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TECHNICAL MEMORANDUM

DATE: April 18, 2022

Project No.: 746-30-21-02
SENT VIA: EMAIL

TO: Kimberly Villa, Yolo County

CC: Stan Gryczko, City of Davis

FROM: Kambria Tiano, PE, RCE #84129
Nick Szigeti, EIT

REVIEWED BY: Corie Moolenkamp, PE(OR) #73588PE
Lindsey Olson, PE #88747

SUBJECT: North Davis Meadows Connection to City of Davis Potable Water System – Updated Recommendations to Serve Existing Residential Fire Suppression Systems

The purpose of this technical memorandum (TM) is to update the recommendations for potable water improvements previously identified to serve North Davis Meadows (NDM). This TM is intended to supplement the assumptions, evaluations, and recommendations outlined in the "North Davis Meadows Connection to City of Davis Potable Water System – Revised Recommendations" TM, dated October 18, 2018 (October 2018 TM), prepared by West Yost and provided for reference as Attachment A. The October 2018 TM superseded the recommendations presented in the "North Davis Meadows Connection to City of Davis Potable Water System" TM, dated May 15, 2018 (May 2018 TM), which was provided as an attachment to the October 2018 TM and is also included with Attachment A.

This TM confirms: (1) the 2018 pipeline sizing recommendations; and (2) the proposed residential connection meter and service size(s) required to serve existing individual home fire suppression (fire sprinkler) systems within NDM. The City's hydraulic model has been recently updated to reflect current demands and revised water system operations. Therefore, West Yost used the City's updated hydraulic model to re-evaluate the 2018 pipeline sizing recommendations and evaluate the adequacy of the proposed water service to NDM to serve existing fire sprinkler systems. Planning-level fire sprinkler requirements were developed based on input from the City's Fire Marshal and discussions with licensed fire protection engineers. Pipeline improvements identified in the October 2018 TM were developed to meet minimum fire flow requirements, as defined by the City of Davis (City) and the City's Fire Marshal.

The results from West Yost's hydraulic evaluation are described in the following sections:

- Updated Hydraulic Model
- Updated Assumptions
- Updated Recommendations

Updated Hydraulic Model

The City's hydraulic model was updated in 2021 by Brown and Caldwell (B&C) and documented in the *Hydraulic Model Development Report*, dated March 15, 2021. Updates completed by B&C since the October 2018 TM include updating the existing (2019) water demands and calibrating the system operations to reflect surface water supply from the Woodland Davis Clean Water Agency (WDCWA). Additional updates were completed by B&C in January 2022 to reflect reduced supply conditions under Term 91 curtailment of surface water supply from WDCWA.

West Yost performed additional updates to the B&C hydraulic model to ensure pipeline accuracy within NDM and maintain consistency with the potable water demands presented in the October 2018 TM. These updates are listed below.

Pipeline Diameter and Connectivity Updates

During preliminary review of the hydraulic model, West Yost identified pipeline connectivity errors and diameter discrepancies in the NDM pipelines. The NDM pipeline diameters and roughness factors were updated to align with the proposed pipeline improvements recommended in the October 2018 TM. In addition, InfoWater's Connectivity and Network Review tools were utilized to locate and correct pipe connectivity issues. It was assumed that all other pipeline diameters and alignments in the City were representative of existing conditions, and a comprehensive review of model connectivity in the City water system beyond NDM was not conducted.

Potable Water Demand Updates

The May 2018 TM calculated a NDM maximum day demand (MDD) equal to 424 gallons per minute (gpm). This demand was based on historical NDM monthly consumption data from 2002 to 2016 and an industry standard MDD peaking factor of 1.2 times the average day demand of the maximum month (i.e., maximum monthly demand). Demands for NDM included in the updated hydraulic model were greater than the MDD previously estimated by West Yost and were calculated using the NDM maximum monthly demand instead of the average day demand. For the purposes of this TM, the original NDM demand of 424 gpm was updated in the B&C model to remain consistent with previous evaluations.

Updated Assumptions

Since completion of the October 2018 TM, the City's supply and demand projections have changed due to on-going conservation efforts. In addition, new planning-level fire suppression system evaluation criteria was developed to confirm the adequacy of the proposed residential connections within NDM. These updated assumptions are discussed below.

Potable Water Demands

Potable water demands for the City are set to the 2025 MDD of 15.9 million gallons per day (mgd), as provided in the hydraulic model. This is consistent with the City's 2020 Urban Water Management Plan (UWMP). Though the previous model evaluated 2030 MDD, anticipated water conservation has reduced the 2030 MDD by approximately 30 percent between the 2015 and 2020 UWMPs. The updated 2025 MDD represents current water demand projections.

Water Supply

The City has up to 10.2 mgd of surface water supply available from WDCWA. However, the availability of the City's WDCWA supply varies seasonally and, in dry years, and the City's allotments could be curtailed to 5.5 mgd when Term 91 is invoked by the State Water Board. For the purposes of this TM, the minimum WDCWA supply of 5.5 mgd was assumed to be available. Under limited surface water supply conditions, the City will utilize its deep wells to balance the maximum day demand. Deep wells 30, 31, 32, 33, and 34 were energized to balance the reduced surface water supply under 2025 MDD conditions.

Evaluation Criteria

Fire flow requirements remain unchanged from the October 2018 TM (see Condition 1) and are summarized below.

1. Fire flow requirements stipulate that a minimum of 1,000 gpm must be supplied to NDM with a minimum residual pressure of 20 pounds per square inch (psi).
2. Maximum velocity allowed is 10 feet per second (fps) in new NDM pipelines.

Additional planning-level evaluation criteria were assumed to determine whether the proposed NDM meter and service connections would be able to serve the existing residential fire sprinklers in NDM with the required sprinkler flows at adequate system pressures. These assumptions and evaluation criteria are described in the sections below.

Planning-Level Residential Fire Sprinkler Requirements

Residential fire suppression systems are uniquely designed for an individual structure by registered fire protection engineers. Therefore, every system requires a slightly different minimum flow and pressure to function properly. According to the National Fire Protection Association's Standard 13D (NFPA 13D), *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, the minimum sprinkler flow and system pressure requirements are calculated based on system configuration and are provided to ensure service to the fire sprinkler located at the most hydraulically distant point of the fire sprinkler system from the connection to the City water main[1].

For the purposes of this planning-level evaluation, it was assumed that a typical NDM residential fire sprinkler system would require a flow of 30 gpm at a minimum pressure of 40 psi to function properly. This criterion was developed based on input from the City's Fire Marshal, review of NFPA 13D, and discussions with licensed fire protection engineers. The City's Fire Marshal provided West Yost with a generic list of sprinkler flow and pressure requirements for a sampling of existing homes in NDM. The sprinkler flow and pressure requirements provided were assumed to meet the NFPA 13D requirements active at the time of construction. The residential fire sprinkler system evaluation criterion is based on the ranges of flow and pressure requirements provided by the Fire Marshal.

It is specified in the current NDM water system consolidation design documents that all NDM customers will be required to install backflow devices (BFD) on their water service laterals before connecting to the City's water distribution system. The losses associated with a BFD are significant and may not have been included in the original fire sprinkler design. Review of every set of fire suppression system design

[1] West Yost consulted with two licensed fire protection engineers and confirmed that minimum flow and pressure requirements provided on fire sprinkler plans correspond with the connection point at the water main.

documents for the homes in NDM to confirm fire sprinkler requirements and/or the existence of a BFD is considered outside the scope of this work. Therefore, it was conservatively assumed that losses over the water meter and BFD were not accounted for in the sprinkler design requirements.

Based on the above assumptions, the proposed City water service to NDM should be able to provide the minimum flow at the required pressure listed below at each customer tie-in location. These requirements are provided for planning-level guidance only.

- Minimum Flow = 30 gpm
- Residual Pressure at 30 gpm = 40 psi + $(\text{Head Loss})_{meter}$ + $(\text{Head Loss})_{BFD}$

Assumed Backflow Device Losses

Losses through a BFD are specific to the make, model, and size of BFD, and are described by loss curves provided by manufacturers. West Yost obtained loss curves from three BFD manufacturers for a range of diameters. Table 1 summarizes the anticipated pressure drop over several BFDs at 30 gpm, which is the assumed minimum sprinkler flow required by existing homes in NDM.

Table 1. Backflow Device Losses

Manufacturer	Model	Pressure Drop (psi) at 30 gpm[(a)]			
		1-inch	1 ½-inch	2-inch	2 ½-inch
Zurn/Wilkins	975XL2 (≤ 2-inch) 375 (≥ 2 ½-inch)	12	13	13	12
Watts	LF909 (all)	14	10	9	13
Apollo	RP4A (≤ 2-inch) RPLF4A (≥ 2 ½-inch	12	11	11	12

(a) Approximate sprinkler flow required by existing NDM homes.

Per the design documents, the existing service lateral diameter for NDM homes varies from 1 ½-inch to 2-inch. As shown Table 1, losses over this range of BFD diameters range from 9 psi to 13 psi. For the purposes of this evaluation, 10 psi was assumed to represent BFD losses at all service locations.

Assumed Meter Losses

Losses through residential service meters vary based on meter size and flow. For purposes of this evaluation, a 1 psi pressure drop over the water meter at all service locations was assumed to occur at a fire sprinkler flow of 30 gpm.

Updated Recommendations

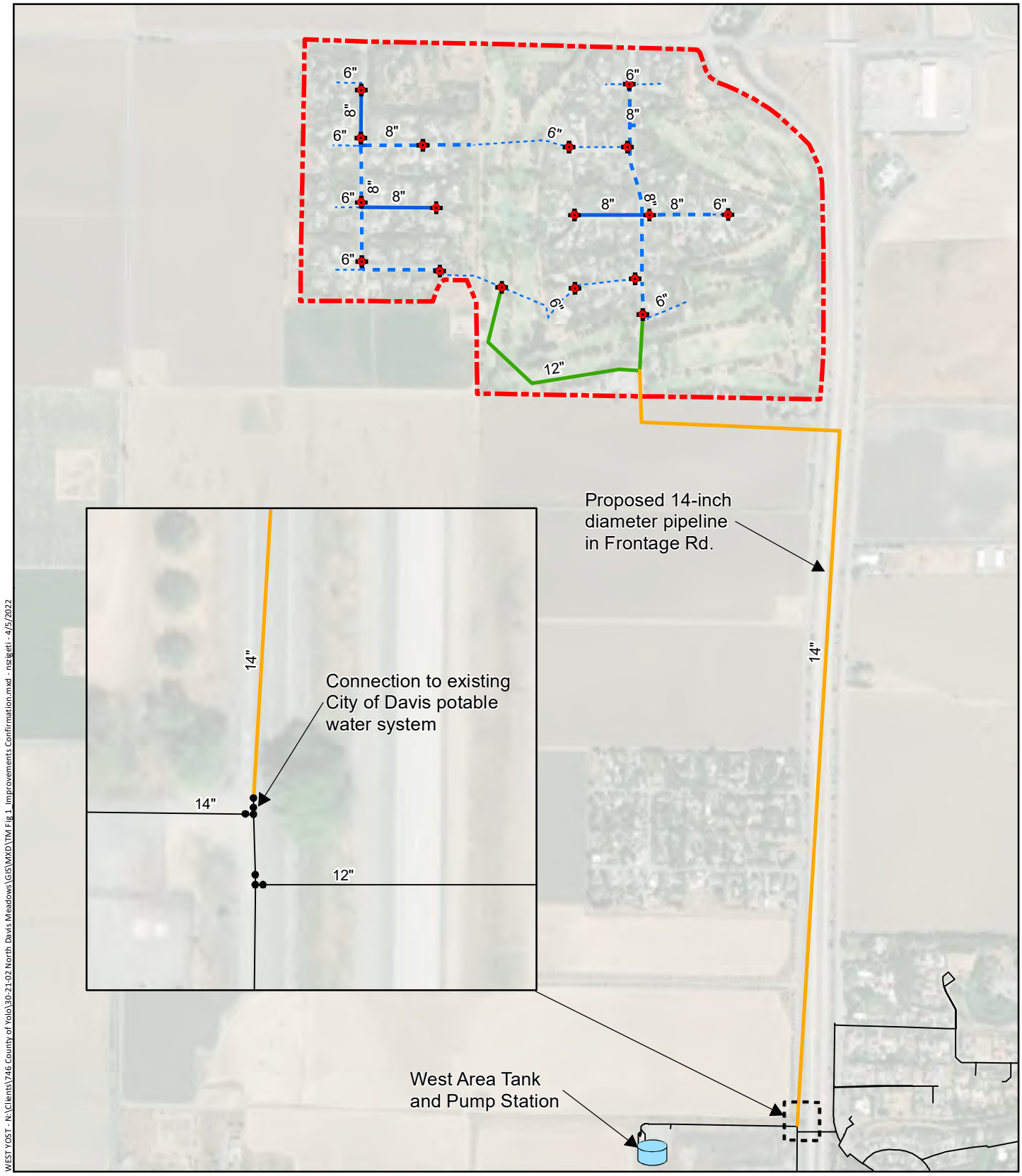
West Yost used the City's updated hydraulic model to re-evaluate "Condition 1 – Fire Flow and Maximum Velocity Requirements" from the October 2018 TM and evaluate the adequacy of the system to serve the existing residential fire suppression systems. Based on the revised supply and demand assumptions listed in this TM, the previously recommended pipeline improvements remain able to meet the City's fire flow requirements. Figure 1 shows the NDM pipeline improvements recommended in 2018 and confirmed in this TM.

The NDM water system should also be able to serve the existing residential fire suppression systems, assuming a 1 ½-inch or 2-inch service connection consisting of a water meter and BFD. As discussed previously, this evaluation defines adequate water service to the fire suppression systems as supplying 30 gpm at a minimum of 40 psi to the existing sprinkler systems (at the customer side of the BFD and water meter). The updated hydraulic model was used to evaluate the fire sprinkler capacity in NDM. Figure 2 presents the residual pressure under 30 gpm of fire sprinkler demand anticipated at customer service locations (i.e., downstream of the water meter and BFD). The majority of NDM locations meet the minimum 40 psi residual pressure criterion. The southeast corner of the existing NDM customers, including the end of the western cul-de-sac of Spyglass Place and approximately 6 customers on Spanish Bay Place, falls just short (within 1 psi) of the minimum 40 psi.

Locations exhibiting a customer-side residual pressure of less than 40 psi on Figure 2 are not considered failing without additional testing. Upon completion of construction, field fire flow and sprinkler testing should be conducted and reviewed against customer-specific sprinkler requirements. Hydraulic models are useful planning tools and the maximum day demand and curtailed supply conditions assumed as the basis of this evaluation are conservative. In addition, customer-specific fire sprinkler requirements range from approximately 32 psi to 41 psi at locations within NDM, per representative values provided by the Fire Marshal. Any locations where the field-observed residual pressures and flows cannot meet customer-specific fire sprinkler requirements would require additional review and action, as specified by a licensed fire protection engineer.

In summary, modeled customer-side residual pressures under flowing fire sprinkler conditions are within ±1 psi of the minimum required pressure at many NDM locations. Therefore, West Yost recommends the following actions to best enable the existing customer fire suppression systems to operate as originally designed.

- BFDs installed in NDM should specify no more than 10 psi of pressure drop at 30 gpm.
- Water meters installed in NDM should specify no more than 1 psi of head loss at 30 gpm.
- Fire flow and fire sprinkler testing should be conducted upon completion of construction.
- Individual fire sprinkler systems should be evaluated after completion of construction and field testing by a licensed fire protection engineer. While several conservative assumptions were made as part of this evaluation, review of individual fire sprinkler system adequacy is beyond the technical scope of the analysis presented in this TM.



WEST YOST - N:\Clients\746 County of Yolo\30-21-02 North Davis Meadows\GIS\MXD\TM Fig 1_Improvements Confirmation.mxd - nsigrett - 4/5/2022

Existing City Potable Water Pipeline
Existing 6-inch NDM Pipeline
Existing 8-inch NDM Pipeline
Replaced 8-inch NDM Pipeline
Proposed 12-inch NDM Pipeline
Proposed 14-inch NDM Pipeline

Hydrants
Storage Tank
North Davis Meadows

N

0 650 1,300
Scale in Feet

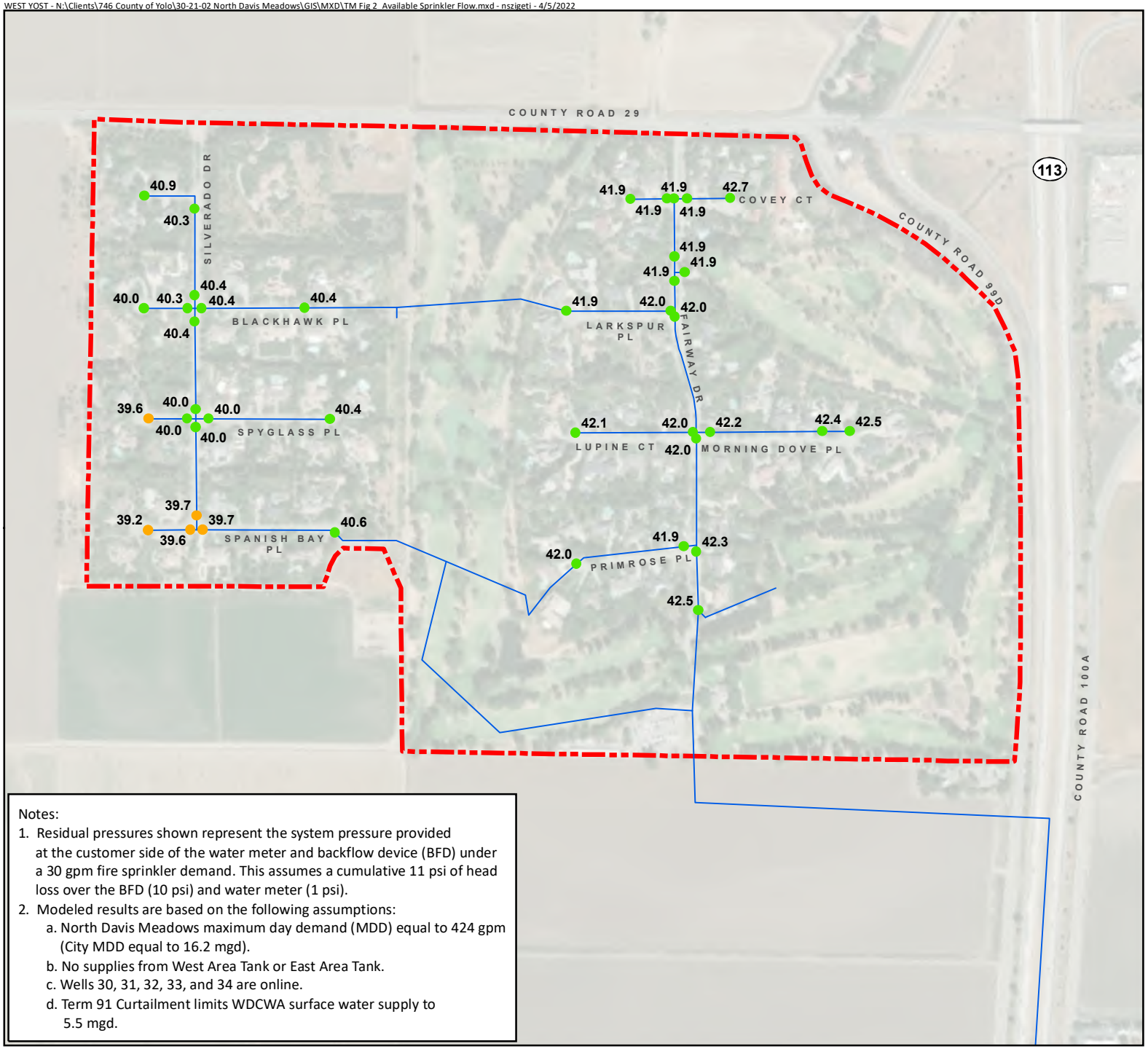
WEST YOST

Figure 1

2018 Recommended Pipeline Improvements

County of Yolo
North Davis Meadows

WEST YOST - N:\Clients\746 County of Yolo\30-21-02 North Davis Meadows\GIS\MXD\TM Fig 2 Available Sprinkler Flow.mxd - nszigeti - 4/5/2022



Notes:
1. Residual pressures shown represent the system pressure provided at the customer side of the water meter and backflow device (BFD) under a 30 gpm fire sprinkler demand. This assumes a cumulative 11 psi of head loss over the BFD (10 psi) and water meter (1 psi).
2. Modeled results are based on the following assumptions:
   a. North Davis Meadows maximum day demand (MDD) equal to 424 gpm (City MDD equal to 16.2 mgd).
   b. No supplies from West Area Tank or East Area Tank.
   c. Wells 30, 31, 32, 33, and 34 are online.
   d. Term 91 Curtailment limits WDCWA surface water supply to 5.5 mgd.

N

0 375 750

Scale in Feet

Pipeline

North Davis Meadows

Residual Pressure at 30 gpm

< 40 psi

≥ 40 psi

WEST YOST

Figure 2

Customer Pressures Under Flowing Sprinkler Conditions

County of Yolo
North Davis Meadows

Attachment A

North Davis Meadows Connection to City of Davis Potable Water System – Revised Recommendations Technical Memorandum (October 2018 TM)

WEST YOST ASSOCIATES
Consulting Engineers

TECHNICAL MEMORANDUM

DATE: October 18, 2018

Project No.: 746-14-16-01
SENT VIA: EMAIL

TO: Beth Gabor, Yolo County

CC: Stan Gryczko, City of Davis

FROM: Kambria Tiano, PE, RCE #84129
David Katz, EIT

REVIEWED BY: Jim Connell, PE, RCE #63052

SUBJECT: North Davis Meadows Connection to City of Davis Potable Water System – Revised Recommendations

The purpose of this technical memorandum (TM) is to update the sizing recommendations for potable water pipeline improvements previously recommended to serve North Davis Meadows (NDM). This TM is intended to supplement the assumptions, evaluations, and recommendations outlined in the "North Davis Meadows Connection to City of Davis Potable Water System" TM, dated May 15, 2018 (May 2018 TM), prepared by West Yost Associates (West Yost), and provided for reference as Attachment A.

The recommendations outlined in this TM are based on revised fire flow requirements provided by the City of Davis (City). The reduction in the fire flow requirements for NDM was approved by the City's Fire Marshal to address residents' concerns regarding the May 2018 recommendations under Scenario 1 (refer to Figure 4 in Attachment A). These concerns included: downsizing the proposed 16-inch diameter pipeline in Frontage Road; preserving 6-inch diameter pipelines in-place (instead of replacing with 8-inch diameter pipelines); and removing the 12-inch diameter pipeline proposed in the existing easement.

The results from West Yost's hydraulic evaluation are described in the following sections:

- Revised Assumptions, and
- Revised Recommended Improvements.

For discussion surrounding the project's background, model updates, potable water demand for NDM, and assumptions governing the current operating conditions, refer to Attachment A.

REVISED ASSUMPTIONS

Based on discussions with City staff on November 21, 2017, West Yost utilized current operating conditions previously set up in the model to evaluate the improvements required to supply the maximum day demand plus fire flow to NDM. The assumptions governing the City's current potable water system operations are provided under Scenario 1 in the May 2018 TM.

On September 26, 2018, the City's Fire Marshal provided the City with a reduction in the fire flow from 1,500 gpm to 1,000 gpm required to serve NDM.[1] The revised fire flow requirement updated Assumption 4 of Scenario 1 in the May 2018 TM, as presented below.

> 4. (Revised) Fire flow requirements require that 1,000 gpm must be supplied to NDM with a minimum residual pressure of 20 pounds per square inch (psi).

In addition to the assumptions concerning current operating conditions, West Yost applied the following design criteria to the NDM evaluation to ensure the model meets City of Davis water distribution system minimum standards.

1. Minimum pipe diameter for new water mains is four inches.[2]
2. Maximum velocity allowed is 10 feet per second (fps).[2]

The assumptions and design criteria listed above were used in the hydraulic evaluation to assess the minimum improvements required to supply sufficient fire flows to NDM.

REVISED RECOMMENDED IMPROVEMENTS

To evaluate the infrastructure needed to serve NDM's domestic and irrigation needs, in addition to fire flow, West Yost used the City's existing potable water system hydraulic model previously modified for the May 2018 NDM evaluation. The following conditions were run under current operations (Scenario 1, as outlined in the May 2018 TM). As described above, fire flow requirements were reduced from 1,500 gpm to 1,000 gpm for NDM. Two conditions were evaluated:

- Condition 1 – Fire Flow and Maximum Velocity Requirements
- Condition 2 – Fire Flow Requirements Only

Improvements recommended to serve each condition are described in the following sections.

Condition 1 – Fire Flow and Maximum Velocity Requirements

Condition 1 was developed to supply the maximum day demand plus revised fire flow to NDM under the City's current potable water system operations, assuming both fire flow and maximum

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[1] The revised fire flow requirement for NDM was taken from the 2016 California Fire Code, Appendix B, Tables B105.1(1) and B105.1(2), as referenced by the letter from the City Fire Marshal, dated September 26, 2018.
[2] From Table 4-3, Water Distribution System Optimization Plan, May 2011, Brown and Caldwell and Kennedy/Jenks Consultants.

velocity requirements would be met. This condition ensures that: (1) a minimum residual pressure of 20 psi is available during a fire flow event of 1,000 gpm; and (2) maximum velocities do not exceed 10 fps in NDM pipelines.

The Condition 1 pipeline improvements required to maintain a 20-psi residual pressure and meet velocity requirements are displayed on Figure 1 and listed in Table 1, below.

Table 1. Pipeline Improvements (Condition 1)

Description	Approximate Length, LF
Replace 6-inch diameter pipeline with 8-inch diameter pipeline	1,370
Install 12-inch diameter pipeline	2,150
Install 14-inch diameter pipeline	6,890

Condition 2 – Fire Flow Requirements Only

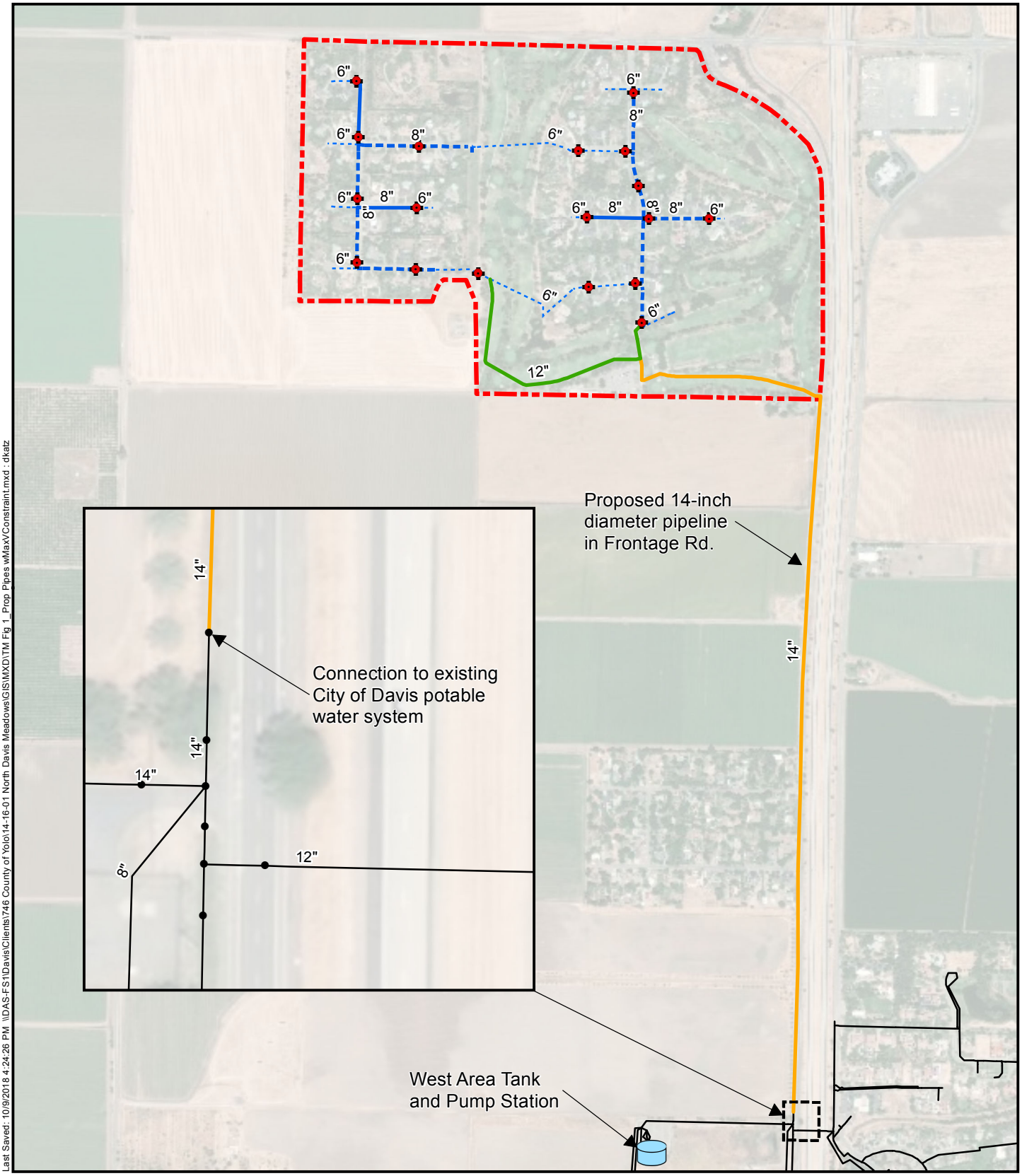
Condition 2 was developed to supply the maximum day demand plus revised fire flow to NDM under the City's current potable water system operations, assuming only fire flow requirements would be met. This condition allows maximum velocities in NDM pipelines to exceed 10 fps and is proposed as an alternative solution to Condition 1 only if the City consents to the high velocities (up to 11.5 fps modeled in Lupine Court). Condition 2 reduces the proposed improvements by removing the pipeline replacement proposed in Lupine Court under Condition 1.

The Condition 2 pipeline improvements required to maintain a 20-psi residual pressure are displayed on Figure 2 and listed in Table 2, below.

Table 2. Pipeline Improvements (Condition 2)

Description	Approximate Length, LF
Replace 6-inch diameter pipeline with 8-inch diameter pipeline	950
Install 12-inch diameter pipeline	2,150
Install 14-inch diameter pipeline	6,890

Because of the risk of damage to the water distribution system at high water velocity, the City has determined that Condition 2 would not be acceptable.



Last Saved: 10/9/2018 4:24:26 PM \\DAS-FS1\Davis\Clients\746 County of Yolo\14-16-01 North Davis Meadows\GIS\MXD\TM Fig 1_Prop Pipes wMaxVConstraint.mxd : dkatz

Symbology

- Existing City Potable Water Pipeline
- Existing 6-inch NDM Pipeline
- Existing 8-inch NDM Pipeline
- Replaced 8-inch NDM Pipeline
- Proposed 12-inch NDM Pipeline
- Proposed 14-inch NDM Pipeline
- Hydrants
- Storage Tank
- North Davis Meadows

N

0 650 1,300

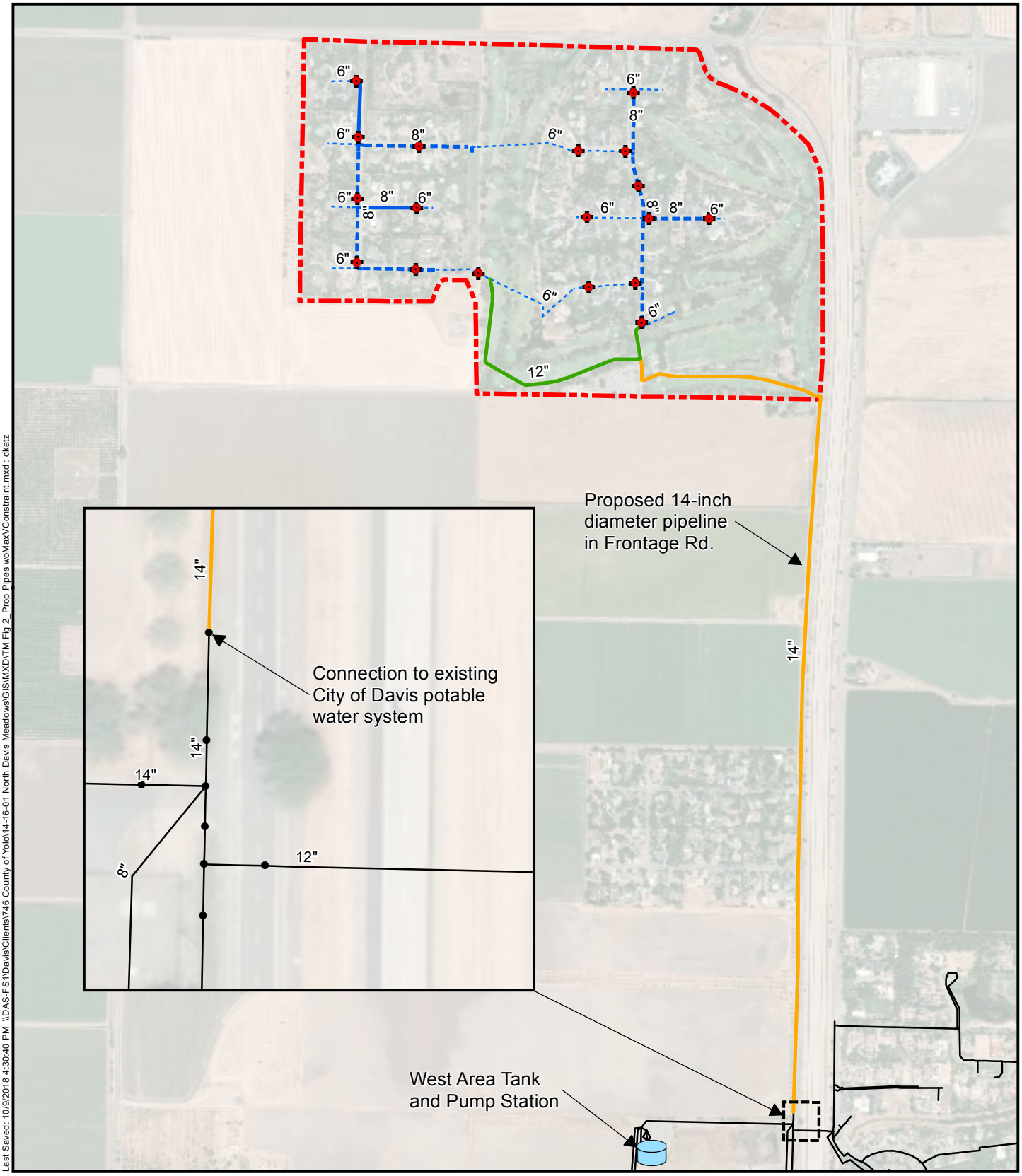
Scale in Feet

WEST YOST ASSOCIATES

Figure 1

Recommended Pipelines Reduced Fire Flows and Maximum Velocity Constraint

County of Yolo
North Davis Meadows
Proposed Potable Water Pipelines



Last Saved: 10/9/2018 4:30:40 PM \\DAS-FS1\Davis\Clients\746 County of Yolo\14-16-01 North Davis Meadows\GIS\MXD\TM Fig 2_Prop Pipes woMaxVConstraint.mxd : dkatz

Symbology

- Existing City Potable Water Pipeline
- Existing 6-inch NDM Pipeline
- Existing 8-inch NDM Pipeline
- Replaced 8-inch NDM Pipeline
- Proposed 12-inch NDM Pipeline
- Proposed 14-inch NDM Pipeline
- Hydrants
- Storage Tank
- North Davis Meadows

N

0 650 1,300

Scale in Feet

WEST YOST ASSOCIATES

Figure 2

Recommended Pipelines Reduced Fire Flows and No Maximum Velocity Constraint

County of Yolo
North Davis Meadows
Proposed Potable Water Pipelines

ATTACHMENT A

North Davis Meadows Connection to City of Davis
Potable Water System Technical Memorandum

WEST YOST ASSOCIATES
Consulting Engineers

REGISTERED PROFESSIONAL ENGINEER
JAMES P. CONNELL
No. 63052
Exp. 6-30-18
CIVIL
STATE OF CALIFORNIA

TECHNICAL MEMORANDUM

DATE: May 15, 2018

Project No.: 746-14-16-01
SENT VIA: EMAIL

TO: Beth Gabor, Yolo County

CC: Stan Gryczko, City of Davis

FROM: Kambria Tiano, PE, RCE #84129

REVIEWED BY: Jim Connell, PE, RCE #63052

SUBJECT: North Davis Meadows Connection to City of Davis Potable Water System

The purpose of this technical memorandum (TM) is to describe the results of an evaluation to size potable water pipelines to serve North Davis Meadows (NDM) from the City of Davis (City) water system. The NDM community is located north of the existing City potable water distribution system, along Highway 113, as shown in Figure 1. NDM is part of the NDM County Service Area (CSA). The CSA currently provides water service to a population of approximately 250 people through 95 residential service connections. The CSA also provides sewer and landscaping services. The NDM groundwater wells (NDM1 and NDM2) have reported nitrate levels in excess of the Maximum Contaminant Level (MCL). In 2009, the Yolo County Health Department, Environmental Health Division issued Compliance Order No: 12-09 (Compliance Order for Noncompliance with Nitrate Drinking Water Standards). Compliance Order 12-09 requires the water system to, among other requirements, submit a Source Capacity Planning Study to correct the water source capacity and water quality problem. The Study was to include the options of:

- Drilling a new well,
- Rehabilitating existing well(s),
- Installing treatment to existing water sources, and
- Connecting to other community water systems.

In 2013, the City requested West Yost Associates (West Yost) to study the feasibility and cost to connect NDM to the City's water distribution system to address item 4, listed above. The study was based on serving strictly domestic (i.e. indoor) water demands from the City's potable water system, with an alternative arrangement to serve both domestic demands and fire flows, and assumed that irrigation needs would be met by the existing water system. Figure 2 shows the alternative pipeline improvements needed to serve the domestic water and fire flow needs of the community.

Yolo County (County) and the City have now determined that domestic, irrigation, and fire flow service would be provided by the City's potable water system, and requested West Yost to update the pipeline sizing evaluation. The results from West Yost's hydraulic evaluation are described in the following sections:

- Model Updates,
- Estimated Potable Water Demand,
- Recommended Improvements, and
- Summary.

MODEL UPDATES

The model was provided to West Yost as representative of existing conditions with current demands, pipeline diameters, and alignments. The model had been used to evaluate planning-level alternate scenarios for the Davis-Woodland Water Supply Project, and it was unclear which alternative represented the as-built system. West Yost requested clarification from Brown and Caldwell prior to re-evaluating the pipeline improvements required to connect NDM to the City's water system. West Yost updated pipeline diameters and alignments to match markups provided by Brown and Caldwell. Updates made to the model included: changes to the diameters of pipelines installed for the surface water project; realignment of the pipeline serving UC Davis; an adjustment to the modeling of the UC Davis potable water system; and, adding or realigning NDM pipelines to match as-built and proposed alignments.

It was assumed that all other pipeline diameters and alignments were representative of existing conditions. West Yost recommends the City review the model to confirm the accuracy of the conditions represented before conducting any additional potable water analyses within the City.

ESTIMATED POTABLE WATER DEMAND

Historical NDM monthly water use data (years 2002 to 2016) were provided to West Yost by the City on August 14, 2017. The water use data represent the total water demand for NDM, including domestic use, landscaping, and unaccounted-for water. Historical monthly water use over the period of record are presented in Table 1.

Table 1. Historical Water Use for North Davis Meadows

Month	Historical Monthly Water Use, MG			
	Minimum	Average	Maximum	Revised Maximum[(a)]
January	0.9	1.6	3.2	3.2
February	1.1	1.6	2.5	2.5
March	1.0	3.5	8.3	5.5
April	2.5	5.6	8.7	8.7
May	7.5	10.1	13.2	13.2
June	8.5	12.9	19.6	14.8
July	9.5	15.7	30.5	15.8
August	9.4	14.1	25.8	15.4
September	8.4	10.8	15.2	12.7
October	5.3	7.5	9.4	9.4
November	1.9	2.8	5.1	5.1
December	1.1	1.7	2.6	2.6
Annual Total	67.0	87.9	128.3	103.8

(a) The revised maximum historical monthly water use excludes monthly water use outliers.
Outliers to the data were defined as individual records (monthly water use or annual consumption) where the value exceeded 2.5 times the standard deviation of other records (for either the same month or the annual total). The following water use values were classified as outliers and removed from the data: March 2003, July 2013, and all monthly consumption during 2016.

West Yost selected the maximum monthly water use, excluding outliers, to estimate the average day demand of the month with maximum consumption. The maximum monthly demand occurred in July 2005, with a total monthly water use of 15.8 million gallons (MG). An industry standard maximum day peaking factor of 1.2 times the average day demand of the maximum month was applied to estimate a NDM maximum day demand of 424 gallons per minute (gpm).

The 2013 evaluation assumed only indoor domestic water demands would be served by the potable water connection between NDM and the City, with outdoor irrigation demands to be served by the existing groundwater system. Maximum day demand remained constant throughout the year at 67 gpm. The pipeline improvements proposed to serve NDM under fire flow conditions, as shown in Figure 2, were based upon this lower maximum day demand. With the increased demands incurred by providing potable water service to supply irrigation at NDM, the pipeline improvements proposed in 2013 would not provide adequate fire flow. Figure 3 shows the extent of the fire flow deficiencies in NDM under revised demand conditions if the pipeline improvements recommended in 2013 had been implemented.

RECOMMENDED IMPROVEMENTS

To evaluate the infrastructure needed to serve NDM's domestic and irrigation needs, in addition to fire flow, West Yost modified the City's existing potable water system hydraulic model to include the NDM connection to the City. Two scenarios were evaluated:

- Scenario 1 – Current Operating Conditions
- Scenario 2 – Modified Operating Conditions

The assumptions governing each scenario are described in the following sections.

Scenario 1 – Current Operating Conditions

Scenario 1 was developed to supply the maximum day demand plus fire flow to NDM under the City's current potable water system operations. Current operating conditions were assumed based on: (1) the existing conditions provided in the model; and (2) feedback from the City. Assumptions governing Scenario 1 are listed below.

1. Surface water supply is fixed at 10.2 million gallons per day (MGD).
2. Demands are set to the 2030 maximum day demands, as provided in the model.
3. Davis Deep Wells were energized to balance the maximum day demand. Though well 30 is not intended to be online in all instances under existing operations, all deep wells except 28 and 29 were needed to supply the 2030 maximum day demand conditions.
4. Fire flow requirements outline that 1,500 gpm must be supplied to NDM with a minimum residual pressure of 20 pounds per square inch (psi).
5. Fire flow is initially provided by the elevated tank. Once the water level in the tank declines or local pressures in the system fall below a set point, the East Area Tank pumps and the West Area Tank pumps turn on to supplement the elevated tank.

Scenario 1 assumes the most conservative condition, when the elevated tank drives pressures in the system. Due to the increased demands required by NDM and the lower pressures associated with the West Area Tank pumps being off, the head losses in the pipeline connecting NDM to the City become large and pressures in NDM are low.

The Scenario 1 pipeline improvements required to maintain a 20-psi residual pressure are displayed in Figure 4 and outlined in Table 2, below.

Table 2. Pipeline Improvements (Scenario 1)	
Description	Approximate Length, LF
Replace 6-inch diameter pipeline with 8-inch diameter pipeline	2,180
Install 12-inch diameter pipeline	1,550
Install 14-inch diameter pipeline	1,870
Install 16-inch diameter pipeline	6,890

West Yost also evaluated the approximate additional water age under low monthly demand periods under Scenario 1. The water age evaluation assumes low average January demands of 1.6 MG, as shown in Table 1. Under low demand conditions, the average water age through the 16-inch diameter pipe from the point of connection to the existing City potable water distribution system to the south side of NDM would be approximately 1 ½ days. The water age would extend to approximately 2 days if the volume of the entire new NDM distribution system pipelines were used. These results may differ slightly if the hydraulic model were used to estimate the water age, as the demand would be distributed to individual services.

Scenario 2 – Modified Operating Conditions

Scenario 2 was developed to minimize pipeline improvements while supplying the maximum day demand plus fire flow to NDM. To optimize the pipeline improvements, West Yost assumed City water system operations would be modified from the current operations. Operating conditions assumed in Scenario 2 include manual pumping operations, in addition to assumptions 1-4 listed under Scenario 1. Assumptions governing Scenario 2 are listed below.

1. Surface water supply is fixed at 10.2 MGD.
2. Demands are set to the 2030 maximum day demands, as provided in the model.
3. Davis Deep Wells were energized to balance the maximum day demand. Though well 30 is not intended to be online in all instances under existing operations, all deep wells except 28 and 29 were needed to supply the 2030 maximum day demand conditions.
4. Fire flow requirements outline that 1,500 gpm must be supplied to NDM with a minimum residual pressure of 20 psi.
5. Fire flow is provided primarily by the West Area Tank and pumps. First responders must confirm that at least two of the West Area Tank pumps are energized during the fire flow condition.

Scenario 2 requires manual operation or confirmation of the West Area Tank pumps. Due to the increase in supply and pressure provided by the West Area Tank pumps, the elevated tank would fill and spill unless shut off, and there would be some backpressure at the surface water supply and wells once the elevated tank is full and closed, which may cause wells to shut off. The backpressure causes the surface water supply (modeled as a constant head reservoir and a flow control valve) to drop to 7,005 gpm (from 10.2 MGD or 7,083 gpm) during the fire event.

Manual operation of the West Area Tank pumps allows for smaller diameter pipes than in Scenario 1, but requires coordination to ensure the pumps are turned on and do not automatically shut off when the elevated tank is full. If the West Area Tank pumps turn off when the elevated tank is full, there would be insufficient available fire flow at the farthest NDM hydrants.

The Scenario 2 pipeline improvements required to maintain a 20-psi residual pressure are displayed in Figure 5 and outlined in Table 3, below.

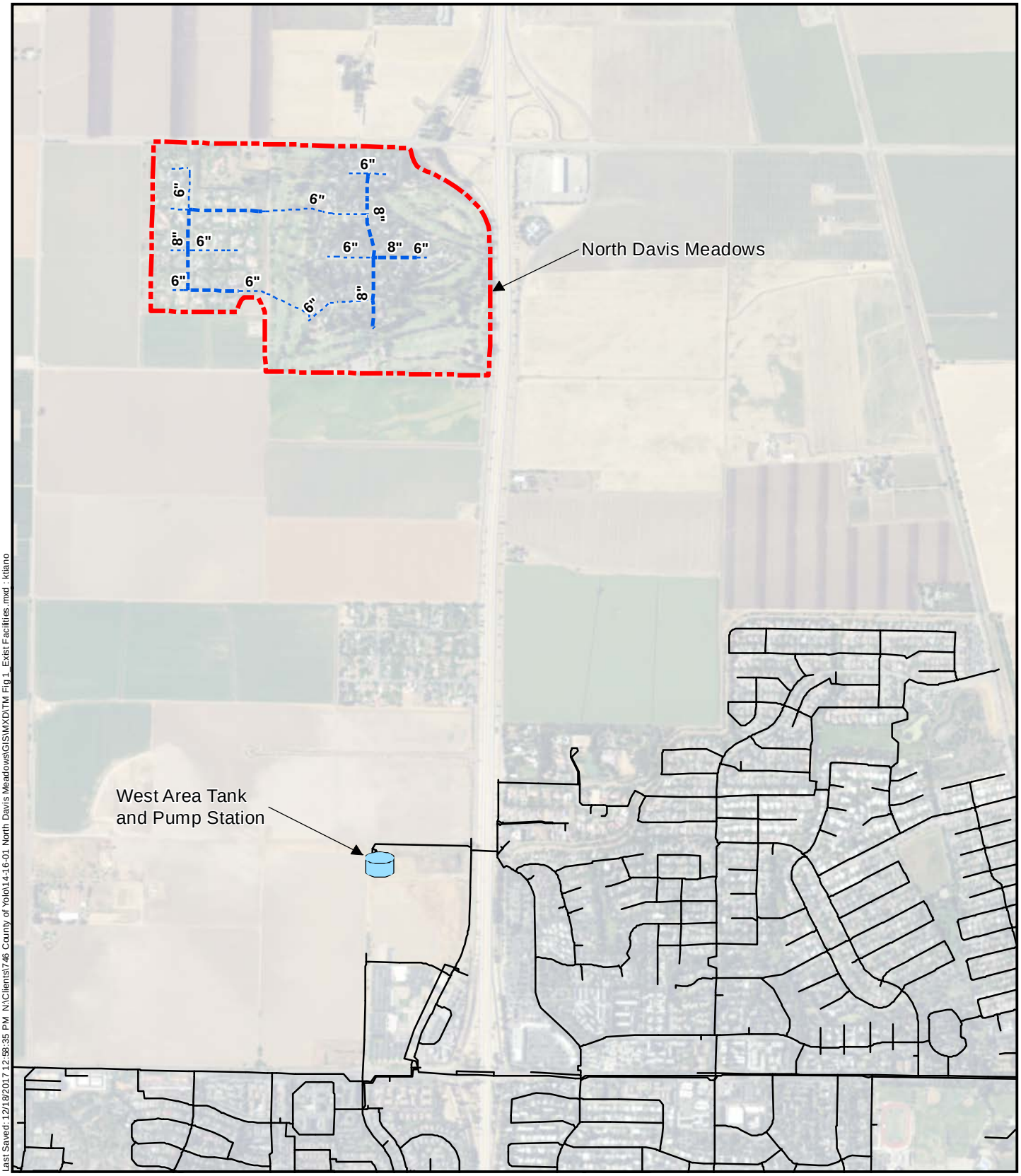
Table 3. Pipeline Improvements (Scenario 2)

Description	Approximate Length, LF
Replace 6-inch diameter pipeline with 8-inch diameter pipeline	2,180
Install 12-inch diameter pipeline	2,440
Install 14-inch diameter pipeline	6,890

SUMMARY

West Yost met with City staff on November 21, 2017, to discuss initial model results. City staff indicated that the manual operation requirements and required control system changes of Scenario 2 would probably eliminate any cost saving of constructing smaller pipelines. Therefore, the City has selected to proceed with Scenario 1. Though Scenario 1 requires larger diameter pipelines and the construction of an additional 12-inch pipeline, the selected scenario will meet fire flow requirements under any of the City's current operations. Under Scenario 1, water age in the proposed NDM water system under average January demands of 1.6 MG per month is estimated to be up to an additional 2 days to individual water services after entry to the NDM infrastructure at the 16-inch pipeline. Scenario 2 risks insufficient available fire flow if the manual operations are overlooked.

Under either scenario, a remote pressure sensing station will be constructed by the City in the NDM water system, probably at the site of the NDM2 well. Pressure signal will be conveyed back to the West Area Tank via radio.



Last Saved: 12/18/2017 12:58:35 PM N:\Clients\746 County of Yolo\14-16-01 North Davis Meadows\GIS\MXD\TM Fig 1_Exist Facilities.mxd - ktiano

Symbology

- Storage Tank
- Existing City Potable Water Pipeline
- Existing 6-inch NDM Pipeline
- Existing 8-inch NDM Pipeline
- North Davis Meadows

N

0 1,000 2,000

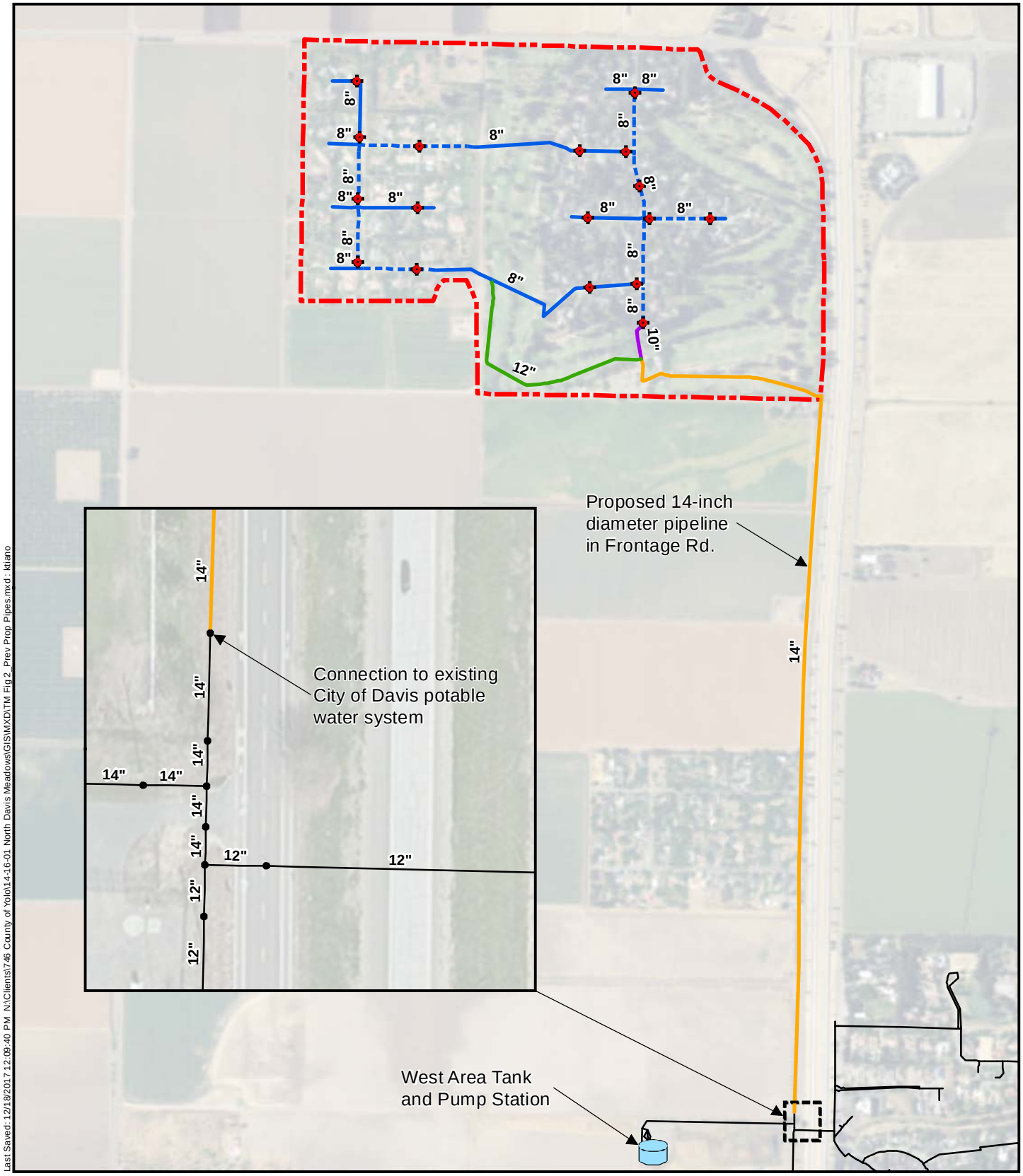
Scale in Feet

WEST YOST ASSOCIATES

Figure 1

North Davis Meadows Location and Existing Facilities

County of Yolo
North Davis Meadows
Proposed Potable Water Pipelines



Last Saved: 12/18/2017 12:09:40 PM N:\Clients\746 County of Yolo\14-16-01 North Davis Meadows\GIS\MXD\TM Fig 2_Prev Prop Pipes.mxd - kliano

Symbology

- Existing City Potable Water Pipeline
- Existing 8-inch NDM Pipeline
- Replaced 8-inch NDM Pipeline
- Proposed 10-inch NDM Pipeline
- Proposed 12-inch NDM Pipeline
- Proposed 14-inch NDM Pipeline
- Hydrants
- Storage Tank
- North Davis Meadows

N

0 650 1,300

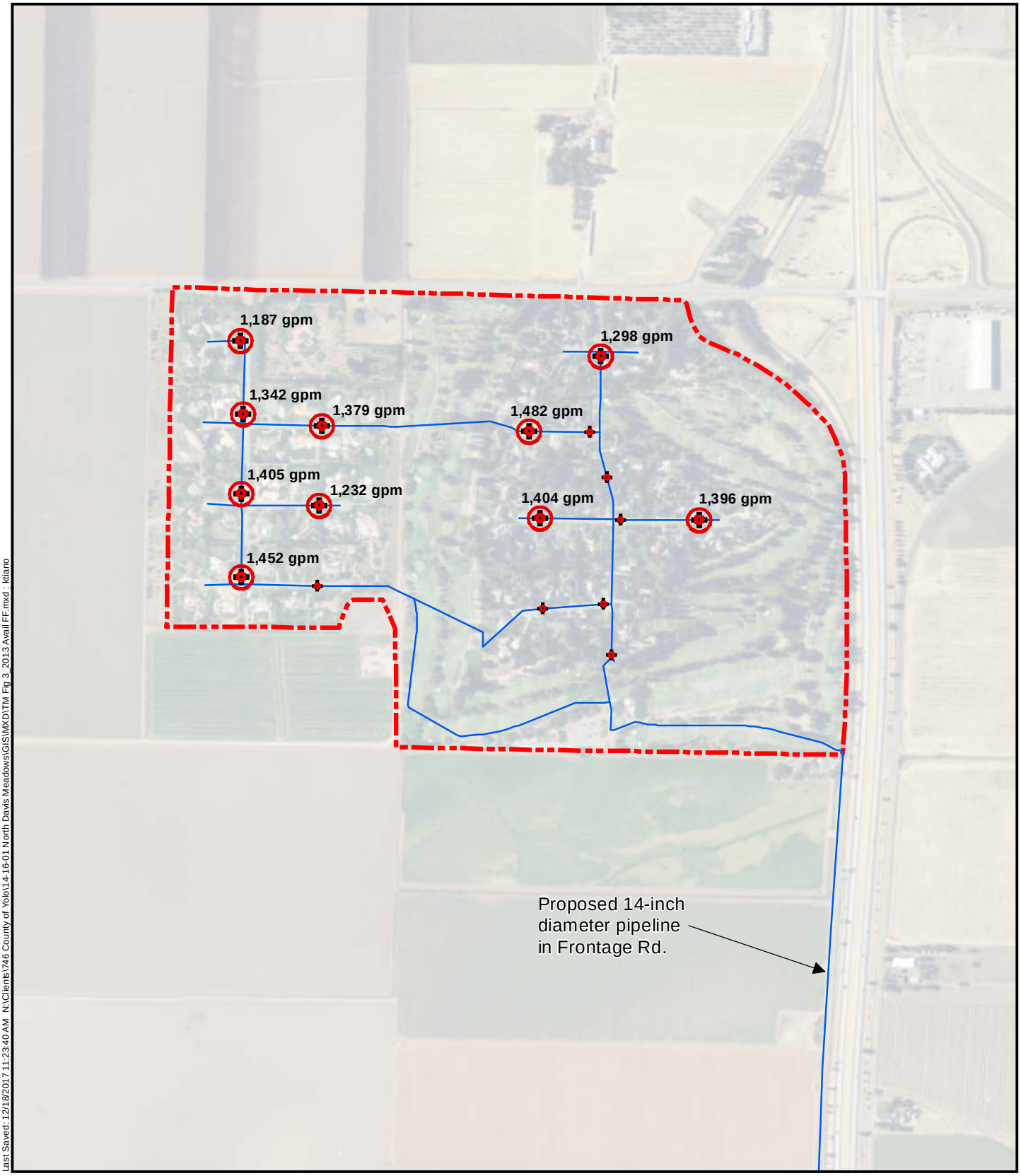
Scale in Feet

WEST YOST ASSOCIATES

Figure 2

2013 Recommended Infrastructure Improvements

County of Yolo
North Davis Meadows
Proposed Potable Water Pipelines



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Symbology

- North Davis Meadows Pipelines
- Existing City Potable Water Pipeline
- Insufficient Fire Flow
- Meets Fire Flow Requirements
- North Davis Meadows

N

0 500 1,000

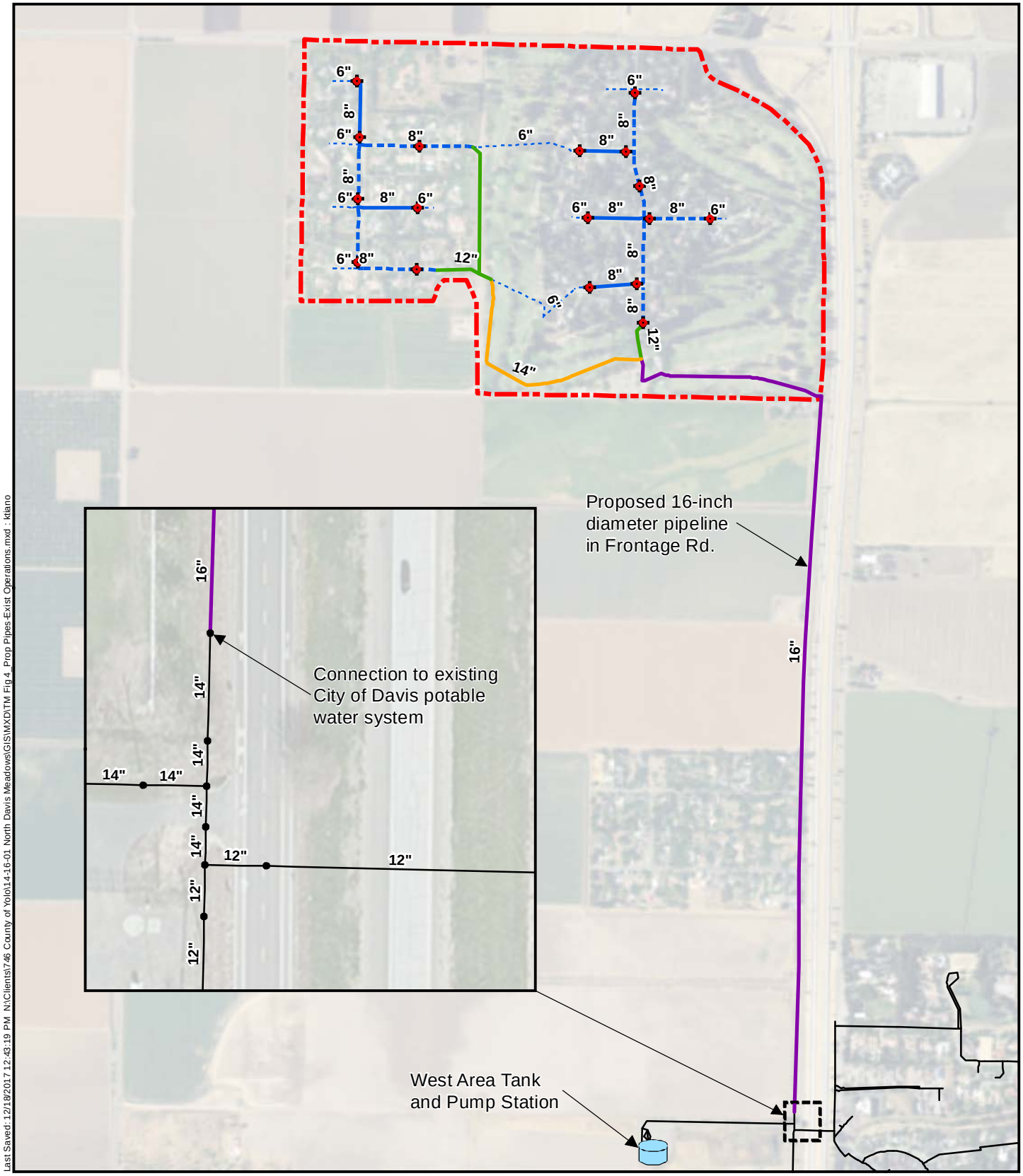
Scale in Feet

WEST YOST ASSOCIATES

Figure 3

Fire Flow Availability
2013 Recommended Facilities

County of Yolo
North Davis Meadows
Proposed Potable Water Pipelines



Last Saved: 12/18/2017 12:43:19 PM N:\Clients\746 County of Yolo\14-16-01 North Davis Meadows\GIS\MXD\TM Fig 4_Prop Pipes-Exist Operations.mxd - ktiano

Symbology

- Existing City Potable Water Pipeline
- Existing 6-inch NDM Pipeline
- Existing 8-inch NDM Pipeline
- Replaced 8-inch NDM Pipeline
- Proposed 12-inch NDM Pipeline
- Proposed 14-inch NDM Pipeline
- Proposed 16-inch NDM Pipeline
- Hydrants
- Storage Tank
- North Davis Meadows

N

0 650 1,300

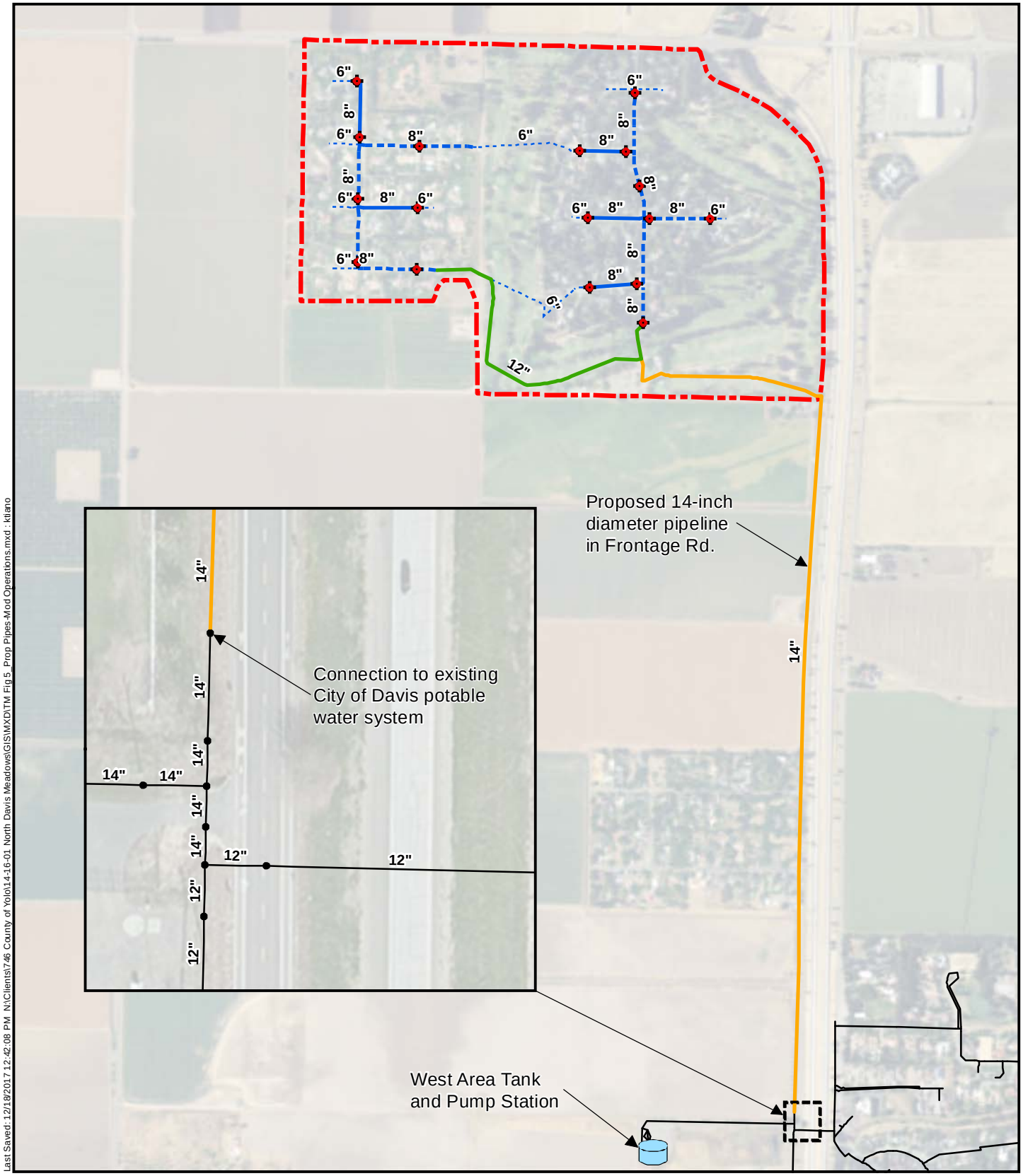
Scale in Feet

WEST YOST ASSOCIATES

Figure 4

Scenario 1 Recommended Pipelines Existing System Operations

County of Yolo
North Davis Meadows
Proposed Potable Water Pipelines



Last Saved: 12/18/2017 12:42:08 PM N:\Clients\746 County of Yolo\14-16-01 North Davis Meadows\GIS\MXD\TM Fig 5_Prop Pipes-Mod Operations.mxd : ktiano

Symbology

- Existing City Potable Water Pipeline
- Existing 6-inch NDM Pipeline
- Existing 8-inch NDM Pipeline
- Replaced 8-inch NDM Pipeline
- Proposed 12-inch NDM Pipeline
- Proposed 14-inch NDM Pipeline
- Hydrants
- Storage Tank
- North Davis Meadows

N

0 650 1,300

Scale in Feet

WEST YOST ASSOCIATES

Figure 5

Scenario 2 Recommended Pipelines Modified System Operations

County of Yolo
North Davis Meadows
Proposed Potable Water Pipelines