m
20170 39.31 m
20180 39.44 m
20160 39.97 m
20030 35.44 m
20100 36.06 m
20080 36.2 m
20070 36.18 m
20040 30.28 m
20090 34.09 m

NFD – RESERVOIR FILLING ANALYSIS



NFD – THERMAL ANALYSIS