| | |
|---|---|
| **TO:** | Tonia Herrera, P.E., Nevada Irrigation District<br>Gary King, P.E., Nevada Irrigation District |
| **FROM:** | Youssif Hussein, P.E., IDModeling, Inc.<br>Jennifer Wood, P.E., IDModeling, Inc. |
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| **DATE:** | January 23, 2018 |

# 1.0 Introduction

IDModeling, Inc. (IDM) has developed this technical memorandum (TM) for the Nevada Irrigation District (NID/District) to summarize the results of the Lake Vera, Rock Creek, and Bloomfield Proposed System Evaluation (Project). The Project is to determine the size of the proposed water mains and location of other facilities such as pressure reducing valve stations (PRVs) and booster stations as an extension to the Elizabeth George (EG) system. Additionally, the evaluation assesses the impact of the proposed network on the EG existing system. The system was evaluated under peak hour demand (PHD) conditions to meet minimum system pressures and under maximum day demand (MDD) to meet fire flow (FF) requirements. The Project goals are listed below:

- Develop demands for the proposed network using parcels land-use designation and allocate demands to model junctions.
- Perform peak hour demand (PHD) model runs to evaluate system pressures under normal system operation and maintain minimum pressure of 40 psi.
- Perform fire flow model runs to evaluate available fire flow by maintaining 20 psi across the proposed system and limiting the maximum velocity to 10 ft/s during maximum day demand conditions.
- Evaluate the impact of the additional demands on the EG existing system.

This TM includes the following sections and attachments:

**Section 1** – Introduction
**Section 2** – System Description
**Section 3** – Model Setup
**Section 4** – System Evaluation
**Section 5** – Conclusions and Recommendations

**Appendix A** – Elevation and HGL Profiles

## 2.0 System Description

The proposed network follows Lake Vera Purdon Rd, Rock Creek Rd, and North and South Bloomfield Rd and will be served as an extension to the EG system. Based on topography, one area of the proposed network will be served by Harmony Ridge Tank at a hydraulic grade line (HGL) of 3,272 feet and the other area will be served by Snow Mountain Tanks at an HGL of 2,942 feet. **Figure 1** below shows the parcels that will be served by each area, and **Figure 2** shows the system layout with elevation contours and pipes color coded by diameters. To better understand the layout of the proposed system, three elevation profiles were created to illustrate the extent of the change in elevation along the alignments of the proposed pipelines. **Attachment A** shows the plan view of the profiles as well as the elevation profiles. The elevation profiles also show the HGL under PHD conditions.

The area served by Harmony Ridge Tank consists of rolling hills with elevation ranging from 2,557 to 3,193 feet above mean sea level (MSL). This range results in an elevation drop of 275 psi. Portions of this area will be served by gravity, booster stations, and PRV stations.

The area served by Snow Mountain Tanks consists of rolling hills with elevation ranging from 2,335 to 2,635 feet above MSL. This range results in an elevation drop of 130 psi. Portions of this area will be served by gravity and portions by PRV stations.

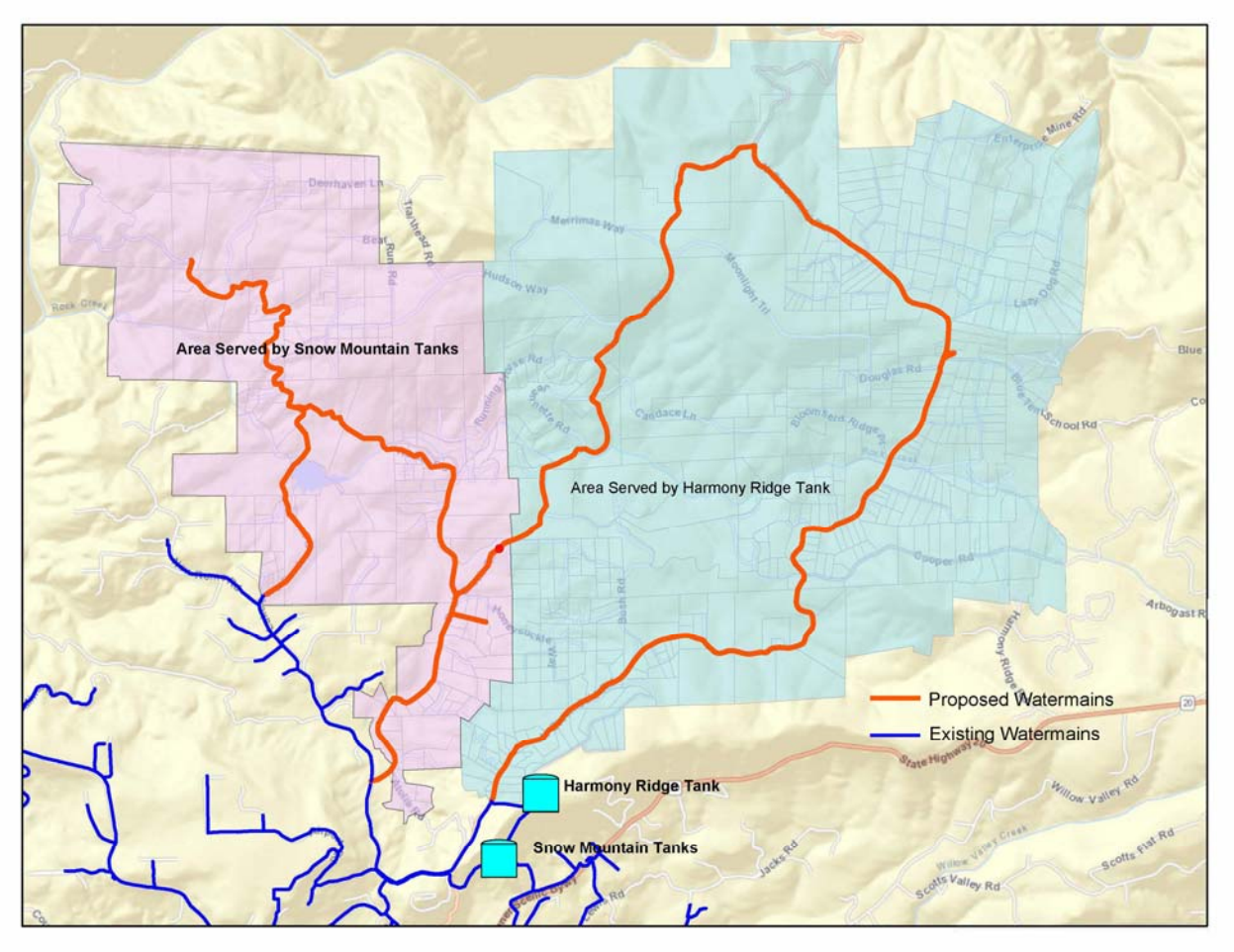



**Figure 1 - Service Areas**

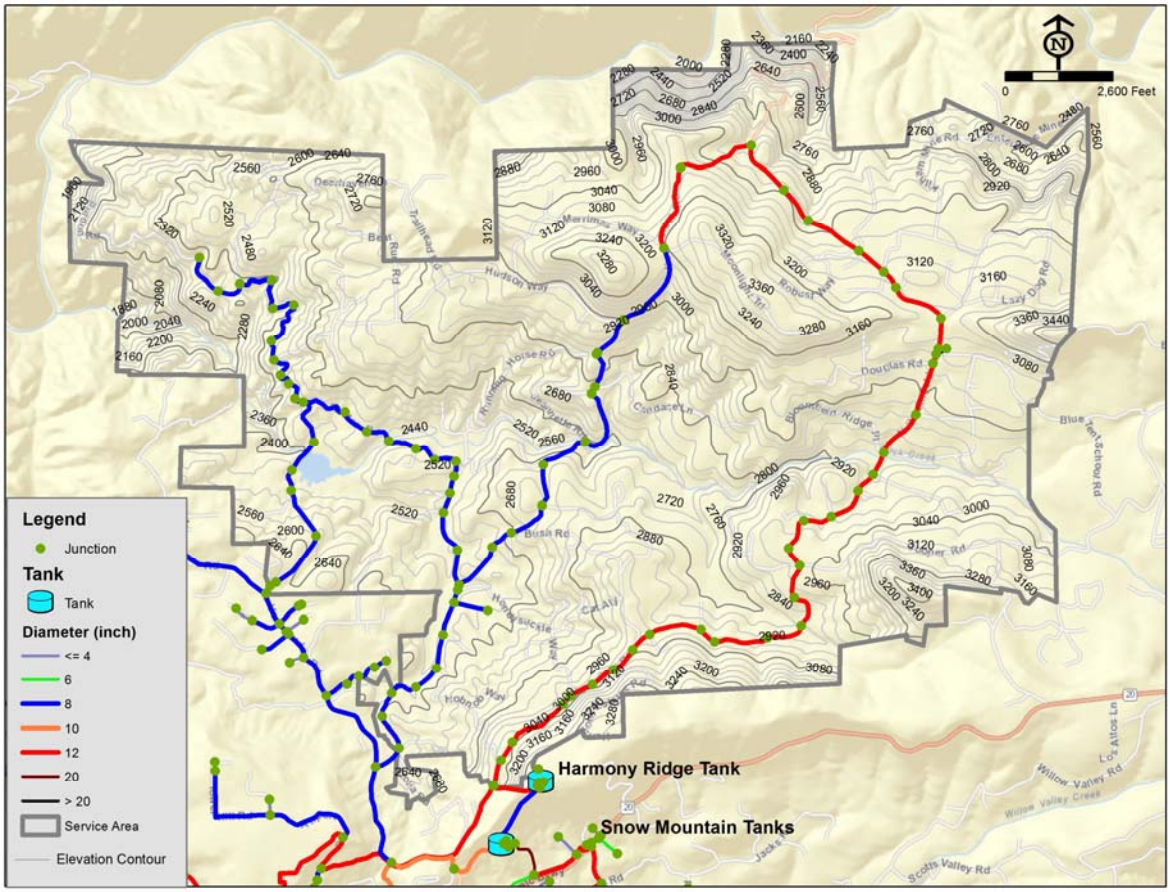



**Figure 2 - Proposed System Layout**

# 3.0 Model Setup

## 3.1 Pipes

The proposed pipe system was added manually to the model by using an initial layout provided by the District. The alignment of the pipes followed the roads as shown on the online ESRI "World Street Map" which was used as a background. Nodes were added at street intersections and at multiple low and high elevations to capture the definition of the system profile. The model automatically calculated pipe length based on the digitized length of the pipes between nodes. A roughness coefficient of 130 was used for the new pipes.

## 3.2 Node Elevation

Digital Elevation Models (DEMs) were used to calculate the model junction elevations. These DEMs consist of a raster grid of regularly spaced elevation values that have been primarily derived from the USGS topographic maps. For this system, maps with 10-meter resolution were used.

The InfoWater tool "Elevation Extractor" was used to process the model junctions with the DEMs raster file to obtain the junction elevations. This topographic information is appropriate for this planning level of analysis.

## 3.3 Demand Allocation

The GIS parcel database was used to calculate demands based on parcel size. If parcel area is less than 10 acres, one (1) dwelling unit was assumed with a MDD of 1.20 gpm. Parcels larger than 10 acres were split by multiple of 10 acres and assigned corresponding demands.

The overall MDD for the proposed system is 1,026 gpm. **Table 1** below summarizes demand by land use zoning designation.

**Table 1 – Demand Estimation**

| Zoning | Area (ac) | MDD (gpm) | PHD (gpm)* |
|---|---|---|---|
| AG-10 | 915.9 | 234.7 | 469.5 |
| AG-20 | 1234.4 | 197.0 | 394.0 |
| AG-30 | 827.7 | 182.9 | 365.7 |
| AG-40 | 208.4 | 30.6 | 61.2 |
| AG-X | 65.7 | 14.4 | 28.8 |
| FR-40 | 364.5 | 46.9 | 93.9 |
| FR-X | 171.0 | 20.5 | 41.0 |
| OS | 1082.4 | 0.0 | 0.0 |
| P | 0.9 | 1.2 | 2.4 |
| RA-10 | 672.8 | 165.1 | 330.3 |
| RA-3 | 183.8 | 49.0 | 97.9 |
| RA-3;RA-10 | 8.8 | 2.4 | 4.8 |
| RA-5-PD | 207.8 | 24.9 | 49.9 |
| RA-X-PD | 47.9 | 13.2 | 26.4 |
| (blank) | 345.5 | 43.3 | 86.6 |
| Total | 6337 | 1026 | 2052 |

*PHD were calculated using a factor of 2.0 times MDD.

Demands were allocated to the appropriate junctions (nodes) of the proposed network using the GIS and model tools. GIS tools were used to calculate the centroid of each parcel to represent the parcel

demand location. Model tool "Demand Allocator" was used to allocate parcel demand to the nearest pipe and nearest junction.

**Table 2** below summarizes system demands by service area which includes demands of 50 gpm for the "Rock Creek Pipeline Analysis." where the analyzed system has not been built yet. Service area boundaries are shown above in **Figure 1**.

**Table 2 – Demand by Service Area**

| Service Area | MDD (gpm) | PHD (gpm) |
|---|---|---|
| Harmony Ridge | 697 | 1,394 |
| Snow Mountain | 329 | 658 |
| Total | 1,026 | 2,052 |

# 4.0 System Evaluation

To determine the adequate pipe sizes of the proposed network, two demand scenarios were considered for this evaluation. One scenario for PHD to evaluate the system performance under normal PHD conditions and one scenario for MDD + FF to evaluate the system performance under high demand conditions.

## 4.1 Evaluation Assumptions and Criteria

The following assumptions were made for the evaluation:

- PHD in the model for the proposed network is 2,052 gpm (2.95 MGD)
- MDD in the model for the proposed network is 1,026 gpm (1.48 MGD)

**Table 3** summarizes the criteria used for this evaluation.

**Table 3 – Evaluation Criteria**

| Criteria | Value |
|---|---|
| Minimum pressure during normal operating conditions | 40 psi for future connections |
| Minimum pressure during MDD plus fire flow | 20 psi |
| Maximum velocity during MDD plus fire flow | 10 ft/s |
| Fire flow Requirement | 1,000 gpm |
| Pumping capacity to provide | MDD |
| MDD peaking factor: | 2.5 x ADD |
| PHD peaking factor: | 5 x ADD |

## 4.2 Scenario 1 – PHD Conditions

This scenario has the following parameters:

- **Demand Condition:** Future PHD (2,052 gpm)
- **Model Changes:** Proposed network
- **Simulation Option:** Steady State at PHD

The PHD simulation was performed with initial pipe diameter of 8-inch for the entire proposed network. Model results showed that the pipelines served by Snow Mountain Tanks are adequate, but the pipelines served by Harmony Ridge Tank are inadequate and exhibiting high head loss resulting in low pressure as shown on **Figure 3**.

The PHD simulation was repeated by upsizing those pipelines with high head loss to 12-inch diameters. Model results showed that there are still few locations where the pressure is below the 40 psi minimum required. The low pressure is not due to head loss but it is due to higher elevation. The model results also showed that there are locations with high pressure exceeding the maximum 160 psi. **Figure 4** shows the model simulation results.

To correct the low pressure due to high elevation, two booster stations were needed. **Table 4** below lists the locations and the required size of pumps to meet the PHD. **Figure 5** shows the locations of these two booster stations.

**Table 4 – PHD Booster Station Capacity**

| Location | TDH (ft) | Flow (gpm) | Calculated HP | Standard Size HP |
|---|---|---|---|---|
| N. Bloomfield Rd at Blue Tent School Rd | 50 | 650 | 12 | 15 |
| Rock Creek Rd west of N. Bloomfield Rd | 120 | 250 | 11 | 15 |

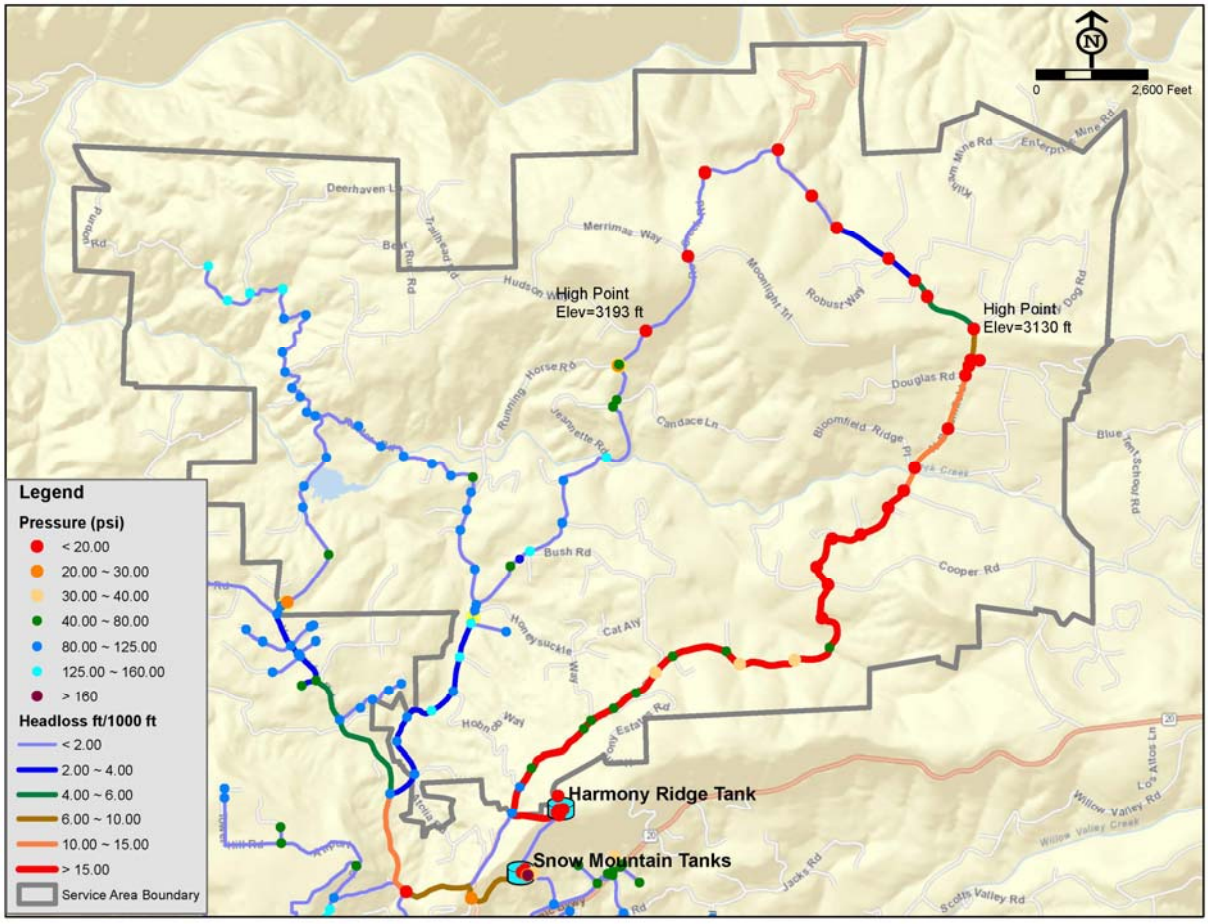



**Figure 3 – PHD Initial Model Results with 8-inch Pipe diameters**

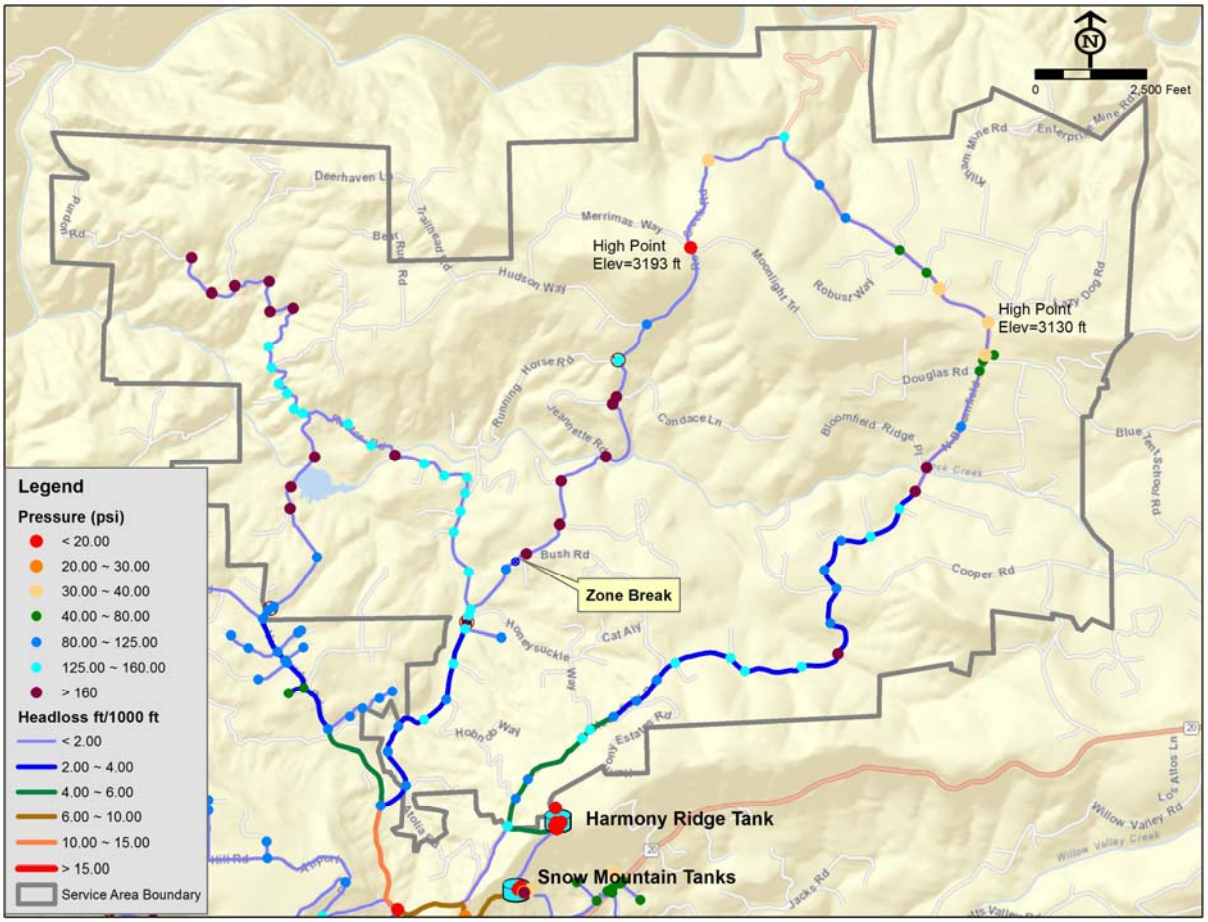



**Figure 4 – PHD Model Results with 12-inch Pipe Diameters**

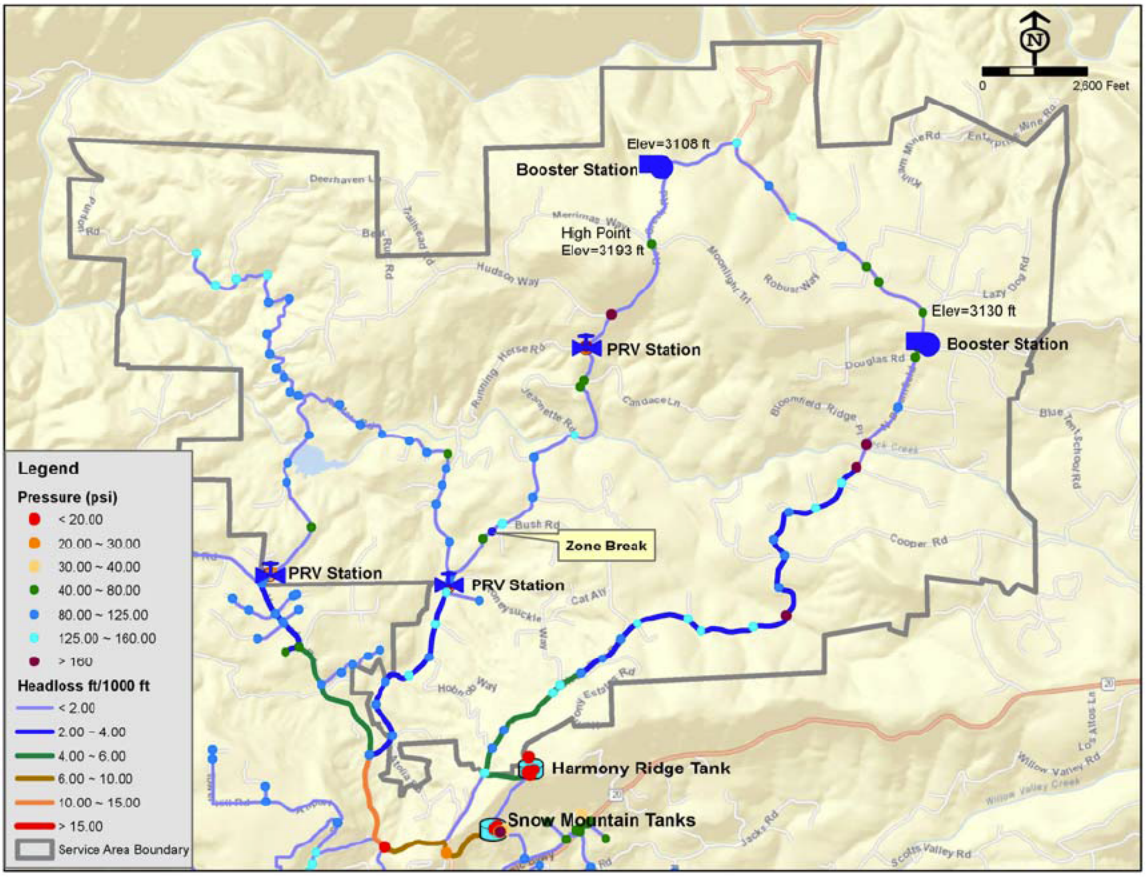



**Figure 5 – PHD Model Results with 12-inch Pipe Diameters, Booster Stations, and PRV Stations**

To mitigate the high pressure due to low elevations, PRV stations were needed. **Table 5** below lists the locations and the settings required to maintain pressure within the criteria.

**Table 5 - PRV Station Setting and Capacity**

| Location | Elevation (ft) | Setting (psi) | HGL (ft) | Flow (gpm) | Size (in) |
|---|---|---|---|---|---|
| Rock Creek Rd at Running Horse Rd | 2851 | 30 | 2920 | 140 | 2 |
| Rock Creek Rd at Honeysuckle Way | 2509 | 80 | 2694 | 290 | 3 |
| Lake Vera Purdon Rd at Charden Rd | 2635 | 25 | 2693 | 270 | 3 |

The area served by Harmony Ridge Tank has a higher HGL than that served by Snow Mountain Tanks. For this analysis a closed valve located near the intersection of Rock Creek Road and Bush Rd was simulated to separate the two systems. Once the area is built it is recommended to install a 2-inch PRV to allow for flow circulation and improve water quality.

It is worth noting that there are locations within the study area boundary that have high elevation and may require booster stations. The focus of this evaluation was on the main loop as identified by the District. Additional analysis is required to determine the size of the new facilities to serve those localized areas.

## 4.3 Scenario 2 – MDD + FF Analysis

This scenario has the following parameters:

- **Demand Condition:** Existing Conditions MDD + FF (1,026 MDD gpm)
- **Model Changes:** Proposed Network
- **Simulation Option:** Fire flow at Steady State MDD

This MDD plus fire flow scenario was performed to evaluate the proposed system adequacy to meet fire flow requirement of 1,000 gpm. Fire flows were evaluated at all junctions with demands (service nodes) within the proposed service area. To be conservative, fire flow was assumed to be provided from the existing Harmony Ridge Tank and the Snow Mountain Tank set at 50 percent full. This level was determined by assuming the fire flow could occur during PHD where tank levels could be about 75 percent full. The fire flow analysis was performed to determine the available fire flow while maintaining a minimum 20 psi across the service area and limiting the maximum pipe flow velocity to 10 ft/s. **Figure 6** shows the fire flow results.

To meet fire flow requirement at high elevation areas two fire flow pumps are needed at the same locations as PHD pumps. **Table 6** below lists the locations and the required size of pumps to meet the MDD + FF demand conditions.

**Table 6 – MDD + FF Booster Station Capacity**

| Location | TDH (ft) | Flow (gpm) | Calculated HP | Standard Size HP |
|---|---|---|---|---|
| N. Bloomfield Rd at Blue Tent School Rd | 50 | 1350 | 24 | 25 |
| Rock Creek Rd west of N. Bloomfield Rd | 100 | 1150 | 41 | 50 |

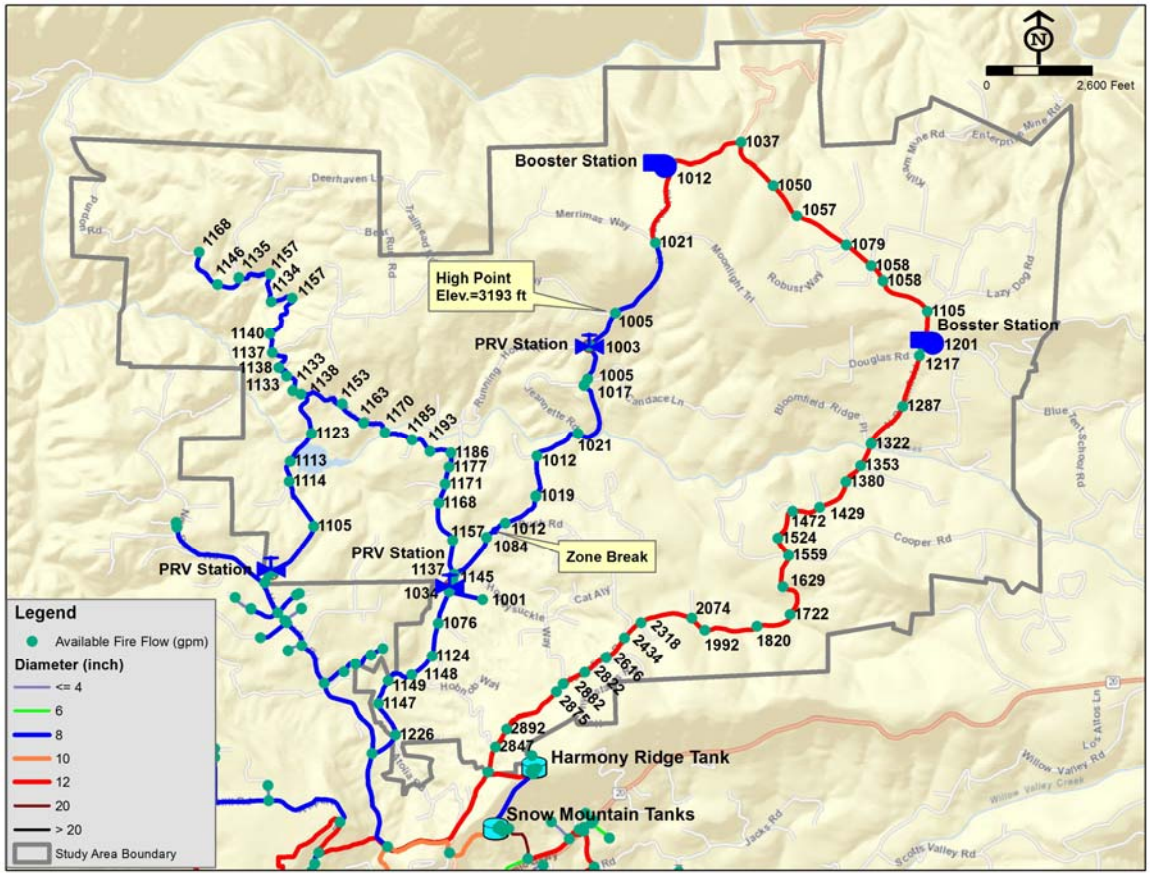



**Figure 6 – Available Fire Flow (gpm) at MDD**

## 4.4 Assessing Impact on Existing System

The impact of the proposed system was evaluated on pipes, pumping capacity, and storage capacity.

### *4.4.1 Existing Pipes*

The existing pipelines that supply the proposed system from the Harmony Ridge Tank and the Snow mountain tanks are adequate with flow velocities less than 6 ft/s.

### *4.4.2 Storage Capacity Evaluation*

To assess the impact of the additional demand on the existing storage, the following storage capacity requirements were considered (as shown in **Table 2**):

- Operational storage (25 % of MDD)
- Fire flow storage (1,000 gpm for 2-hour duration)
- Emergency storage (75 % of MDD)

**Table 7** summarizes the storage capacity evaluation for existing demand conditions.

**Table 7 – Storage Evaluation for Future Conditions**

| North Auburn System | MDD (MGD)[1] | Maximum FF Requirement (gpm)[2] | Storage Requirements (MG) | | | | Existing Storage (MG) | Storage Deficit (MG) | Storage Surplus (MG) |
|---|---|---|---|---|---|---|---|---|---|
| | | | Operational & Emergency (25% MDD) | Operational & Emergency (75% MDD) | Fire Reserve (MG) | Total Storage Needed (MG) | | | |
| Area Served by Harmony Ridge Tank | 2.03[3] | 1,000 | 0.51 | 1.52 | 0.12 | 2.15 | 1.00 | -1.15 | - |
| Area Served by Snow Mountain Tanks | 1.55[4] | 1,000 | 0.39 | 1.16 | 0.12 | 1.67 | 1.62 | -0.05 | - |

Notes:
[1] Maximum Day Demand = 2.5 * Average Day Demand
[2] Fire flows are assumed to be 1,000 gpm with 2-hour duration for residential.
(3) Includes proposed system demand plus other demands served by Harmony Ridge tank
(4) Includes proposed system demand plus other demands served by Snow Mountain Tanks

The storage capacity evaluation showed that the Future system storage is inadequate to accommodate the additional demand of the proposed system. Snow Mountain tanks are marginally deficient, but Harmony Ridge tank shows a significant deficit of 1.15 mg.

## 4.5 Pumping Capacity Evaluation

The proposed system is supplied by the Harmony Ridge Tank which is in turn supplied by the Snow Mountain pump station which draws suction from the Snow Mountain tanks at the same site. The Snow Mountain tanks are supplied by the Joeday pump station. **Figure 7** below is a system elevation schematic that shows how the proposed system will be supplied from the existing system. Pumps are normally sized to deliver MDD using pump station firm capacity by assuming the largest unit as a standby. **Table 8** summarizes the pumping capacity evaluation.

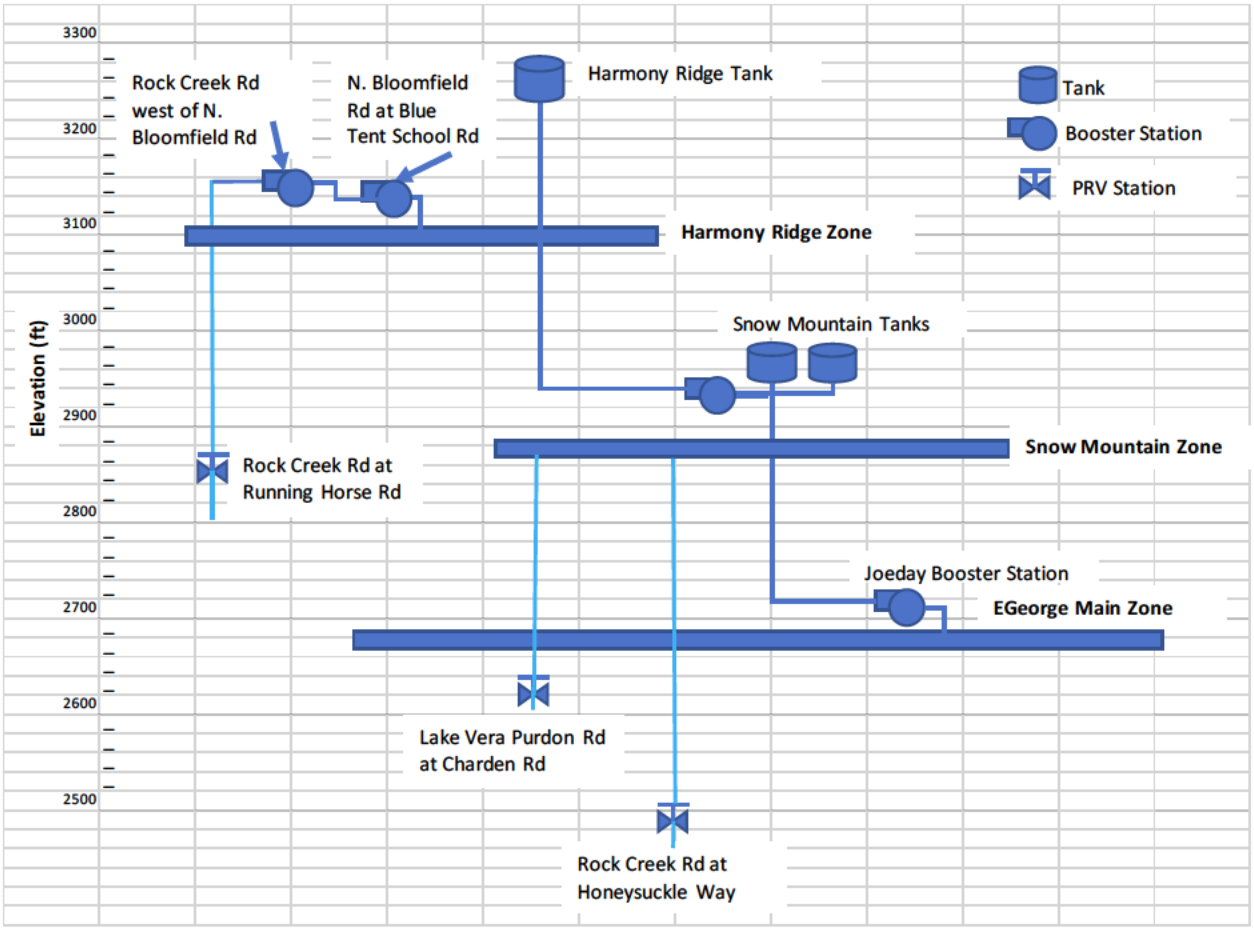



**Figure 7 – System Elevation Schematic**

**Table 8 – Pumping Capacity Evaluation for Future Conditions**

| Water System | ADD (gpm) | MDD (gpm) | Total No. of Pumps | Total Pump Capacity (gpm) | Firm Pumping Capacity [1] (gpm) | Pumping Deficit (gpm) | Pumping Surplus (gpm) |
|---|---|---|---|---|---|---|---|
| Served by Joeday PS | 1,180 | 2,951 | 2 | 1,200 | 600 | 2,351 | - |
| Served by Snow Mountain PS | 578 | 1,444 | 2 | 520 | 260 | 1,184 | - |

[1] Firm capacity assumes the largest unit as a standby

The pumping capacity evaluation for the future demand conditions showed that the existing pumping capacity is inadequate to accommodate the additional demand of the proposed system.

# 5.0 Conclusions and Recommendation

The following conclusions and recommendations were developed based on the results of the evaluations as presented in the previous sections:

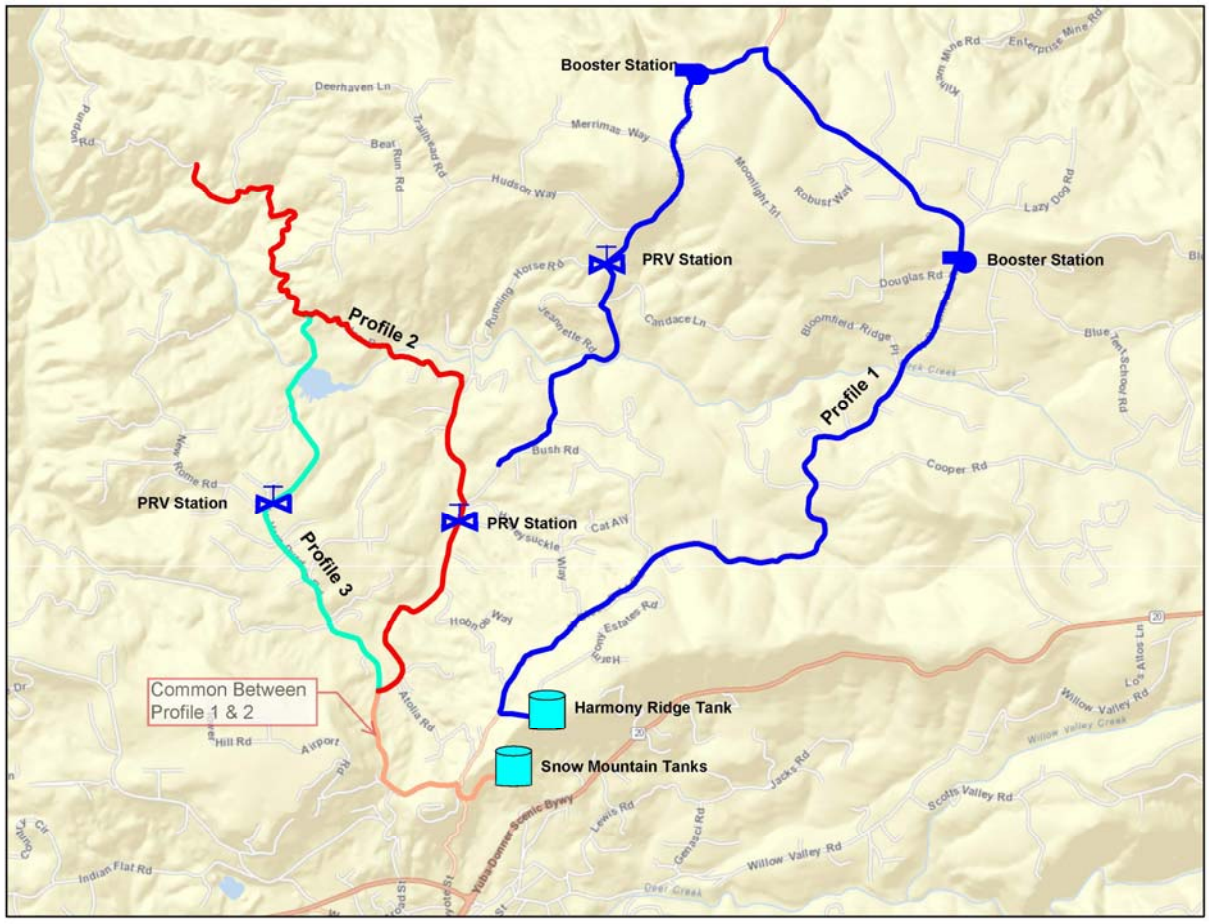
- **Pipelines:** No pipeline improvements are needed in the existing system that serve the proposed network. Velocities are less than 6 ft/s.
- **Pump Stations:** The existing pumps that will supply the proposed system do not have adequate capacity to serve the future demands. For the proposed system, two booster stations were needed, each sized to meet peak hour demands and MDD + FF requirements.
- **Storage Capacity**: The existing Harmony Ridge tank does not have adequate capacity to serve the combined existing and proposed system and shows a storage deficit of 1.15 MG. The Snow Mountain tanks are marginally deficient with a shortage of 0.05 MG.
- **New Storage**: The hydraulic analysis initially evaluated having a tank within the project area. However, the existing Harmony Ridge tank current demand is low resulting in operating it at a level to maintain circulation and improve water quality. If a new tank were built within the project service area, it would most likely suffer poor circulation due to low demand and experience water quality issues, thus being operated at a lower level than ultimately designed. For the near-term growth, the demand will be met from the existing Harmony Ridge tank as the new tank is not required for hydraulic performance. However, as the project area continues to develop, it is recommended that a study be further conducted to evaluate the storage in the area to determine the size and timing of the new storage.
- **PRV Stations:** For the proposed system, three PRV stations were needed to reduce high pressure due to low elevations. One PRV station in the area that will be supplied by Harmony Tank and two (2) PRV stations in the area that will be served by Snow Mountain tanks.
- **Zone Valve:** A 2-inch PRV is recommended between the system served by Harmony Ridge Tank and the system served by Snow Mountain tanks to allow for flow circulation and improve water quality.
- **Peak Hour:** The proposed system was sized to meet PHD conditions to maintain a minimum pressure of 40 psi.
- **Fire Flow:** The proposed system was sized to meet fire flow of 1,000 gpm during MDD while maintaining a minimum pressure of 20 psi across the system and limiting the flow velocity to 10 ft/s.

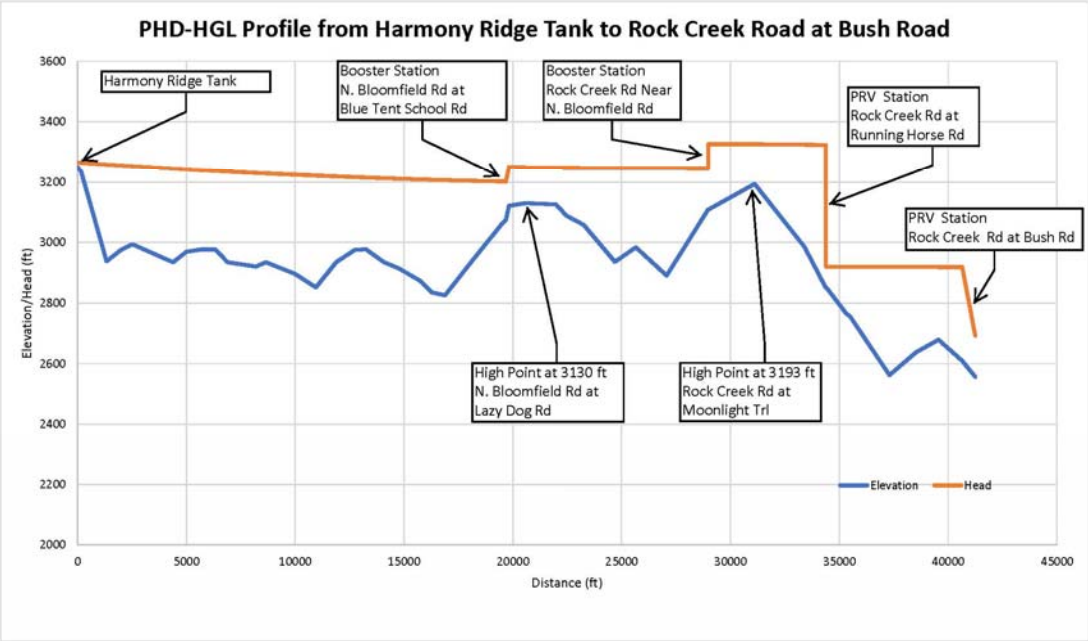
There are areas within the study area boundary with higher elevations that will require a detailed evaluation, once those areas are developed, to determine the required infrastructure to provide adequate service.

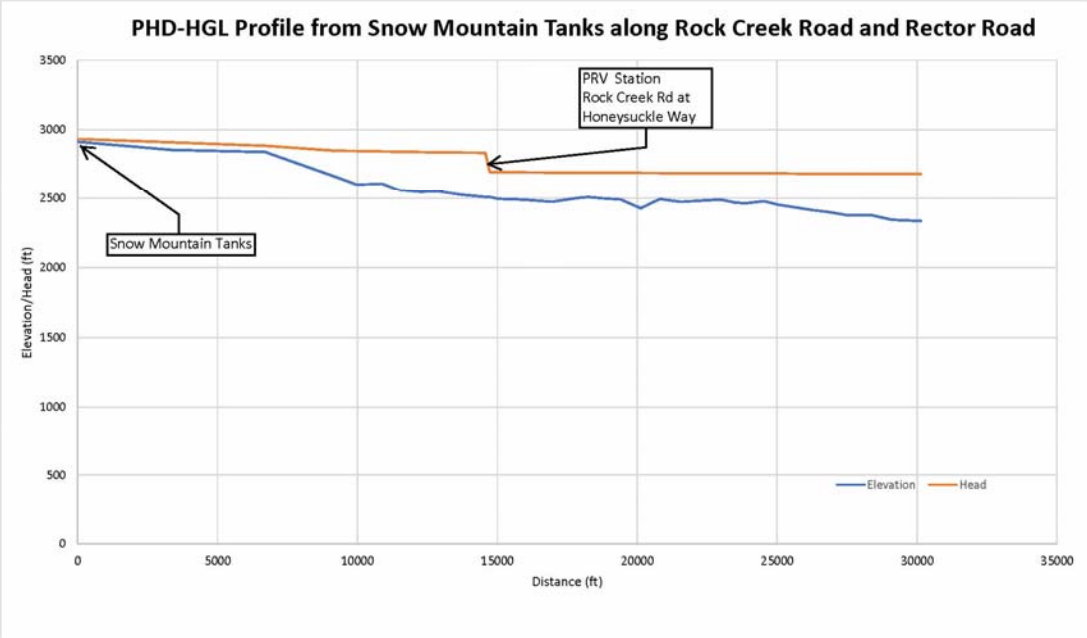
Nevada Irrigation District

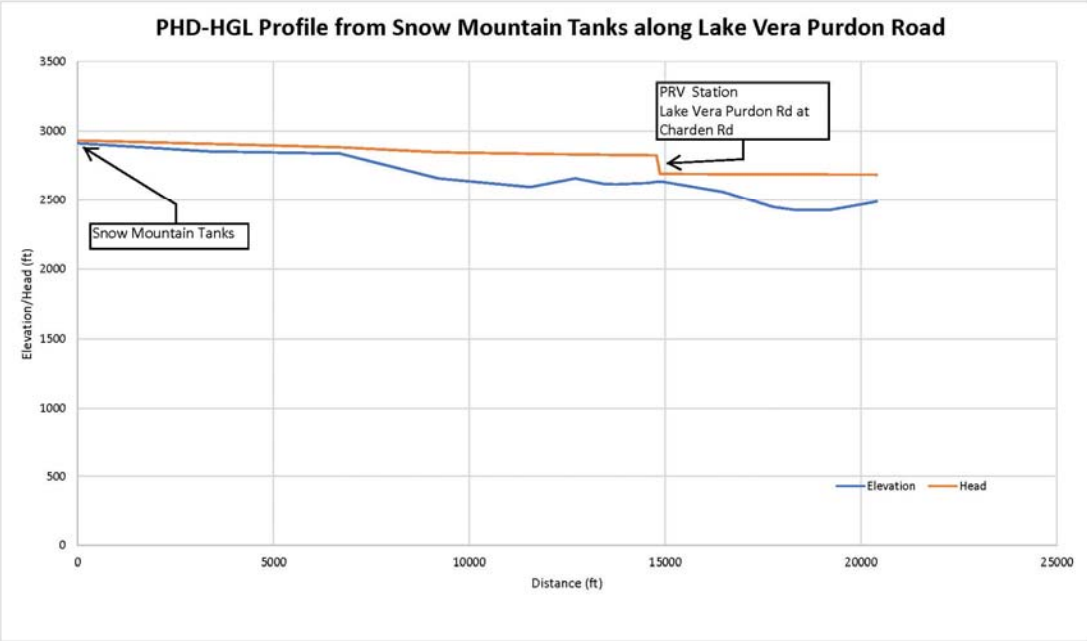
# Appendix A -
# Elevation and HGL Profiles

## Plan View of Elevation Profiles




PHD-HGL Profile from Harmony Ridge Tank to Rock Creek Road at Bush Road
Harmony Ridge Tank
Booster Station
N. Bloomfield Rd at
Blue Tent School Rd
Booster Station
Rock Creek Rd Near
N. Bloomfield Rd
PRV Station
Rock Creek Rd at
Running Horse Rd
PRV Station
Rock Creek Rd at Bush Rd
High Point at 3130 ft
N. Bloomfield Rd at
Lazy Dog Rd
High Point at 3193 ft
Rock Creek Rd at
Moonlight Trl
Elevation
Head
Elevation/Head (ft)
Distance (ft)
3600
3400
3200
3000
2800
2600
2400
2200
2000
0
5000
10000
15000
20000
25000
30000
35000
40000
45000


PHD-HGL Profile from Snow Mountain Tanks along Rock Creek Road and Rector Road
PRV Station
Rock Creek Rd at
Honeysuckle Way
Snow Mountain Tanks
Elevation
Head
Elevation/Head (ft)
Distance (ft)
3500
3000
2500
2000
1500
1000
500
0
0
5000
10000
15000
20000
25000
30000
35000


PHD-HGL Profile from Snow Mountain Tanks along Lake Vera Purdon Road
PRV Station
Lake Vera Purdon Rd at
Charden Rd
Snow Mountain Tanks
Elevation/Head (ft)
Distance (ft)
Elevation
Head
3500
3000
2500
2000
1500
1000
500
0
0
5000
10000
15000
20000
25000