ENGINEERING REPORT
Thoreau Baca Well Connection

The Navajo Nation

August 2020

SMA
Souder, Miller & Associates
Engineering ♦ Environmental ♦ Surveying
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Project Background and Overview

Thoreau Baca Well Connection
Project Background and Overview

The Baca Thoreau Community Water System (CWS) consists of the water systems serving the adjacent Chapters of Thoreau and Baca/Prewitt (see Figure 1). The water system was constructed in the 1990's, and currently does not have adequate water supply from the two active wells within the Thoreau Chapter to supply the current demand of the combined Thoreau and Baca/Prewitt service areas.

The Baca Thoreau CWS serves approximately 470 homes (according to NTUA GIS Data 2014). It also serves two chapter houses, two head starts, a school, two senior centers and other commercial properties, for a total of 44 additional Equivalent Dwelling Units (EDUs). The total estimated daily water demand for existing connections is 102,820 gpd. Population growth was projected using a 20-year horizon and a 1.3% annual growth rate. Based on this population growth projection, estimated future water demand is calculated to be 133,100 gpd.

The Baca Thoreau CWS currently relies on two wells with a total production capacity of 105 gpm (75,600 gpd if pumped 12 hrs/ day). Thus, the water system's current water demand exceeds the capacity of the wells when operating at the recommended standard of 12 hrs/ day. It has been reported that the wells currently run 17 to 19 hours per day.

A previous phase of the Thoreau Baca Well project drilled a pilot well and constructed a final production well.

The Thoreau Baca Well Connection project is a follow-on project that will include installing the well pump, constructing the well pumphouse, finishing the well site (grading, surfacing & fencing), tying-in the waterline, and constructing the powerline (see Figure 2).

The project will include a two-room wellhouse with a gas chlorination system. The project will also include a powerline extension to the wellhouse, an access drive to the wellhouse, and a waterline extension (approx. 2,400 LF) to an existing NTUA distribution system pipeline (see Figure 2).

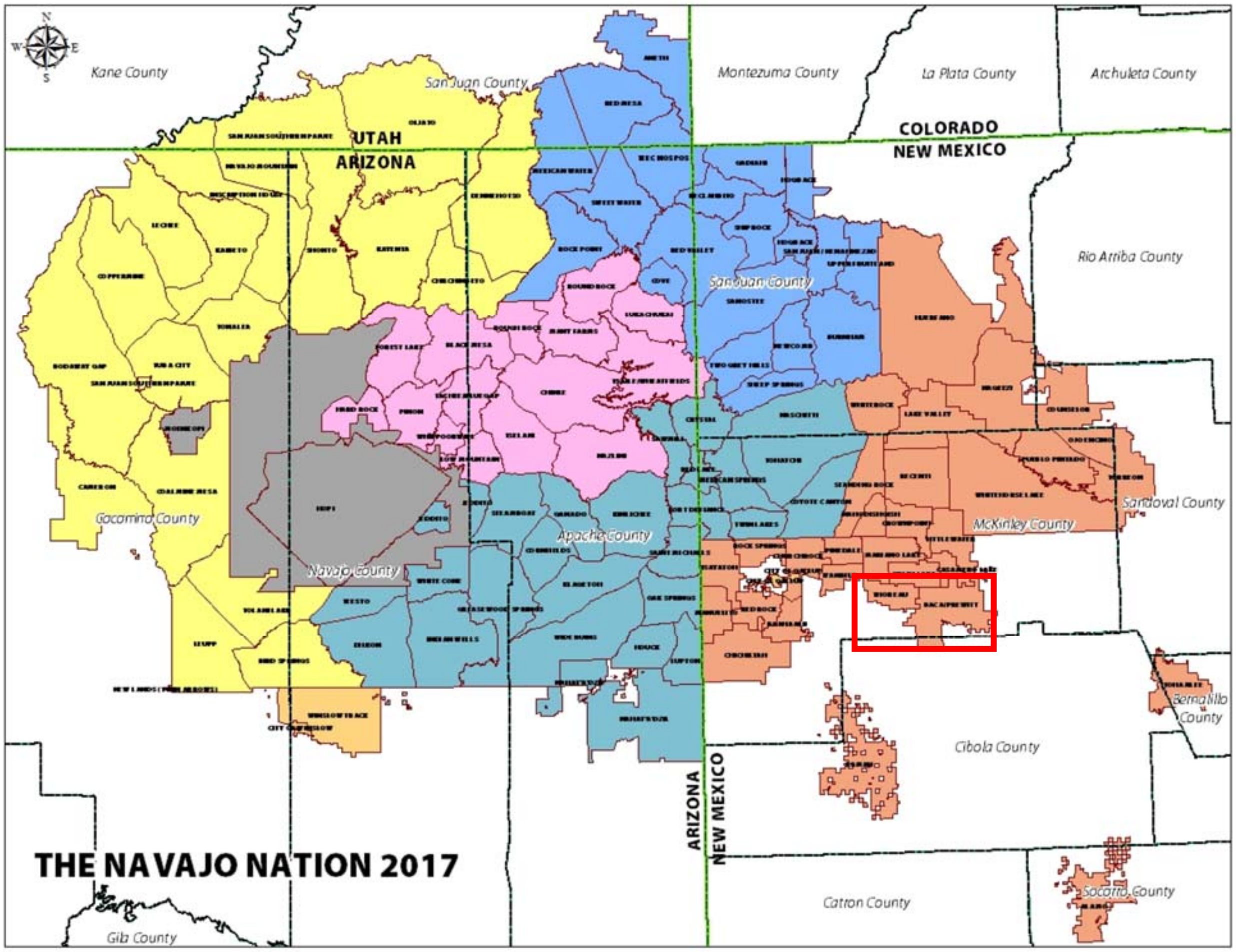

Figure 1 – Thoreau Location Project Map

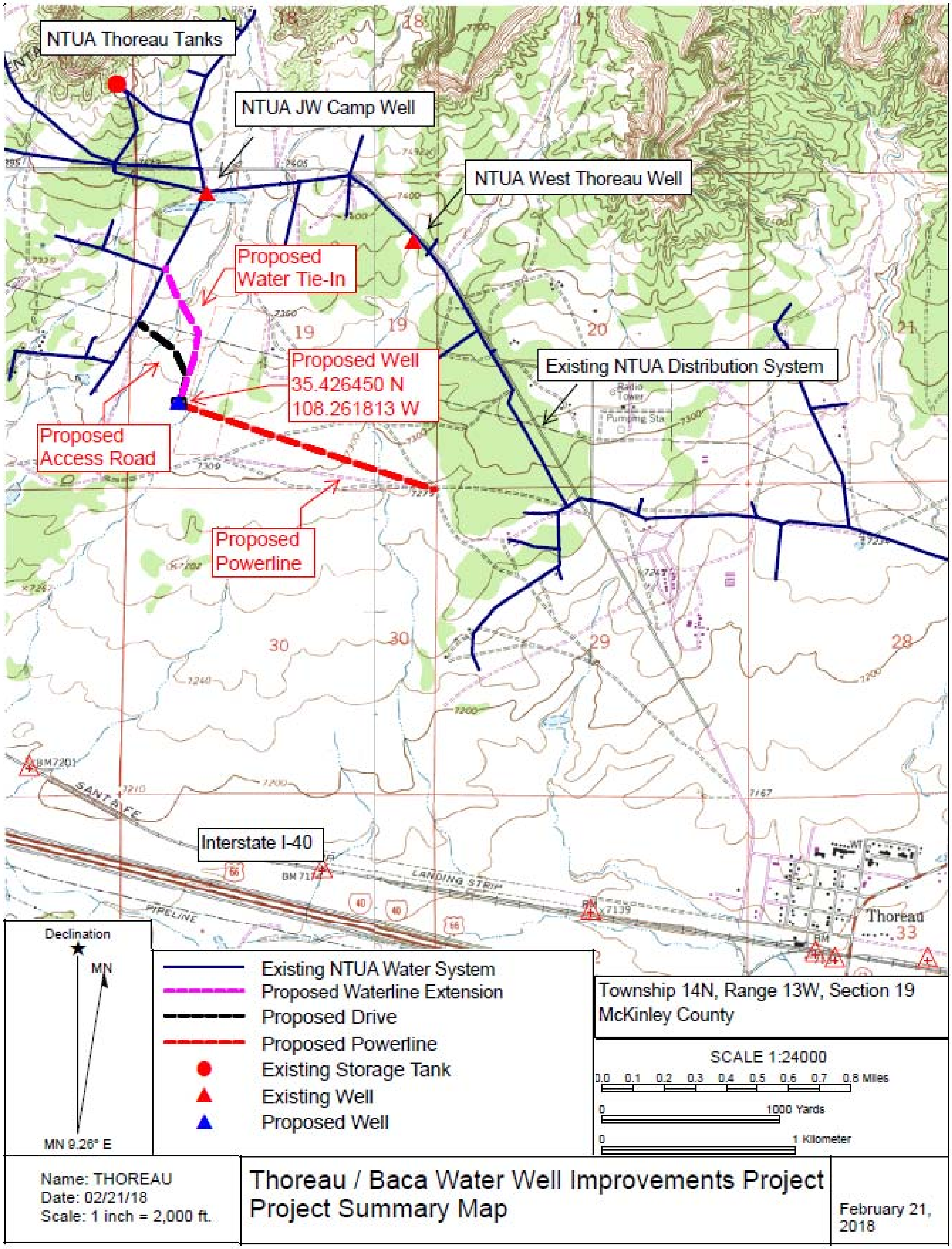

Figure 2 – Project Map

Hydraulic Model Report of New Thoreau Well Connection

Hydraulic Model Analysis of the Proposed New Thoreau Baca Well And Connection Pipeline

Baca – Thoreau Well Project

Thoreau Chapter, McKinley County, New Mexico

Amendment #1

Emily Sotelo, PE

November 12, 2018

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Executive Summary

The Baca and Thoreau Navajo Chapters in McKinley Country, New Mexico have interconnected water systems, hereafter referred to as the Baca-Thoreau system. See Appendix A, Figure 1 for a location map of the Chapters and existing system. The current supply for the Baca-Thoreau system comes from two active Navajo Tribal Utility Authority (NTUA) wells within the area, both located in Thoreau.

A new well located in Thoreau is being designed, and will serve as an additional water supply to the Baca-Thoreau system. See Appendix A, Figure 2 for a map of the existing Baca-Thoreau water system, and the location of the proposed new well. This new well was a recommendation of the Baca / Thoreau Water System Improvements Project Preliminary Engineering Report prepared by Souder, Miller & Associates (SMA) in April 2016.

As part of the design of the new Thoreau Baca well, a Hydrogeologic Investigation Report for the Baca-Thoreau Water System Well Project was prepared by SMA in November 2017.

As part of the design of the new well, SMA also created a hydraulic model in Bentley WaterCAD that analyzed the effects of the new well on the existing Baca-Thoreau system. The effects were analyzed by the following scenarios:

- o Existing wells and new well are operating, no distribution system demands
- o Only the new well is operating, no distribution system demands
- o Only the new well operating, with distribution demands

The proposed 4” HDPE and PVC Thoreau Baca Well connection pipeline was included in the hydraulic model, and hydraulic profiles from the new Thoreau Baca well to the existing Thoreau Tanks 2A and 2B were generated.

The results of the hydraulic analysis show that system pressures after the addition of the new well are below the pressure ratings of the existing pipelines.

The modeling parameters are presented below, followed by an outline of the different scenarios used to analyze the proposed new Thoreau well, and their results.

Modeling Parameters

Below are parameters used to build the hydraulic model of the Baca-Thoreau system.

Model Elevations

The Baca-Thoreau water system hydraulic model utilized the NTUA Geographic Information System (GIS) geodatabase, and the United States Geological Survey (USGS) quadrangle map digital elevation model (DEM) topographic plotting for elevation data.

Storage Tanks

The primary two water storage tanks included in this hydraulic model are summarized in Table 1, and are per DEM elevations. Note that DEM elevations used in the model for the tanks may differ slightly (within 5 feet) from the elevations shown in the NTUA GIS geodatabase and NTUA as-built drawings.

Table 1 – Summary of Tanks

Tank	Chapter of Tank Location	Base Elevation (ft)	Overflow Elevation (ft)	Capacity (gallons)	Diameter (ft)	Height (ft)
No. 2A	Thoreau	7541’	7565‘	70,000	22	24
No. 2B	Thoreau	7541’	7565’	20,000	12	24

Water Sources

The two active NTUA water supply wells within the Baca-Thoreau water system are both located in Thoreau, though there are a number of abandoned wells throughout the region. Both wells draw from the Sonsela and San Andres / Glorieta Aquifers. The two active wells that were included in the hydraulic model are summarized in Table 2. They pump directly into the Baca-Thoreau water system.

Table 2 – Summary of Wells

Well	Year Drilled	Capacity (GPM)	Well Depth (ft)	Surface Elev. (aMSL)	Static Water Level (ft)	Pumping Water Level (ft)	Pump Intake Level (ft)
W. Thoreau #1 (16T-614)	1982	85	1,760	7,377	286 (1982 pump test) 396 (1983 as-builts) 292 (1984 pump test)	590 (1983 as-builts)	804
JW Camp #2 (16T-529)	1964	20	1,700	7,404	228 (1964 pump test) 300 (1978 as-builts) 260 (1979 pump test)	460 (1978 as-builts)	803

Water Lines
According to as reported on Indian Health Service (IHS) as-built drawings, the original main lines of the Thoreau water system are primarily constructed of 6-inch and 4-inch-diameter SDR 26 Polyvinyl Chloride (PVC) pipe, with a pressure rating of 160 psi; and service lines to homes are primarily 2-inch-diameter PVC pipe with a pressure rating of 200 psi. A Hazen Williams C-factor of 130 was used in the hydraulic model.

Demands
The average estimated household demand used in the hydraulic model was 200-GPHD, which is the minimum design average daily usage rate according to the Navajo Area Indian Health Service Design Criteria (IHS, 1998).

Pressures
For analyzing the pipeline pressures generated in the hydraulic model, the Navajo Area IHS Design Criteria manual and the Navajo Nation Primary Drinking Water Regulations (NNPDWR) were referenced. For distribution in a community water system, pressures at the user's meters are to be within a range of a minimum dynamic pressure of 20 psi to a maximum static pressure of 70 psi.

There are fourteen existing main control valves within the entire Baca-Thoreau water system, but only two were included in this hydraulic model. These are summarized in Table 3.

Table 3 – Summary of Control Valves Present in the Baca-Thoreau Service Area

Control Valve	Size (inch)	Elevation (ft. aMSL)	Inlet Pressure (psi)	2" Outlet Pressure (psi)	Status
PRV-4A	2" x 3/4"	7371	82	45	Active
PRV-6	2" x 3/4"	7282	120	55	Active

In the model, only the pressure zone in which the Thoreau 2A & 2B tanks and Thoreau wells (existing and future) operate is considered, see Appendix A, Figure 2 for a map of the existing water system with this pressure zone delineated. This pressure zone is delineated on the east by PRV-6, on the south by PRV-4A, and on the west by another PRV. However, the western extents of the modeled system terminate at a low-elevation point upstream of the western-boundary PRV, because the highest pressure in the system occurs at this low-elevation point, therefore making it the most critical point in this portion of the pressure zone. The modeled pressure at this low-elevation spot, under the Base Scenario, is 130 psi.

Individual PRVs at home connections were not included in the model. It is assumed that modeled home connections with pressures that exceed the IHS and NNPDWR maximum pressure regulation (70 psi) under existing conditions have individual PRVs to keep them within the acceptable range.

Model Analysis Scenarios for the New Proposed Well

The addition of the new proposed Thoreau well was modeled in order to analyze the effects on the existing system.

Parameters assumed in the model for the new Thoreau well are based on the Baca-Thoreau Hydrogeologic Investigation Report (SMA, 2017), and the existing conditions of the two active wells in Thoreau. Parameters are:

- Ground Surface elevation: 7,330 ft-aMSL (based on Google Earth)
- Static water level: 292 ft (assumed, based on review of historical records of NTUA Wells 16T-614 and 16T-529)
- Assumed drawdown per GPM: 3.51 ft/GPM (based on historical pump test data for Well 16T-614)
- Estimated pumping water level elevation at 120 GPM: 6,617 ft (713 ft below ground surface - assumed static water level of 292 ft plus assumed drawdown calculated at 120 GPM)
- Pump elevation: 6,330 ft-aMSL (assumed 1,000 ft below ground surface)
- Design well casing size: 8”
- Design pump size: 6” pump with 50 hp motor
- Design drop pipe: 1,000 ft pipe of 3-inch diameter, used C-factor = 120 in model
- Length from well to system tie-in: 2,611 ft
    - 2,247-feet of 4” DR 18 PVC (4.23-inch I.D.)
    - 364-feet of 4” DR 11 HDPE (3.63-inch I.D.) under the wash crossing at Sta. 10+36
- New well flowrate assumed = 120 GPM (per the Hydrogeologic Investigation Report) in Scenario 1

A base scenario, and three analysis scenarios that model the new well under various conditions were created. They were all Steady State models, and are described below.

Scenario 0: Existing Wells Only, No Demands – “Base Scenario”

- Both existing wells are operational and delivering water.
- Thoreau Tanks 2A & 2B are almost full. All other tanks in the system are completely full.
- No distribution demands.
- Results:
    - New well flow rate = 0 GPM
    - Well 16T-529 flow rate = 20 GPM
    - Well 16T-614 flow rate = 85 GPM
    - Flow rate into the Thoreau Tanks 2A & 2B = 105 GPM
    - Pressure at the location where the new well will tie-in to existing system = 85 psi

    - Max system pressure (in west portion of pressure zone) = 130 psi
        - The maximum system pressure in this pressure zone occurs at the lowest-elevation spot, west of the Thoreau tanks and wells.
    - Pressure at inlet of PRV-6 = 124 psi
        - The inlet pressure at PRV-6 is the second highest pressure in the pressure zone.
        - The as-built drawings record PRV-6 to have an inlet pressure of 120 psi.
    - The lowest pressure at a home connection = 30 psi
    - The highest pressure at a home connection = 101 psi (homes with modeled pressure greater than 70 psi assumed to have individual PRV).
    - See Figure 3 for the WaterCAD model of this scenario.

- **Scenario 1: Existing and New Wells, No Demands**
  - Both existing wells and the new well are operational and delivering water.
  - Thoreau Tanks 2A & 2B are almost full. All other tanks in the system are completely full.
  - No distribution demands modeled.
  - Results:
    - New well flow rate = **120 GPM**
        - Pump TDH resulting from pumping at 120 GPM in Scenario 1 = **1,053 ft**
    - Well 16T-529 flow rate = 20 GPM
    - Well 16T-614 flow rate = 85 GPM
    - Flow rate into the Thoreau Tanks 2A & 2B = 225 GPM
    - Pressure at the location where the new well will tie-in to existing system = 101psi
        - For comparison, the pressure at this location was modeled in the Base Scenario to have a pressure of 85 psi.
    - Max system pressure (in west portion of pressure zone) = 133 psi
        - For comparison, the max system pressure in the considered pressure zone was modeled in the Base Scenario to have a pressure of 130 psi.
    - Pressure at inlet of PRV-6 = 129 psi
    - The lowest pressure at a home connection = 32 psi.
    - The highest pressure at a home connection = 106 psi.
    - See Figure 4 for the WaterCAD model of this scenario.
  - Comparison to Base Model: This scenario models the greatest head that the new well would be required to pump against, and results in the highest pressures of all the

considered scenarios.

  - The largest relative pressure increase was 16 psi, and occurred at the location where the new well will tie-in to the existing system.
  - The highest pressure at a home connection increased by 5 psi (from 101 psi to 106 psi). Since the modeled pressure under the Base Scenario already exceeded the IHS and NNPDWR maximum pressure regulation (70 psi), it is assumed that this branch already has an individual PRV that reduces the pressure to 70 psi or less.
    - There was only 1 home connection that was less than or equal to 70 psi under the Base Scenario (where it was 70 psi), and increased to more than 70 psi under Scenario 1 (where it was 74.6 psi).
  - The pressures in the model of the system are all below the pressure ratings of the pipes (160 psi) as reported on the as-built drawings.

- **Scenario 2: New Well Only, No Demands**
  - Only the new well is operational and delivering water.
  - Thoreau Tanks 2A & 2B are almost full. All other tanks in the system are completely full.
  - No distribution demands modeled.
  - <u>Results</u>:
    - New well flow rate = **121 GPM**
      - This is using the same pump curve created in Scenario 1 to operate at 120 GPM with a TDH of 1,053 ft
      - Pump TDH resulting in this Scenario = **1,045 ft**
    - Well 16T-529 flow rate = 0 GPM
    - Well 16T-614 flow rate = 0 GPM
    - Flow rate into the Thoreau Tanks 2A & 2B = 121 GPM
    - Pressure at the location where the new well will tie-in to existing system = 97 psi
      - For comparison, the pressure at this location was modeled in the Base Scenario to have a pressure of 85 psi.
    - Max system pressure (in west portion of pressure zone) = 131 psi
      - For comparison, the max system pressure in the considered pressure zone was modeled in the Base Scenario to have a pressure of 130 psi.
    - Pressure at inlet of PRV-6 = 123 psi
    - The lowest pressure at a home connection = 30 psi.
    - The highest pressure at a home connection = 99 psi.

    - See Figure 5 for the WaterCAD model of this scenario.
  - Comparison to Base Model: This scenario models the flow rate that the new well would be required to pump directly to the Thoreau Tanks 2A & 2B while the existing wells are not operating.
    - The largest relative pressure increase was 12 psi, and occurred at the location where the new well will tie-in to the existing system.
    - The pressures in the system are overall relatively unchanged from the pressures modeled under the Base Scenario, except around the area where the new well will tie-in to the existing system.
    - The highest pressure at a home connection decreased from the Base Scenario by 2 psi (from 101 psi to 99 psi).
    - The pressures in the model of the system are all below the pressure ratings of the pipes (160 psi) as reported on the as-built drawings.

- **Scenario 3: New Well Only, With Demands**
  - Only the new well is operational and delivering water.
    - Thoreau Tanks 2A & 2B are approximately 20% full. All other tanks in the system are also approximately 20% full.
  - Distribution demands are modeled, with an average household demand of 200 GPHD per IHS design criteria.
  - Because this Scenario is different from the other scenarios in that it has distribution demands modeled, it is not directly comparable to the other scenarios.
  - Results:
    - New well flow rate = **124 GPM**
      - This is using the same pump curve created in Scenario 1 to operate at 120 GPM with a TDH of 1,053 ft
      - Pump TDH resulting in this Scenario = **1,030 ft**
    - Well 16T-529 flow rate = 0 GPM
    - Well 16T-614 flow rate = 0 GPM
    - Flow rate into the Thoreau Tanks 2A & 2B = 23 GPM
    - Pressure at the location where the new well will tie-in to existing system = 89 psi
    - Max system pressure (in west portion of pressure zone) = 123 psi
    - Pressure at inlet of PRV-6 = 95 psi
    - The lowest pressure at a home connection = 23 psi.
    - The highest pressure at a home connection = 83 psi (homes with modeled pressure greater than 70 psi assumed to have individual PRV).

- o See Figure 6 for the WaterCAD model of this scenario.

New Well Water System Summary

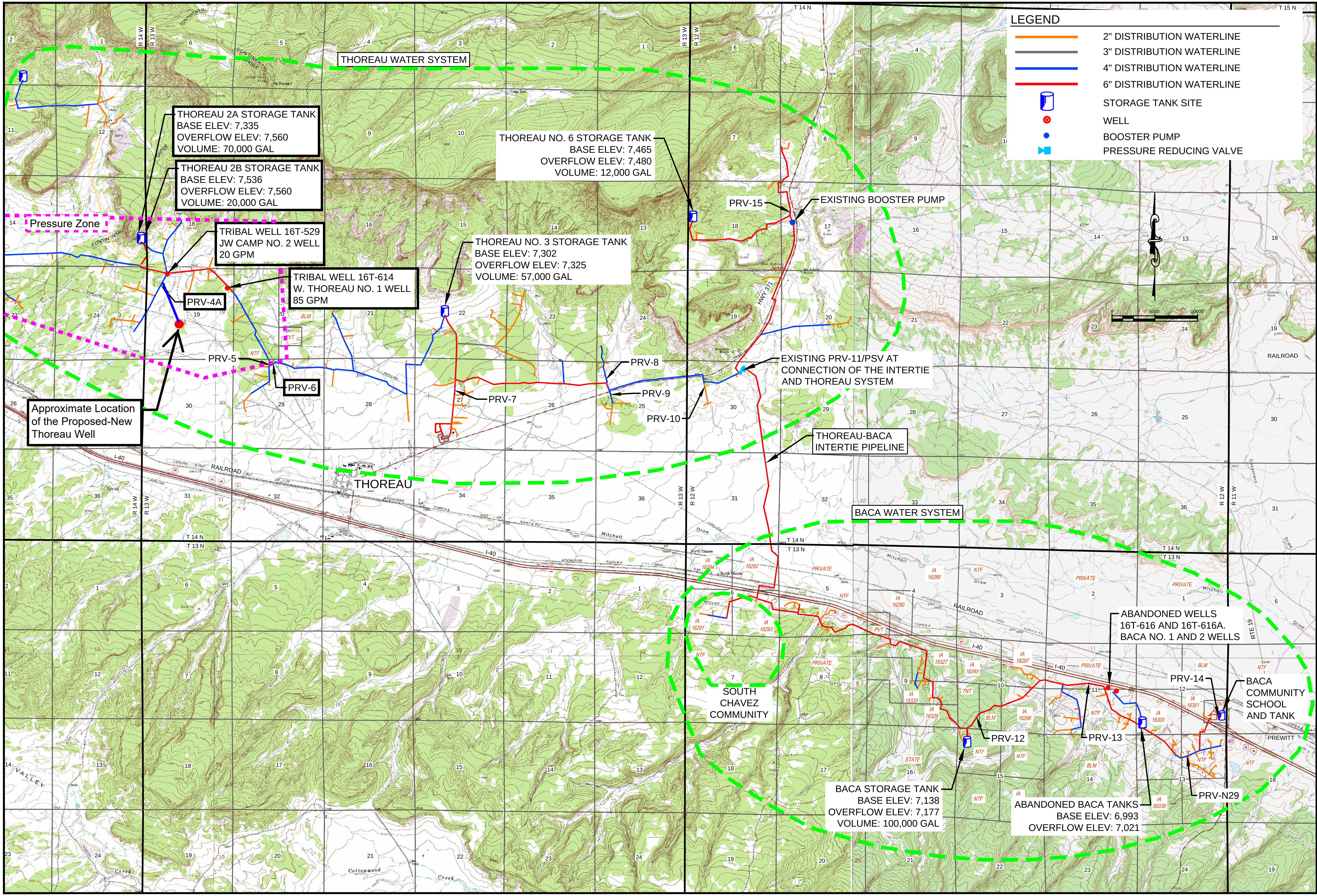
A hydraulic model for the new proposed well in Thoreau was analyzed under four scenarios. See the attached pressure maps of each scenario, and the below table for a comparison of the results of the different scenarios. Hydraulic profiles were created for Scenarios 1 – 3, and are attached.

	Scenario 0: Existing Wells Only, No Demands	Scenario 1: Existing and New Wells, No Demands	Scenario 2: New Well Only, No Demands	Scenario 3: New Well Only, With Demands
New Well's Flow Rate (gpm)	**0**	**120**	**121**	**124**
Total system flow rate (gpm)	105	225	121	124
New Flow into Thoreau Tanks 2A & 2B	105	225	121	23
New Well's Resulting Pump TDH (ft)	**0**	**1,053**	**1,045**	**1,030**
Max pressure in system (psi)	130	133	131	123
Pressure at the location where the new well will tie-in to existing system upstream of PRV-4A (psi)	85	101	97	89
Pressure at PRV-6 (psi)	124	129	123	95
Lowest pressure at a home connection (psi)	30	32	30	23
Highest pressure at a home connection (psi)	101	106	99	83

With the addition of the new well, all modeled pressures are below the pressure ratings of the pipe (minimum of 160 psi, as reported on IHS as-built drawings).

Appendix A

Figure 1: Project Location Map



MAP OF EXISTING FACILITIES

THOREAU - BACA WATER DISTRIBUTION SYSTEM

BACA / PREWITT NAVAJO CHAPTER, McKINLEY CO., N.M.

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EAS	MLS	TTT

Date: 12/28/17

Scale: Horiz: AS NOTED Vert: N/A

Project No: 6922883

Sheet: FIGURE 2

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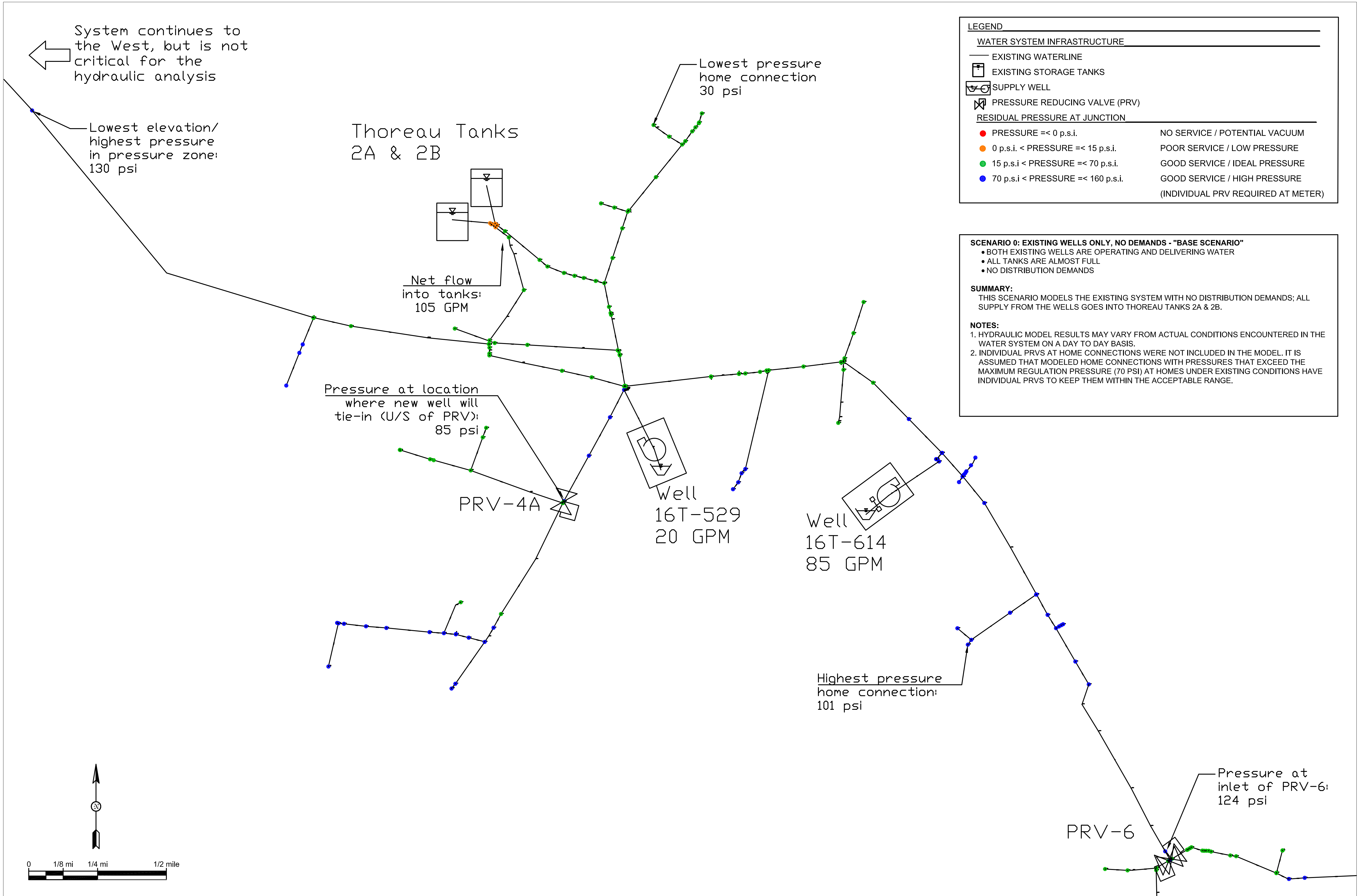

LEGEND

WATER SYSTEM INFRASTRUCTURE

- EXISTING WATERLINE
- EXISTING STORAGE TANKS
- SUPPLY WELL
- PRESSURE REDUCING VALVE (PRV)

RESIDUAL PRESSURE AT JUNCTION

PRESSURE =< 0 p.s.i.	NO SERVICE / POTENTIAL VACUUM
0 p.s.i. < PRESSURE =< 15 p.s.i.	POOR SERVICE / LOW PRESSURE
15 p.s.i < PRESSURE =< 70 p.s.i.	GOOD SERVICE / IDEAL PRESSURE
70 p.s.i < PRESSURE =< 160 p.s.i.	GOOD SERVICE / HIGH PRESSURE (INDIVIDUAL PRV REQUIRED AT METER)

SCENARIO 0: EXISTING WELLS ONLY, NO DEMANDS - "BASE SCENARIO"

- BOTH EXISTING WELLS ARE OPERATING AND DELIVERING WATER
- ALL TANKS ARE ALMOST FULL
- NO DISTRIBUTION DEMANDS

SUMMARY:

THIS SCENARIO MODELS THE EXISTING SYSTEM WITH NO DISTRIBUTION DEMANDS; ALL SUPPLY FROM THE WELLS GOES INTO THOREAU TANKS 2A & 2B.

NOTES:

1. HYDRAULIC MODEL RESULTS MAY VARY FROM ACTUAL CONDITIONS ENCOUNTERED IN THE WATER SYSTEM ON A DAY TO DAY BASIS.
2. INDIVIDUAL PRVS AT HOME CONNECTIONS WERE NOT INCLUDED IN THE MODEL. IT IS ASSUMED THAT MODELED HOME CONNECTIONS WITH PRESSURES THAT EXCEED THE MAXIMUM REGULATION PRESSURE (70 PSI) AT HOMES UNDER EXISTING CONDITIONS HAVE INDIVIDUAL PRVS TO KEEP THEM WITHIN THE ACCEPTABLE RANGE.

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SCENARIO 0: BASE SCENARIO
EXISTING WELLS ONLY, NO DEMANDS
THOREAU, NM

Designed	Drawn	Checked
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Date: 1/11/18

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Project No: 6922883

Sheet: FIG. 3

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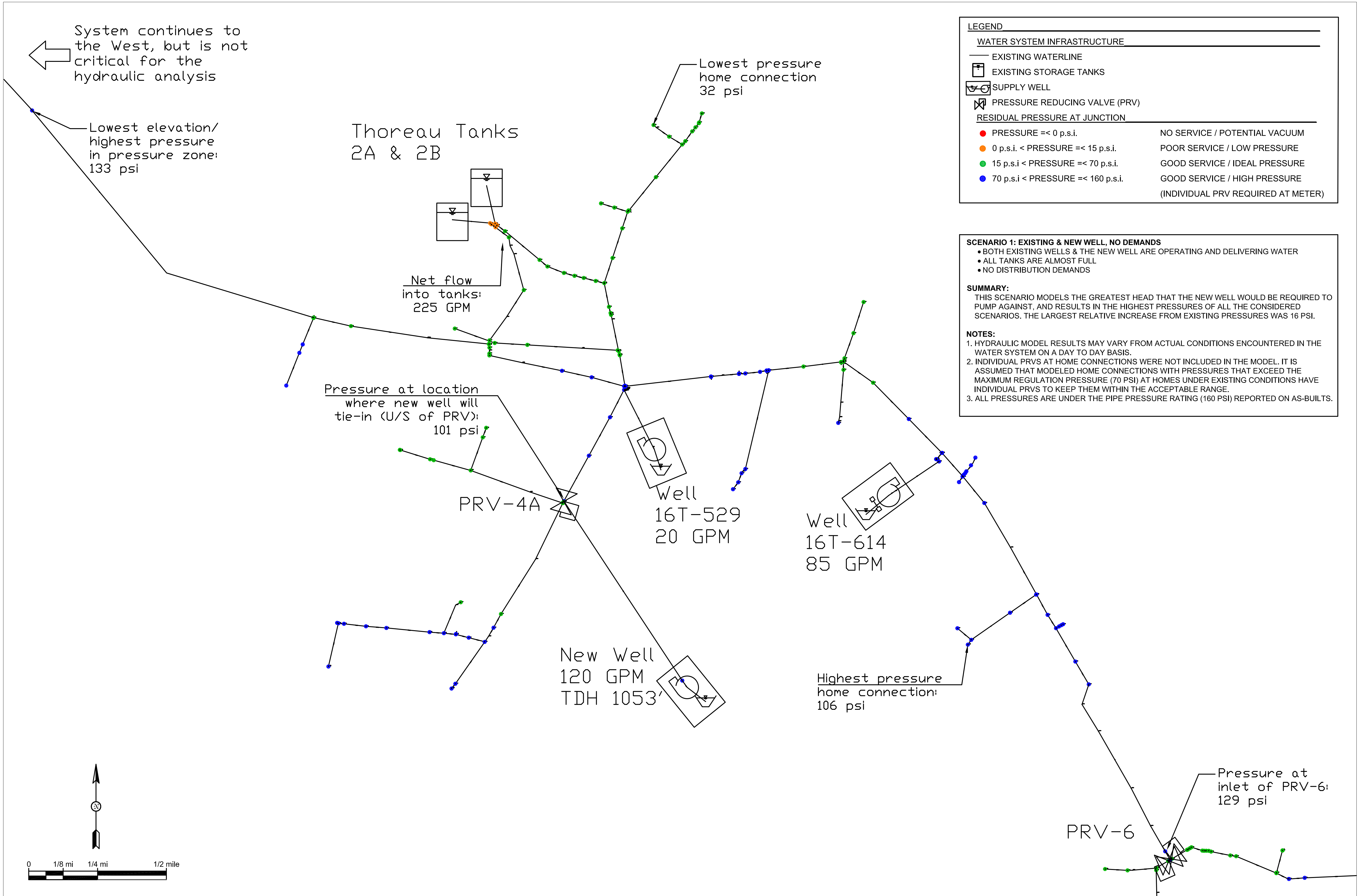

LEGEND

WATER SYSTEM INFRASTRUCTURE

- EXISTING WATERLINE
- EXISTING STORAGE TANKS
- SUPPLY WELL
- PRESSURE REDUCING VALVE (PRV)

RESIDUAL PRESSURE AT JUNCTION

PRESSURE =< 0 p.s.i.	NO SERVICE / POTENTIAL VACUUM
0 p.s.i. < PRESSURE =< 15 p.s.i.	POOR SERVICE / LOW PRESSURE
15 p.s.i < PRESSURE =< 70 p.s.i.	GOOD SERVICE / IDEAL PRESSURE
70 p.s.i < PRESSURE =< 160 p.s.i.	GOOD SERVICE / HIGH PRESSURE (INDIVIDUAL PRV REQUIRED AT METER)

SCENARIO 1: EXISTING & NEW WELL, NO DEMANDS

- BOTH EXISTING WELLS & THE NEW WELL ARE OPERATING AND DELIVERING WATER
- ALL TANKS ARE ALMOST FULL
- NO DISTRIBUTION DEMANDS

SUMMARY:

THIS SCENARIO MODELS THE GREATEST HEAD THAT THE NEW WELL WOULD BE REQUIRED TO PUMP AGAINST, AND RESULTS IN THE HIGHEST PRESSURES OF ALL THE CONSIDERED SCENARIOS. THE LARGEST RELATIVE INCREASE FROM EXISTING PRESSURES WAS 16 PSI.

NOTES:

1. HYDRAULIC MODEL RESULTS MAY VARY FROM ACTUAL CONDITIONS ENCOUNTERED IN THE WATER SYSTEM ON A DAY TO DAY BASIS.
2. INDIVIDUAL PRVS AT HOME CONNECTIONS WERE NOT INCLUDED IN THE MODEL. IT IS ASSUMED THAT MODELED HOME CONNECTIONS WITH PRESSURES THAT EXCEED THE MAXIMUM REGULATION PRESSURE (70 PSI) AT HOMES UNDER EXISTING CONDITIONS HAVE INDIVIDUAL PRVS TO KEEP THEM WITHIN THE ACCEPTABLE RANGE.
3. ALL PRESSURES ARE UNDER THE PIPE PRESSURE RATING (160 PSI) REPORTED ON AS-BUILTS.

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SCENARIO 1
EXISTING & NEW WELLS, NO DEMANDS
THOREAU, NM

Designed	Drawn	Checked
EAS	EAS	TTT

Date: 1/11/18
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Project No: 6922883
Sheet: FIG. 4

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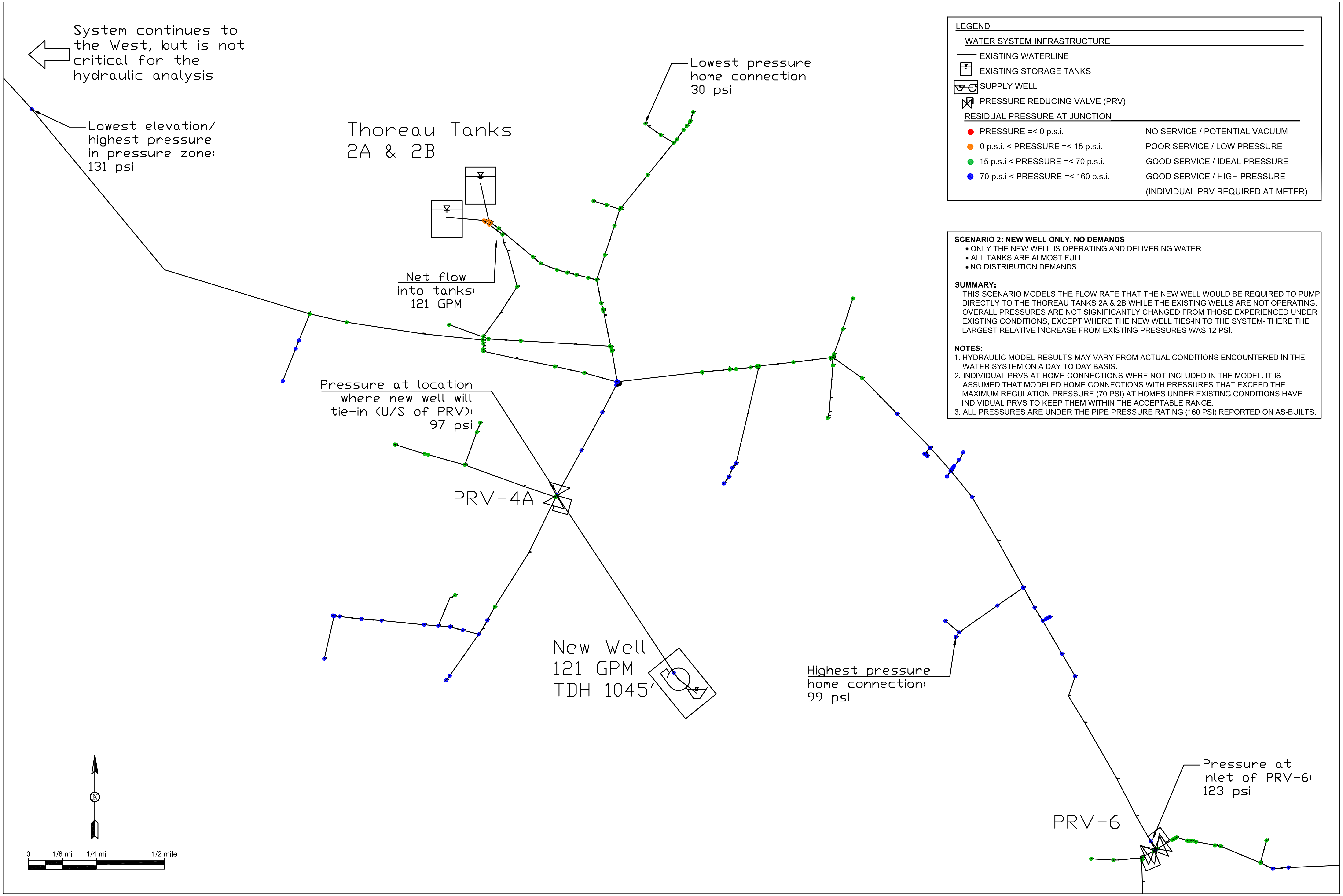

LEGEND

WATER SYSTEM INFRASTRUCTURE

- EXISTING WATERLINE
- EXISTING STORAGE TANKS
- SUPPLY WELL
- PRESSURE REDUCING VALVE (PRV)

RESIDUAL PRESSURE AT JUNCTION

PRESSURE =< 0 p.s.i.	NO SERVICE / POTENTIAL VACUUM
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70 p.s.i < PRESSURE =< 160 p.s.i.	GOOD SERVICE / HIGH PRESSURE (INDIVIDUAL PRV REQUIRED AT METER)

SCENARIO 2: NEW WELL ONLY, NO DEMANDS

- ONLY THE NEW WELL IS OPERATING AND DELIVERING WATER
- ALL TANKS ARE ALMOST FULL
- NO DISTRIBUTION DEMANDS

SUMMARY:

THIS SCENARIO MODELS THE FLOW RATE THAT THE NEW WELL WOULD BE REQUIRED TO PUMP DIRECTLY TO THE THOREAU TANKS 2A & 2B WHILE THE EXISTING WELLS ARE NOT OPERATING. OVERALL PRESSURES ARE NOT SIGNIFICANTLY CHANGED FROM THOSE EXPERIENCED UNDER EXISTING CONDITIONS, EXCEPT WHERE THE NEW WELL TIES-IN TO THE SYSTEM- THERE THE LARGEST RELATIVE INCREASE FROM EXISTING PRESSURES WAS 12 PSI.

NOTES:

1. HYDRAULIC MODEL RESULTS MAY VARY FROM ACTUAL CONDITIONS ENCOUNTERED IN THE WATER SYSTEM ON A DAY TO DAY BASIS.
2. INDIVIDUAL PRVS AT HOME CONNECTIONS WERE NOT INCLUDED IN THE MODEL. IT IS ASSUMED THAT MODELED HOME CONNECTIONS WITH PRESSURES THAT EXCEED THE MAXIMUM REGULATION PRESSURE (70 PSI) AT HOMES UNDER EXISTING CONDITIONS HAVE INDIVIDUAL PRVS TO KEEP THEM WITHIN THE ACCEPTABLE RANGE.
3. ALL PRESSURES ARE UNDER THE PIPE PRESSURE RATING (160 PSI) REPORTED ON AS-BUILTS.

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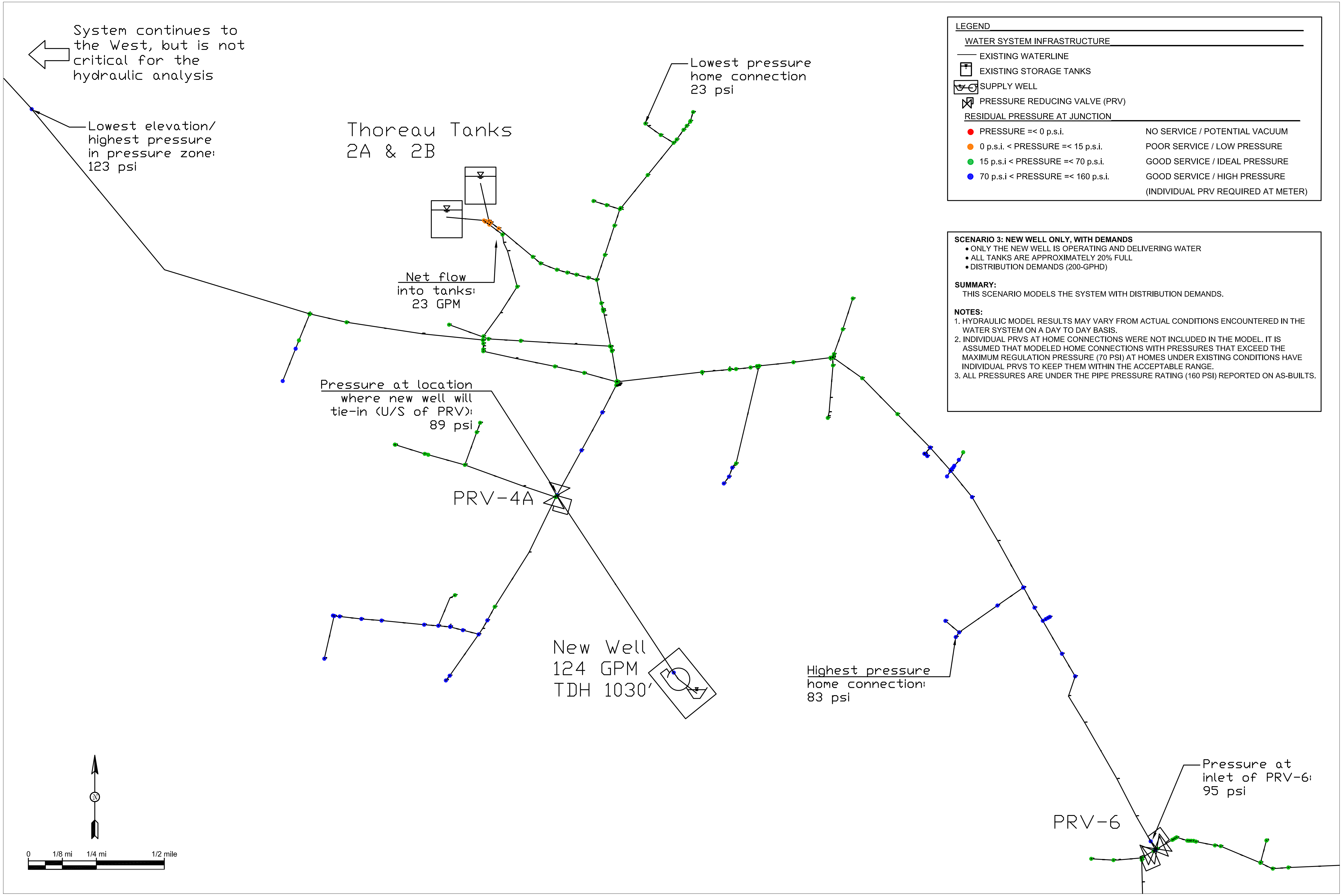
SCENARIO 2
NEW WELL ONLY, NO DEMANDS
THOREAU, NM

Designed	Drawn	Checked
EAS	EAS	TTT

Date: 1/11/18
Scale: Horiz: N/A Vert: N/A
Project No: 6922883
Sheet: FIG. 5

P:\6-Baca-Prewitt (6922883)\Baca Thoreau Well\Hydraulic Model of Baca Water System\WaterCAD Model - New Baca-Thoreau Well\1-11-18\Baca-Thoreau System 1-11-18.dwg, 1/12/2018 11:00:04 AM eas



LEGEND

WATER SYSTEM INFRASTRUCTURE

- EXISTING WATERLINE
- EXISTING STORAGE TANKS
- SUPPLY WELL
- PRESSURE REDUCING VALVE (PRV)

RESIDUAL PRESSURE AT JUNCTION

PRESSURE =< 0 p.s.i.	NO SERVICE / POTENTIAL VACUUM
0 p.s.i. < PRESSURE =< 15 p.s.i.	POOR SERVICE / LOW PRESSURE
15 p.s.i < PRESSURE =< 70 p.s.i.	GOOD SERVICE / IDEAL PRESSURE
70 p.s.i < PRESSURE =< 160 p.s.i.	GOOD SERVICE / HIGH PRESSURE (INDIVIDUAL PRV REQUIRED AT METER)

SCENARIO 3: NEW WELL ONLY, WITH DEMANDS

- ONLY THE NEW WELL IS OPERATING AND DELIVERING WATER
- ALL TANKS ARE APPROXIMATELY 20% FULL
- DISTRIBUTION DEMANDS (200-GPHD)

SUMMARY:
THIS SCENARIO MODELS THE SYSTEM WITH DISTRIBUTION DEMANDS.

NOTES:
1. HYDRAULIC MODEL RESULTS MAY VARY FROM ACTUAL CONDITIONS ENCOUNTERED IN THE WATER SYSTEM ON A DAY TO DAY BASIS.
2. INDIVIDUAL PRVS AT HOME CONNECTIONS WERE NOT INCLUDED IN THE MODEL. IT IS ASSUMED THAT MODELED HOME CONNECTIONS WITH PRESSURES THAT EXCEED THE MAXIMUM REGULATION PRESSURE (70 PSI) AT HOMES UNDER EXISTING CONDITIONS HAVE INDIVIDUAL PRVS TO KEEP THEM WITHIN THE ACCEPTABLE RANGE.
3. ALL PRESSURES ARE UNDER THE PIPE PRESSURE RATING (160 PSI) REPORTED ON AS-BUILTS.

Rev #	Date	Description	By	Chk'd

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SCENARIO 3
NEW WELL ONLY, WITH DEMANDS
THOREAU, NM

Designed	Drawn	Checked
EAS	EAS	TTT

Date: 1/11/18
Scale: Horiz: N/A Vert: N/A
Project No: 6922883
Sheet: FIG. 6

P:\6-Baca-Prewitt (6922883)\Baca Thoreau Well\Hydraulic Model of Baca Water System\WaterCAD Model - New Baca-Thoreau Well\1-11-18\Baca-Thoreau System 1-11-18.dwg, 1/12/2018 11:00:39 AM eas

Flush Valves Summary and Spacing Table, Air Valves Summary and Spacing Table, Crossing Summary

Thoreau Baca Well Connection
Flush Valve and Air Valve Summary & Spacing and Crossing Summary

Thoreau Well Site Elevation	7,328	ft aMSL
Thoreau 2A & 2B Tanks Overflow Elevation	7,560	ft aMSL

Flush Valve Summary and Spacing

Station (LF)	Elevation (ft-AMSL)	Pipe DR	Static Pressure (psi)	Maxium Dynamic Pressure (psi)	Size (in)	Type of FV Discharge
Well site	7,324	18	102	131	2	Above-ground discharge

Air Valve Summary and Spacing

Station (LF)	Elevation (ft-AMSL)	Air valve type & size	Static pressure (psi)	Maxium Dynamic Pressure (psi)	Spacing from last valve (LF)	Is spacing less than 1/2-mile?[1]
08+75	7,334	1" air release valve	98	123	-	-
14+78	7,345	1" air release valve	93	115	603	Yes

[1] AWWA M-51 recommends 1/2 mile for air valve spacing, although this is not a strict requirement. In most instances where spacing is greater than 1/2 mile, there is a low point between the air valves, such that air would not have to travel further than 1/2 mile to reach an air valve.

Crossing Summary

Beginning Station	Ending Station	Type of Crossing	Pipe
09+10	12+74	Wash	4" HDPE DR11
16+02	16+42	Gas Line	8" PVC DR18 Casing

Isolation Valves Summary and Spacing Table, Hydrostatic Testing Pressure Calculations

Filling, Testing, Flushing, and Disinfection Plan

After construction of the Thoreau Baca Well Connection is completed, the following procedures shall be performed: predisinfection flushing, hydrostatic pressure and leakage testing, disinfection of all segments of the new pipeline, disinfection of the well, and bacteriological testing. These procedures shall be performed according to the industry standards referenced in each of the following plans for filling, testing, flushing, and disinfection.

Note: Coordination shall be made with NTUA prior to filling, flushing or disinfecting the pipeline.

1. **<u>Filling, Hydrostatic Pressure and Leakage Testing</u>**

   The Thoreau Baca Well Connection shall undergo hydrostatic pressure and leakage testing prior to disinfection. Test pressure parameters and the maximum allowable leakage for the Thoreau Baca Well Connection have been determined in the attached Hydrostatic Pressure and Leakage Test Calculations, and are summarized briefly below.

   The maximum test pressure (at the lowest point in the test section) is the greater of: the DR pressure rating, or 1.25-times the actual maximum working pressure. The max allowable leakage for PVC pipe during pressure testing is determined by Equation 8-1 from AWWA M23. See the attached Test Hydrostatic Pressure and Leakage Calculations for more details.

   See the following filling and testing plan and reference AWWA C605-13 (Underground Installation of PVC and PVC Pressure Pipe Fittings), AWWA M23-02 (PVC Pipe Design and Installation) and technical specification 33 11 00 (Water Utility Distribution Piping).

   1. Notify NTUA 7 days before applying pressure to pipeline.
   2. Do not perform leak tests when water is ponded on ground surface from major rain or snow storm, unless approved by engineer.
   3. Conduct hydrostatic pressure testing with potable water.
   4. Vent all air from the pipeline prior to pressurization.
   5. Fully restrain the pipeline, including permanently installed items and any temporary appurtenances used for testing, prior to pressurization.
   6. Perform testing in accordance with applicable standards:
      a. Test pressure: In accordance with the Hydrostatic Pressure and Leakage Test Calculations.
      b. Simultaneous hydrostatic pressure and leakage test. The system shall be pressure tested in-ground in accordance with AWWA C605 and M23.
      c. Test duration: 2 hours minimum.

d. Engineer may require longer duration test (up to 24 hours) if there is any doubt as to integrity of the test section of pipe or appurtenances.

7. In no case shall the test pressure exceed the manufacturers' recommended maximum safe test pressure for the pipe, fittings or appurtenances.
8. No observable leakage is allowed, if leakage is detected halt test. Measurable leakage must be within the maximum allowable limits set forth by applicable AWWA and ASTM standards including AWWA C605 Sec. 10.3.6 and as presented in the attached Hydrostatic Pressure and Leakage Test Calculations.
9. Any leaks detected during testing shall be repaired after pipe is depressurized. After repairs are completed, another full duration test shall be performed on the section of the pipeline to which the repairs were made.
10. All hydrostatic pressure and leakage tests will be witnessed by NTUA personnel.
11. Repeat test until acceptance criteria is achieved.

Thoreau Baca Well Connection
Isolation Valves Summary & Spacing Table and Hydrostatic Testing Pressure Calculations

Thoreau Well Site Elevation	7,328	ft aMSL
Thoreau 2A & 2B Tanks Overflow Elevation	7,560	ft aMSL

Isolation Valve Summary and Spacing

Station (LF)	Elevation (ft-AMSL)	Pipe DR -	Static Pressure (psi)	Size (in)	Maxium Dynamic Pressure	Valve Type	Spacing from last valve (LF)	Is spacing less than 1 mile?
Downstream of Pumphouse ~Sta. 00+00	7,324	18	102	4	131	Gate Valve	-	-
08+90.0	7,331	18	99	4	111	Gate Valve	890	Yes
26+06	7,368	18	83	4	101	Gate Valve	1,716	Yes

Hydrostatic Pressure Test Calculations

Testing Range						Testing ARV			High Point			Low Point			Static Pressure Difference Low to High psi	Max Test Pressure[1] at Low Point psi	Min Test Pressure[1] at High Point psi	Min Test Pressure[1] at Testing ARV psi
Beginning Station LF	Ending Station LF	Distance Testing Range LF	Pipe Diameter in	Pipe DR -	DR Pressure Rating -	Sta. LF	Elevation ft-AMSL	Maximum Dynamic Pressure psi	Sta. LF	Elevation ft-AMSL	Maximum Dynamic Working psi	Sta. LF	Elevation ft-AMSL	Maximum Dynamic Pressure psi				
00+00	26+06	2,606	4	18	235	14+78	7,345	115	26+06	7,368	101	00+00	7,324	131	19	235	**216**	**226**

Notes:

[1] Maximum test pressure at low point is based on either pipe working pressure rating or 1.25 X actual max. working pressure, whichever is greater.

[2] Isolate Pumphouse prior to testing well site piping. Pressure test chlorination equipment to 100 psi.

Hydrostatic Pressure and Leakage Test Summary

Test Section					Testing ARV Location			Allowable Leakage Calculations[1]		
Beginning Station LF	Ending Station LF	Length of Test Section LF	Nominal Pipe Diameter in	Pipe DR -	Station LF	Elevation ft-AMSL	Test Pressure psi	Number of Joints Tested (N) -	Inner Diamter of Pipe (D) in	Allowable Leakage, 2 Hour Test (2Q) gal.
00+00	26+06	2,606	4	18	14+78	7,345	226	112	4.23	**1.96**

Notes:

[1] Where the AWWA M23 Allowable Leakage **per Hour** $(Q) = \frac{ND(P^{1/2})}{7400}$. Allowable Leakage values above are for 2 hour tests, 2*(Q).

Thrust Block Calculations

Thrust Block Dimension Schedule

Pipe Location	Pipe Size	90° Bend (H x W)	Tee (H x W)
Well Pumphouse, Inlet & Outlet	4"	2' 0" x 2' 0"	N/A
Tee for Thoreau System Tie-in	4"	N/A	2' 0" x 2' 0"

Thrust Block Calculations

Well Pumphouse, Inlet & Outlet		
Pipe Outside Diameter	4.8	in
Line Pressure	235.0	psi
Area	18.1	in^2
Flow Rate	120	GPM
Velocity	2.1	ft/sec
Density Water	62.3	lb_m/ft^3
Mass Flow Rate	16.7	lb_m/sec
Soil Bearing	1,500	psf
1 lb_f	32.2	$lb_m\text{-}ft/sec^2$
Static Load on 90	6,014	lbs
	6.0	kips
Dynamic Load on 90	1.6	lbs
	0.0	kips
Total Load on 90	6.0	kips
Thrust Block Size if Square	2.0	ft

Note: A soil bearing pressure of 1,500 psf was assumed as a conservative value, per recommendation from our geotechnical sub-consultant.

Thrust Block Calculations

Tee for Thoreau System Tie-in		
Pipe Outside Diameter	4.8	in
Line Pressure	235.0	psi
Area	18.1	in^2
Flow Rate	120	GPM
Velocity	2.1	ft/sec
Density Water	62.3	lb_m/ft^3
Mass Flow Rate	16.7	lb_m/sec
Soil Bearing	1,500	psf
1 lb_f	32.2	lb_m-ft/sec^2
Static Load on Tee	4,252	lbs
	4.3	kips
Dynamic Load on Tee	1.1	lbs
	0.0	kips
Total Load on Tee	4.3	kips
Thrust Block Size at Tee if Square	1.68	ft
Design Thrust Block Size if Square	2.00	ft

Note: A soil bearing pressure of 1,500 psf was assumed as a conservative value, per recommendation from our geotechnical sub-consultant.

Restraint Length Calculations

Thoreau Baca Well Connection
Restraint Length Calculations

Calculations for required restraint lengths for valves, tees, reducers, and horizontal bends or sweeps were calculated utilizing the EBAA Restraint Calculator V7.1.2 software. See software inputs below.

<u>Inputs for the software were as follows:</u>

Pipe Materials: **PVC**

Soil Type: **SM** – The majority of the soils encountered while performing the rock and soil potholing were silty-sands. Additionally, silty-sands result in conservative restraint lengths.

Safety Factor: **2.0 to 1**

Trench Type: **3** – Trench Type 3 is the pipe bedded in 4 inches minimum loose soil. The backfill is lightly consolidated to the top of the pipe. This is the most conservative trench type available on the EBAA Restraint Calculator 6.

Depth of Bury: **4 feet** – This is the average minimum depth of pipe. This results in a more conservative restraint length for any pipe buried deeper than 4 feet.

Test Pressure: **235 psi**

Note that flush valve assemblies will not be pressure tested beyond the gate valve.

Minimum Required Restraint Lengths for Individual Fittings

Fitting	Pipe Size	Pipe DR	Test Pressure (psi)	Design Restraint Length (ft)
Isolation Valve/ Dead End	4	18	235	65
From End of Casing	4	18	235	30
Horizontal Bend or Sweep				
90°	4	18	235	30
45°	4	18	235	20
22.5°	4	18	235	20
11.25°	4	18	235	20
Vertical Bend or Sweep[1]				
22.5°, upper bend	4	18	235	20
22.5°, lower bend	4	18	235	20
11.25°, upper bend	4	18	235	20
11.25°, lower bend	4	18	235	20

Minimum Required Restraint Length
for Pipe Exiting Casing

			4" DR18
Poisson Pullback			
Pressure	P	psi	235
Dimension Ratio	DR	-	18
Poisson Ratio	μ	-	0.38
Outside Diameter	OD	in	4.8
Inside Diameter	ID	in	4.2
Internal Pressure Hoop Stress	Sp	psi	1,997.5
Pullout Force	**F**	lb	**2,883**
Elastic Modulus	E	psi	400,000
Thermal Drop	ΔT	F	30
Thermal Expansion Coefficient	α	in/in/F	0.00003
Pipe Wall Cross-Sectional Area	A_W	in^2	4.0
Thermal Pullback Force	**F**	lbs	**1,455**
Total Force	**F**	lbs	**4,338**
Pipe Depth	h	ft	4.0
Unit Weight of soil	W	pcf	120.0
Earth Pressure on Pipe	Pe	psf	480.0
Earth Pressure on Pipe	Pe	psi	3.3
Outside Diameter	OD	ft	0.4
Safety Factor	SF	-	2.0
Friction Force of pipe[1]	Z	psf/psi	78.2
Friction Resistance	F	lbs/ft	**327.4**
Friction Resistance	F	lbs/ft	**163.7**
Calculated Restraint Length		ft	**26.5**
Design Restraint Length		ft	**30.0**

[1]Friction force of pipe in silty sand. From Underground Solutions, Experimental Evaluation of Pipe Soil Friction Coefficient for FPVC

HDPE / PVC Transition Wall Anchor Calculations

SMA

Wall Anchor Calculations

On the new 4" waterline that ties the new Thoreau well to the existing Thoreau water system, there is a section of HDPE pipe under the wash located at Station 10+36. Wall anchors are utilized at the transitions from PVC to HDPE at Station 9+10 and HDPE to PVC at Station 12+74 to prohibit axial movement of the pipeline due to temperature changes and the Poisson effect from internal pressure changes. Per IHS Design Criteria, the minimum height and width of the wall anchors is 3 ft. A summary of the wall anchor design is given in the table below. See attachments for wall anchor calculations.

Station	Fitting	Type	Pipe Size (in)	DR Rating DR	Design Wall Anchor Size (H x W x T) (ft)
9+10	PVC TO HDPE	Wall Anchor	4	11	3' x 3' x 2'
12+74	HDPE TO PVC	Wall Anchor	4	11	3' x 3' x 2'

Design Assumptions:

Allowable bearing pressure of the soil: 1,500 lbs/ft^2 was assumed as a conservative value, per recommendation from our geotechnical sub-consultant.

Min Bury: 1.5 feet

Min Height and Width of Wall Anchor: 3 feet (per IHS Design Criteria)

Internal Pressure of HDPE Pipe: Equal to the hydrostatic test pressure of the relative section of PVC pipe that the HDPE pipe is located within (235 psi).

Internal Pressure of PVC Pipe: Equal to the hydrostatic test pressure of the PVC carrier pipe (235 psi).

Poisson Ratio (μ), Long-Term Stress of HDPE: 0.45

Poisson Ratio (μ), Long-Term Stress of PVC: 0.38

HDPE Apparent Elastic Modulus: 63,000 psi

> Assumes an average temperature of 73˚F (standard assumption), and a duration of sustained loading of 12 hours. For HDPE piping material PE4XXX, which denotes all polyethelenes that comply to the density cell classification of 4 in accordance with ASTM D3350, per Chapter 3 Appendix B of the PPI Handbook of Polyethylene.

PVC Elastic Modulus: 400,000 psi

HDPE Thermal Expansion Coefficient (α): 0.00008 in/in/˚F assumed for HDPE piping material PE4XXX, which denotes all polyethelenes that comply to the density cell classification of 4 in accordance with ASTM D3350. Per the PPI Handbook of Polyethylene.

PVC Thermal Expansion Coefficient (α): 0.00003 in/in/˚F assumed for HDPE piping material PE4XXX, which denotes all polyethelenes that comply to the density cell classification of 4 in accordance with ASTM D3350. Per the PPI Handbook of Polyethylene.

Temperature Change: 30 ˚F

HDPE Pipe Diameter Convention: IPS

HDPE Wall Anchor Calculations: 4 inch DR 11 HDPE Located Within a Section of 4 inch DR18 PVC Pipe

Design Parameters				
Pipe DR -	Pipe Outside Diameter (IPS) (in)	Pipe Inside Diameter (IPS) (in)	Pipe Wall Cross-Sectional Area (in^2)	Soil Bearing Preasure[1] (psf)
11	**4.5**	**3.6**	**5.7**	**1,500**

Poisson Effect Pullout Force				
Internal Pressure of HDPE Pipe[2] (psi)	Internal Pressure Hoop Stress (psi)	Poisson Ratio (μ), Long-Term Stress -	Pi (π) -	Poisson Effect Pullout Force (lbs)
235	1,175	0.45	3.14	2,780

Longitudinal Force Due to Temperature Change				
Thermal Expansion Coefficient[3] (α) (in/in/˚F)	Temperature Change (˚F)	Apparent Elastic Modulus[3,4]	Longitudinal Stress (σ_T) (psi)	Thermal Longitudinal Force (lbs)
0.00008	30.0	63,000	151.2	866

Wall Anchor Design				
Total Force (lbs)	Wall Anchor Required Area (ft^2)	Calculated Wall Anchor Size if Square (ft)	Design Wall Anchor Height & Width[5] (ft)	Design Wall Anchor Thickness[6] (ft)
3,646	2.4	1.6	**3.0**	**2.0**

[1]A soil bearing pressure of 1,500 psf was assumed as a conservative value, per recommendation from our geotechnical sub-consultant.

[2]Internal Pressure is equal to the hydrostatic test pressure of the relative section of PVC pipe that the HDPE pipe is located within.

[3]Values are for HDPE piping material PE4XXX, which denotes all polyethelenes that comply to the density cell classification of 4 in accordance with ASTM D3350.

[4]Apparent Elastic Modulus assumes an average temperature of 73˚F (standard assumption), and a duration of sustained loading of 12 hours.

[5]Per IHS Design Criteria, the minimum height and width for the wall anchors is 3 ft.

[6]Wall Anchor thickness per consultation with licensed structural engineer.

Design References:

Handbook of Polyethylene Pipe, Second edition. Plastics Pipe Institute, 2002.

Thrust Restraint Design for Ductile Iron Pipe, Seventh Edition. DIPRA, 2016.

Navajo Area Indian Health Service Design Criteria. IHS, 1999

Wall Anchor Summary and Depth Check

Station	Fitting	Type	Pipe size (inches)	DR rating	PVC Pipe outer diameter (OD) (inches)	Pipe depth to top, per plan set drawings (ft)	Required bearing area (ft^2)	Minimum depth to top of block (ft)	Max allowable height above top of pipe (ft)	Max allowable height above pipe centerline (ft)	Max allowable height/width of block (ft)	Min. required height/width (ft)	Required height/width (ft)	Is it deep enough?
9+10	PVC TO HDPE	Wall Anchor	4	11	4.5	6.7	2.4	1.5	5.2	5.4	10.7	1.6	**3.0**	TRUE
12+74	HDPE TO PVC	Wall Anchor	4	11	4.5	6.7	2.4	1.5	5.2	5.4	10.7	1.6	**3.0**	TRUE

Quantity Summary

Thoreau Baca Well Connection

Quantity Summary

ITEM NO.	ITEM DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	TOTAL PRICE
General and Miscellaneous					
1	Mobilization (75%) / demobilization (25%).	LS	1		
2	Testing allowance, (reimbursable lab fees only, incl. compaction, concrete, materials, water quality. Excludes bacteriological lab test fees).	Allow.	1		
Erosion and Storm Water Controls					
3	Wire-caged riprap (item includes rock, wire cage, geotextile, and staking) or cable concrete. Final quantities, dimensions and locations TBD in field, CIP.	CY	TBD in field by engineer		
4	Re-seeding of waterline ROW, CIP.	LF	2,611		
5	Re-seeding of well site, CIP	LS	1		
6	SWPPP pursuant to NPDES stormwater program and consistent with USEPA's general construction permit. Includes preparation of document, implementation of all BMPs required by SWPPP, filing of all notices and inspections required by EPA, etc.	LS	1		
Water Mainline					
7	4-inch PVC DR 18 C900 Pipeline, with appurtenances, CIP.	LF	2,247		
8	4-inch HDPE DR 11 C906 Pipeline, with wall anchors and other appurtenances, CIP.	LF	364		
9	Flushing, disinfection and bacteriological testing, CIP.	LF	2,611		
10	Hydrostatic testing of main pipeline, CIP	LF	2,611		
Water Valve Assemblies					
11	4-inch Gate valve assembly, CIP.	EA	3		
12	2-inch flush valve assembly with above- grade discharge, CIP. Includes 2" gate valve.	EA	1		
13	1-inch air release valve assembly with enclosure, CIP	EA	2		
14	Tie-in to existing Thoreau Water system, CIP.	LS	1		
Gas Line Crossings					
15	Gas/petroleum line crossing location and exposure of gas lines per gas company requirements, CIP.	EA	1		
16	Gas/petroleum line crossing, incl. 8-inch casing, with petroleum-resistant gaskets and end seals, CIP. Excludes carrier pipe.	LF	40		
Pumphouse and Site Work					
17	Site earthwork and grading for sub-foundation, pads and driveways, CIP. Excludes surfacing material and riprap.	LS	1		
18	Well site piping, (incl. all new plumbing components within the site and drain line ROWs not separately listed), CIP. Excludes gate valves, 4-inch main line.	LS	1		
19	Pumphouse building, (incl. all structural elements), CIP.	LS	1		
20	Pumphouse building plumbing, CIP.	LS	1		
21	Gas chlorination equipment, CIP.	LS	1		
22	Site surfacing with 2-inch gravel and 3-inch NMDOT specification base course, CIP.	SY	275		
23	Site Access road surfacing with 6-inch NMDOT specification base course, CIP.	SY	373		
24	Fencing (8 ft. with 3-strand barbed wire), incl. Two 20' double swinging gates, CIP.	LF	208		

Thoreau Baca Well Connection

Quantity Summary

ITEM NO.	ITEM DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	TOTAL PRICE
Well and Pump Work					
25	Furnish & install 1" diameter schedule 40 galvanized iron well sounding line to 2' above top of pump, CIP.	LF	1000		
26	Furnish & install schedule 40, 3-inch diameter galvanized iron drop pipe with API Couplings, CIP.	LF	1000		
27	Furnish & install check valves, CIP.	EA	3		
28	Furnish & install #2 pump wire to indicated depth of 860' with 10 extra feet left coiled at well seal, CIP.	LF	1000		
29	Furnish, install, & test 50HP, 460V three phase submersible production pump & motor, final sizing and model to be determined by Engineer based on pump test results.	EA	1		
30	Furnish & install transducer & transducer wire, CIP.	EA	1		
31	Surface completion incl. furnishing and installing pitless adapter, stub-outs for discharge line and electrical conduit, 4'x4' concrete pad around well seal and appurtenances, CIP.	LS	1		
32	Supply, install, & remove test pump, flow meters, discharge lines, etc.	LS	1		
33	Develop screened intervals by pumping.	HR	24		
34	Disinfect well and perform bacteriological testing	LS	1		
35	Allowance for water quality analyses	Allow.	1	$ 5,000.00	$ 5,000.00
Electrical					
36	Well site electrical, CIP. Includes meter pole and socket. Excludes SCADA equipment listed separately and primary pole, primary conductor, transformer and meter provided by utility.	LS	1		
37	Chlorination building electrical/ HVAC, CIP.	LS	1		
38	Well electrical, CIP.	LS	1		
39	SCADA equipment, CIP	LS	1		
40	SCADA programming allowance, programming sub-contractor to be selected by Owner, CIP	Allow	1		

TOTAL OF BASE BID: $ ____________________

Tax not included

IN WORDS:____

____

Filling, Flushing, & Disinfection Plan

SMA

Filling, Testing, Flushing, and Disinfection Plan

After construction of Thoreau Baca Well Connection is completed, the following procedures shall be performed: predisinfection flushing, hydrostatic pressure and leakage testing, disinfection of all segments of the new pipeline, and bacteriological testing. These procedures shall be performed according to the industry standards referenced in each of the following plans for filling, testing, flushing, and disinfection.

Note: Coordination shall be made with the NTUA prior to filling, flushing or disinfecting the pipeline.

1. **Predisinfection Filling and Flushing**

   As specified in AWWA C605 Sec. 10.1, "prior to filling, testing, and disinfecting the installed line, the constructor shall ensure that the line is clean in conformance with ANSI/AWWA C651. To facilitate effective disinfection and minimize the chlorine dosage needed, when practicable, predisinfection flushing should continue until the discharge turbidity drops below 5 ntu, using measurement procedures described in AWWA Manual M12 (ANSI/AWWA C605-13, 2013). Predisinfection flushing shall be performed in accordance with AWWA C605 Sec. 10.2 and AWWA C651 Sec. 4.4.2. A minimum flow velocity of 3 feet per second (fps) is required, or as otherwise approved by Engineer.

2. **Filling, Hydrostatic Pressure and Leakage Testing**

   The Thoreau Baca Well Connection shall undergo hydrostatic pressure and leakage testing prior to disinfection. Test pressure parameters and the maximum allowable leakage for the Thoreau Baca Well Connection have been determined in Section 4, Hydrostatic Pressure and Leakage Test Calculations, and are summarized briefly below.

   For sections of PVC pipe, the maximum test pressure (at the lowest point in the test section) is the greater of: the DR pressure rating, or 1.25-times the actual maximum working pressure. The max allowable leakage for PVC pipe during pressure testing is determined by Equation 8-1 from AWWA M23. See Section 10, Test Hydrostatic Pressure and Leakage Calculations, for more details.

   See the following filling and testing plan and reference AWWA C605-13 (Underground Installation of PVC and PVC Pressure Pipe Fittings), AWWA M23-02 (PVC Pipe Design and Installation) and technical specification 33 11 00 (Water Utility Distribution Piping).

   1. Notify NTUA 7 days before applying pressure to pipeline.
   2. Do not perform leak tests when water is ponded on ground surface from major rain or snow storm, unless approved by engineer.
   3. Conduct hydrostatic pressure testing with potable water.
   4. Vent all air from the pipeline prior to pressurization.
   5. Fully restrain the pipeline, including permanently installed items and any temporary appurtenances used for testing, prior to pressurization.
   6. Perform testing in accordance with applicable standards:
      a. Test pressure: In accordance with the Hydrostatic Pressure and Leakage Test Calculations.

b. Simultaneous hydrostatic pressure and leakage test. The system shall be pressure tested in-ground in accordance with AWWA C605 and M23.

c. Test duration: 2 hours minimum.

d. Engineer may require longer duration test (up to 24 hours) if there is any doubt as to integrity of the pipe or appurtenances.

7. In no case shall the test pressure exceed the manufacturers' recommended maximum safe test pressure for the pipe, fittings or appurtenances.
8. No observable leakage is allowed, if leakage is detected halt test. Measurable leakage must be within the maximum allowable limits set forth by applicable AWWA and ASTM standards including AWWA C605 Sec. 10.3.6 and as presented in the Thoreau Baca Well Connection Hydrostatic Pressure and Leakage Test Calculations.
9. Any leaks detected during testing shall be repaired after pipe is depressurized. After repairs are completed, another full duration test shall be performed on the section of the pipeline to which the repairs were made.
10. All hydrostatic pressure and leakage tests will be witnessed by NTUA personnel.
11. Repeat test until acceptance criteria is achieved.

3. Pipeline Flushing and Disinfection Plan

Disinfection of the Thoreau Baca Well Connection shall be performed in accordance with the continuous-feed method of chlorination as set-forth in AWWA C651. Only properly designed and constructed equipment for this method shall be used.

The disinfection chemicals may be one of the following, with regard to the corresponding standard: Hypochlorite (AWWA B300), Liquid Chlorine (AWWA B301), Ammonium Sulfate (AWWA B302), and Sodium Chlorite (AWWA B303).

See the following flushing and disinfection plan and reference AWWA C651-14 (Disinfecting Water Mains), AWWA C605-13 (Underground Installation of PVC and PVCO Pressure Pipe Fittings), AWWA M12 (Simplified Procedure for Water Examination), AWWA C655-09 (Field Dechlorination), and Technical Specification 33 13 00.C (Disinfection of Water Utility Transmission Systems).

1. Introduce treatment into piping system and perform disinfection in accordance with AWWA C651 Sec. 4.4.3 which states that at a point not more than 10 ft downstream from the beginning of the new main, water entering the new main shall receive a dose of chlorine fed at a constant rate such that the water will have not less than 25 mg/L free chlorine.

    a. Measure chlorine concentration at all sampling ports provided on the drawings including air valve vaults and building plumbing.

    b. Per AWWA C651 Sec. 4.4.3, the free chlorine concentration shall be measured at regular time intervals in accordance with the procedures described in Standard Methods for the Examination of Water and Wastewater or AWWA Manual M12.

2. Maintain disinfectant in system for 24 hours, or 48 hours if the temperature is less than 41 degrees Fahrenheit.
    a. During this period, valves and hydrants in the treated section shall be operated to ensure disinfection of the appurtenances.
    b. At the end of this period, the treated water in all portions of the main shall have a residual of not less than 10 mg/L (10 ppm) of free chlorine.
    c. Ensure that a disinfection report is generated and includes items listed below:
        1) Type and form of disinfectant used.
        2) Date and time of disinfectant injection start and time of completion.
        3) Test locations.
        4) Name of person collecting samples.
        5) Initial and 24 hour disinfectant residuals in treated water in ppm for each outlet tested.
        6) Date and time of flushing start and completion.
        7) Disinfectant residual after flushing in ppm for each outlet tested.
3. Flush, circulate, and clean using domestic water.
    a. Neutralize residual chlorine to levels normally associated with potable water prior to discharging water to the environment.
        1) If dechlorination is required, refer to AWWA C655 (Field Dechlorination) for the procedure.
    b. Flush pipeline until chlorine concentration in water leaving pipeline is no higher than that of the water used for flushing or 0.4 ppm, whichever is greater.
4. After final flushing and before pipeline is placed in service, sample, test and certify that water quality is suitable for human consumption, in accordance with AWWA C651.
    a. At least one set of bacteriological samples shall be collected from every 1,200 LF of new waterline, plus one set at each end of the line, unless otherwise approved by NTUA and the Engineer.
    b. Ensure that a bacteriological report is generated and includes items listed below:
        1) Date issued, project name, and testing laboratory name, address, and telephone number.
        2) Time and date of water sample collection.
        3) Name of person collecting samples.
        4) Test locations.
        5) Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
        6) Coliform bacteria test results for each outlet tested.

7) Certify water conforms, or fails to conform, to bacterial standards of authority having jurisdiction.

c. Certify that the water conforms to the quality standards of the authority having jurisdiction and is suitable for human consumption.

d. In the event that the performed water quality testing fails, the affected portions of the system will be disinfected again, and retested.

e. The new pipeline shall not be put in service until all testing and disinfection is completed, and all bacteriological test results certifying that the water is free of coliform bacteria contamination.

5. Replace any permanent system devices removed for disinfection.

4. <u>Well and Disinfection Plan</u>

1. Immediately after well development by zoned air-lift pumping or swabbing is complete and prior to installing the test pump, the Contractor shall completely disinfect the well, per AWWA C-654 and AWWA 100 Section 4.9. Sixty-five percent HTH granular calcium hypochlorite shall be distributed evenly throughout the water column with a chlorine-basket. The chlorine basket shall have a fine mesh exterior and be of such design so that is can be lowered on a wire line to the full depth of the well and be capable of holding at least 10-pounds of chlorine. Disinfection with sodium hypochlorite will not be allowed with the exception of filter pack installation.

2. The quantity of chlorine used shall be equal to ½-pound for each 100 feet of water column in the well. The quantity of chlorine shall be sufficient to initially produce a chlorine concentration of 100 milligrams per liter (mg/l). Based on the above ratio, the total quantity of chlorine shall be determined and placed in the chlorine basket. The basket shall then be run to the bottom of the well on a wire line and slowly retrieved. This process shall be repeated until all of the chlorine has dissolved. The chlorine-bearing solution shall remain in the well for a period of at least 24 hours.

3. In conjunction with disinfection with the chlorine basket, the Contractor shall wash the upper casing with a solution of chlorine and water. The solution shall be mixed in the ratio of 1pound of chlorine for each 1,000 gallons of potable water, yielding a chlorine concentration of at least 100 mg/l. The inside of the production casing and the gage line shall be washed with the solution followed by thorough flushing with potable water.

4. During the time interval between disinfection, as described above and installation of the test pump, the well shall be capped with a 3/8-inch steel plate securely welded to the casing.

5. Bacteriological Testing

   a. In order to determine if the well contains unacceptable numbers of bacteria, the Contractor shall collect and properly preserve water samples from the well for bacteriological testing. No residual chlorine may be detected at the time of sampling. Bacteriological testing shall be performed and approved results received prior to the completion of pumping.

b. Bacteriological tests shall include total coliforms (presence/absence method). The water shall be deemed unacceptable if coliform bacteria are “present” in the collected water samples.

c. It shall be the Contractor’s responsibility to see that the well is so tested and, if unacceptable, follow the disinfection procedures specified by the Engineer. Disinfection and subsequent testing shall continue until test results are approved, indicating acceptable conditions, or until a maximum of three disinfection procedures have been followed as outlined in the paragraph of this specification entitled “Disinfection After Air-Lift Pumping”. If additional disinfection procedures are required, they shall be paid at the unit bid price.

d. Results of all bacteriological testing shall be provided for approval prior to the use of the well.