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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.

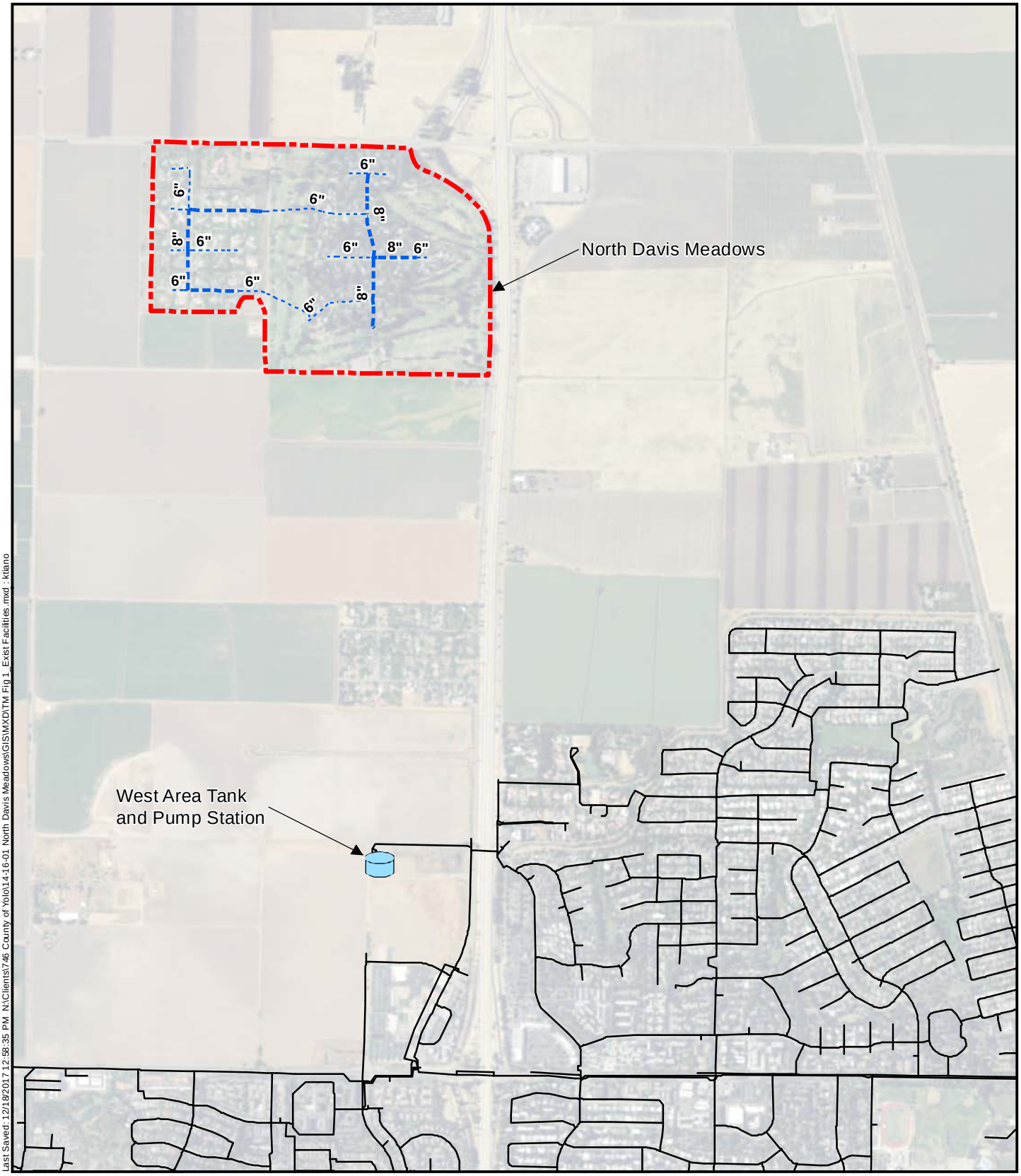
Table 3. Pipeline Improvements (Scenario 2)

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

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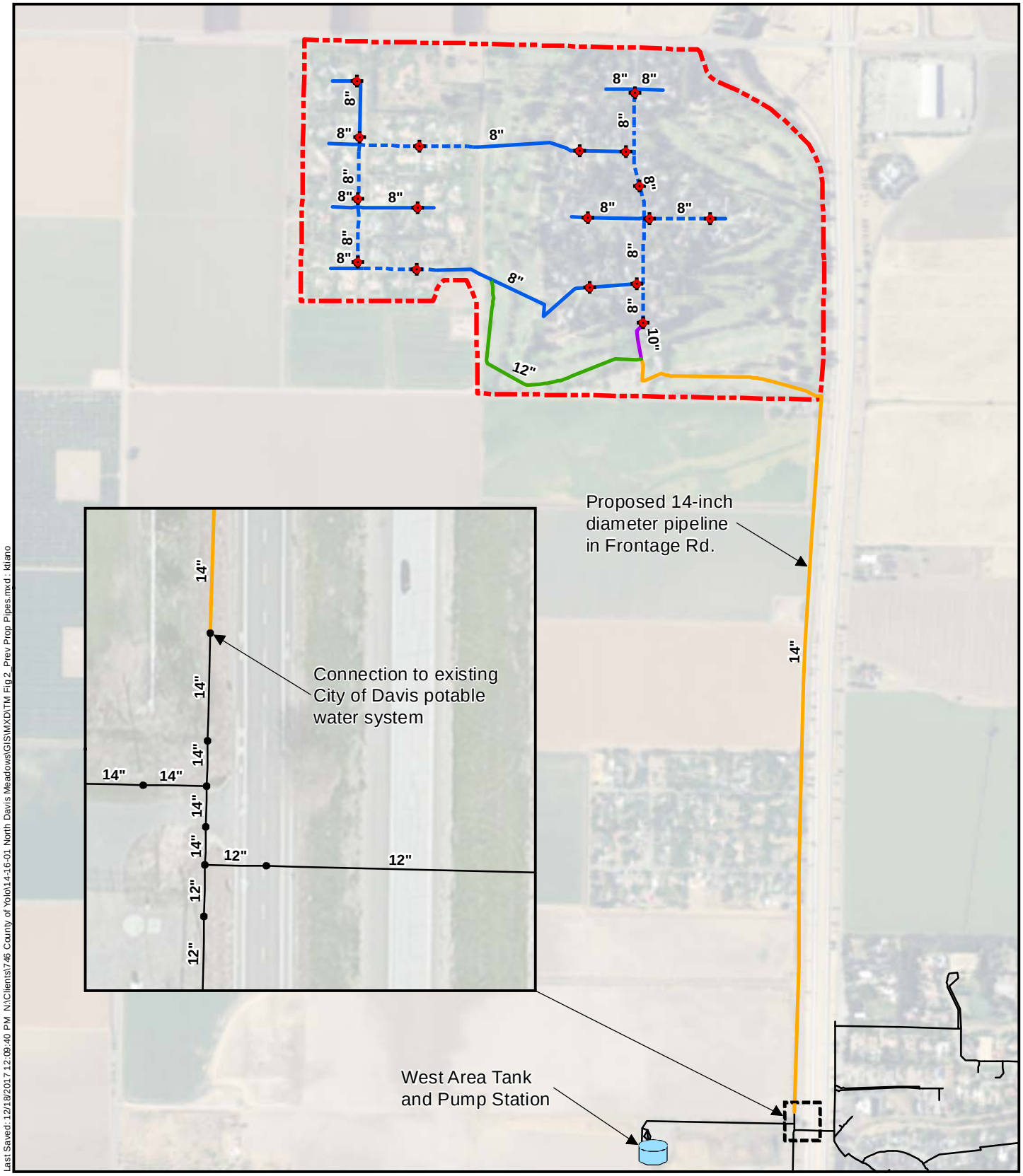
Figure 1

North Davis Meadows Location and Existing Facilities

County of Yolo
North Davis Meadows
Proposed Potable Water Pipelines



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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

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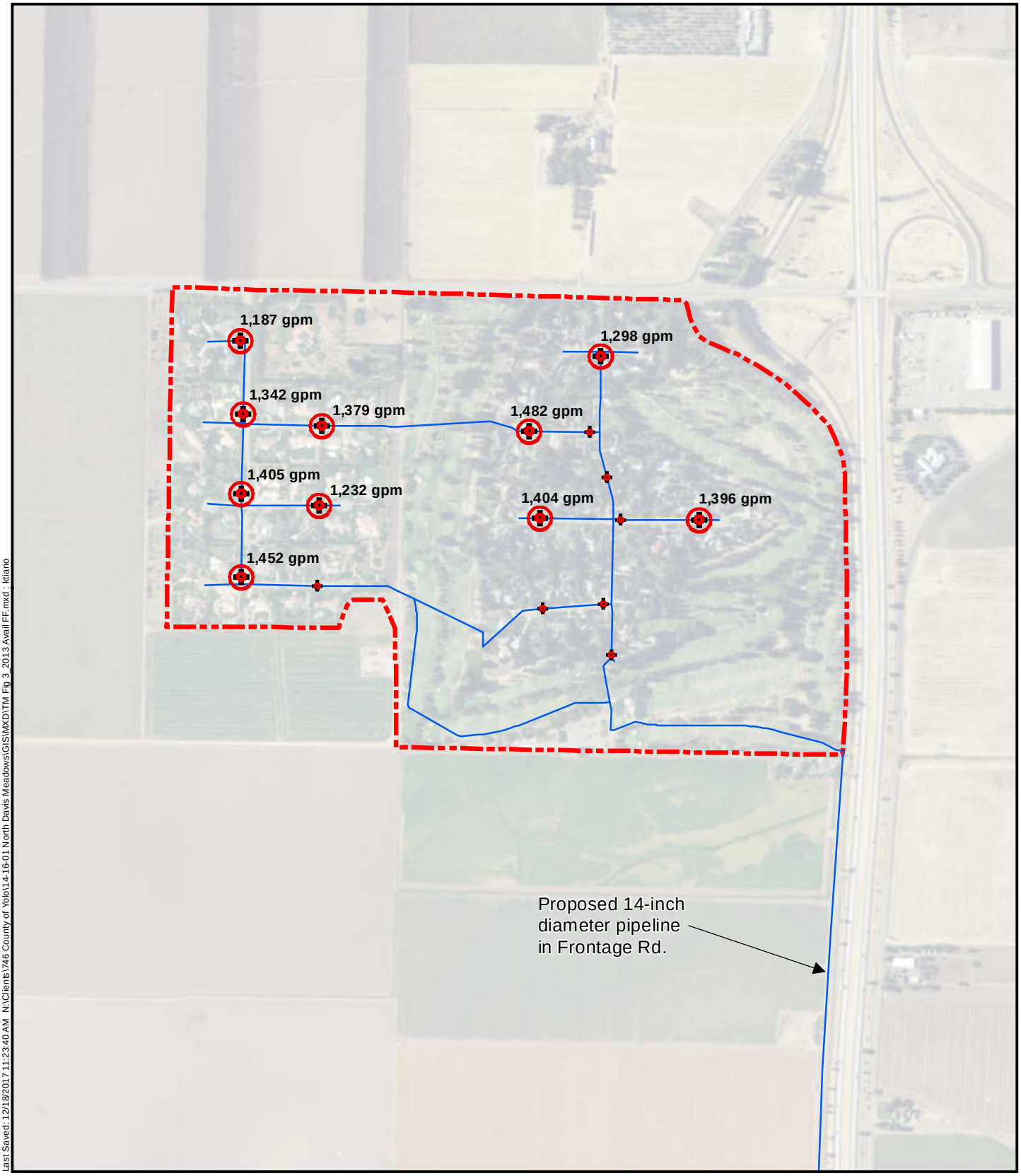
Figure 2

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

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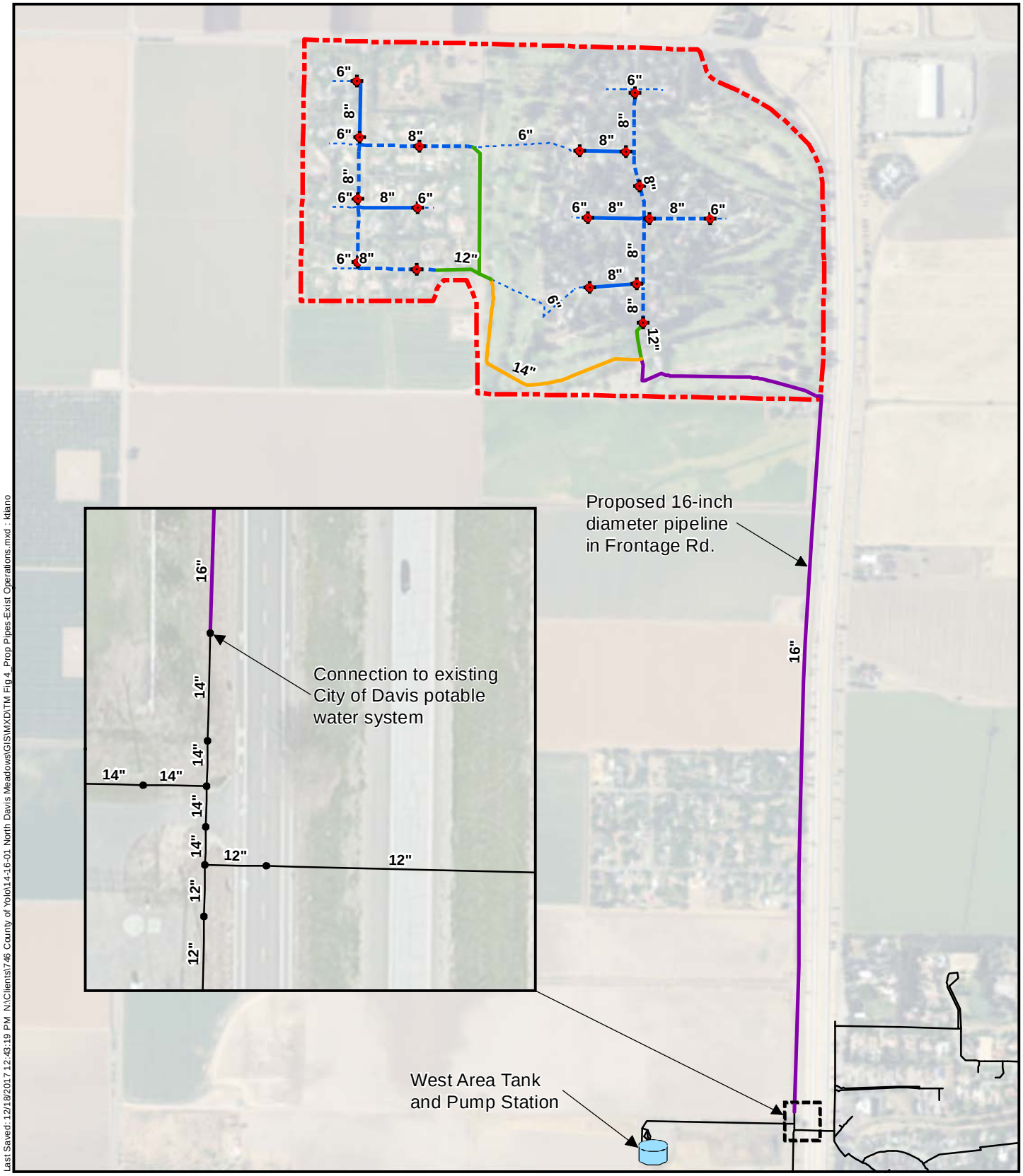
Figure 3

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

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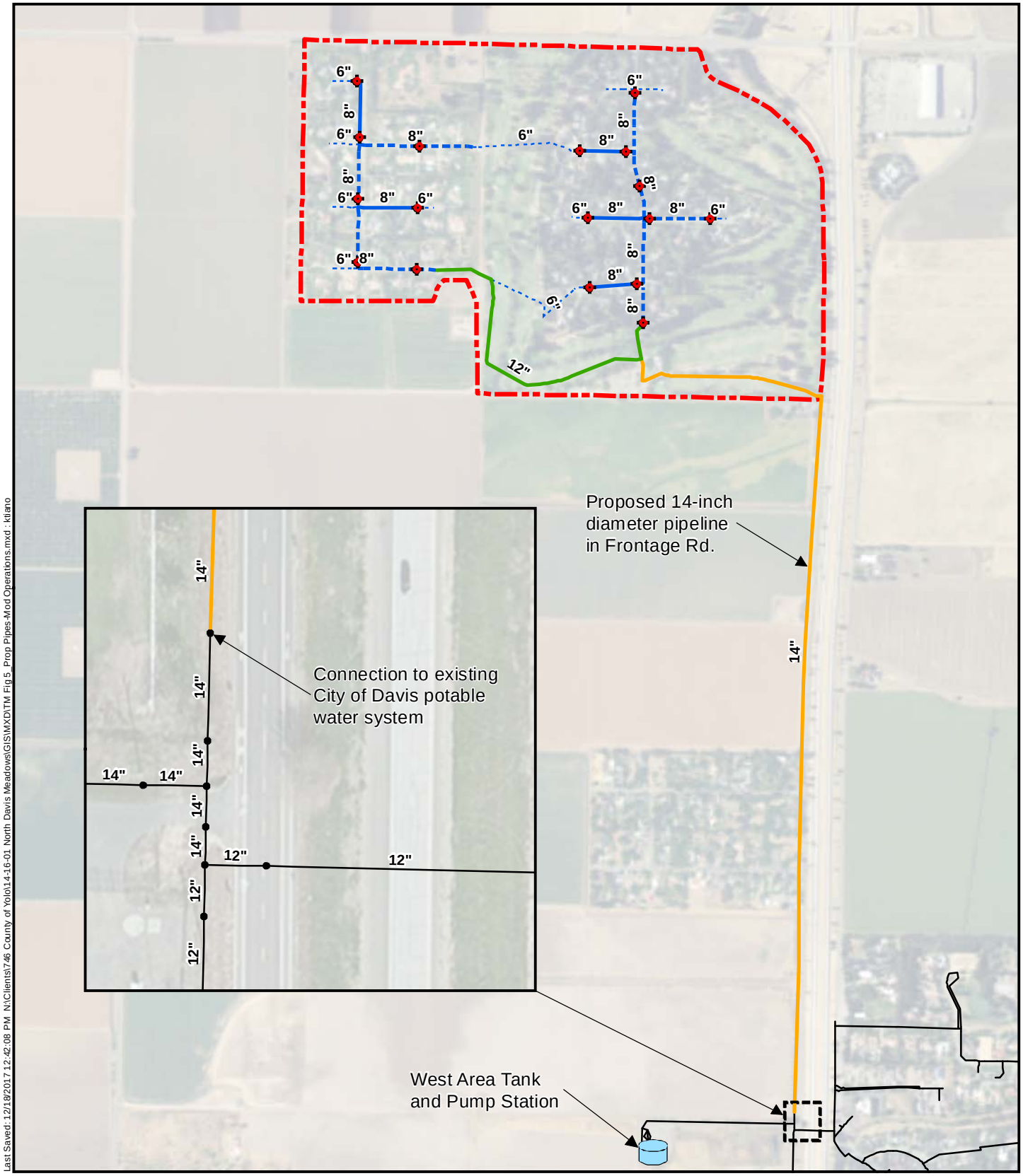
Figure 4

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

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Figure 5

Scenario 2 Recommended Pipelines Modified System Operations

County of Yolo
North Davis Meadows
Proposed Potable Water Pipelines