Luhdorff & Scalmanini
Consulting Engineers

TECHNICAL MEMORANDUM

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SUBJECT: REVISED North Davis Meadows Irrigation System Feasibility Study

1. BACKGROUND

The North Davis Meadows (NDM) County Service Area (CSA) is a rural-residential enclave in Yolo County, nestled just west of Highway 113, between the cities of Davis and Woodland, California. Home to 96 single-family residences, each property boasts large lots with extensive grass and landscaping areas. Historically, the community's water needs, both for drinking and irrigation, have been served by two groundwater well pump stations and an accompanying distribution system. However, due to persistent nitrate contamination issues, NDM is in the process of consolidating its drinking water services with the City of Davis, aiming to enhance water quality and safety for its residents.

As part of this consolidation, and to address the anticipated increase in water costs associated with using potable water for irrigation under the new City of Davis water rates, NDM is considering the installation of a completely new and separate irrigation supply system. This initiative is driven by the goal to provide a cost-effective and sustainable solution for irrigating the community's large lots, while the City of Davis will take over the provision of drinking water post-consolidation.

To explore this possibility, NDM has engaged Luhdorff and Scalmanini Consulting Engineers (LSCE) to conduct a feasibility study. This study aims to assess the viability of establishing a dedicated irrigation system, including reviewing potential infrastructure configurations, estimating irrigation water demand, and developing preliminary operating and capital cost projections. This technical memorandum summarizes LSCE's findings, offering insights into the feasibility, potential benefits, and financial implications of implementing a standalone irrigation system in the NDM community.

2. EXISTING FACILITIES

Overview

The existing North Davis Meadows water system includes two groundwater pump stations: NDM 1 and NDM 2. NDM 1 is located on Fairway Drive between Larkspur Place and N Start Place and includes a well, submersible pumping equipment, a hydropneumatic tank, a storage tank, disinfection equipment, three booster pumps rated for the demands of the existing distribution system, a fire pump, an emergency generator, and associated piping and electrical equipment. The site is enclosed by a wooden fence. Based on a review of the NDM improvement plans and other existing data, it is assumed that NDM 1 was installed as part of NDM Phase I in 1987.

NDM 2 is located off a paved access road that extends from Black Hawk Place. The site includes a well, submersible pumping equipment, variable frequency drive (VFD), disinfection equipment, and associated piping and electrical equipment enclosed by a chain-link fence with privacy slats. Based on a review of the NDM improvement plans, it is assumed that NDM 2 was installed as part of NDM Phase 2 in 1996.

Field and Data Reviews

Following our evaluation of existing system records provided by the County, LSCE undertook a detailed field inspection of NDM 1 and NDM 2 facilities. LSCE also reviewed the project design plans outlining the scope of work to replace the existing NDM potable water system. This section presents our findings, grounded in both the recent field visit and an extensive review of existing data, to offer a holistic view of the current system's condition and operational efficacy. Should the NDM community require more detailed information regarding the expected lifespan of the existing infrastructure, it is recommended that additional condition assessments be conducted by experts specialized in the specific infrastructure, such as booster pump manufacturers, tank coating specialists, and others.

Wells

Based on a review of the NDM improvement plans and other existing data, it is assumed that NDM Well 1 is 37 years old, and NDM Well 2 is 30 years old. The typical lifespan of a well can range widely but is often between 25 to 50 years. Decisions on whether to replace a well should consider not only its age but also the results of the comprehensive evaluations, the cost of ongoing maintenance versus replacement, and projected future water needs. Additionally, wells often require rehabilitation every 8 to 15 years, depending on usage intensity, water quality, and maintenance practices. Based on a review of the NDM improvement plans and other existing data, it is assumed that both wells will require replacement in the next 10 years given their age.

Well Pumps

Per discussion with system operators during a field review, the submersible well pumps were replaced 7 years ago. Pump test data from 2010 indicates that NDM 1 is capable of pumping approximately 460 gallons per minute (gpm), and NDM 2 is capable of pumping 450 gpm under the existing system head conditions. NDM 1 pumps to the onsite storage tank, and NDM 2 pumps directly to the distribution system. It is assumed that both pumps will need to be replaced within the next 10 years based on the typical useful life of pumping equipment.

Booster Pumps

NDM 1 has three booster pumps to supply water from the storage tank to the distribution system. Per discussion with operators in the field, two of the three pumps have been replaced recently and they are assumed to operate at 100 gpm each.

Storage Tank

The system has 29,000-gallons of usable storage capacity in the existing storage tank at NDM 1. This tank is constructed of bolted steel and assumed to be 37 years old. It is assumed that the tank will need to be relined and coated within the next 10 years to extend the useful life of the tank.

Hydropneumatic Tank

NDM 1 includes a hydropneumatic tank that has a reported allowable drawdown of 800 gallons. Operators report that it has not been inspected, and there is known sediment in the tank from well sanding. The tank size is unknown. It is used to provide water to the system and maintain a cushion for necessary pressure in the distribution system to prevent the booster pumps from short-cycling. It is assumed based on available data that the tank is 37 years old and will need to be replaced within the next 10 years. Replacement will include the tank itself, associated piping, valving, and appurtenances.

Disinfection

The existing NDM well sites include chlorination equipment in a chemical shed. Disinfection is not required for irrigation water. These facilities can be removed from the system if it is used for irrigation water only.

Fire Suppression Facilities

There is an existing booster pump at NDM 1 solely for providing fire suppression for the system. The age of this pump is unknown and assumed to be very old. Fire suppression and fire hydrants will be included in the water distribution system as part of the City of Davis Consolidation Project for the NDM system. Fire suppression was not considered as part of the scope of the irrigation project, and it is assumed that the existing fire suppression booster pump will be abandoned.

Emergency Generator

There is a 100-kW emergency generator at NDM 1 to provide back-up power in the event of a power outage. The generator age is unknown, but the Automatic Transfer Switch (ATS), which switches the pump station from the electrical service to generator power, was replaced one year ago. The generator can remain in service as is. If it becomes no longer operable because it reaches the end of its service life or for other reasons, it is assumed that it will not be replaced because the irrigation system is not a critical facility. During a prolonged power outage, it is assumed that customers can temporarily halt irrigation or use City of Davis water to irrigate.

Distribution System

The majority of the distribution system piping will remain in service to supply drinking water upon completion of the consolidation project with the City of Davis. There are some sections of pipe being abandoned in place to be replaced by new mains. There is a limited potential for cost savings to reuse these sections of existing water main for the irrigation system, however, these pipelines sections are limited and would be subject to evaluation for pipe condition, separation requirements, mixed asset ages, etc. Therefore, it is assumed that the irrigation system will consist of all new distribution piping, isolation valving, service connections, meters, and meter boxes.

System Capacity

NDM 1 pumps to a storage tank which is then boosted into the system by three booster pumps that are 100 gpm each. Therefore, it is assumed that NDM 1 has a total capacity of 300 gpm. NDM 2 pumps directly to the system and has a capacity of 450 gpm based on the most recent pumping test. The total combined capacity is assumed to be 750 gpm.

Recommendations

Each component of the NDM system, assumed ages, and recommendations are provided in **Table 1** and **Table 2** below. Recommendations for equipment maintenance and replacements are based on equipment ages and industry standards for service life, as well as a field review and review of existing data on the equipment. Recommended replacements and maintenance were spaced out over a 10-year Capital Improvement Plan (CIP) planning timeframe.

Table 1: NDM 1 Existing Equipment Recommendations

System Component(s)	Assumed Age	Recommendations	System Role
Well	37 years	Replace between 25-50 years of service life.	Provides Water Supply
Submersible Pump	7 years	Replace at end of service life, 15-20 years.	Conveys Water Supply
Booster Pumps	2 replaced recently, 2 unknown	Replace oldest booster. Replace newer boosters at end of service life, 10-15 years.	Maintains System Pressure & Accommodates Peak Demands
Storage Tank	37 years	Reline and coat to extend service life of tank.	Accommodates Peak Demands
Hydropneumatic Tank	37 years	Replace tank and associated piping, valves, and appurtenances.	Maintains System Pressure & Protects Against Pump Cycling
Disinfection Equipment	Unknown	Remove. Chlorination is not needed for irrigation water.	No future role
Fire Suppression	Unknown	Abandon fire pump.	No future role
Emergency Generator	Unknown	Remain in service. Do not replace at end of service life.	Provides Backup Power In Event of Power Outages
Electrical	Unknown	Replace electrical equipment at end of service life.	Supplies Power and Controls to Critical System Components
Station Piping	37 years	Add flowmeter to station piping.	Conveys Water Supply From Well To Distribution System

Table 2: NDM 2 Existing Equipment Recommendations			
System Component(s)	**Assumed Age**	**Recommendations**	**System Role**
Well	30 years	Replace between 25-50 years of service life.	Provides Water Supply
Submersible Pump	7 years	Replace at end of service life, 15-20 years.	Conveys Water Supply
Disinfection Equipment	Unknown	Remove. Chlorination is not needed for irrigation water.	No future role
Electrical	Unknown	Replace electrical equipment at end of service life.	Supplies Power and Controls to Critical System Components
Station Piping	30 years	Add flowmeter to station piping.	Conveys Water Supply From Well To Distribution System

In summary, our assessment of the NDM water system infrastructure indicates that, although parts have been well-maintained and updated, significant components are approaching the end of their service life. This situation highlights the need for a strategic approach to maintenance, upgrades, and replacements to ensure the continuity of reliable water service for the NDM community. Aligning these needs with a comprehensive (CIP) will enable NDM to efficiently manage its resources while enhancing the system's resilience and reliability. Fortunately, the NDM water system is set to be consolidated with the City of Davis, the consolidation project's design phase is complete, and construction is scheduled to begin this year. This drinking water system consolidation project will remove all dependency on the infrastructure surveyed at both the NDM 1 and NDM 2 sites.

3. IRRIGATION DEMAND

Overview

Several methods are available to calculate water demand, such as analyzing meter records and conducting evapotranspiration calculations for irrigated areas. However, due to the lack of functional production meters in NDM 1 and NDM 2, and records consisting of combined drinking and irrigation usage, meter records cannot be utilized to determine water demand. Consequently, evapotranspiration calculations were employed to estimate the demand for landscaping irrigation. This study exclusively considered landscaping irrigation demands. It is assumed that water for pools and other miscellaneous non-potable uses is sourced from the drinking water system

Landscaping irrigation requires a certain volume of applied water to offset the evapotranspiration. Evapotranspiration involves water evaporating into the atmosphere from ground and vegetation surfaces, and transpiring from vegetation pores. The volume of water to offset the evapotranspiration is typically considered the minimum volume of water needed to keep the vegetation alive. Irrigators tend to apply more than the minimum volume because of irrigation efficiency and non-uniform application. Estimating landscaping water demand requires several parameters: crop type, a local weather station with reference evapotranspiration estimates, and the total irrigated area.

Crop Coefficient

The crop type is used to determine a crop coefficient (Kc) in the evapotranspiration calculation. Based on a review of the NDM area during a field visit and reviews completed on ArcGIS and Google Earth, the landscaping in NDM includes a combination of watered lawns, bushes, flowers, and dispersed trees. The exact species and quantities are unknown, however, it appears that there is a mix of high water using species (i.e. redwoods) and low water using species (i.e. roses) and that the majority of the irrigable areas are lawn. The crop coefficient for turfgrass (i.e. lawn) is 0.8 for cool season species; tall fescue, ryegrass, bentgrass, and Kentucky bluegrass, and 0.7 for warm season species; bermudagrass, zoysiagrass, and Saint Augustinegrass. Since the majority of the NDM irrigable area appears to consist of lawns, and the crop coefficient for turfgrass tends to fall between the crop coefficients of low-water demand and high-water demand species, the turfgrass coefficients of 0.6 and 0.7 were selected for the NDM area.

Reference Evapotranspiration

A weather station located in Davis, California (CIMIS, Station ID 6) provided the reference evapotranspiration (ET_o). The reference crop at this weather station is turfgrass, and evapotranspiration values are provided for the station by month. The reference evapotranspiration ranges from 1.22 inches in December to 8.34 inches in July, and the annual total evapotranspiration is 56.73 inches for turfgrass at the reference station.

Crop Evapotranspiration

Crop evapotranspiration was calculated for each month using the minimum and maximum crop-coefficient (K_c) and reference evapotranspiration as described above (ET_o) (**Equation 1**). The calculated evapotranspiration is presented in **Table 3** below.

Equation 1: Landscaping Water Evapotranspiration

$$ET_L = K_c * ET_o$$

Table 3: Calculated Evapotranspiration

	ET_o Minimum[1] (ft)	ET_o Average (ft)	ET_o Maximum[2] (ft)
January	0.07	0.08	0.09
February	0.11	0.12	0.14
March	0.18	0.22	0.25
April	0.28	0.32	0.37
May	0.35	0.41	0.47
June	0.41	0.48	0.55

Table 3: Calculated Evapotranspiration			
July	0.42	0.49	0.56
August	0.37	0.43	0.49
September	0.29	0.33	0.38
October	0.21	0.24	0.28
November	0.10	0.12	0.14
December	0.06	0.07	0.08
TOTAL	2.84	3.31	3.78

[1] *Minimum ET_o calculated using minimum K_c of 0.6 and reference ET from CIMIS Station 6*
[2] *Maximum ET_o calculated using maximum K_c of 0.8 and reference ET from CIMIS Station 6*

Irrigable Land Area

The irrigable area within NDM was calculated to be 54.8 acres, as detailed in Attachment A. This calculation was conducted using ArcGIS by subtracting the built environment and hardscape areas from NDM's total area. The built environment, which encompasses buildings, driveways, patios, pools, and other similar features, was assessed by randomly selecting five parcels and quantifying all hardscape features. This analysis indicated that approximately 30% of these parcels consisted of built environments. This percentage was then extrapolated to the entire residential acreage to estimate the irrigable area within NDM. **Table 4** provides a detailed breakdown of the methodology used to determine the irrigable area."

Table 4: Irrigable Land Area

Feature	Acres	Determined By
Total North Davis Meadows Area	94.07	Total area within NDM boundaries shown on Attachment A
Roads	10.60	Total area of roads within NDM boundaries shown on Attachment A
Residential Parcels – Total	83.47	Total NDM area minus Total road area
Residential Parcels – Buildings and Hardscape	25.04	30% of total area of residential parcels
Residential Parcels – Irrigable	58.43	Total residential area minus area of buildings and hardscape

Water Demand

The irrigable area was multiplied by the crop evapotranspiration (ET_o) to determine the total estimated water demand for NDM (**Equation 2**).

Equation 2: Water Demand for Evapotranspiration Requirement

$$Water\ Volume\ = ET_L * Area$$

The water demand calculations incorporated the efficiencies of both the irrigation distribution system and the homeowner irrigation systems at each lot. The distribution system efficiency was assumed to be 95%, based on the expectation that the new distribution piping would minimize leakage. The efficiency of the irrigation system at each lot was evaluated by considering the total volume of water passing through the service connection and the amount actually utilized by the landscaping. Due to uncertainties regarding the age and construction of the irrigation systems and the potential for inefficient water application by sprinklers, this efficiency was assumed to be lower. An average application efficiency of 75% was applied, based on the findings from 'Spatial Analysis of Application Efficiencies for the State of California' (UC Davis Water Management Research Laboratory, 2013).

The estimated monthly water demand, expressed in hundred cubic feet (CCF), is detailed in **Table 5** below. The annual estimated water demand for NDM irrigation varies between 101,274 and 135,032 CCF. Additionally, the instantaneous flow rates in gallons per minute (gpm) for assumed watering times of 12 hours and 6 hours are presented in **Table 6** below. Assuming a 12-hour watering period, the maximum required flow rate for the irrigation system is 665 gpm. Given that the total capacity of the system is 750 gpm, it is inferred that the existing system can adequately meet the irrigation demands within a 12-hour timeframe."

Table 5: Water Demand Summary

	Minimum Water Demand (CCF)	Average Water Demand (CCF)	Maximum Water Demand (CCF)
January	2,321	2,708	3,094
February	3,802	4,436	5,070
March	6,587	7,685	8,783
April	9,836	11,476	13,115
May	12,514	14,600	16,686
June	14,674	17,120	19,566
July	14,889	17,370	19,851
August	13,175	15,371	17,566
September	10,211	11,913	13,615
October	7,409	8,643	9,878
November	3,678	4,290	4,903
December	2,178	2,541	2,904
TOTAL	101,274	118,153	135,032

Table 6: Instantaneous Flowrate for 12 Hour and 6 Hour Watering Times						
	Minimum		Average		Maximum	
	12 Hour (gpm)	6 Hour (gpm)	12 Hour (gpm)	6 Hour (gpm)	12 Hour (gpm)	6 Hour (gpm)
January	78	156	91	181	104	207
February	127	255	149	297	170	340
March	221	442	258	515	294	589
April	330	659	385	769	440	879
May	419	839	489	979	559	1,118
June	492	984	574	1,147	656	1,311
July	499	998	582	1,164	665	1,331
August	442	883	515	1,030	589	1,177
September	342	684	399	798	456	913
October	248	497	290	579	331	662
November	123	246	144	288	164	329
December	73	146	85	170	97	195

The irrigation demand calculation incorporated several key assumptions:

- The crop coefficient for the entire irrigable area was determined based on the predominance of lawn and a mix of species with varying water demands. It was assumed that the lawn represents the average crop coefficient for the remaining landscaping.
- The distribution system is expected to have minimal leakage, with an assumed efficiency of 95%. Consequently, it is projected that 95% of the water pumped will reach the customer service connections.
- It was presumed that the majority of NDM utilizes sprinklers for irrigation, with an irrigation efficiency of 75%. Thus, it is estimated that 75% of the water passing through each service connection effectively meets the evapotranspiration needs of the landscaping.

The estimated irrigation demand for NDM, derived from detailed evapotranspiration calculations and adjusted for system and irrigation efficiencies, suggests that the proposed irrigation system, with a capacity of 750 gallons per minute (gpm), is suitably designed to fulfill the community's requirements. These estimates, based on thorough data analysis and well-founded assumptions regarding system performance and area landscaping, establish a reliable framework for planning a potential new irrigation system.

Conceptual Irrigation System

Attachment A contains the detailed proposal for the conceptual irrigation system. This design assumes that the irrigation distribution system will generally mirror the existing drinking water distribution layout, albeit installed on the opposite side of the street from the drinking water system to adhere to minimum horizontal set-back requirements from the planned new drinking water system consolidation project.

In alignment with the estimated water demand detailed in Section 3, 8-inch piping is planned for installation along the main thoroughfares within the system, including Fairway Drive, Silverado Drive, and the connecting routes between NDM 1 and NDM 2. Additionally, 6-inch piping is designated for the laterals and dead-end roadways to ensure comprehensive coverage. To facilitate maintenance and repair operations, gate or butterfly valves, sized at both 8-inch and 6-inch, will be strategically placed to allow for the isolation of pipelines as needed. Each residential lot will be equipped with a new service connection, which includes a 1-inch lateral, a meter, and a meter box, to accurately measure and manage water usage for irrigation purposes.

Regarding backflow prevention, it is assumed that new backflow devices would need to be incorporated into the drinking water system to fulfill cross-connection control requirements and safeguard the drinking water supply.

Groundwater Use Considerations

It is advisable for the community and project stakeholders to engage in discussions with local water quality control boards and regulatory agencies. This dialogue will ensure compliance with existing policies and facilitate the acquisition of any necessary permits or approvals if the community decides to utilize the existing wells for irrigation purposes. Additionally, the project should include strategies for monitoring and managing water quality to protect the groundwater resources and ensure the health and safety of the community.

Recent groundwater level trends in parts of Yolo County have shown fluctuations due to various factors, including prolonged drought conditions and the influence of new wells in the area, which have led to increased well interference. However, over the last several years groundwater level measurements in the basin indicate a moderate recovery in water levels, primarily attributed to the recent period above average cumulative annual rainfall. It is important to note that with the introduction of surface water into the North Davis Meadows, which is designated mainly for in-home potable uses, there will be a shift in the utilization of groundwater sources. Specifically, groundwater will now be used exclusively for irrigation purposes, unlike in previous years when it served both in-house and irrigation needs. This change is anticipated to result in a reduced withdrawal from the groundwater sources compared to earlier periods. Consequently, we predict a diminished impact on the groundwater aquifer from the two existing wells, contributing to more sustainable groundwater management in the region.

Lanscaping Considerations

Utilizing treated surface water offers significant advantages in water quality, as it typically contains lower levels of electrical conductivity (EC), boron, salinity, and other contaminants. This leads to healthier plant growth and a wider range of viable landscaping options, thereby enhancing both the aesthetic and ecological value of the community. On the other hand, continuing to use groundwater for irrigation, which has historically been the norm, may limit plant variety and require additional soil treatments to counteract the adverse effects of higher contaminant levels.

Groundwater and Beneficial Use

It is crucial to differentiate between "potable" and "non-potable" water in the context of groundwater usage and regulatory frameworks. Throughout the state, and specifically the Yolo Subbasin, groundwater is subject to beneficial use designations as outlined in the Water Quality Control Plan (Basin Plan).. These designations include Municipal and Domestic Supply (MUN), which covers water systems used for drinking water and other community and individual purposes. The use of groundwater, even when impaired (e.g., nitrate levels above drinking water standards), does not conflict with its designated beneficial uses as long as the extraction and use positively contribute to aquifer quality management and restoration, in alignment with the overarching goals of water resource management.

Regulatory Considerations and Precedents

The Nitrate Control Program (NCP), part of the Basin Plan Amendment, outlines strategic goals for the long-term management and restoration of aquifer systems, particularly in regions identified with nitrate impairments. The Yolo Subbasin's inclusion in Priority 2 Subbasins for NCP implementation sets a regulatory pathway for considering the extraction and beneficial use of nitrate-impaired groundwater, including for non-drinking purposes such as irrigation. This aligns with efforts to reduce nitrate concentrations in groundwater and leverage existing resources judiciously to support both potable and non-potable demands.

It is important to note that any newly-built wells would need to comply with the state's well construction regulations, including obtaining the necessary permits and adhering to specific design and construction standards. Furthermore, the absence of specific prohibitions against the use of MUN-designated groundwater for irrigation, coupled with historical applications of similar practices in various communities, supports the feasibility of the proposed use within the NDM community. Instances such as Village Homes in Davis exemplify the practical application of groundwater for irrigation purposes, aligning with both regulatory compliance and community objectives for sustainable water use.

Therefore, based on regulatory guidelines and LSCE's prior working history on the NCP and Basin Plan, the use of groundwater from existing wells designated with a MUN beneficial use for irrigation within the NDM community is feasible and does not inherently conflict with state or local regulatory frameworks. However, it is crucial to highlight that any future well replacements or new well constructions within the community would be subject to the aforementioned well construction regulations. This conclusion is predicated on the understanding that such use will be managed in a manner that contributes to the broader goals of aquifer restoration and sustainable water resource management, including considerations for nitrate levels and the potential for beneficial reuse in reducing surface water demand for irrigation."

4. ESTIMATED CAPITAL AND OPERATIONS COSTS

The irrigation system operational budget is presented in **Attachment B**. This includes operations and maintenance (O&M) costs, CIP costs for: 1) the new infrastructure to make the irrigation system operational and associated financing costs, and 2) recommended maintenance and replacement costs for existing infrastructure at NDM 1 and NDM 2. A 10-year timeframe was considered with all new infrastructure costs assumed in Year 1 under a loan and all other recommended maintenance and replacement activities spaced over the 10-year planning period.

Inflation Factors

The operational budget incorporates various inflation factors for labor, construction, and PG&E rate increases. Labor inflation was assumed to be 3% based on average expected pay increases and the inflation rates used in the 2021 Water Reserves Report. A construction inflation of 8% was used based on the average California Construction Index (CCI) over the last 5 years. The CCI is difficult to predict over a 10-year timeframe, as, prior to 2020, the average CCI was around 3% (2016-2020). Since that time, the average CCI has been at almost 11%. It is assumed that the average CCI over the last 5 years best captures what the CCI may do over the upcoming years.

A separate inflation factor of 4% was applied to PG&E energy costs based on a projected average PG&E rate increase of 3.6% over the next three years. Inflations applied to each cost in the budget are reflected in **Table 9** below.

Capital Costs (Year 1)

Since the existing drinking water distribution system will remain in service under the consolidation project, the NDM irrigation system will require the installation of new distribution system infrastructure as described below. Required infrastructure, quantities, assumed unit prices, the estimated cost for engineering, and total costs are presented in **Table 7** below.

Distribution Piping

Based on expected flowrates, the new distribution system piping will be 8-inch along the main roadways (Fairway Drive and Silverado Drive) and 6-inch on the dead-end streets. It is assumed that the new irrigation system piping will be C909 PVC, SDR 18, or similar and will be installed under the NDM roadways, similar to the existing distribution system. The new piping will need to meet the required setbacks from existing utilities and will require trenching along the roadways. Costs for pipeline installations in developed areas are higher than costs for pipeline installations in undeveloped areas, as contractors will need to sawcut the asphalt and work around the existing utilities. It is estimated that 10,515 lineal feet (LF) of new pipe will be required at a cost of $190/LF for the pipe, trenching, and installation.

Isolation Valves

Gate or butterfly valves will need to be installed as part of the irrigation system to allow pipelines to be isolated for maintenance and repairs. 15 valves are assumed to be needed.

Service Connections

Each connection (96 total) will require a new service lateral from the distribution mains, meter, and meter box. The customer will be responsible for the new connection from the meter to their irrigation system.

Production Flowmeters

Production flowmeters are recommended to be installed on the station piping at NDM 1 and NDM, as they are helpful for testing and monitoring practices.

Other Construction Costs

Construction of the NDM irrigation system will include the components described above in addition to other typical construction costs; contractor mobilization, submittals, traffic control, training, etc. These were assumed to be 15% of the total cost for materials and installation of the distribution system.

Engineering

Engineering design and construction management services for the irrigation system project are anticipated to be 8.5% of the total cost of project construction.

Contingency

A 20% contingency was also applied to the total construction costs given that pricing is based off of a conceptual system and there are numerous unknowns. Examples include the potential for an unpredictable installation timeframe, which could lead to increased construction inflation costs, and the presence of unidentified existing utilities in the roadways that may complicate the installation of new piping."

Table 7: Year 1 Capital Cost Summary: New Distribution System Infrastructure

Item	Quantity	Unit Price	Total Cost
8-inch and 6-inch C909 PVC Piping	10,515 LF	$190/LF	$1,997,850
8-inch and 6-inch Isolation Valves	15	$15,000 EA	$75,000
1-inch Service Connection * (Service Line, Meter, Meter Box)	96	$5,000 EA	$480,000
Production Flowmeters for NDM 1 and NDM 2	2	$5,000/EA	$10,000
Other Misc. Construction Costs (Mobilization, Submittals, Testing, etc.)	NA	15% of Material Total	$384,430
Engineering	NA	8.5% of Construction Total	$250,000
Contingency	NA	20% of Construction Total	$589,460
		TOTAL CONSTRUCTION COST	**$3,786,733**

**Note: Owner is responsible for the cost of the plumbing downstream of the meter.*

Debt Service

It is anticipated that a loan will be utilized to cover the cost of the new irrigation system infrastructure. A 30-year loan at 6% interest was assumed. For a total construction cost of $3,786,733, the annual loan payment is therefore estimated to be approximately $275,102 or $2,866 per homeowner for the 96 residences which assumes 100% participation amongst NDM customers.

Capital Costs (Years 2-10)

As described in Section 2 above, recommendations for the existing NDM infrastructure includes replacement of most of the existing infrastructure over the 10-year planning period given the age of most of the equipment (28 to 37 years) and industry standard service life. It is also recommended to reline and coat the existing storage tank at NDM 1 to extend the service life of the tank. These CIP recommendations were ranked by priority to spread the costs over the 10-year planning period. Each CIP project, associated recommendation, present day estimated construction cost, year to complete, and cost at completion are included in **Table 8** below. Cost at completion includes the yearly assumed CCI of 8%. CIP projects for existing infrastructure are assumed to be completed during Years 2-10 because the new distribution system infrastructure will be installed on Year 1.

Table 8: Existing Infrastructure CIP Costs over 10-Year Planning Period

CIP Project	Recommendation	Estimated Cost Present Day	CIP Priority Year to Complete	Estimated Cost Completion
NDM 1 - Well	Replacement	$250,000	Year 5	$340,120
NDM 1 - Submersible Pump	Replacement	$150,000	Year 9	$277,640
NDM 1 – Oldest Booster Pump (1 Total)	Replacement	$20,000	Year 2	$21,600
NDM 1 – Newest Booster Pumps (2 Total)	Replacement	$40,000	Year 8	$68,550
NDM 1 - Storage Tank	Line & Coat	$100,000	Year 6	$146,930
NDM 1 - Hydropneumatic Tank	Replacement	$100,000	Year 2	$108,000
NDM 1 - Electrical	Replacement	$250,000	Year 3	$291,600
NDM 2 - Well	Replacement	$250,000	Year 7	$396,720
NDM 2 - Submersible Pump	Replacement	$150,000	Year 10	$299,850
NDM 2 - Electrical	Replacement	$250,000	Year 4	$314,930
TOTAL CIP COSTS OVER 10-YEAR PLANNING PERIOD				**$2,265,940**

Operations & Maintenance Costs

Table 9 includes anticipated O&M costs for the irrigation system, along with descriptions, assumptions, and applied inflation rates.

Table 9: O&M Summary

O&M Item	Description/Assumptions	Inflation Applied
Administration/Management	Includes County costs to manage the system. Assumed to be $5,000/year	Labor (3%)

Table 9: O&M Summary		
Operations	Cost for an Operator to maintain facilities. Assumed to be $30,000/year	Labor (3%)
Legal Services	Assumed to be $5,000/year	Labor (3%)
Energy Costs (PG&E)	Cost for electricity for the NDM 1 and NDM 2 pump stations. Assumed to be $74,000/year	PG&E Rate Increase (4%)
Facilities Maintenance – ex. Meters/valves/pipes	Cost for maintenance and repairs within system (i.e. leaks, pipe bursts, etc). Assumed to be $15,000/year	Construction (8%)
Meter Reading Costs – reading/billing	Cost for Operator to read meters each month, monthly billing, and associated postage costs. Assumed to be $12,000/year	Labor (3%)
Insurance	Insurance for irrigation system equipment. Assumed to be $2,000/year	Labor (3%)
O&M Reserves	Money set aside for O&M. Assumed to be 15% of total O&M costs for each year.	N/A

The total O&M cost for Year 1 includes the administration/management, operations, legal, energy, facilities maintenance, meter reading, and insurance costs listed in **Table 9** above. The subtotal of those costs for Year 1 ($143,000) has a 15% O&M reserve applied to bring the total cost to $164,450. Inflation factors listed in **Table 9** are applied each year which results in an estimated annual cost of $236,633 by Year 10.

The capital and operational budget estimates for the NDM irrigation system, detailed in **Attachment B**, encompasses a comprehensive analysis of O&M expenses, capital costs for the initial system setup, and subsequent CIP costs for maintaining and updating existing infrastructure. Over a 10-year planning horizon, this budget takes into account inflationary pressures on labor, construction, and energy rates, ensuring a realistic financial framework for the system's implementation and sustained operation. With a projected annual revenue requirement ranging from approximately $150,000 in Year 1 to approximately $800,000 in Year 10, the budget reflects the varying costs associated with CIP project execution and operational demands. This financial plan lays a solid foundation for the irrigation system's fiscal management, aiming for efficiency and sustainability over the decade.

5. WATER RATE

The annual revenue requirements for the NDM irrigation system will be funded through irrigation water rates paid by NDM customers. The costs are detailed below, both per service connection and per hundred cubic feet (CCF) of water usage for NDM customers. **Table 10** presents the annual revenue needs for O&M, CIP debt service payments for the initial irrigation system installation and anticipated future additional CIP projects. The total anticipated CIP project costs for Years 2 through 10 of $2,265,945 was averaged over a 10-year planning period to stabilize water rates annually and establish a reserve to finance future projects without resorting to unplanned additional loans or debt payments. This results in an annual average Year 2 through 10 CIP cost of $226,594.

Table 11 delineates the cost per service connection and per CCF of water based on minimum, average, and maximum estimated water demands. Each scenario indicates a water rate increase of approximately 1% per year. These figures are based on the assumption that all 96 lots within the NDM service area fully participate in the irrigation system. Reduced participation or lower water usage will lead to increased unit costs to meet the irrigation system revenue requirements. The presented base cost per service connection and single tier cost per CCF reflects the total expense necessary to support the system's revenue needs.

Table 10: Annual Revenue Needs

Year	Annual Revenue Needs O&M	Annual Revenue Needs CIP – Debt Service	Annual Revenue Needs CIP - Projects	Annual Revenue Needs Total
Year 1	$164,450	$0	$226,594	$391,044
Year 2	$171,097	$275,102	$226,594	$672,794
Year 3	$178,046	$275,102	$226,594	$679,743
Year 4	$185,314	$275,102	$226,594	$687,011
Year 5	$192,917	$275,102	$226,594	$694,614
Year 6	$200,874	$275,102	$226,594	$702,571
Year 7	$209,203	$275,102	$226,594	$710,899
Year 8	$217,924	$275,102	$226,594	$719,621
Year 9	$227,060	$275,102	$226,594	$728,757
Year 10	$236,633	$275,102	$226,594	$738,330

Table 11: Annual Revenue per Service Connection and per CCF of Water for Minimum, Average, and Maximum Water Use

Year	Irrigation System Annual Fee/Connection	Irrigation System Fee/CCF for Minimum Water Use	Irrigation System Fee/CCF for Average Water Use	Irrigation System Fee/CCF for Maximum Water Use
Year 1	$4,073	$3.86	$3.31	$2.90
Year 2	$7,008	$6.64	$5.69	$4.98
Year 3	$7,081	$6.71	$5.75	$5.03
Year 4	$7,156	$6.78	$5.81	$5.09
Year 5	$7,236	$6.86	$5.88	$5.14
Year 6	$7,318	$6.94	$5.95	$5.20

Table 11: Annual Revenue per Service Connection and per CCF of Water for Minimum, Average, and Maximum Water Use				
Year 7	$7,405	$7.02	$6.02	$5.26
Year 8	$7,496	$7.11	$6.09	$5.33
Year 9	$7,591	$7.20	$6.17	$5.40
Year 10	$7,691	$7.29	$6.25	$5.47

It is important to note that the development of a base charge per meter and a single-tier rate is based on a broad spectrum of assumptions as identified throughout this report, including but not limited to: inflation rates, finance market fluctuations, total water usage, community participation levels, and infrastructure resilience. Given these potential variabilities, this report serves as an initial estimation of the irrigation system fees. Full community participation is paramount; otherwise, the cost disparity will significantly widen, potentially rendering the separate irrigation system financially unfeasible for the NDM community.

Water Rate Comparisons

"Historical water rates from the City of Davis were analyzed for the period from 2004 to 2024. During this time, the water rate increased from $0.77 per hundred cubic feet (CCF) for usage between 0-36 CCF, and $0.86 per CCF for usage above 36 CCF in 2004, to $5.01 per CCF in 2019. Over this 20-year span, the average annual increase was 12%. From 2016 to 2024, however, the rate growth moderated to an average of 7% per year. Since 2019, the water rate has remained stable, and discussions with City of Davis personnel indicate no imminent plans for a water rate study.

In a similar analysis, the City of Woodland's base tier water rates from 2013, projected through 2026, showed an average annual increase of 7%. The City of Dixon's base tier water rates from 2013 through 2019 experienced an approximate 12% yearly increase.

Water rates generally rise to fund Capital Improvement Plan (CIP) projects, accommodate water system growth, and cover increased operational, maintenance, permitting, and compliance costs. As a result, future costs are often prioritized over historical rates to ensure adequate funding for anticipated CIP and operational needs.

Considering the stable base water usage rate of the City of Davis over the past five years and the lack of significant planned CIP projects or recent water rate studies, a 3% annual increase in City of Davis rates was assumed for comparison with the costs of the new NDM irrigation system.

For this feasibility study, several rate scenarios for the City of Davis were evaluated against the cost of the new irrigation system:

- No change, maintaining the rate at $19.86 (base) plus $5.01/CCF.
- A 3% annual increase in the current base rate and cost per CCF.
- A 7% annual increase in the current base rate and cost per CCF.

These scenarios are contrasted with the estimated annual cost of the irrigation system in the figures provided below, encompassing the minimum, average, and maximum water demand scenarios. The figures include the estimated cost of irrigation water per household per year, using the minimum water demand scenario for:

- The proposed irrigation system.
- City of Davis water at the current monthly base rate of $19.86 and water rate of $5.01/CCF.
- City of Davis water assuming a 3% annual increase in the base rate and cost per CCF.
- City of Davis water assuming a 7% annual increase in the rate and cost per CCF.

Figure 1 assumes the NDM community water usage aligns with the minimum estimated water demand of 101,274 CCF/year, or 1,055 CCF per household. Under a 7% annual increase in City of Davis rates, the breakeven point for the irrigation system is projected around 2028, or Year 4, while a 3% rate increase suggests a breakeven in 2034, or Year 10.

Figure 2 assumes water usage of 118,153 CCF/year, or 1,231 CCF per household; with a 7% increase in City rates, the irrigation system is anticipated to cost less than City of Davis water over the full planning horizon, and with a 3% increase, the breakeven point occurs in 2027, or Year 3.

Figure 3, based on a usage of 135,032 CCF/year, or 1,407 CCF per household, shows that regardless of a 7% or 3% annual rate increase, the irrigation system is expected to cost less than City of Davis water throughout the planning horizon.

Figure 1: Annual Cost of Irrigation Water per Household
Minimum Water Demand Scenario

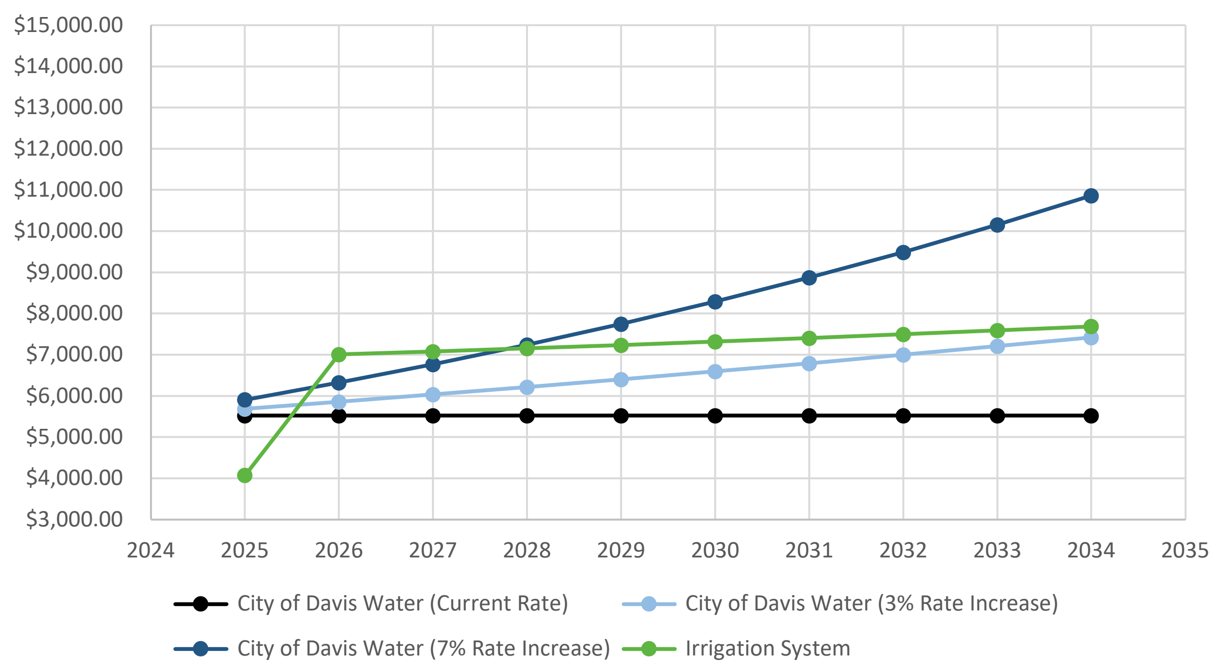


Figure 2: Annual Cost of Irrigation Water per Household
Average Water Demand Scenario

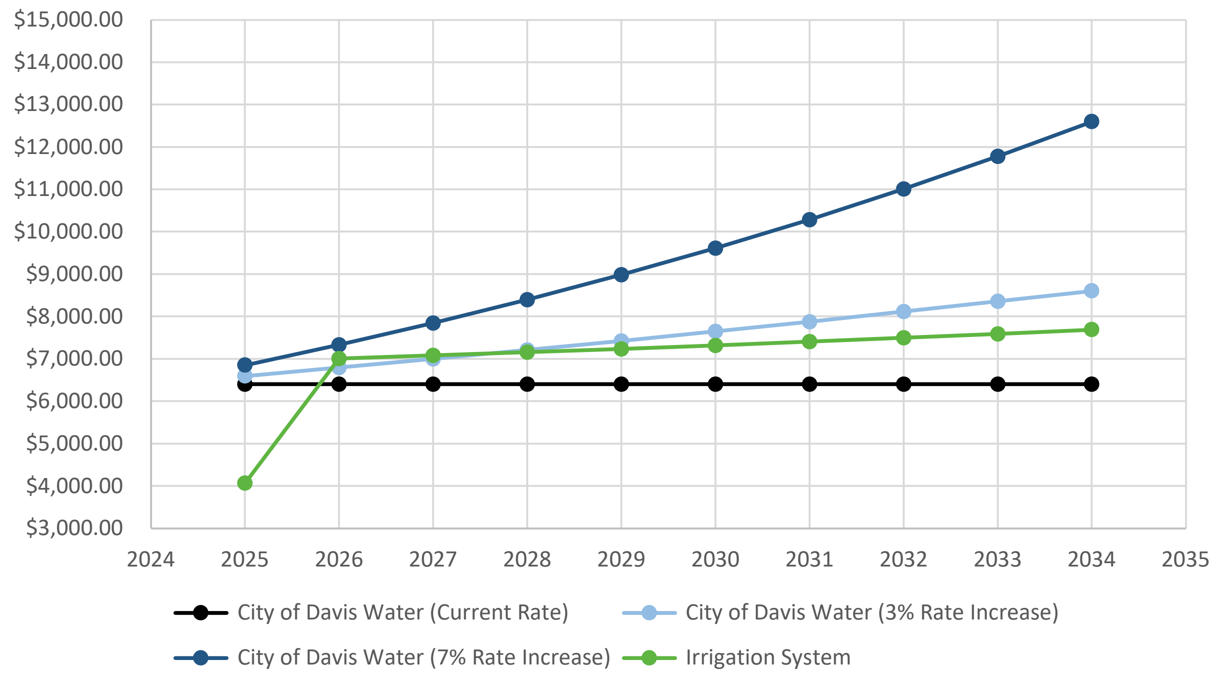
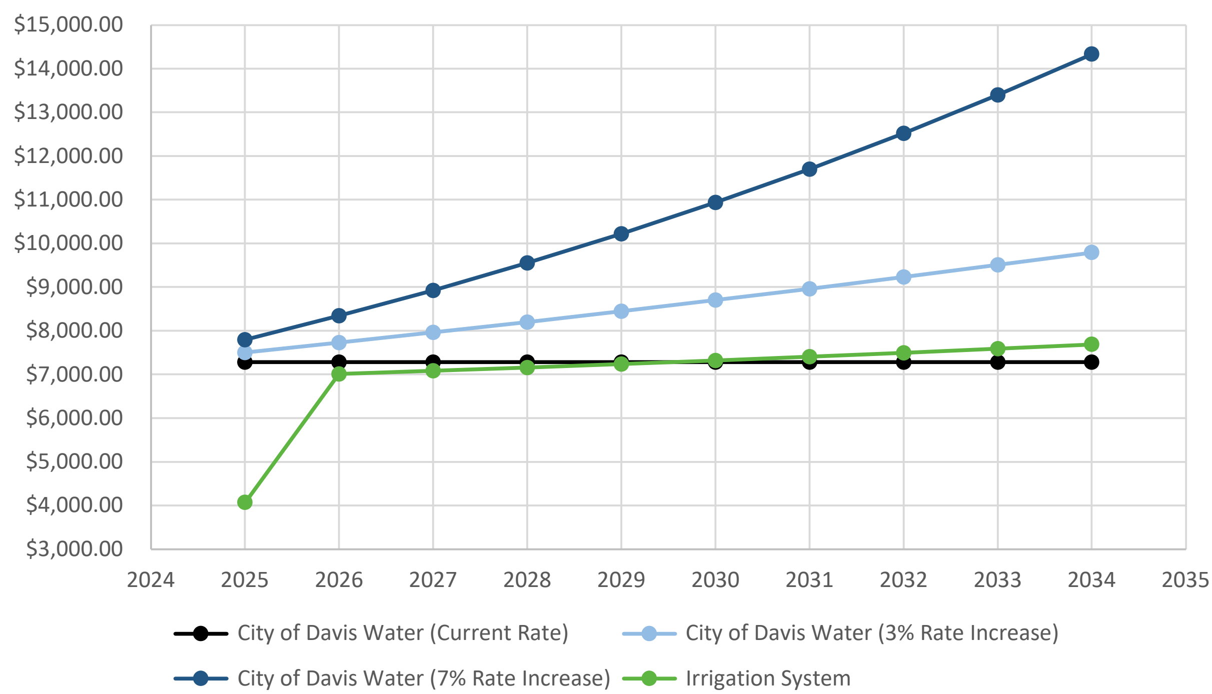


Figure 3: Annual Cost of Irrigation Water per Household
Maximum Water Demand Scenario



Potential Cost Savings

There are approximately 2,210 lineal feet of existing pipeline in the NDM area designated to be abandoned in place during the water system consolidation project. Depending on the size, condition, locations, and feasibility of connections to these sections of pipeline, some portions may be suitable for reuse in the irrigation system. Assuming all 2,210 lineal feet are suitable for reuse, the total required new piping would be reduced from 10,515 lineal feet to 8,305 lineal feet, thus reducing the cost of the new irrigation system by approximately $580,000. This results in a reduced annual debt service cost of $233,000 as compared to $275,000 for all irrigation system distribution system piping. Estimated water rates by service connection and per CCF of water given the potential reuse of pipes are presented in **Table 12** below. This is a best-case scenario assumption, assuming that all abandoned pipe is suitable for reuse. It may be the case that no pipe is suitable for reuse.

Table 12: Annual Revenue per Service Connection and per CCF of Water for Minimum, Average, and Maximum Water Use with Potential Cost Savings

Year	Irrigation System Annual Fee/Connection	Irrigation System Fee/CCF for Minimum Water Use	Irrigation System Fee/CCF for Average Water Use	Irrigation System Fee/CCF for Maximum Water Use
Year 1	$2,360	$2.24	$1.92	$1.68
Year 2	$6,570	$6.23	$5.34	$4.67
Year 3	$6,642	$6.30	$5.40	$4.72
Year 4	$6,718	$6.37	$5.46	$4.78
Year 5	$6,797	$6.44	$5.52	$4.83
Year 6	$6,880	$6.52	$5.59	$4.89
Year 7	$6,967	$6.60	$5.66	$4.95
Year 8	$7,058	$6.69	$5.73	$5.02
Year 9	$7,153	$6.78	$5.81	$5.09
Year 10	$7,252	$6.87	$5.89	$5.16

6. CONCLUSION

Upon comprehensive evaluation of the proposed water rates needed to cover both the capital and operational/maintenance expenses of a new, separate NDM irrigation system, it appears that the financial burden on the NDM community may initially outweigh the benefits, given the current City of Davis water rate. In Year 2, following the installation of the irrigation system, the estimated water rates range from $4.98 to $6.64 per CCF, while by Year 10, these rates are projected to be between $5.47 and $7.29 per CCF, depending on usage. These rates are generally higher than the City of Davis's current rate of $5.01 per CCF.

However, if we assume an average rate increase of 3% per year for City of Davis base and unit rates, the irrigation system is anticipated to be more cost-effective than City of Davis water under the maximum demand scenario, with a breakeven point in Year 10 for the minimum demand scenario and Year 3 for the average demand scenario. Assuming a 7% annual increase, the irrigation system is expected to be less costly than City of Davis water for the average and maximum demand scenarios, with the breakeven point occurring in Year 4 for the minimum water demand scenario.

It is crucial to note that these conclusions are highly dependent on the accuracy of several assumptions used in this report. Variations in factors such as full community participation, projected water rates, projected inflation, system resiliency, inflationary factors, the scope and cost estimates of CIP and O&M, and actual water usage could drastically alter the outcomes. The most significant factor which may influence the costs for irrigation water per CCF is if there is less than full participation among NDM water users. This scenario would further widen the cost disparity, potentially rendering the separate irrigation system financially unfeasible for the NDM community.

To refine the analysis and provide a more robust foundation for decision-making, it is recommended that the NDM community commission a formal water rate study if they wish to further explore the feasibility and costs of installing a standalone irrigation system. A formal water rate study would provide a comprehensive analysis of all relevant factors, including detailed rate projections, system usage estimates, and a thorough assessment of financial sustainability. This study would enable a more accurate determination of the potential financial implications and help ensure that any investment in the irrigation system is based on the most reliable and up-to-date information.

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North Davis Meadows

Davis, California

Figure X-X

North Davis Meadows: 10-year DRAFT Irrigation System Operational Budget - With CIP Implementation										
10-Year Revenue Projection Inflation Adjustment (Labor)		3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
10-Year Revenue Projection Inflation Adjustment (Construction)		8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%
Energy Costs (PG&E) - Rate Increase		4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%
Cost Category - Operations & Maintenance (O&M) Costs	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Personnel/Staffing Costs										
Admin/Mgmt.	$5,000	$5,150	$5,305	$5,464	$5,628	$5,796	$5,970	$6,149	$6,334	$6,524
Operations	$30,000	$30,900	$31,827	$32,782	$33,765	$34,778	$35,822	$36,896	$38,003	$39,143
Personnel/Staffing Costs - Subtotal	**$35,000**	**$36,050**	**$37,132**	**$38,245**	**$39,393**	**$40,575**	**$41,792**	**$43,046**	**$44,337**	**$45,667**
Legal Costs										
Legal Services	$5,000	$5,150	$5,305	$5,464	$5,628	$5,796	$5,970	$6,149	$6,334	$6,524
Legal Costs - Subtotal	**$5,000**	**$5,150**	**$5,305**	**$5,464**	**$5,628**	**$5,796**	**$5,970**	**$6,149**	**$6,334**	**$6,524**
Direct Costs										
Energy Costs (PG&E) - w/ 15% rate increase projected for 2024	$74,000	$76,960	$80,038	$83,240	$86,570	$90,032	$93,634	$97,379	$101,274	$105,325
Facilities Maintenance - ex. meters/valves/pipes	$15,000	$16,200	$17,496	$18,896	$20,407	$22,040	$23,803	$25,707	$27,764	$29,985
Meter Reading Costs - reading/billing	$12,000	$12,360	$12,731	$13,113	$13,506	$13,911	$14,329	$14,758	$15,201	$15,657
Insurance	$2,000	$2,060	$2,122	$2,185	$2,251	$2,319	$2,388	$2,460	$2,534	$2,610
Direct Costs - Subtotal	**$103,000**	**$107,580**	**$112,387**	**$117,434**	**$122,734**	**$128,302**	**$134,153**	**$140,305**	**$146,773**	**$153,577**
Reserve and Contingency										
O&M Reserves (2 months of O&M costs, 15%)	**$21,450**	**$22,317**	**$23,223**	**$24,171**	**$25,163**	**$26,201**	**$27,287**	**$28,425**	**$29,617**	**$30,865**
Irrigation O&M Costs Sub-total	**$164,450**	**$171,097**	**$178,046**	**$185,314**	**$192,917**	**$200,874**	**$209,203**	**$217,924**	**$227,060**	**$236,633**
Cost Category - CIP Project Summary	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Irrigation System										
10,515 LF of New Piping	$1,997,850									
New Production Flowmeters for NDM 1 and NDM 2	$10,000									
New Isolation Valves	$75,000									
New Service Connections, Meters, Meter Boxes	$480,000									
Other Construction Costs	$384,428									
Engineering	$250,000									
Contingency	$589,456									
NDM 1										
Well Replacement					$340,122					
Replace Submersible Well Pump									$277,640	
Replace Oldest Booster Pump (1 Total)		$21,600								
Replace Newer Booster Pumps (2 Total)								$68,553		
Replace Electrical System			$291,600							
Line & Coat Storage Tank						$146,933				
Replace Hydropneumatic Tank		$108,000								
NDM 2										
Well Replacement							$396,719			
Replace Submersible Well Pump										$299,851
Replace Electrical System				$314,928						
Irrigation CIP Costs Sub-total	**$3,786,733**	**$129,600**	**$291,600**	**$314,928**	**$340,122**	**$146,933**	**$396,719**	**$68,553**	**$277,640**	**$299,851**
Cost Category - Irrigation System Debt Service	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Irrigation System Loan - No current financing	$0	$275,102	$275,102	$275,102	$275,102	$275,102	$275,102	$275,102	$275,102	$275,102
Irrigation System Debt Service Sub-total	**$0**	**$275,102**	**$275,102**	**$275,102**	**$275,102**	**$275,102**	**$275,102**	**$275,102**	**$275,102**	**$275,102**
TOTAL NDM IRRIGATION SYSTEM BUDGET (O&M/CAPITAL/DEBT SERVICE)	**$164,450**	**$575,799**	**$744,748**	**$775,344**	**$808,142**	**$622,909**	**$881,023**	**$561,579**	**$779,802**	**$811,586**