ENGINEERING, REIMAGINED

PRELIMINARY INFRASTRUCTURE TECHNICAL MEMO

Lockwood TEDD

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PROJECT BACKGROUND

Preliminary Design Report

The purpose of this report is to investigate options for development of the backbone water and sanitary sewer infrastructure needed to serve the Lockwood Targeted Economic Development District (TEDD) and provide general recommendations related to infrastructure layout and sizing. Included in the assessment is the impact to the Lockwood Water and Sewer Districts (LWSD). The locations of possible points of connection of the TEDD water and sewer main to the LWSD.

Previous Studies

The preliminary infrastructure design analyzed in this report, expands on the Lockwood TEDD Infrastructure Master Plan, Dated November 2017 (IMP); and Lockwood TEDD – Water and Sewer Main Extension Preliminary Engineering Technical Memorandum, Dated June 30, 2021, prepared by Morrison-Maierle (M&M Memo), included in **Appendix A**. Water and sewer layouts presented in this report vary from those shown in the IMP, due to adjustments in the TEDD boundary since 2017 and supplemental analysis of the LWSD infrastructure, provided by M&M. However, the overall Study Area provided in the IMP and basic infrastructure needs have remained the same.

Strategic Plan

Big Sky Economic Development Agency completed a strategic plan for the Lockwood TEDD in 2019. The purpose of the Strategic Plan was to identify two projects that should be completed first. The two projects identified within the strategic plan include:

1) Old Hardin Road to Coulson Road Water and Sewer Main Extension. **(Figure 1)**

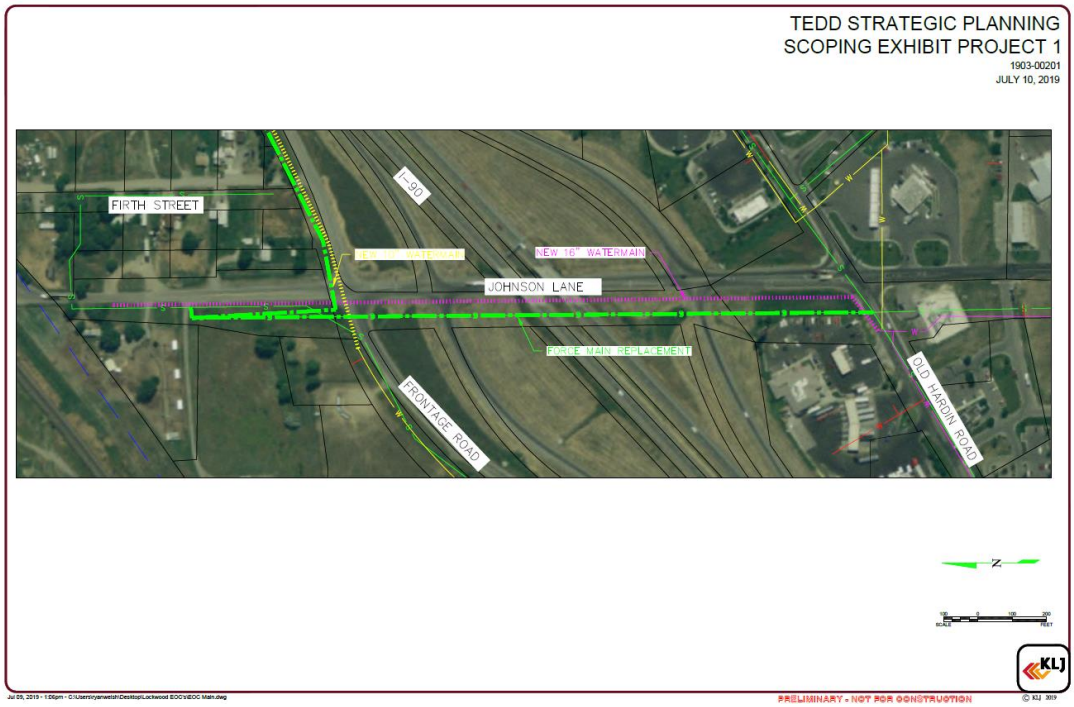

Figure 1: Scoping Exhibit Project 1

This project extended the LWSD water and sewer mains from Old Hardin Road on the south side of I-90, to the north side of I-90 along Johnson Lane. These main extensions would be located under the new double diamond interchange currently being designed and constructed to by the Montana Department of Transportation (MDT). These mains would remain unused but would be stubbed out for future connections, that would prevent interfering with the new Johnson Lane Interchange. The pipes that would be extended include a water main and a sewer force main.

2) Water, sewer and road extension along I-90 Frontage Road. **(Figure 2)**

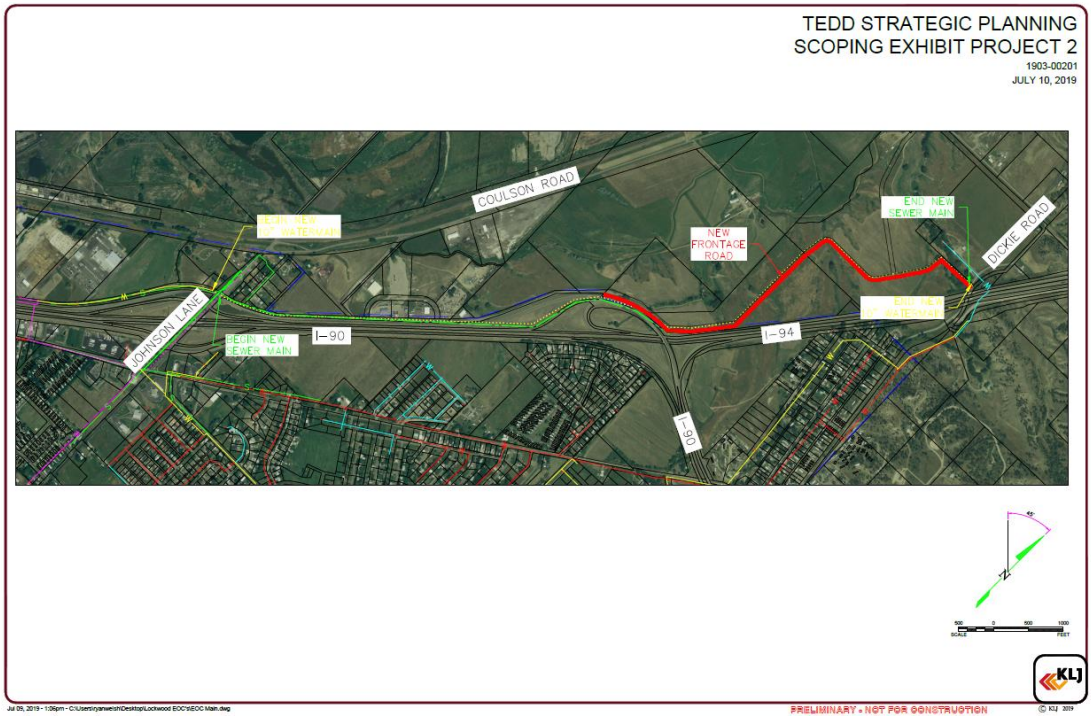

Figure 2: Scoping Exhibit Project 2

This project extends a water main from the termination of the first project, down the North Frontage Road, across some vacant land, and terminates at the I-90 and Dickie Road intersections. This would provide water to all the east side of the TEDD. A gravity sewer main would have been installed from the Firth Lift Station to the north frontage road and then extend along the same route as water main. This gravity sewer main would provide sanitary sewer service to the east side of the TEDD.

During discussions with the LWSD about the points of connection, the LWSD expressed their preference to have the water mains and sewer mains out from underneath the double diamond interchange currently under construction by MDT. An alternate route was determined to bore underneath I-90 and connect to the LWSD mains in Old Hardin Road. Although this new route requires boring, it will make maintenance easier to conduct on the crossing, rather than interfering with the new interchange

The strategic plan also shows would provide 12,000 lineal feet of gravity sewer main that connects to the Firth Lift Station. During the preparation of this study, elevations were surveyed at the approximate route the new gravity sewer main. The actual elevations were then compared to minimum design grades of the

proposed gravity sewer main. The results of analysis show the proposed sewer main, laid at minimum grade, will be more than 15 feet below the bottom of the Firth Lift Station. Furthermore, the sewer main in the strategic plan installs close to 3,000 lineal feet of sewer main that will not be needed at full build out of the Lockwood TEDD.

Design Water and Wastewater Flow Rates

For full buildout of the TEDD Study Area, the IMP estimates peak hour flow rates for water and wastewater of 526 gpm and 405 gpm respectively. These estimates account for full buildout of all land within the TEDD Study Area, less area for roads, rail right-of-way, MDT bypass and some lower areas near the Yellowstone River that are not believed to be not developable due to the flood plain. The total area assumed to contribute to wastewater flow rates from the IMP is 973 acres. The IMP estimates typical flow rates on a per acre basis from several industrial sites that are assumed to be similar to those that could be developed within the TEDD.

Properties included within the TEDD have varied over time. It is advisable that the infrastructure be designed and sized to assure there is capacity to allow all properties within the Study Area to join the TEDD in the future. This approach may result in estimated flow rates toward the higher end, but it provides flexibility for future expansion. Also, since the estimated flow rates are relatively modest, a conservative estimation shouldn't significantly affect installation costs for the infrastructure.

It is anticipated that the Firth Sanitary Lift Station will connect to the TEDD's gravity sewer mains in the future. The peak design flow of the Firth Lift Station is 110 gpm according to the Technical Memorandum prepared by Morrison-Maierle, dated June 30, 2021.

Right-of-Way

Figure 3 provides a map of various roads and right of ways (ROW) within the TEDD planning area. A variety of various ROW scenarios occur along alignments proposed for utility extensions. At several locations, the County has agreements or easement for roads, but that does not necessarily translate to rights to install utilities. At some other locations, the County owns road strips in fee or possesses ROWs. However, throughout much of the areas, roads are provided for local access and are constructed within private easements. Many of the utility alignments are proposed within future roads, in areas where there are no known access easement or ROWs. Installation of water and sanitary sewer facilities will require substantial ROW acquisition throughout the TEDD. Each existing easement or ROW that is to be utilized should be investigated more thoroughly to determine if additional utility allowances are needed.

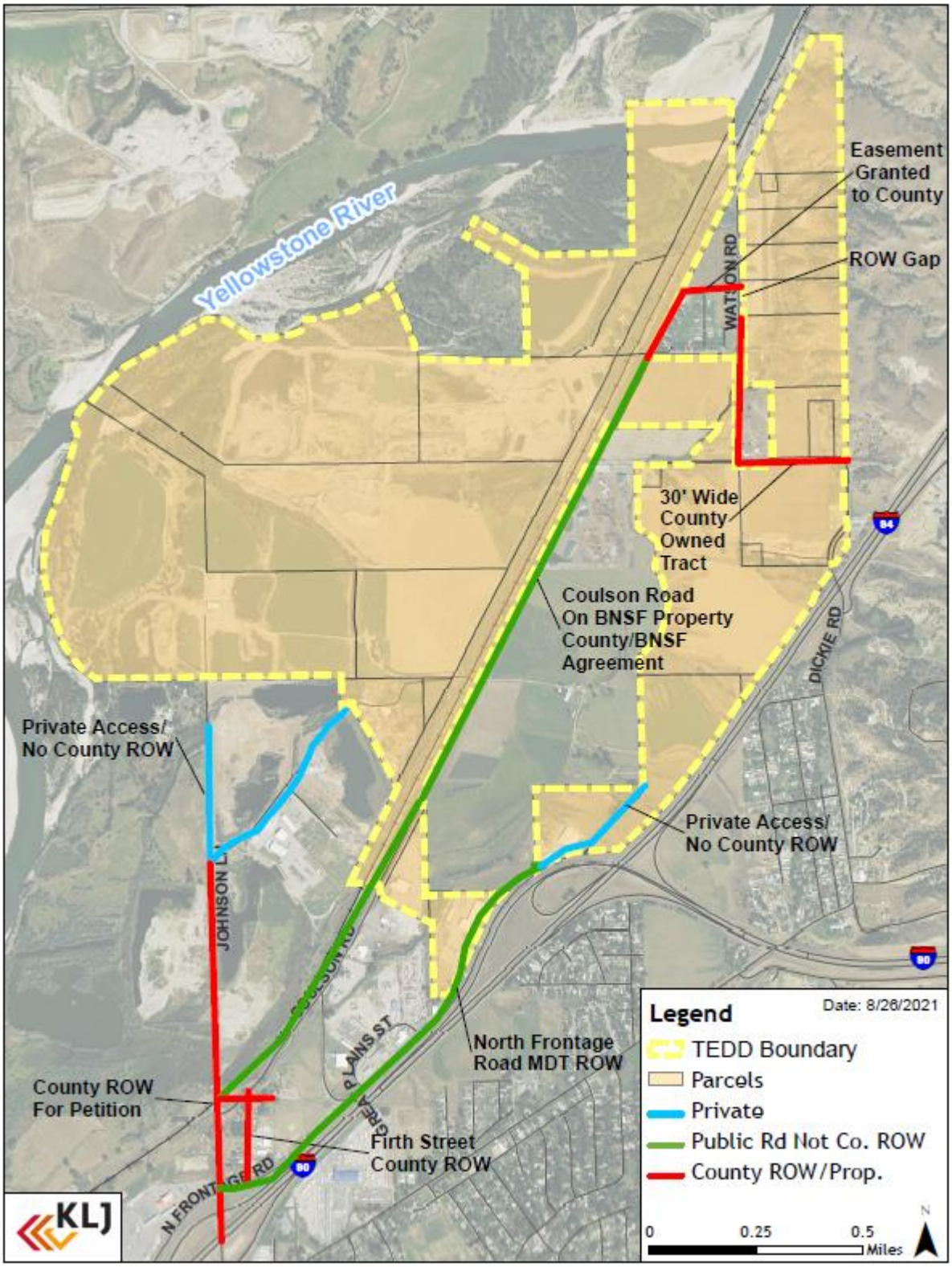

Figure 3: Right-of-Ways

Preliminary Water Design

Inside the TEDD Study Area, a water model was built to determine pressures and flows within the TEDD. InfoWater Suite 12.3 which is an ArcGIS program supplied and copyrighted by Innovyze was used to model the flows. The system was model with the proposed build out and demands of 265,692 gpd or 184 gpm for average day and 584,523 gpd or 406 gpm evenly distributed across the 19 nodes. A pressure of 88 psi was used to model the incoming water main to the system and the model was run at steady state conditions. It was found that with an incoming pressure of 88 psi into the system the Junctions to the North and the West had the highest pressure due to changes in elevation. Pressures ranged from 102 psi to 114 psi. The lowest pressure in the system just North of the connection node was 74.64 psi. With this information it was concluded that a PRV was needed at the connection point in order to maintain pressures under 100 psi. The model was modified to have a 70 psi at the connection point to simulate the addition of a pressure reducing valve (PRV). In addition to the PRV the main from the connection point to the lowest pressure node was up sized to 12-inch in the model. With this the PRV the system the operates as shown below at static pressure. The highest pressure is 96.17 during Max Day and lowest pressure is 56.62 psi. **Figure 4** shows static pressures at full build out of the TEDD.

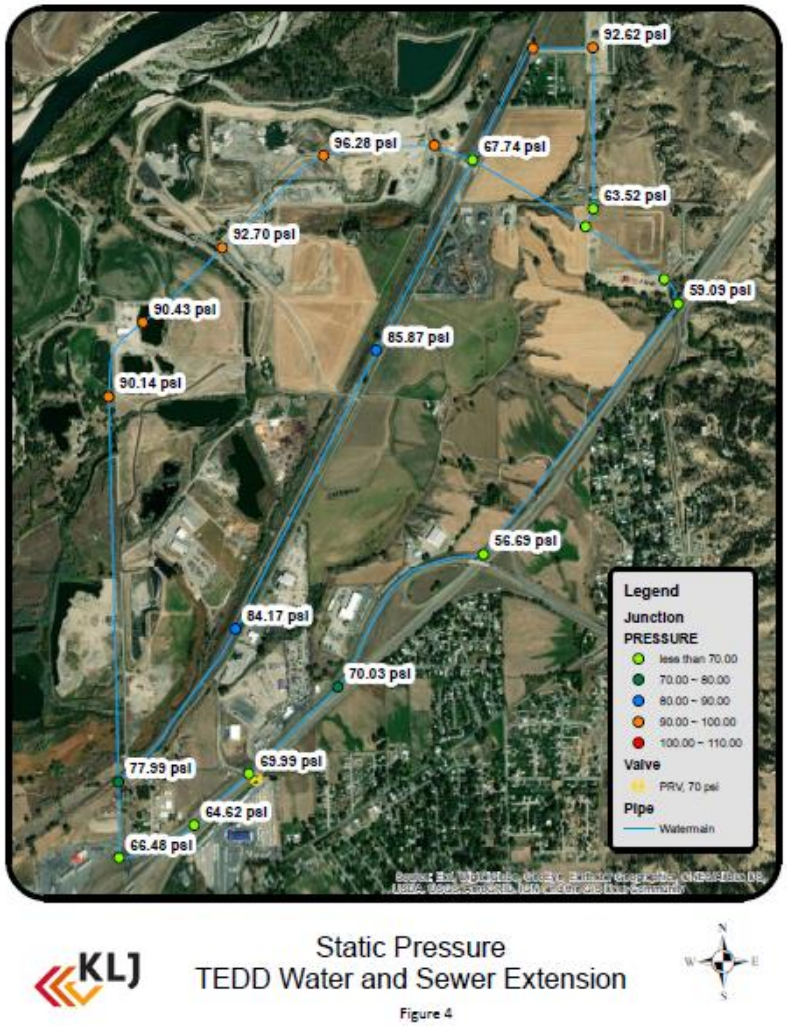

Figure 4: Static Pressure

Water Main Layout

Figure 5 shows the proposed water main layout system to the TEDD. This layout includes three (3) water mains that will form a loop within the TEDD Study Area. The water system will connect to the LWSD 12" water main at the entrance along Old Hardin Road at the access to Bretz RV, on the south side of I-90. A second connection will also be required in the North Frontage Road and Johnson Lane Intersection. Based on the water modelling conducted by M&M, these two connections will provide fire flow of 3500 GPM and Peak Day flows of 406 GPM. Velocities within the water main will remain below 5 ft/s and during fire flows there will be a minimum of 20-psi as required by DEQ Circular 1. During Peak hour conditions, a water pressure of 86 psi was maintained around the point of connection.

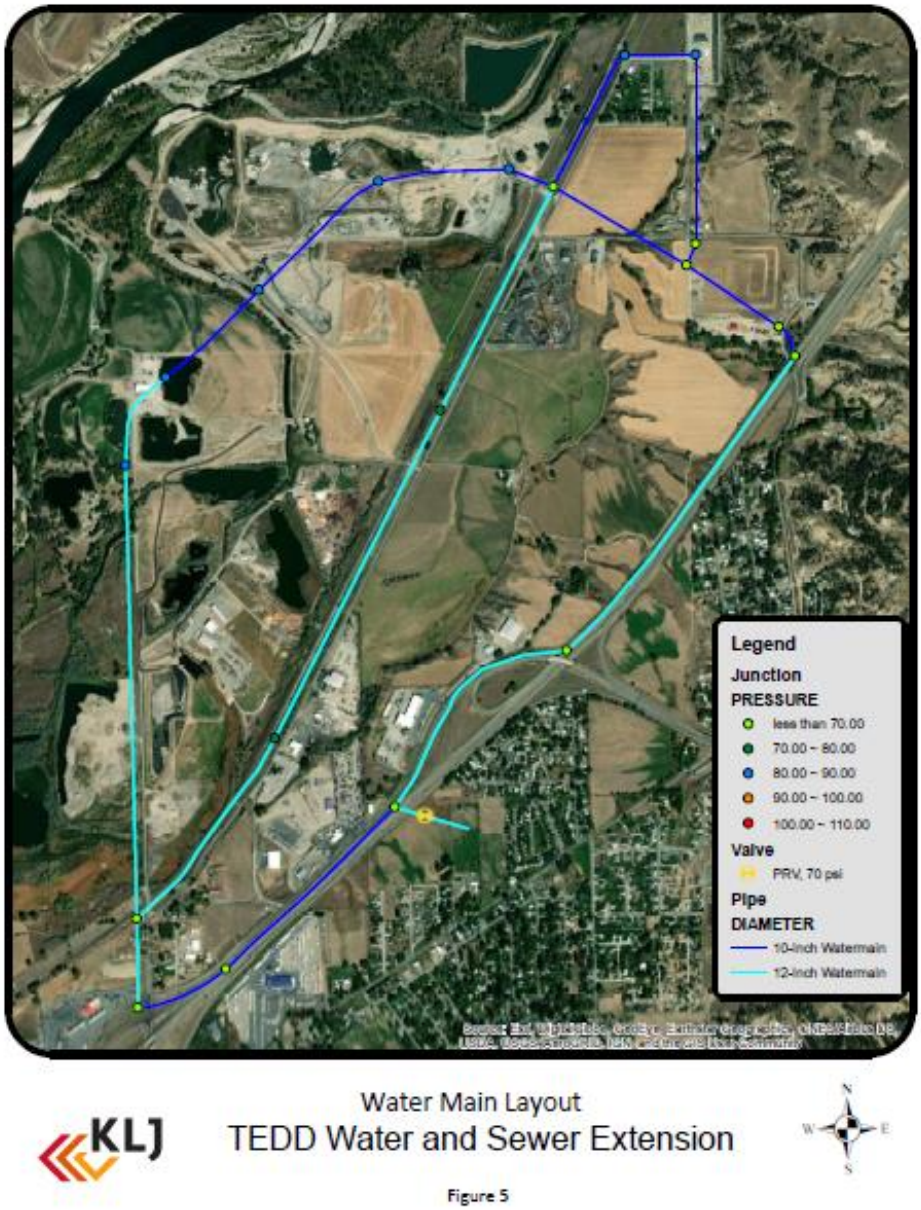

Figure 5: Proposed Water Main Layout

PRELIMINARY SEWER DESIGN

Sanitary Sewer Layout

Figures 6 and 7 show the proposed sanitary sewer system layout to serve the TEDD. The layout includes proposed sewer trunk mains, two lift stations and sanitary sewer force mains. Additional sewer laterals and services will be needed to serve individual sites as the area develops. The intent of the trunk mains is to provide means for lateral extensions into each site.

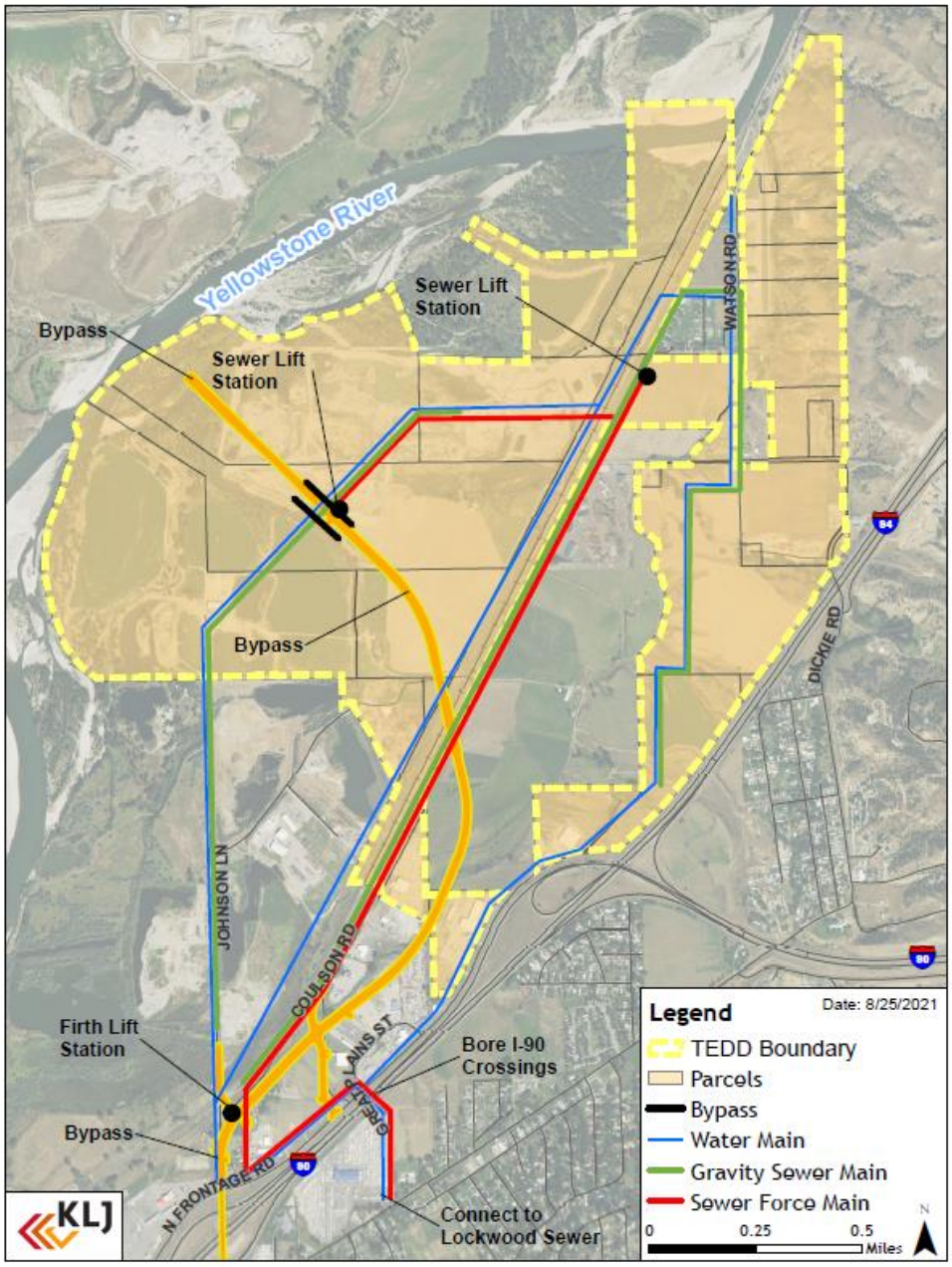

Figure 6: Proposed Water and Sewer Layout 1

As shown in the layout, there are three primary gravity trunk mains. One to serve the west part of the TEDD (West Trunk Main), located west of the BNSF rail; another to serve the east part of the TEDD (East Trunk Main); and a third to serve sites along the east side of Coulson Road (Coulson Trunk Main). Most of the properties that would be served by the Coulson Trunk Main are currently not included in the TEDD, but they are within the TEDD Study Area. It is anticipated that some of these properties could annex into the TEDD. Timing of construction of the Coulson Trunk Main should take this into consideration.

Where practical, the proposed sanitary sewer trunk mains and force mains follow existing road ROWs. Where there are no ROWs, they follow routes that are anticipated could be road alignments as the area develops. The West Trunk Main follows a proposed new road alignment shown in the IMP (Figure 7: Potential Future Transportation Network – Roads). Potential road alignments for the east part of the TEDD are not as well identified in the IMP, due to much of the eastern part joining after the IMP was completed. Exact alignments will need to be confirmed with landowners during final design. Some adjustments are anticipated.

Figure 6 shows the force main installed along Firth Ave. The Firth Lift station would then be connected to this force main (see attached M-M report). As an alternate, the gravity main that is proposed in Coulson Road may be extended to a gravity sanitary sewer manhole. This would connect the sewer flows currently being handled by the Firth Lift Station down Coulson Road and into the main TEDD Lift station. This would allow the abandonment of the Firth Lift Station. This would also shorten the lineal footage of force main that would need to be installed, as shown in Figure 7.

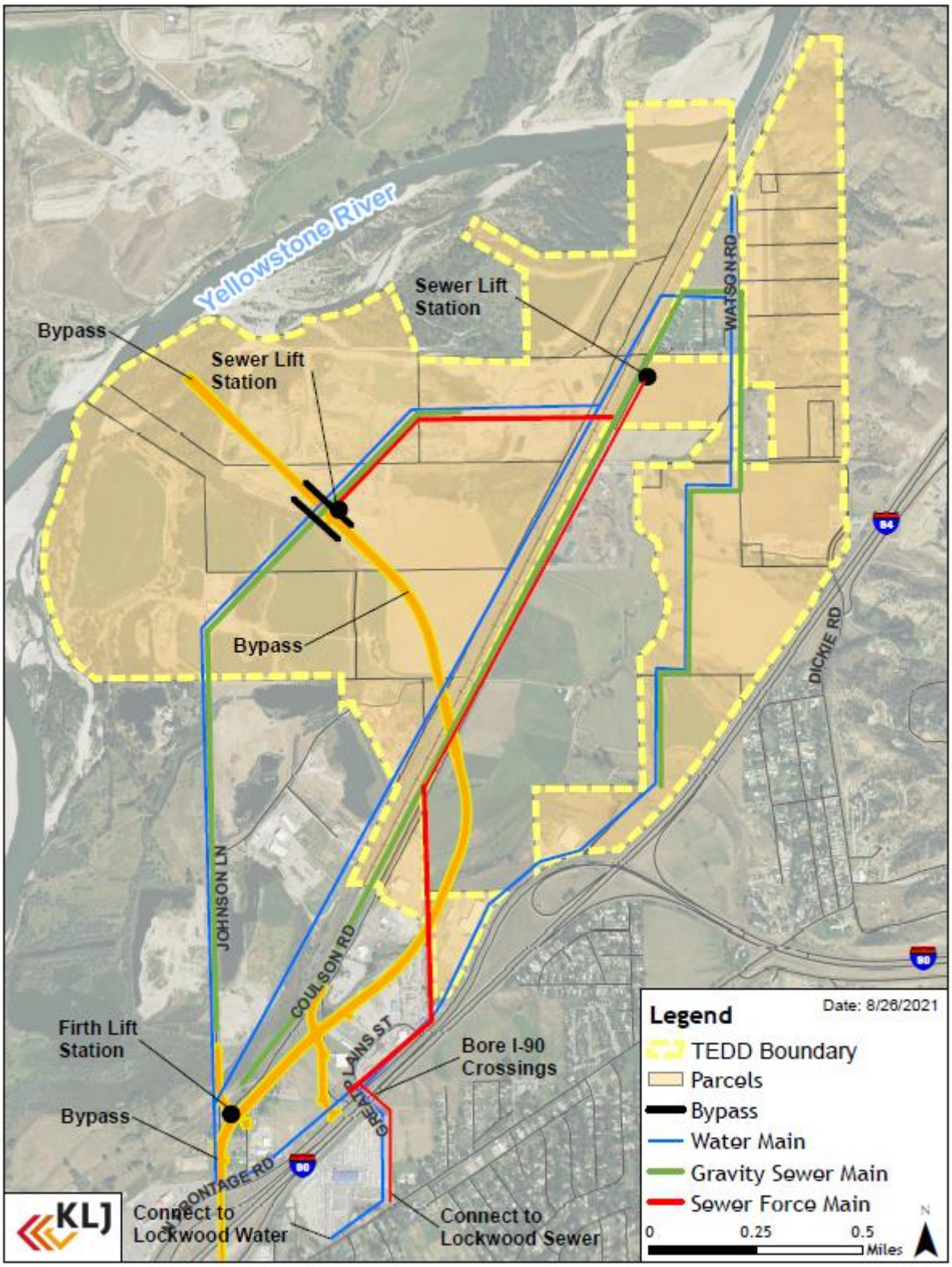

Figure 7: Proposed Water and Sewer Layout 2

Elevations in the TEDD fall to the west, toward the Yellowstone River at a relatively steep gradient. Each trunk main is held toward the west side of the area it serves to account for the terrain, thereby minimizing trenching depths. The TEDD area also slopes gently to the north, following the natural gradient of the Yellowstone River. Both lift stations are located toward the north end of the service area to account for the natural slope. The minimum allowable sewer slope is greater than the northward slope of the natural topography. As a result, the gravity mains get deeper as they fall to the north. Two lift stations are necessary to avoid excessive trunk main and lift station depths due to the length and minimal drop in elevation. The lift stations are strategically placed to minimize sanitary sewer depths.

Gravity Sewer Sizing

The following table provides a summary of gravity sewer main design flow rates and sizes to serve the TEDD.

Table 1: Summary of Gravity Sewer Main Design Flow Rates and Sizes

Sewer Main	Approximate Portion of TEDD Served	Design Flow Rate (gpm)	Proposed Pipe Size (in)
West Trunk Main (south of Lift Station)	50%	202	8
West Trunk Main (north of Lift Station)	10%	41	8
West Trunk Main (portion Conveying Discharge from Lift Station 1)	60%	300	10
Coulson Trunk Main (except as noted below)	20%	81 (TEDD) +110 (Firth Lift Station) 191 Total	8
Coulson Trunk Main (portion Conveying Discharge from Lift station 1)	80%	324 (TEDD) +110 (Firth Lift Station) 434 Total	10
East Trunk Main	20%	81	8

DEQ Circular 2 specifies a minimum sanitary sewer size of 8-inch diameter. The table below provides design information for the capacity of both 8-inch and 10-inch diameter sewer mains. The estimated capacities are based on the sewers laid at minimum allowable slope permitted by DEQ. All sewers are expected to be designed at minimum slope to accommodate the relatively flat gradient in the natural topography and avoid excessive trench depths.

Table 2: 8-Inch and 10-Inch Diameter Sewer Main Capacity

Sewer Main Size	Minimum Allowable Slope	Full Flowing Capacity (gpm)	Design Capacity (gpm)
8	0.40%	373	298
10	0.28%	565	452

1. *Full Flow Capacity is calculated from the Manning's equation, using a roughness coefficient of n=0.012.*
2. *Design Capacity is calculated as 0.8xFull Flow Capacity to provide for some safety factor.*

Lift Station Force Main Sizing

DEQ Circular 2, Section 42.38 specifies, sanitary sewer lift stations should be deigned to deliver as uniform flow as practicable to minimize hydraulic surges in receiving sanitary sewer flows. Pump stations must also be designed for a minimum capacity equal to the peak inflow rate into the pump station. Uniform flow and reduction in hydraulic surges are achieved by avoiding pumping at higher than necessary rates. This also prevents excessive on and off cycles for the pumps, lengthens pump life and minimizes sizing and infrastructure cost. The design flow rate for the force mains is equal to the design peak flow rated into the lift stations accordingly.

Per DEQ Circular 2, sanitary sewer force mains are to be designed at flow velocities of between 2 and 8 feet per second (fps), with a minimum recommended cleansing velocity of 3 fps. Keeping velocities toward the lower end of this range helps limit friction losses and saves on energy. Following is a summary of design flow rates and force main sizing for both lift stations:

Table 3: Summary of Design Flow Rates and Force Main Sizing for Lift Stations

Lift Station	Design Flow Rate (gpm)	Proposed Force Main Size (in)	Pumping Velocity
1	300	6	3.4
2	515 (TEDD + Firth)	8	3.3

Appendix A

LOCKWOOD TEDD – WATER AND SEWER MAIN EXTENSION PRELIMINARY ENGINEERING

Technical Memorandum

Prepared by: Kurtis DeShaw, PE
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Morrison Maierle
engineers ▪ surveyors ▪ planners ▪ scientists

June 30, 2021

KLJ Engineering LLC
Attn: Matt Smith
2611 Gabel Road
Billings, MT 59102

RE: Lockwood TEDD – Water and Sewer Main Extension Preliminary Engineering
Technical Memorandum

INTRODUCTION

Morrison-Maierle was hired by KLJ Engineering LLC under Task Order No. 2103-00301-1 to complete the work summarized in this Technical Memorandum. This work consists of a water analysis and sewer analysis to evaluate water and sewer infrastructure upgrades to and/or use of the Lockwood Water and Sewer District (LWSD) existing water and sewer systems to serve the properties within the Lockwood Targeted Economic Development District (TEDD) Study Area.

References

The following references were used in the completion of this analysis:

- Lockwood TEDD Water & Wastewater Data Memo, Matt Smith, KLJ Engineering LLC, May 5, 2021 (included as Attachment 1)
- Lockwood TEDD Infrastructure Master Plan, KLJ Engineering LLC & Morrison-Maierle Inc., November 2017

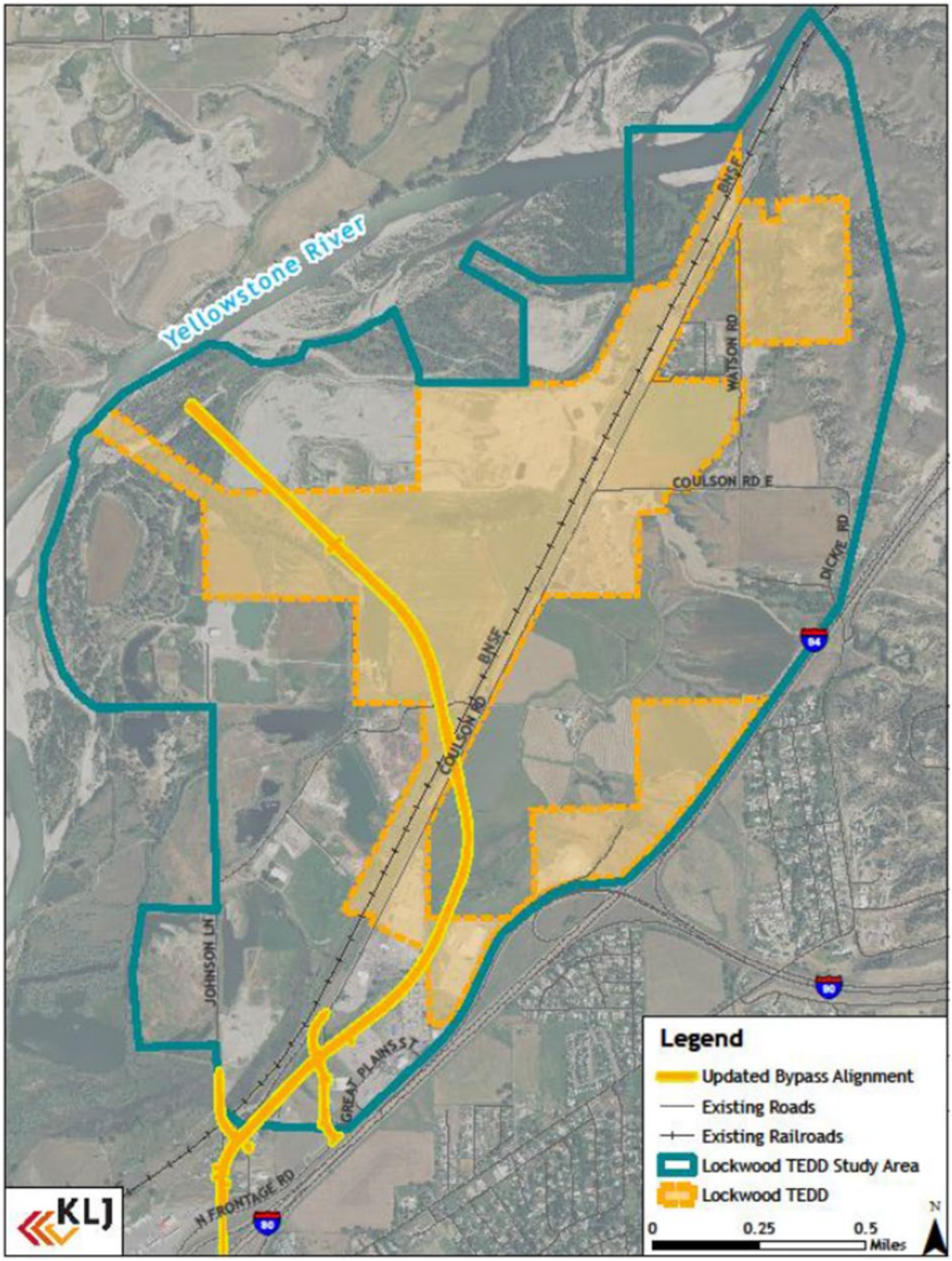
WATER ANALYSIS

The purpose of the water analysis is to evaluate which infrastructure upgrades would be required for the existing Lockwood Water and Sewer District (LWSD) distribution system to adequately serve the current and future demands of the Lockwood TEDD Study Area properties as defined in the 2017 TEDD Infrastructure Master Plan (Figure W-1). Of interest is determining if the Lockwood TEDD Study Area could be served using a 12-inch water main extension that extends water distribution east from the existing water main at the North Frontage Road/Johnson Lane intersection, along the North Frontage Road, then south across I-90 to an easement (both existing and to be obtained) on the Bretz RV property to the water main in Old Hardin Road without additional improvements to the LWSD distribution system.

Study Area

The major focus of this study is the hydraulic impacts on the existing LWSD distribution system from the distribution of water to the proposed Lockwood TEDD Study Area shown in Figure W-1.

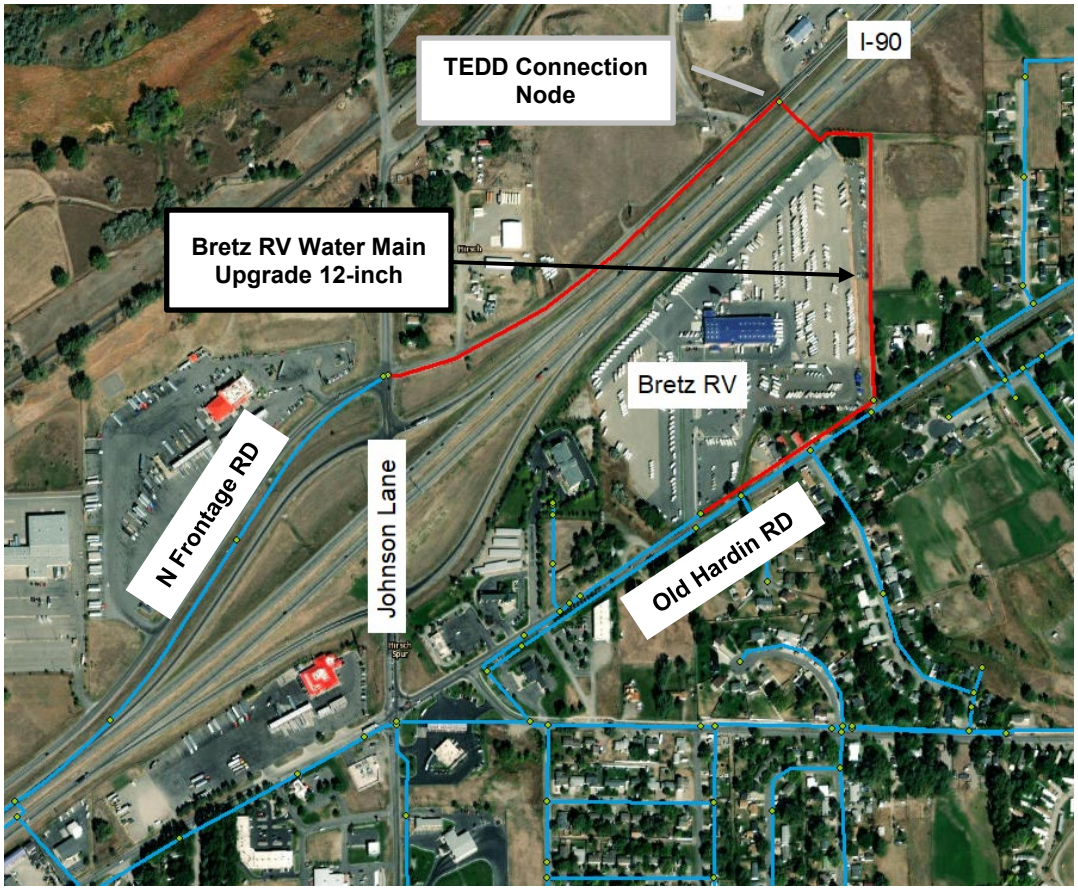
Figure W-1: Map of TEDD Study Area



The proposed water main upgrade examined in this study would connect the existing water mains in the North Frontage Road and Old Hardin Road with a new water main located in an existing public utility easement along the east Bretz RV property line and in future easements to be obtained from the property owners on the east side of and to the northeast of the Bretz RV site. This proposed pipe extension is referred to as the "Bretz RV Water Main Upgrade." If constructed, this pipe would loop the dead-end main in the North Frontage Road right-of-way into the existing distribution system at Old Hardin Road. This extension would consist of a 12-inch water main that would connect the existing 16-inch PVC in the North Frontage Road to the 12-inch PVC main in Old Hardin Road. As part of this proposed extension, the North Frontage Road waterline, which terminates on the west side of Johnson Lane, will be extended east to the Bretz RV Water Main Upgrade as shown below in Figure W-2.

The Bretz RV Water Main Upgrade would help better serve current industrial businesses near Johnson Lane along I-90, as well as the future development within the Lockwood TEDD Study Area. The boundary and anticipated water demands of the TEDD Study Area can be referenced in the Lockwood TEDD Infrastructure Master Plan (2017).

Figure W-2: Study Area with Proposed Water Main Upgrade



Design Criteria

The following criteria in Table 1 were sourced from the Water Demand Data Memo (KLJ, 2021) and used as part of this study. The KLJ memo is attached to this memo for reference.

Table 1: TEDD Water Demands			
Lockwood Study Area Scenario	**Average Water Demand (GPM)**	**Peak Day (GPM)**	**Peak Hour (GPM)**
TEDD Study Area	58	127	202
Ultimate TEDD Development Area	93	204	324
Total	**185**	**406**	**526**

When analyzing the model, the following were used as acceptable flow and pressure design parameters:

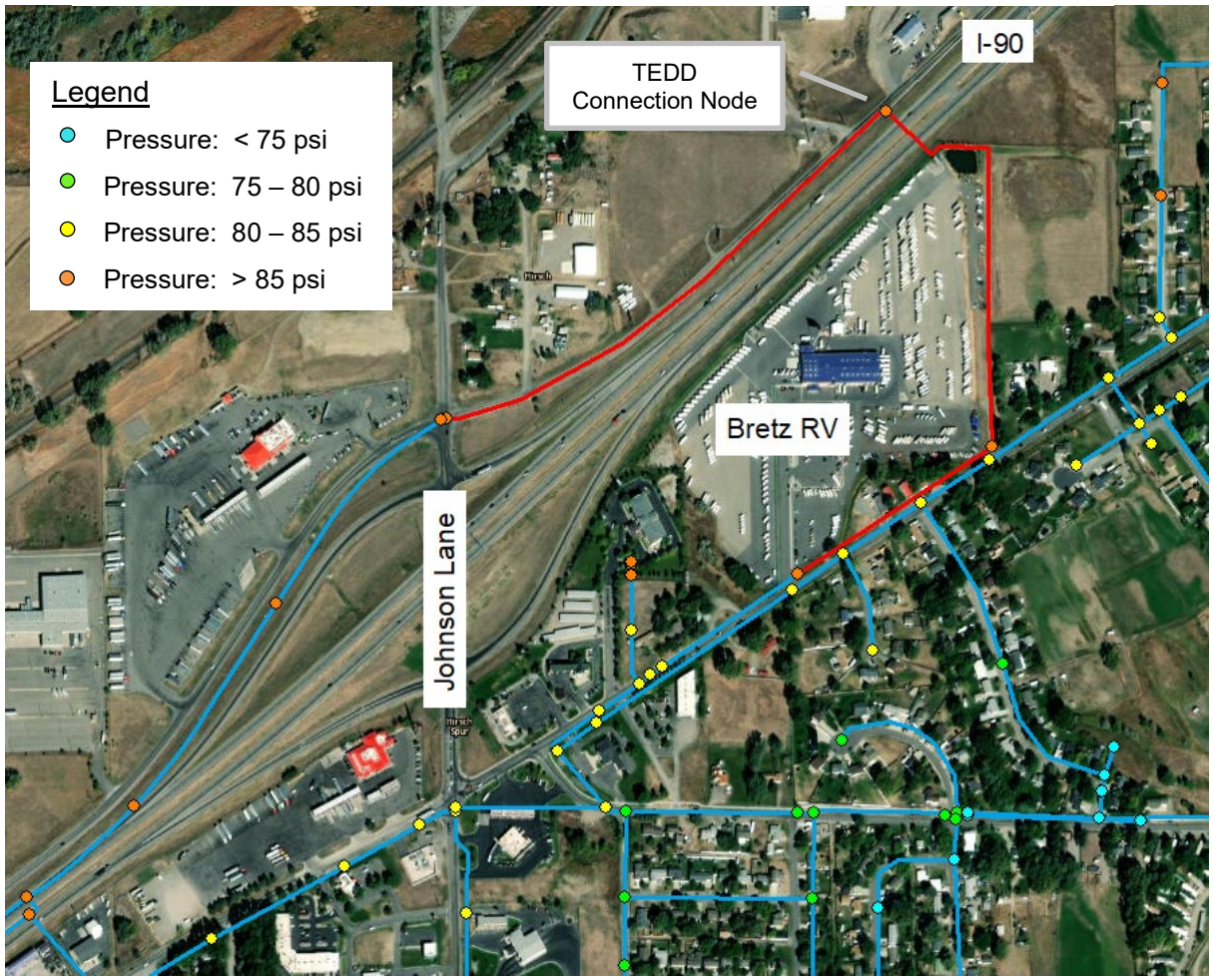
- Pressure: 40 psi – 90 psi
- Flow Velocity: 0 ft/s – 5 ft/s

InfoWater (developed by Innovyze) was used to model the LWSD water distribution system and to determine the impacts of the demands from the Lockwood TEDD Study Area with the Bretz RV Water Main Upgrade and the extension of the water main from the North Frontage Road, across Johnson Lane, to the TEDD Study Area. This Bretz RV upgrade was modeled using 12-inch DR 14 PVC pipe. Other upgrades to the existing LWSD distribution system proposed in the Lockwood TEDD Infrastructure Master Plan were not incorporated into the analysis. Future demand flows for the TEDD Study Area were used for all modeled scenarios. Using these future flows within the model gave insight on how the existing Lockwood distribution would handle larger water demands at the time of full buildout within the TEDD Study Area.

The hydraulic model was initially run using Peak Day Water Demand conditions. A flow of 406 gallons per minute (gpm) was used for the overall TEDD Study Area demand (per Table 1). The hydraulic model indicates that under these conditions, the entire LWSD water system would operate within acceptable pressure and flow velocity ranges.

During Peak Day conditions, a water pressure of approximately 88 psi is anticipated at the TEDD connection identified in Figure W-3 as the "TEDD Connection Node". Pressures ranged between 71 - 94 psi in the distribution system surrounding Bretz RV and are also shown in Figure W-3.

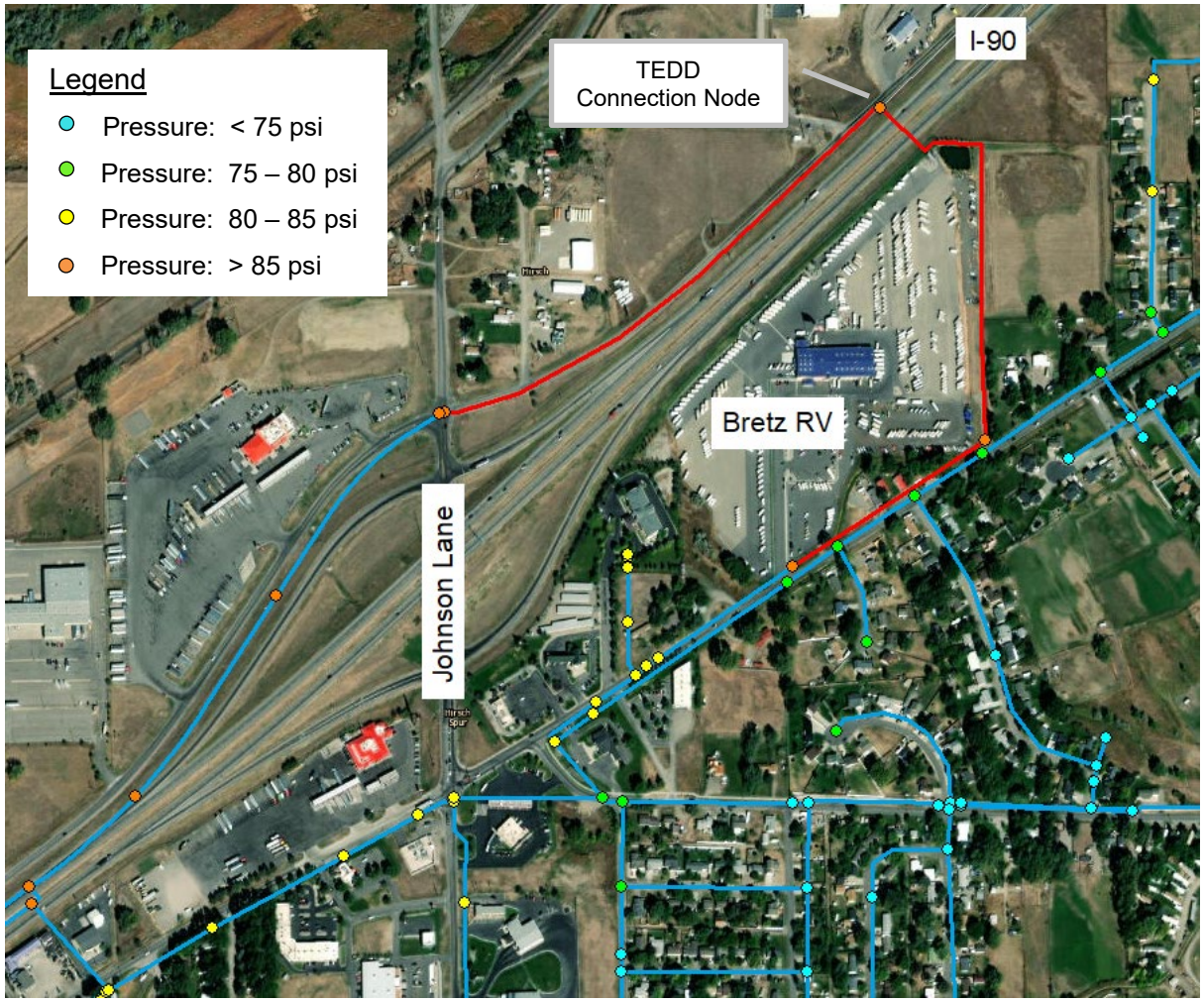
Figure W-3: Peak Day Water Demand Analysis



The model was also analyzed under Peak Hour Water Demand conditions using a water demand of 526 gpm. The hydraulics indicate that under these conditions, the entire system would operate within acceptable pressure and flow velocity ranges. During Peak Hour conditions, a water pressure of approximately 86 psi is anticipated at the TEDD Connection Node. Pressures ranged between 66 - 93 psi in the distribution system surrounding Bretz RV and are also shown in Figure W-4.

An additional Peak Day Water Demand analysis was evaluated with a fire flow demand of 3,500 gpm placed at the TEDD Node. Under these conditions, pressures at the TEDD Connection Node dropped to approximately 69 psi. This area can achieve approximately 7,520 gpm fire flow at a 20-psi residual indicating that it is capable of meeting anticipated fire flow demands. Both scenarios achieve the minimum fire flow criteria of 20 psi set by DEQ Circular 1.

Figure W-4: Peak Hour Water Demands Analysis



Water Conclusion

The existing LWSD water distribution system should be able to meet the current and future demands, as well as the fire flow demands of the TEDD with the proposed 12-inch water main connection adjacent to Bretz RV and the extension of the water main in North Frontage Road, crossing Johnson Lane. This should be feasible without constructing other infrastructure upgrades proposed in the Lockwood TEDD Master Plan (2017).

Water velocities within the distribution system remained under 5 ft/s while under average demand conditions both for current flows and for projected flows at TEDD full buildout. A minimum pressure of 40 psi is maintained throughout the system during these conditions. Under fire flow conditions, the existing system with the Bretz RV Water Main Upgrade and extension of the water main in the North Frontage Road, east across Johnson Lane, can serve 3,500 gpm to the TEDD for a duration of three hours while still serving Peak Day Flow Demands throughout the existing LWSD water system at a minimum pressure of 20 psi.

WASTEWATER ANALYSIS

This wastewater analysis consists of the following tasks:

- Evaluate current flows and summarize future flows for the existing Firth Lift Station
- Evaluate the capacity of the Firth Lift Station to accommodate wastewater flows from upgradient properties in the Lockwood TEDD Study Area whereby wastewater flows could be conveyed by gravity sewer main to the Firth Lift Station
- Evaluate the possibility of combining flows from the existing Firth Lift Station and future TEDD Lift Station into one common force main to be routed along the east side of the Bretz RV business in an easement

Current and Future Firth Lift Station Flows

Information provided by the Lockwood Water and Sewer District indicates there are five properties currently connected to the Firth Lift Station. These properties are located within the original Firth Lift Station tributary area identified as subbasin NE1 in previous reports and studies prepared for the Lockwood Water and Sewer District. Current wastewater flows to the Firth Lift Station are estimated based on water usage data provided by LWSD for these individual properties for the time period of April 2020 to April 2021. Water usage data and estimated wastewater flow data is summarized in Attachment 2. Wastewater flows are estimated based on winter water usage for the months of October through April. Water usage for the summer months of May through September are excluded from wastewater flow calculations to eliminate the possibility of accounting for water usage that occurs during this period to irrigate landscaped areas or other outside uses. It is assumed that 95% of metered water is returned to the sewer system for all properties except for the Billings Livestock Commission where it is assumed that 50% of metered water is returned to the sewer system. The monthly water usage equated to a daily flow is translated to wastewater average daily flows less the assumed percent return to the sewer system. A peaking factor of 4.15 is applied to the average daily flow to estimate the peak hourly flow to the Firth Lift Station. Current estimated wastewater flows to the Firth Lift Station are summarized as follows:

- Average daily flow: 2 gpm
- Peak hourly flow: 8 gpm

The Firth Lift Station was originally designed and constructed in 2012 for the following flows from subbasin NE1 of the original LWSD Sewer Service area:

- Average daily flow: 50 gpm
- Peak hourly flow: 190 gpm

A wastewater flow projection study completed in 2017 re-evaluated the tributary area to the Firth Lift Station. Updated water usage data for top twenty water users located in subbasin NE1 and

revisions to areas within the subbasin resulted in a reduction in wastewater design flows. The revised design flows are as follows:

- Average daily flow: 30 gpm
- Peak hourly flow: 110 gpm

These revised flows are also documented in the Lockwood TEDD Infrastructure Master Plan completed in 2017.

TEDD Study Area Flows to Firth Lift Station

In the Lockwood TEDD Water & Wastewater Data Memo, Attachment 1 to this memo, KLJ identified properties in the Lockwood TEDD Study Area along the North Frontage Road whose wastewater they propose to flow by gravity sewer main to the Firth Lift Station. These properties are located within the Lockwood TEDD Study Area and shown outlined by a black dashed line in Figure 2 of the KLJ memo included in Attachment 1. These properties lie within the undeveloped Lockwood TEDD on the North Frontage Road and other future development areas (Groups A and B of the TEDD Study Area) on the North Frontage Road. Total estimated wastewater flows for these areas provided by KLJ are as follows:

- Average daily flow: 9 gpm
- Peak hourly flow: 29 gpm

Combining these flows with the Firth Lift Station design flows results in the following flows:

- Average daily flow: 39 gpm
- Peak hourly flow: 139 gpm

These combined flows do not exceed the original 2012 design flows of the Firth Lift Station. Thus, the Firth Lift Station as originally designed and constructed has available capacity to accept wastewater flows from the upgradient areas identified in the TEDD Water & Wastewater Data Memo by KLJ.

Combined Force Main for Firth and TEDD Lift Stations

Combined Force Main

The Firth Lift Station force main is currently routed south on Firth Street to the North Frontage Road where it jogs to the west and then south onto Johnson Lane, under Interstate 90 (I-90) at the Johnson Lane and I-90 interchange, and south to discharge into manhole #21 which is part of the gravity sewer system at the intersection of Johnson Lane and Old Hardin Road as shown on a general site map included as Figure SS-1 in Attachment 3. This memo evaluates whether the discharged flows from the Firth Lift Station can be combined with flows from the TEDD Lift Station into one common force main. Consideration will be given to: 1) re-using a portion of the existing Firth Lift Station force main in combination with extending this force main to a new location that

avoids the Johnson Lane/I-90 interchange and 2) installation of an entirely new force main. Both force main scenarios will use the same route as discussed further in the following section. The proposed common force main is shown on Figure SS-1.

Preliminary hydraulic calculations have been completed to examine combining the TEDD and Firth flows into one force main. These calculations are included in Attachment 4. The calculations indicate that the Firth Lift Station at full build-out will operate at a design point of 380 gpm and a total dynamic head of 79 feet when the TEDD Lift Station is also operating. Under the same scenario with both lift stations operating, preliminary sizing of the TEDD Lift Station at full build-out and using the flows noted in the memo included in Attachment 1 indicate that the TEDD Lift Station will operate at a design point of 425 gpm and a total dynamic head of 147 feet. The force main is sized as follows:

- TEDD Lift Station to Firth Lift Station: 10-inch
- Firth Lift Station to SSMH #27 in Old Hardin Road: 12-inch

A 6-inch force main size is not feasible for either of the above force mains. Thus, the 6-inch Firth Lift Station force main in Firth Street could not be used to accommodate both Firth Lift Station and TEDD Lift Station flows. However, based on these calculations it is feasible to combine flows from the two lift stations into one upsized force main as identified above.

It should be noted that the TEDD Lift Station operates at a flow rate that is only 20 gpm more than the peak hourly flow rate of 405 gpm. A greater difference is more desirable in case the estimated peak hourly flows are exceeded. During final design of the TEDD Lift Station, further consideration should be given to increasing this difference. Consideration should also be given to replacing the Firth Lift Station submersible pumps with higher head pumps to better accommodate the head created by combining flows from the two lift stations.

Location of Common Force Main

The reader is directed to Figure SS-1 included as Attachment 3 to this memo for reference in this discussion. Please note that the aerial photo in Figure SS-1 does not align properly with the property linework especially on the east side of the Bretz RV business. It should be noted that the force main location is proposed. Final alignment of the force main would be finalized during such time that the force main is actually under design.

There is a 60-foot wide private access easement and public utility easement (PUE) on the east side of Lot 6-A of the Cole Acreage Tracts that extends from Old Hardin Road on the south end to within 138 feet of the north boundary of Lot 6-A. This easement is shown in the plat included as Attachment 5 to this memo. The easement provides access to Lot 6-B which is an empty lot but owned by the same owners of Lot 6-A and allows for installation of public utilities. Lot 6-A houses a portion of the Bretz RV business. This easement does not extend all the way to the Interstate 90 right-of-way as it stops short of the Lot 6-A north property line. A storm drainage pond is located between the end of this easement and the north property boundary. This easement could feasibly

be used for the siting of a common force main for the Firth and TEDD Lift Stations. However, additional utility easements would have to be obtained from the owner of Lot 5-A and the owner of Certificate of Survey 1015 in order to install a force main in this existing utility and access easement and based on the proposed force main alignment shown on Figure SS-1. Installation of a force main under Interstate 90 and in the North Frontage Road right-of-way would require a utility permit from the Montana Department of Transportation.

A force main installed in this alignment would discharge into the gravity sewer system in Old Hardin Road. Manhole #28 is located approximately 30 feet east of the east property line of Lot 6-A. The next downstream manhole #29 is approximately 401 feet from manhole #28. The gravity sewer main connecting manholes #28 and #29 is 15 inches in diameter. The gravity sewer main downstream of manhole #29 is 18 inches in diameter. As noted in the TEDD Infrastructure Master Plan, the 15-inch sewer main would need to be upsized to 18 inches in order to receive flows from the TEDD. Thus, approximately 370 to 401 feet of 15-inch sewer main would need to be upsized if the force main discharges directly into the 15-inch sewer main or at manhole #28 unless the force main is routed directly to manhole #29 in which case no gravity sewer main upsizing would be required. Installation of a force main in Old Hardin Road to manhole #29 would likely have to occur in the paved roadway between the existing sewer main and the natural gas line on the north side of the road. Wherever the force main discharges to the gravity system, a manhole larger than a 48-inch diameter manhole should be installed at that location. Likely the manhole would need to be a minimum of 60 inches in diameter to allow for an internal force main drop structure while still allowing adequate space for access to the manhole for cleaning and tv inspection.

Sincerely,

Morrison Maierle

Jill A. Cook

Jill A. Cook, PE
Project Manager

Attachment 1
Lockwood TEDD Water & Sewer Data Memo

2611 Gabel Road
Billings, MT 59102-7329
406 245 5499
KLJENG.COM

Memorandum

Date: 5/27/2021
To: Jill Cook, Morrison-Maierle
From: Matt Smith, KLJ
RE: Lockwood TEDD Water & Wastewater Data

Remarks

The data requested on March 17 for the Lockwood TEDD Analysis is summarized below.

- Water demands (avg day, peak day, peak hour).
- Wastewater flows (avg day, peak day, peak hour) for the future TEDD lift station.
- Wastewater flows (avg day, peak day, peak hour) for the undeveloped properties on the North Frontage Road located within the TEDD area that can flow by gravity to the existing Firth Lift Station and identification of such properties.
- Results of researching the existing easement on the Bretz RV property.

The following table shows the estimated water demands within the study area as depicted in Figure 2. Figure 1 shows the preliminary future water and sewer layout for the TEDD and the other future development areas.

Lockwood Study Area Water Demand	Average Water Demand (gal/day)	Peak Day Water Demand (gal/day)	Peak Hour Water Demand (gpm)
TEDD Area	83,016	182,634	202
Ultimate Development Areas	133,482	293,661	324
Total	265,692	584,523	526

The following table shows the estimated wastewater flows at the future TEDD lift station located near the northeast corner of the TEDD near Town & Country Supply Associates as shown in Figure 1.

Wastewater Flows at TEDD Lift Station	Average Wastewater Flow (gal/day)	Average Wastewater Flow (gpm)	Peak Wastewater Flow (gpm)
TEDD Area	72,900	51	152
Ultimate Development Areas	117,217	81	244
Total	190,117	132	396

Figure 1 shows that the proposed sewer layout will have all of the wastewater from the TEDD and the other future development areas will flow to the new TEDD lift station where it will be pumped southwest to the Firth Lift Station. Thus, the wastewater flows at the Firth Lift Station will be the sum of the flows at the current developments and the flow coming in from the TEDD lift station.

The following table shows the estimated wastewater flows from the undeveloped areas on North Frontage Road. These areas are shown with a black dashed outline in Figure 2.

Frontage Road Wastewater Flows	Average Wastewater Flow (gal/day)	Average Wastewater Flow (gpm)	Peak Wastewater Flow (gpm)
Undeveloped TEDD Area on Frontage Road	4,780	3	10
Future Development Area on Frontage Road	8,998	6	19
Total	13,778	9	29

The Bretz RV easement research results are shown following Figure 2.

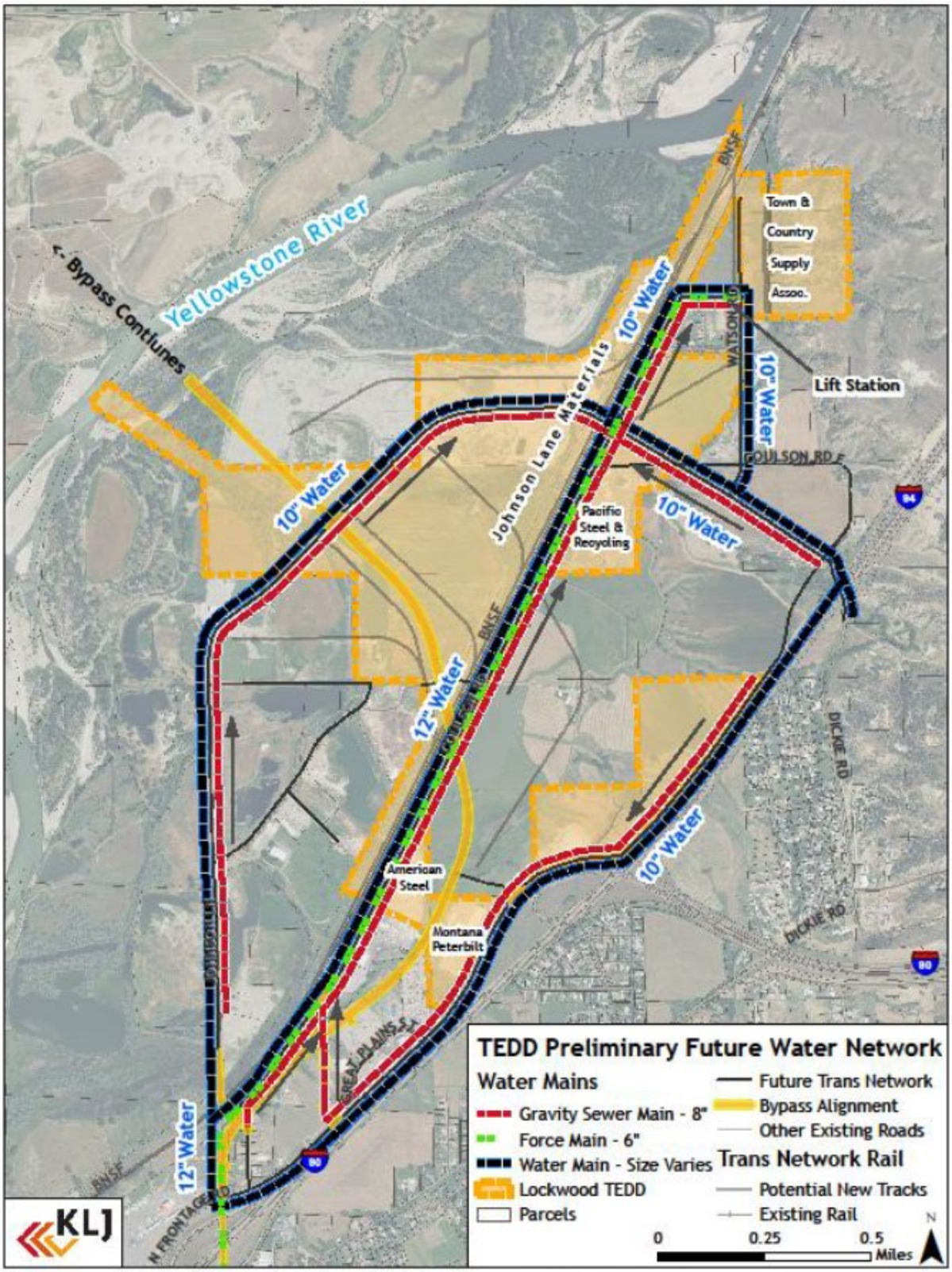


Figure 1: Future Water & Wastewater Network

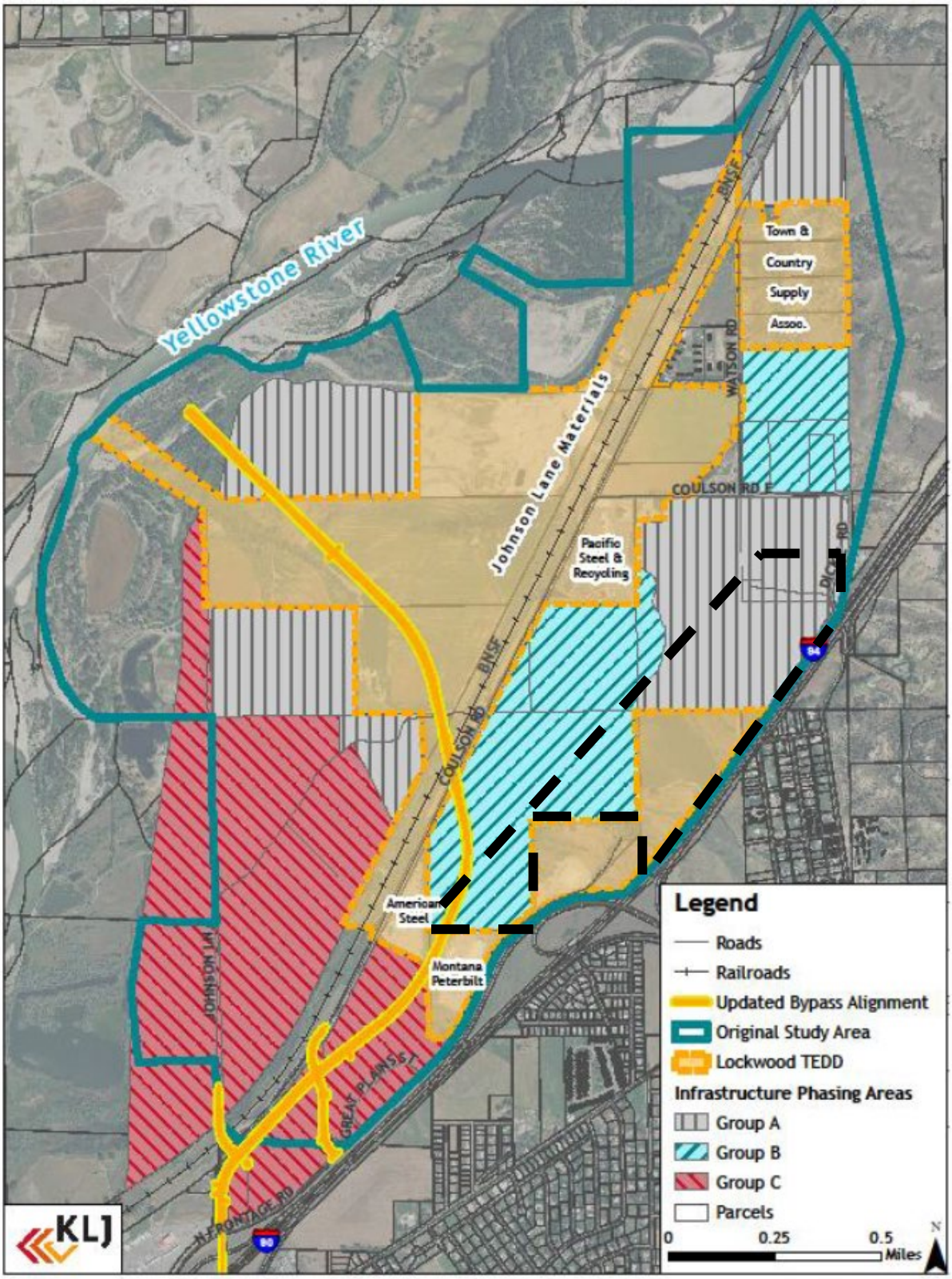


Figure 2: TEDD Study Area

Attachment 2
Estimated Current Wastewater Flows to Firth Lift Station Based on Water Usage Data

GROSSKOPF, SCOTT
1101 FIRST ST

	Winter (Oct-Apr)	Summer
Apr-21	200	
Mar-21	300	
Feb-21	200	
Jan-21	200	
Dec-20	200	
Nov-20	100	
Oct-20	600	
Sep-20		300
Aug-20		200
Jul-20		200
Jun-20		300
May-20		400
Apr-20	300	

monthly average wtr usage	271	gallons	9 gpd
monthly average ww flow (assume 95% return to sewer)	258	gallons	9 gpd

BILLINGS LIVESTOCK COMMISSION CO.
2443 N FRONTAGE RD

	Winter (Oct-Apr)	Summer
Apr-21	108600	
Mar-21	111000	
Feb-21	66000	
Jan-21	73700	
Dec-20	165400	
Nov-20	111100	
Oct-20	85290	
Sep-20		102000
Aug-20		103600
Jul-20		137100
Jun-20		114600
May-20		108100
Apr-20	44100	

monthly average wtr usage	95649	gallons	3188 gpd
monthly average ww flow (assume 50% return to sewer)	47824	gallons	1594 gpd

WARREN TRANSPORT INC
2348 N FRONTAGE RD

	Winter (Oct-Apr)	Summer
Apr-21	22400	
Mar-21	28500	
Feb-21	13600	
Jan-21	24100	
Dec-20	27900	
Nov-20	22300	
Oct-20	32000	
Sep-20		36100
Aug-20		26000
Jul-20		33900
Jun-20		28100
May-20		33400
Apr-20	34000	

monthly average wtr usage	25600	gallons	853 gpd
monthly average ww flow (assume 95% return to sewer)	24320	gallons	811 gpd

LJJ LLC (United Rentals)
2340 N FRONTAGE RD

	Winter (Oct-Apr)	Summer
Apr-21	15800	
Mar-21	7900	
Feb-21	6200	
Jan-21	5400	
Dec-20	5600	
Nov-20	6100	
Oct-20	5200	
Sep-20		5100
Aug-20		5400
Jul-20		7300
Jun-20		6100
May-20		5500
Apr-20	6100	

monthly average wtr usage	7288	gallons	243 gpd
monthly average ww flow (assume 95% return to sewer)	6923	gallons	231 gpd

RAY, JERRY T (west of United Rentals)
2330 N FRONTAGE RD

	Winter (Oct-Apr)	Summer
Apr-21	1200	
Mar-21	1200	
Feb-21	1500	
Jan-21	1400	
Dec-20	1100	
Nov-20	800	
Oct-20	1500	
Sep-20		200
Aug-20		100
Jul-20		0
Jun-20		0
May-20		0
Apr-20		0

monthly average wtr usage	1243	gallons	41 gpd
monthly average ww flow (assume 95% return to sewer)	1181	gallons	39 gpd

Firth Lift Station Current Flows Summary

Total Estimated Monthly WW Flow to Firth LS	80506	gallons
Estimated Average Daily Wastewater Flow to Firth LS	1.86	gpm
Assumed Peaking Factor	4.15	
Estimated Peak Hourly Wastewater Flow to Firth LS	7.73	gpm

Attachment 3
Figure SS-1

NOTE: BASED ON DIFFERENCES IN COORDINATE SYSTEMS, THE AERIAL PHOTO DOES NOT ALIGN EXACTLY WITH THE PROPERTY AND RIGHT-OF-WAY LINEWORK.

Morrison Maierle
engineers ▪ surveyors ▪ planners ▪ scientists
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DRAWN BY: JAC
DSGN. BY: SAS
APPR. BY: JAC
DATE: 6/2021

LOCKWOOD TEDD
LOCKWOOD MONTANA

PROJECT NO. 5927.003

FORCE MAIN EXTENSION

FIGURE NUMBER SS-1

V:\5927\003\ACAD\Exhibits\SS-1.dwg Plotted by kent kuehn on Jun/30/2021

Attachment 4
Lift Station Calculations

Morrison Maierle engineers • surveyors • planners • scientists	PROJECT:	Firth Lift Station		
	BY: SAS	DATE: 6/25/21	PROJECT NO.	5927.003
	CHK:	DATE:	PAGE: 1	OF 3

FIRTH LIFT STATION - PUMP & SYSTEM CURVES

revised flow for service area + TEDD gravity flow areas
new 12" force main along east side of Bretz RV
Firth Lift Station flow + TEDD Lift Station flow

PUMP CURVE DATA: (USEMCO Submersible Pump - Model S4M)

FLOW (GPM)	HEAD (FT)	EFFICIENCY (%)
0	92	0
105	83	25
150	79.5	33
300	71.5	53
450	65.5	64
600	59.5	69
750	52.5	69
900	42.5	62
998	30	53

DEVELOP SYSTEM CURVE:

FORCE MAIN:

LENGTH	= 4,250 ft	Firth Lift Sta to SSMH #27	
DIAMETER	= 10.656 in	12" FM, DIPS DR 11 (200 psi) HDPE pipe	
AREA	= 0.6193 ft^2		
PEAK HOUR FLOW	= 137 gpm		
DESIGN FLOW	= 380 gpm		
C	= 130		

STATIC HEAD CONDITIONS:

	ELEVATION	DIST (from static to discharge)
HIGH WATER LEVEL (HWL)	3088.0	52.3
LOW WATER LEVEL (LWL)	3085.6	54.7
DISCHARGE	3140.3	

FIRTH LIFT STATION - PUMP & SYSTEM CURVES CONT'D

revised flow for service area + TEDD gravity flow areas
new 12" force main along east side of Bretz RV
Firth Lift Station flow + TEDD Lift Station flow

MINOR LOSSES SUMMARY:

Appurtenance	K	No.	Total		Appurtenance	K	No.	Total
Gate Valve					45° Wye			
3/4 Closed	24.0		0		Value	0.5		0
1/2 Closed	5.6		0		Sudden Contraction			
1/4 Closed	1.2		0		d/D = 1/4	0.4		0
Open	0.5		0		d/D = 1/2	0.3		0
Plug Valve					d/D = 3/4	0.2		0
Open	0.5	1	0.5		Sudden Enlargement			
Swing Check Valve					d/D = 1/4	0.9		0
Value 1	0.6		0		d/D = 1/2	0.6		0
Value 2	2	1	2		d/D = 3/4	0.2	1	0.2
Elbows					Entrance			
90° Standard	0.8	5	4		Pipe Projecting	0.8		0
90° Long Radius	0.6		0		Pipe Flush	0.5		0
45° Standard	0.2	5	1		Exit			
22.5° Standard	0.15	5	0.75					
11.25° Standard	0.1	3	0.3					
Tee					All Conditions	1	1	1
Branch Flow	0.75	1	0.75			**TOTAL "K"**		**10.5**

COMPUTE FRICTION HEAD: $h_F = (L/D^{4.87})*((2.31*Q)/(C*448.8))^{1.852}$

$(L/D^{4.87})$ = 7579.1 $2.31/(C*448.8))^{1.852}$ = 7E-09

COMPUTE MINOR LOSSES $h_M = K*V^2/2g$

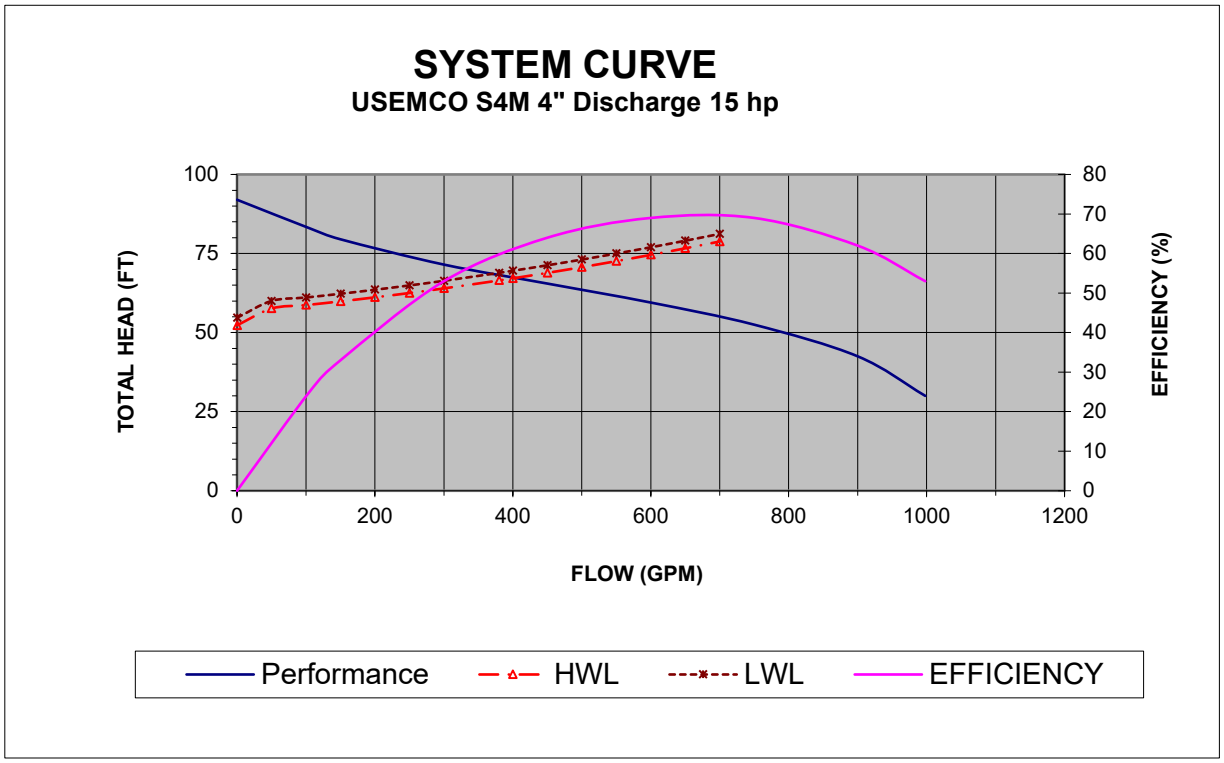
TEDD Firth

Q (gpm)	Q (gpm)	$Q^{1.852}$	V (fps)	h_F (ft)	h_M (ft)	$\sum h_L$ (ft)	HWL (ft)	HWL (psi)	LWL (ft)	LWL (psi)
0	0	0	0	0	0	0.0	52.30	22.6	54.70	23.7
425	50	90622.6	1.7089	4.8266	0.4762	5.3	57.60	24.9	60.00	26.0
425	100	109077.5	1.8888	5.8095	0.5817	6.4	58.69	25.4	61.09	26.4
425	150	129093.6	2.0687	6.8755	0.6978	7.6	59.87	25.9	62.27	27.0
425	200	150650.2	2.2486	8.0237	0.8244	8.8	61.15	26.5	63.55	27.5
425	250	173728.3	2.4285	9.2528	0.9616	10.2	62.51	27.1	64.91	28.1
425	300	198310.6	2.6084	10.562	1.1093	11.7	63.97	27.7	66.37	28.7
425	380	240732.1	2.8962	12.821	1.3676	14.2	66.49	28.8	68.89	29.8
425	400	251925.8	2.9681	13.418	1.4364	14.9	67.15	29.1	69.55	30.1
425	450	280930.5	3.148	14.962	1.6158	16.6	68.88	29.8	71.28	30.9
425	500	311382.7	3.3279	16.58	1.8057	18.4	70.69	30.6	73.09	31.6
425	550	343270.6	3.5078	18.283	2.0062	20.3	72.59	31.4	74.99	32.5
425	600	376582.9	3.6877	20.057	2.2172	22.3	74.57	32.3	76.97	33.3
425	650	411309.2	3.8676	21.906	2.4388	24.3	76.65	33.2	79.05	34.2
425	700	447439.7	4.0475	23.83	2.671	26.5	78.80	34.1	81.20	35.2

Morrison Maierle engineers • surveyors • planners • scientists	PROJECT:	Firth Lift Station		
	BY: SAS	DATE: 6/25/21	PROJECT NO.	5927.003
	CHK:	DATE:	PAGE: 3	OF 3

FIRTH LIFT STATION - PUMP & SYSTEM CURVES CONT'D

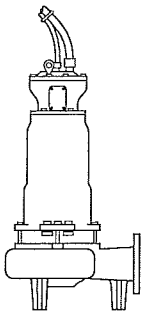
revised flow for service area + TEDD gravity flow areas
new 12" force main along east side of Bretz RV
Firth Lift Station flow + TEDD Lift Station flow



FIRTH LIFT STATION - FORCE MAIN

Q = VA

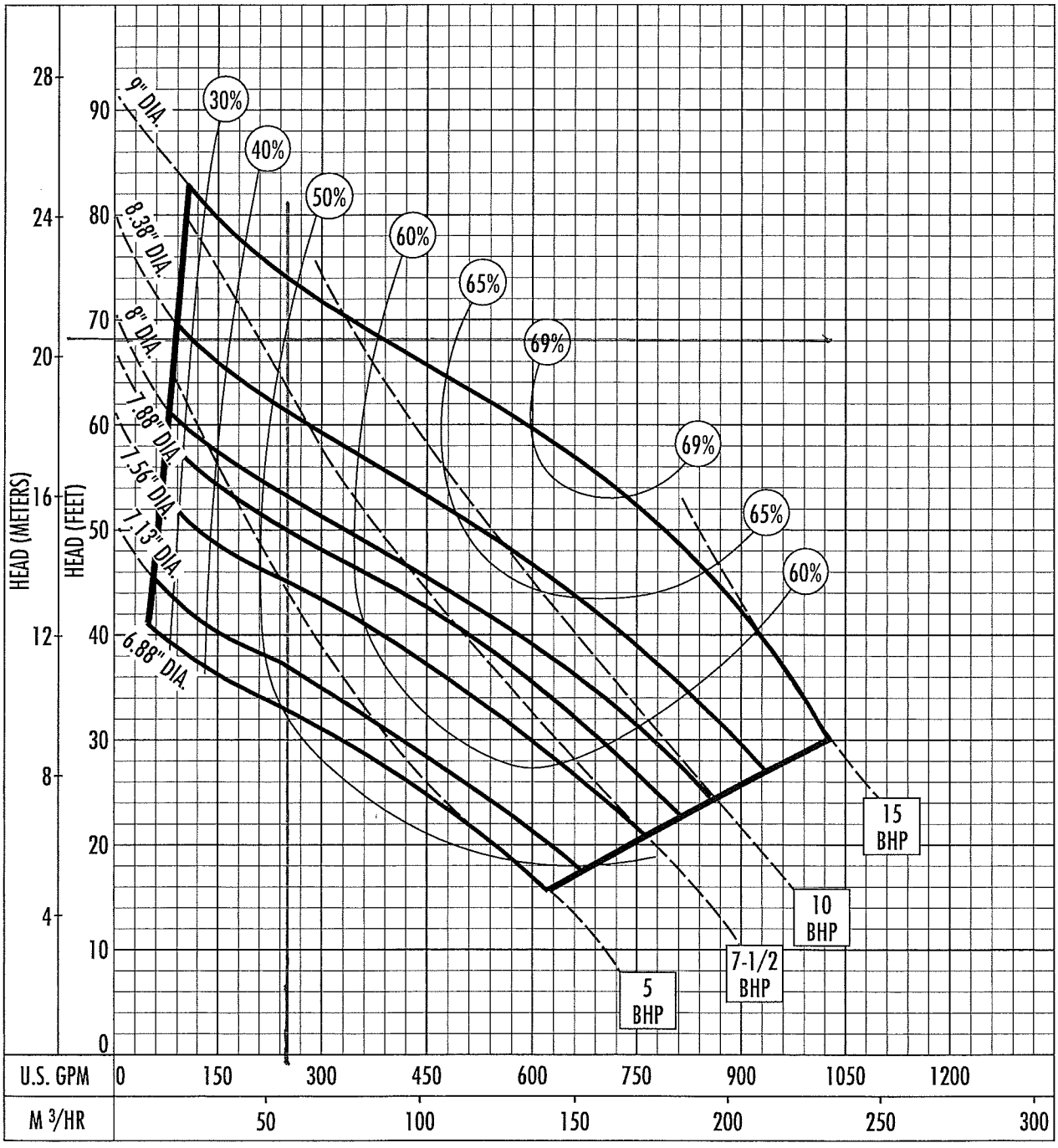
Design Flow =	805	gpm	Design Flow
Velocity =	2.9	fps	(Min. velocity is 2 fps per DEQ-2, para. 49.1. A cleaning velocity of 3 fps is desirable. Max. velocity shall not exceed 8 fps for the design pump rate.)



Performance Curve

S4M/S4MX

RPM: **1750** Discharge: **4"** Solids: **3"**



The curves reflect maximum performance characteristics without exceeding full load (Nameplate) horsepower. All pumps have a service factor of 1.2. Operation is recommended in the bounded area with operational point within the curve limit. Performance curves are based on actual tests with clear water at 70° F. and 1280 feet site elevation.

Conditions of Service:

GPM: _____ **TDH:** _____

HYDROMATIC®

Morrison Maierle engineers · surveyors · planners · scientists	PROJECT:	TEDD Lift Station		
	BY: SAS	DATE: 6/25/21	PROJECT NO.	5927.003
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TEDD LIFT STATION - PUMP & SYSTEM CURVES

TEDD Lift Station flow + Firth Lift Station flow
10" force main from TEDD Lift Station to Firth Lift Station
12" force main from Firth Lift Station to SSMH #27

PUMP CURVE DATA:

Gorman-Rupp Submersible Pump - Model SF4D

11.50" impeller

FLOW (GPM)	HEAD (FT)	EFFICIENCY (%)
0	146	0
240	140	39
400	137	50
600	130	59
800	119	63.5
1000	108	64

11.75" impeller

FLOW (GPM)	HEAD (FT)	EFFICIENCY (%)
0	156	
260	150	
400	146	
600	140	
800	128	
1000	116	

12.00" impeller

FLOW (GPM)	HEAD (FT)	EFFICIENCY (%)
0	162	0
280	157	45
400	154	48
600	147	58
800	135	64
1000	124	65

DEVELOP SYSTEM CURVE:

FORCE MAIN:

LENGTH	=	12,900	ft	TEDD to Firth	4250 ft	Firth to SSMH #27
DIAMETER	=	8.961	in	10" FM, DR 11 (200 psi)	10.656 in	12" FM, DR 11 (200 psi)
AREA	=	0.4380	ft^2		0.6193 ft^2	
PEAK HOUR FLOW	=	405	gpm			
DESIGN FLOW	=	425	gpm			
C	=	130				

STATIC HEAD CONDITIONS:

	ELEVATION	DIST (from static to discharge)
HIGH WATER LEVEL (HWL)	3039.5	100.8
LOW WATER LEVEL (LWL)	3035.5	104.8
DISCHARGE	3140.3	

Morrison Maierle engineers • surveyors • planners • scientists	PROJECT: TEDD Lift Station		
	BY: SAS	DATE: 6/25/21	PROJECT NO. 5927.003
	CHK:		PAGE: 2 OF 3

TEDD LIFT STATION - PUMP & SYSTEM CURVES CONT'D

TEDD Lift Station flow + Firth Lift Station flow
10" force main from TEDD Lift Station to Firth Lift Station
12" force main from Firth Lift Station to SSMH #27

MINOR LOSSES SUMMARY: TEDD to Firth TEDD flow only

Appurtenance	K	No.	Total		Appurtenance	K	No.	Total
Gate Valve					45° Wye			
3/4 Closed	24.0		0		Value	0.5		0
1/2 Closed	5.6		0		Sudden Contraction			
1/4 Closed	1.2		0		d/D = 1/4	0.4		0
Open	0.5		0		d/D = 1/2	0.3		0
Plug Valve					d/D = 3/4	0.2		0
Open	0.5	1	0.5		Sudden Enlargement			
Swing Check Valve					d/D = 1/4	0.9		0
Value 1	0.6		0		d/D = 1/2	0.6		0
Value 2	2	1	2		d/D = 3/4	0.2	1	0.2
Elbows					Entrance			
90° Standard	0.8	7	5.6		Pipe Projecting	0.8		0
90° Long Radius	0.6		0		Pipe Flush	0.5		0
45° Standard	0.2	10	2		Exit			
22.5° Standard	0.15	10	1.5					
11.25° Standard	0.1	10	1					
Tee					All Conditions	1	1	1
Branch Flow	0.75	1	0.75			**TOTAL "K"**		**14.6**

COMPUTE FRICTION HEAD: $h_F = (L/D^{4.87})*((2.31*Q)/(C*448.8))^{1.852}$

$(L/D^{4.87})$ = 53484 $2.31/(C*448.8))^{1.852}$ = 7E-09

COMPUTE MINOR LOSSES $h_M = K*V^2/2g$

TEDD

Q (gpm)	$Q^{1.852}$	V (fps)	h_F (ft)	h_M (ft)	$\sum h_L$ (ft)
0	0	0	0	0	0.0
50	1401.2	0.2544	0.5266	0.0146	0.5
100	5058.2	0.5088	1.9011	0.0585	2.0
150	10718.2	0.7631	4.0284	0.1316	4.2
200	18260.3	1.0175	6.8631	0.2339	7.1
250	27604.8	1.2719	10.375	0.3655	10.7
300	38692.7	1.5263	14.543	0.5263	15.1
350	51477.1	1.7806	19.347	0.7164	20.1
425	73752.4	2.1622	27.72	1.0563	28.8
450	81987.9	2.2894	30.815	1.1842	32.0
500	99653.5	2.544	37.45	1.4619	38.9
550	118891.7	2.798	44.69	1.769	46.5
600	139680.6	3.053	52.50	2.1052	54.6
650	162000.2	3.307	60.89	2.4707	63.4
700	185832.5	3.561	69.84	2.8654	72.7

Morrison Maierle	PROJECT:	TEDD Lift Station		
engineers • surveyors • planners • scientists	BY: SAS	DATE: 6/25/21	PROJECT NO.	5927.003
	CHK:	1/16/12	PAGE: 2	OF 3

TEDD LIFT STATION - PUMP & SYSTEM CURVES CONT'D

TEDD Lift Station flow + Firth Lift Station flow
10" force main from TEDD Lift Station to Firth Lift Station
12" force main from Firth Lift Station to SSMH #27

MINOR LOSSES SUMMARY: Firth to SSMH #27 TEDD + Firth flows

Appurtenance	K	No.	Total		Appurtenance	K	No.	Total
Gate Valve					45° Wye			
3/4 Closed	24.0		0		Value	0.5		0
1/2 Closed	5.6		0		Sudden Contraction			
1/4 Closed	1.2		0		d/D = 1/4	0.4		0
Open	0.5		0		d/D = 1/2	0.3		0
Plug Valve					d/D = 3/4	0.2		0
Open	0.5		0		Sudden Enlargement			
Swing Check Valve					d/D = 1/4	0.9		0
Value 1	0.6		0		d/D = 1/2	0.6		0
Value 2	2	1	2		d/D = 3/4	0.2		0
Elbows					Entrance			
90° Standard	0.8	5	4		Pipe Projecting	0.8		0
90° Long Radius	0.6		0		Pipe Flush	0.5		0
45° Standard	0.2	3	0.6		Exit			
22.5° Standard	0.15		0					
11.25° Standard	0.1		0					
Tee					All Conditions	1	1	1
Branch Flow	0.75	1	0.75			**TOTAL "K"**		**8.4**

COMPUTE FRICTION HEAD: $h_F = (L/D^{4.87})*((2.31*Q)/(C*448.8))^{1.852}$

$(L/D^{4.87})$ = 7579.1 $2.31/(C*448.8))^{1.852}$ = 7E-09

COMPUTE MINOR LOSSES $h_M = K*V^2/2g$

Firth TEDD

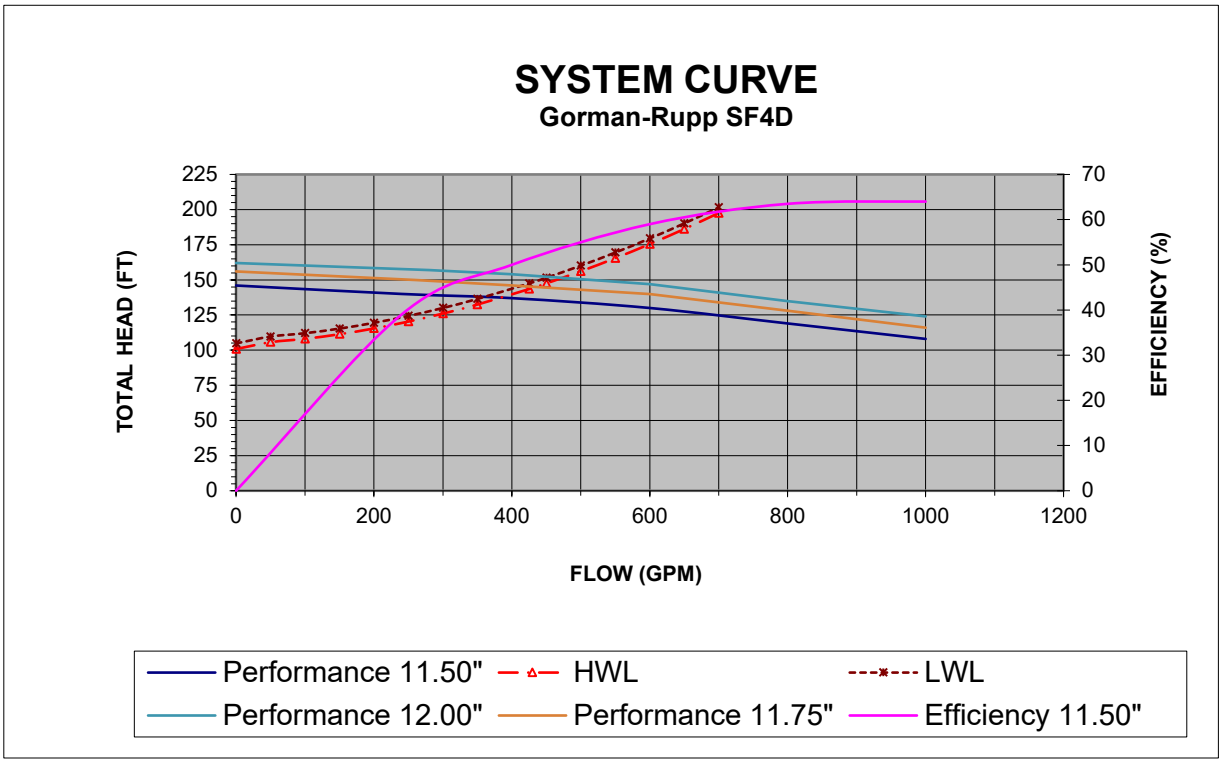
Q (gpm)	Q (gpm)	$Q^{1.852}$	V (fps)	h_F (ft)	h_M (ft)	$\sum h_L$ (ft)
0	0	0	0	0	0	0.0
380	50	75367.4	1.547	4.0141	0.3103	4.3
380	100	92397.2	1.7269	4.9211	0.3867	5.3
380	150	111009.2	1.9068	5.9124	0.4714	6.4
380	200	131180.3	2.0867	6.9867	0.5646	7.6
380	250	152889.9	2.2666	8.1429	0.6661	8.8
380	300	176119.1	2.4465	9.3801	0.776	10.2
380	350	200851.0	2.6264	10.697	0.8944	11.6
380	425	240732.1	2.8962	12.821	1.0876	13.9
380	450	254760.8	2.9861	13.569	1.1562	14.7
380	500	283910.8	3.166	15.121	1.2997	16.4
380	550	314507.1	3.3459	16.751	1.4515	18.2
380	600	346537.9	3.5258	18.457	1.6118	20.1
380	650	379992.1	3.7057	20.238	1.7805	22.0
380	700	414859.3	3.8856	22.095	1.9575	24.1

HWL		LWL	
(ft)	(psi)	(ft)	(psi)
100.80	43.6	104.80	45.4
105.67	45.7	109.67	47.5
108.07	46.8	112.07	48.5
111.34	48.2	115.34	49.9
115.45	50.0	119.45	51.7
120.35	52.1	124.35	53.8
126.02	54.6	130.02	56.3
132.46	57.3	136.46	59.1
143.48	62.1	147.48	63.8
147.52	63.9	151.52	65.6
156.14	67.6	160.14	69.3
165.46	71.6	169.46	73.4
175.47	76.0	179.47	77.7
186.18	80.6	190.18	82.3
197.56	85.5	201.56	87.3

Morrison Maierle engineers · surveyors · planners · scientists	PROJECT:	TEDD Lift Station					
	BY:	SAS	DATE:	6/25/21	PROJECT NO.	5927.003	
	CHK:		DATE:		PAGE:	3 OF 3	

TEDD LIFT STATION - PUMP & SYSTEM CURVES CONT'D

TEDD Lift Station flow + Firth Lift Station flow
10" force main from TEDD Lift Station to Firth Lift Station
12" force main from Firth Lift Station to SSMH #27



TEDD LIFT STATION - FORCE MAIN

TEDD to Firth — 10" FM, DR 11 (200 psi)
Q = VA
Design Flow = 425 gpm
Velocity = 2.2 fps

(Min. velocity is 2 fps per DEQ-2, para. 49.1. A cleaning velocity of 3 fps is desirable. Max. velocity shall not exceed 8 fps for the design pump rate.)

Firth to SSMH #27 — 12" FM, DR 11 (200 psi)
Design Flow = 805 gpm
Velocity = 2.9 fps

PERFORMANCE CURVE

AMPS

575V AMPS | 460V AMPS

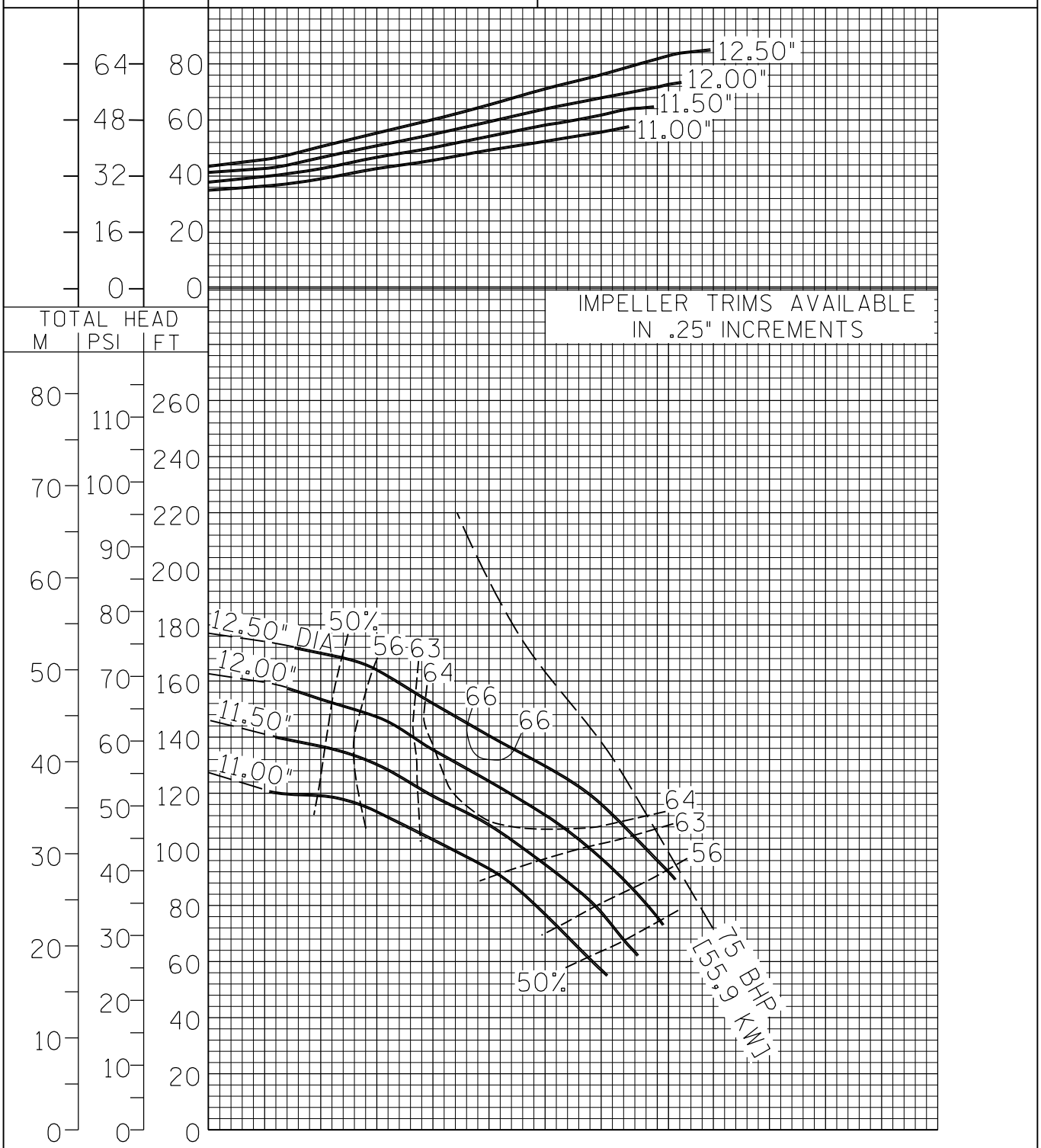
HYDRAULIC EFFICIENCY SHOWN

3.00" DIA. SPHERICAL SOLIDS

CURVE SF4D-1 MODEL SF4D SF4D-X

SIZE 4" IMP. DIA. NOTED

SP.GR. 1.0 RPM 1750



FILE NO. SF4D.S01

GORMAN-RUPP PUMPS

T-7-18-R

Attachment 5
Plat

AMENDED PLAT OF

COLE ACREAGE TRACTS, LOTS 5 AND 6, JOHNSTON SUBDIVISION, FIRST FILING, LOTS 5, 6, 7 AND 8, AND AN UNPLATTED TRACT OF LAND IN E1/2NW1/4SE1/4 AND NE1/4SE1/4 OF SECTION 19

TO DEPICT THE RETRACEMENT OF LOTS 5, 6, 7 AND 8 OF JOHNSTON SUBDIVISION, FIRST FILING AND LOT 5 OF COLE ACREAGE TRACTS, TOGETHER WITH THE RELOCATION OF COMMON BOUNDARIES OF LOT 6 OF COLE ACREAGE TRACTS AND PORTIONS OF THE E1/2NW1/4SE1/4 AND NE1/4SE1/4 OF SECTION 19, LOCATED IN THE SE1/4 OF SECTION 19, T. 01N., R.27E., P.M.M., YELLOWSTONE COUNTY, MONTANA

PREPARED FOR: TOUR AMERICA RV CENTER INC.

PREPARED BY: TERRITORIAL–LANDWORKS, INC.

DATE: SEPTEMBER, 2015

PERIMETER LEGAL DESCRIPTION

LOTS 5 AND 6 OF COLE ACREAGE TRACTS, A SUBDIVISION OF YELLOWSTONE COUNTY, TOGETHER WITH LOTS 5, 6, 7 AND 8 OF JOHNSTON SUBDIVISION, FIRST FILING, A SUBDIVISION OF YELLOWSTONE COUNTY, TOGETHER WITH THAT PROPERTY DESCRIBED IN DOCUMENT NO. 3058528, RECORDS OF YELLOWSTONE COUNTY, LOCATED IN THE SOUTHEAST ONE–QUARTER (SE1/4) OF SECTION 19, TOWNSHIP 01 NORTH, RANGE 27 EAST, PRINCIPAL MERIDIAN MONTANA, YELLOWSTONE COUNTY, MONTANA, BEING MORE PARTICULARLY DESCRIBED AS FOLLOWS:

BEGINNING AT THE EAST QUARTER CORNER OF SECTION 19, SAID POINT BEING THE TRUE POINT OF BEGINNING; THENCE ALONG THE EAST LINE OF SECTION 19, S0°37'21"E, 671.90 FEET TO THE NORTHEAST CORNER OF C.O.S. 671, YELLOWSTONE COUNTY RECORDS; THENCE ALONG THE NORTH LINE OF SAID C.O.S. 671, S89°22'39"W, 185.00 FEET TO THE NORTHWEST CORNER OF SAID C.O.S. 671; THENCE ALONG THE NORTH LINE OF C.O.S. 1278, YELLOWSTONE COUNTY RECORDS, S88°46'13"W, 324.41 FEET TO THE NORTHWEST CORNER OF SAID C.O.S. 1278; THENCE ALONG THE WEST LINE OF SAID C.O.S. 1278, S02°24'32"E, 486.05 FEET TO THE NORTH RIGHT–OF–WAY OF OLD HARDIN ROAD; THENCE ALONG SAID RIGHT–OF–WAY, S56°05'44"W, 217.47 FEET TO THE NORTHEASTERLY CORNER OF JOHNSTON SUBDIVISION, FIRST FILING, A SUBDIVISION OF YELLOWSTONE COUNTY; THENCE ALONG THE NORTH LINE OF SAID JOHNSTON SUBDIVISION, FIRST FILING, N87°02'27"W, 333.90 FEET TO THE NORTHEAST CORNER OF LOT 8 OF SAID JOHNSTON SUBDIVISION, FIRST FILING; THENCE ALONG THE EAST LINE OF SAID LOT 8, S30°35'49"W, 90.09 FEET; THENCE ALONG THE COMMON LINE FOR LOTS 5, 6, 7 AND 4 OF SAID JOHNSTON SUBDIVISION, FIRST FILING, S13°47'12"W, 201.12 FEET TO THE NORTH RIGHT–OF–WAY OF OLD HARDIN ROAD; THENCE ALONG SAID RIGHT–OF–WAY, S59°09'23"W, 708.83 FEET TO THE SOUTHWEST CORNER OF LOT 5 OF COLE ACREAGE TRACTS, A SUBDIVISION OF YELLOWSTONE COUNTY; THENCE ALONG THE COMMON LINE OF LOTS 4, 5, 6, AND 7 OF SAID COLE ACREAGE TRACTS, N00°25'12"W, 673.38 FEET TO THE NORTHWEST CORNER OF SAID LOT 6; THENCE ALONG THE NORTH LINE OF LOT 7–A–1 OF COLE ACREAGE TRACTS – LOTS 1, 2, 3 & 7, AN AMENDED PLAT OF YELLOWSTONE COUNTY, N87°02'27"W, 232.53 FEET, MORE OR LESS, TO A NON–TANGENT POINT CURVATURE ON THE SOUTHERLY RIGHT–OF–WAY LINE OF INTERSTATE HIGHWAY I–90, SAID POINT HAVING A RADIAL BEARING OF S56°49'31"E; THENCE ALONG SAID SOUTHERLY RIGHT–OF–WAY LINE THE FOLLOWING FIVE (5) COURSES: AN ARC DISTANCE OF 520.70 FEET ALONG SAID NON–TANGENT CURVE TO THE RIGHT, OF RADIUS 2232.00 FEET AND DELTA OF 13°21'59" TO A POINT TO A NON–TANGENT LINE; THENCE N33°39'57"E, 41.23 FEET; THENCE N47°42'08"E, 801.84 FEET TO THE NORTH LINE OF THE SOUTHEAST ONE–QUARTER (SE1/4) OF SECTION 19; THENCE ALONG SAID NORTH LINE, S86°52'53"E, 692.76 FEET TO THE TRUE POINT OF BEGINNING.

CONTAINING A TOTAL OF 40.61 ACRES, MORE OR LESS, BEING SUBJECT TO ALL EASEMENTS AND RIGHTS–OF–WAY AS SHOWN, EXISTING OR OF RECORD.

OWNER'S CERTIFICATION

I HEREBY CERTIFY THAT THE PURPOSE OF THIS SURVEY IS TO DEPICT THE RETRACEMENT OF THOSE LOTS AFFECTED BY THE VACATION OF SLEEPER LANE PER COUNTY RESOLUTION NO. 15–74 PURSUANT TO SECTION 76–3–404 M.C.A., AND IS NOT INTENDED TO CREATE NEW PARCELS OR AGGREGATE EXISTING PARCELS OF RECORD, AND TO DEPICT THE RELOCATION OF COMMON BOUNDARIES BETWEEN A SINGLE LOT WITHIN A PLATTED SUBDIVISION AND ADJOINING LAND OUTSIDE A PLATTED SUBDIVISION, THEREFORE THIS DIVISION OF LAND IS EXEMPT FROM REVIEW AS A SUBDIVISION PURSUANT TO SECTION 76–3–207 (1)(e) M.C.A., TO WIT: "DIVISIONS MADE FOR THE PURPOSE OF RELOCATING A COMMON BOUNDARY LINE BETWEEN A SINGLE LOT WITHIN A PLATTED SUBDIVISION AND ADJOINING LAND OUTSIDE A PLATTED SUBDIVISION. A RESTRICTION OR REQUIREMENT ON THE ORIGINAL PLATTED LOT OR ORIGINAL UNPLATTED PARCEL CONTINUES TO APPLY TO THOSE AREAS." AND FURTHER, TRACT A IS EXEMPT FROM REVIEW BY THE DEPARTMENT OF ENVIRONMENTAL QUALITY PURSUANT TO ARM 17.36.605(2)(a), TO WIT: "A PARCEL THAT HAS NO FACILITIES FOR WATER SUPPLY, WASTEWATER DISPOSAL, STORM DRAINAGE, OR SOLID WASTE DISPOSAL, IF NO FACILITIES WILL BE CONSTRUCTED ON THE PARCEL." AND FURTHER, LOT 6–A IS GREATER THAN 20 ACRES AND THEREFORE EXEMPT FROM SANITATION REVIEW PURSUANT TO SECTION 76–4–103 M.C.A.

ARM 24.183.1104(1)(f)(iii)(C)
"THE AREA THAT IS BEING REMOVED FROM ONE TRACT OF RECORD AND JOINED WITH ANOTHER TRACT OF RECORD IS NOT ITSELF A TRACT OF RECORD. SAID AREA SHALL NOT BE AVAILABLE AS A REFERENCE LEGAL DESCRIPTION IN ANY SUBSEQUENT REAL PROPERTY TRANSFER AFTER THE INITIAL TRANSFER ASSOCIATED WITH THE AMENDED PLAT ON WHICH SAID AREA IS DESCRIBED, UNLESS SAID AREA IS INCLUDED WITH OR EXCLUDED FROM ADJOINING TRACTS OF RECORD."

FURTHER, I HEREBY GRANT UNTO EACH AND EVERY PERSON, FIRM, OR CORPORATION, WHETHER PUBLIC OR PRIVATE, PROVIDING OR OFFERING TO PROVIDE TELEPHONE, TELEGRAPH, ELECTRIC POWER, GAS, CABLE TELEVISION, WATER, OR SEWER SERVICE TO THE PUBLIC THE RIGHT TO THE JOINT USE OF AN EASEMENT FOR THE CONSTRUCTION, MAINTENANCE, REPAIR, AND REMOVAL OF THEIR LINES AND OTHER FACILITIES, IN, OVER, AND ACROSS EACH AREA DESIGNATED ON THIS AMENDED PLAT AS "UTILITY EASEMENT" TO HAVE AND TO HOLD FOREVER, AND

FURTHER, I GRANT A SHARED PRIVATE ACCESS EASEMENT FOR THE USE AND BENEFIT OF LOTS 5–A, 5–B, 6–A, 6–C, 7–A AND 8–A AS SHOWN HEREON, TO BE USED BY THE OWNERS AND GUESTS OF SAID LOTS; IN THE EVENT OF FUTURE DEVELOPMENT/SUBDIVISION THIS EASEMENT MAY BE FURTHER BURDENED, AND

FURTHER, I GRANT A PRIVATE ACCESS EASEMENT FOR THE USE AND BENEFIT OF LOT 6–B AS SHOWN HEREON, TO BE USED BY THE OWNERS AND GUESTS OF SAID LOT; IN THE EVENT OF FUTURE DEVELOPMENT/SUBDIVISION THIS EASEMENT MAY BE FURTHER BURDENED, AND

FURTHER, I CERTIFY THAT THIS PLAT IS TO BE KNOWN AS: *COLE ACREAGE TRACTS, LOTS 5 AND 6, JOHNSTON SUBDIVISION, FIRST FILING, LOTS 5, 6, 7 AND 8, AND AN UNPLATTED TRACT OF LAND IN E1/2NW1/4SE1/4 AND NE1/4SE1/4 OF SECTION 19.*

BY: MARK A. BRETZ

STATE OF MT

COUNTY OF Missoula

THIS INSTRUMENT WAS ACKNOWLEDGED BEFORE ME ON June 29, 2016 BY MARK A. BRETZ.

NOTARY PUBLIC FOR THE STATE OF Montana

PRINTED NAME OF NOTARY: Jennifer L Brooks

RESIDING AT: Missoula

MY COMMISSION EXPIRES: February 05, 2020

JENNIFER L BROOKS NOTARY PUBLIC for the State of MONTANA Residing at Missoula, MT My Commission Expires February 05, 2020

COUNTY ATTORNEY'S OFFICE:

THIS DOCUMENT HAS BEEN REVIEWED BY THE COUNTY ATTORNEY'S OFFICE AND IS ACCEPTABLE AS TO FORM.

REVIEWED BY: Mark A. Crosser

DATED THIS 12th DAY OF July, 2016

COUNTY TREASURER'S OFFICE:

I HEREBY CERTIFY THAT ALL REAL PROPERTY TAXES AND SPECIAL ASSESSMENTS ASSESSED HAVE BEEN PAID PER M.C.A. 76–3–611(1)(b) AND M.C.A. 76–3–207(3).

BY: Mona Braaten, 1 July 2016
DEPUTY – YELLOWSTONE COUNTY TREASURER DATE

CITY–COUNTY HEALTH DEPT:

THIS DOCUMENT HAS BEEN REVIEWED AND APPROVED BY YELLOWSTONE COUNTY HEALTH DEPARTMENT.

BY: [signature] RS 07/08/2016
YELLOWSTONE CITY–COUNTY HEALTH DEPT. (DBA RIVERSTONE HEALTH) DATE

PURPOSE OF SURVEY

THE PURPOSE OF THIS SURVEY IS TO DEPICT THE RETRACEMENT OF THOSE LOTS AFFECTED BY THE VACATION OF SLEEPER LANE PER COUNTY RESOLUTION NO. 15–74 PURSUANT TO SECTION 76–3–404 M.C.A., AND IS NOT INTENDED TO CREATE NEW PARCELS OR AGGREGATE EXISTING PARCELS OF RECORD, AND TO DEPICT THE RELOCATION OF COMMON BOUNDARIES BETWEEN A SINGLE LOT WITHIN A PLATTED SUBDIVISION AND ADJOINING LAND OUTSIDE A PLATTED SUBDIVISION, THEREFORE THIS DIVISION OF LAND IS EXEMPT FROM REVIEW AS A SUBDIVISION PURSUANT TO SECTION 76–3–207 (1)(e) M.C.A.

SURVEYOR'S CERTIFICATION

I HEREBY CERTIFY THAT THE ATTACHED AMENDED PLAT REPRESENTS A SURVEY MADE UNDER MY SUPERVISION, AND SUBSTANTIALLY COMPLETED ON THE DATE SHOWN HEREON.

MATTHEW JACOBSON, PROFESSIONAL LAND SURVEYOR DATE
MONTANA REGISTRATION NO. 13748LS

MONTANA MATTHEW JACOBSON 13748 LS LICENSED PROFESSIONAL LAND SURVEYOR

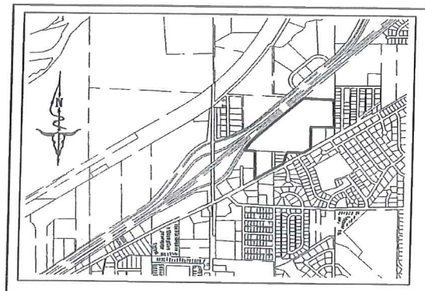
CLERK AND RECORDER FILING INFORMATION

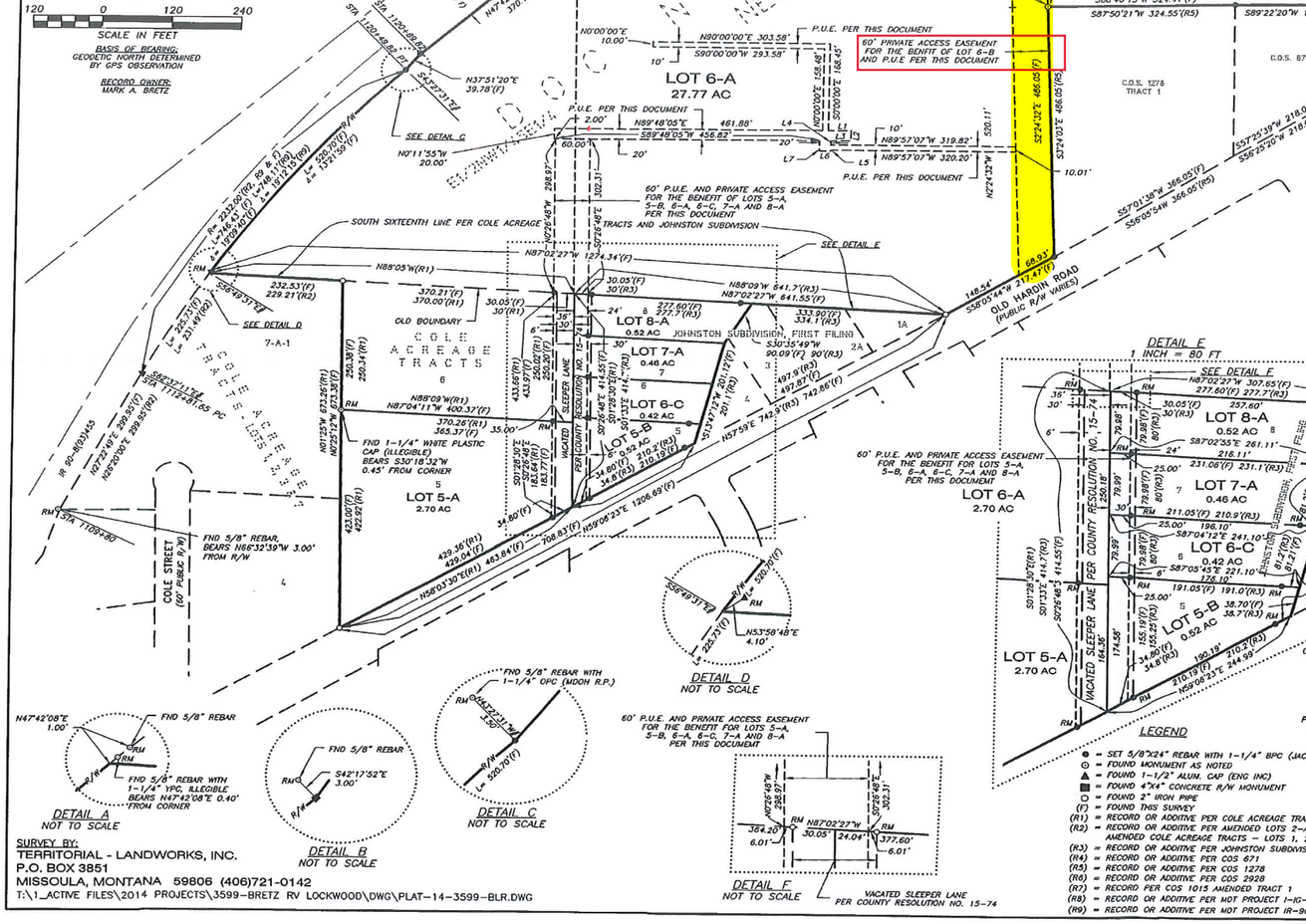
SP 3783453
07/21/2016 09:39 AM Pages: 1 of 1 Fees: 28.50
Jeff Martin Clerk & Recorder Yellowstone MT

Easement - 3783454
Easement - 3783455

1/4	SEC	T	R
	19	01N	27E

YELLOWSTONE COUNTY CLERK





LEGEND

- C.O.S. = CERTIFICATE OF SURVEY
- POB = POINT OF BEGINNING
- RM = REFERENCE MONUMENT
- BPC = BLUE PLASTIC CAP
- OPC = ORANGE PLASTIC CAP
- YPC = YELLOW PLASTIC CAP
- FND = FOUND
- P.U.E. = PUBLIC UTILITY EASEMENT
- R/W = RIGHT–OF–WAY
- ( ) = RADIAL BEARING

LEGEND

- ● = SET 5/8"X24" REBAR WITH 1–1/4" BPC (JACOBSON, 13748LS)
- ⊙ = FOUND MONUMENT AS NOTED
- ▲ = FOUND 1–1/2" ALUM. CAP (ENG INC)
- ■ = FOUND 4"X4" CONCRETE R/W MONUMENT
- ○ = FOUND 2" IRON PIPE
- (F) = FOUND THIS SURVEY
- (R1) = RECORD OR ADDITIVE PER COLE ACREAGE TRACTS
- (R2) = RECORD OR ADDITIVE PER AMENDED LOTS 2–A, 3–A AND 7–1 OF AMENDED COLE ACREAGE TRACTS – LOTS 1, 2, 3 & 7
- (R3) = RECORD OR ADDITIVE PER JOHNSTON SUBDIVISION (FIRST FILING)
- (R4) = RECORD OR ADDITIVE PER COS 671
- (R5) = RECORD OR ADDITIVE PER COS 1278
- (R6) = RECORD OR ADDITIVE PER COS 2928
- (R7) = RECORD PER COS 1015 AMENDED TRACT 1
- (R8) = RECORD OR ADDITIVE PER MDT PROJECT I–IG–90–8(93)433
- (R9) = RECORD OR ADDITIVE PER MDT PROJECT IR–90–8(93)455

SURVEY BY:
TERRITORIAL - LANDWORKS, INC.
P.O. BOX 3851
MISSOULA, MONTANA 59806 (406)721-0142
T:\1_ACTIVE FILES\2014 PROJECTS\3599–BRETZ RV LOCKWOOD\DWG\PLAT–14–3599–BLR.DWG