Start-up of a Secondary Water Supply Company and First Phase Design of a Regional System

by

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***Abstract*.** Highland Ditch Company formed the Highland Secondary Water Company (HSWC) as the entity that will provide pressurized untreated water to new multi-use developments within their historical agricultural water service area for new landscape irrigation needs. This case study describes the process from the start-up of the HSWC through the final design of the first phase of their regional pressurized irrigation transmission system.

The Highland Ditch Company participated in the Dual Water Systems Study (which reviewed opportunities for mutual irrigation ditch companies to promote their water delivery service to growing urbanizing areas along the Colorado Front Range by delivering pressurized raw water for landscape irrigation) conducted by Colorado State University and funded by the Colorado Water Conservancy Board.

Aqua Engineering completed a Feasibility Study for the Highland Ditch Company to evaluate the options of providing raw water to new developments. A business plan was developed to evaluate company operations and to determine the water rate structure. The Preliminary Design was developed to serve four initial developments and to be oversized for future developments within a 3-square-mile area.

Meetings and negotiations took place between HSWC and local potable water purveyors. A drought study was conducted to help set forth operational decisions necessary to help preserve the secondary water for both agricultural and urbanized users in future possible droughts. Standards and specifications were produced. Legal agreements were drafted between parties.

The first phase transmission system is currently under design and includes a check structure, ditch lining, pump station, pipeline, and SCADA system.

Introduction

The Highland Secondary Water Company (HSWC) was formed by the Highland Ditch Company as the entity that would provide pressurized untreated water to new multi-use developments within their historical service area (agricultural water delivery) for landscape irrigation needs.

Aqua Engineering has assisted the Highland Ditch Company and the HSWC from before the inception of HSWC. This case study will describe our work with both companies including the

process from the concept idea to the start-up of the HSWC and the final design of the first phase of their regional pressurized irrigation transmission system.

Background

The Highland Ditch Company holds direct flow and storage water rights, which are historically used for irrigation water for agriculture. The company's headworks and diversion, and the start of the canal system known as Highland Ditch, are located within the Town of Lyons on the St. Vrain Creek in Northern Colorado. The total service area of approximately 35,000 acres is located between the Little Thompson River on the north and Saint Vrain Creek on the south. The irrigated area served by Highland Ditch and several other incorporated lateral companies is generally surrounded by the communities of Longmont, Johnstown, Milliken, and Platteville.

The Highland Ditch Company participated in the Dual Water Systems Study conducted by Colorado State University and funded by the Colorado Water Conservancy Board. This study involved looking at the opportunities available for traditional mutual irrigation ditch companies to promote their water delivery service to the growing urbanizing areas along the Front Range of Colorado by delivering pressurized raw water for landscape irrigation. After participating in this study (which can be located on the web at http://waterlab.colostate.edu/DualStudy/finished_dualstudy.pdf), the Highland Ditch Company chose to pursue investigating their opportunities by conducting a feasibility study specific to their company and service area.

Feasibility Study

Aqua Engineering was retained to complete a Feasibility Study for the Highland Ditch Company to evaluate the options of providing raw water to new developments. The study included a broad look at the entire historical service area, estimates of development impact, and conceptual infrastructure design. The study was cost-shared by the Colorado Water Conservancy Board. The Feasibility Study was completed in November 2004.

The primary purpose of the Feasibility Study was to examine the opportunity to provide pressurized secondary water to housing developments, parks, streetscapes, and golf courses that are envisioned to be built. Pressurization in and of itself results in a fully modernized canal, even to the extent that the canal may eventually become obsolete and essentially replaced at some point by pressure piping. Urbanization at the current level is expected to occur rapidly over the next 10 to 15 years. Although the potential for urbanization within the Highland Ditch service area is high, it is likely that traditional agricultural will remain a part of the system for some time.

A secondary supply or dual system is basically a utility. Potable water is provided for largely indoor culinary uses and a secondary or "dual system" is provided for primarily outdoor landscape irrigation. A sound engineered approach to secondary water management includes a detailed design of the infrastructure piping and the irrigation system, and due consideration to long-term system operation and management. The provision of secondary supply may also afford significant opportunities for the ditch company to modernize its 100-year-old plus canal infrastructure. Modernization may include structural or operational improvements, or a combination of these, the benefits of which can complement the ditch company's provision of secondary supply for urbanization. This is expected to materially benefit the larger community, in terms of the water conserved in agricultural uses.

Pressurized secondary water is envisioned to be, not only a key canal modernization strategy, but a mechanism for actually sustaining an agricultural economy and setting (i.e. desirable open

space areas) under Highland Ditch. The study took the approach of fast forwarding to a complete secondary supply build-out scenario. Consideration was given to the whole system service area and a forecast of the mix of landscape treatments and changing irrigated areas associated with new housing. Several phases have been suggested based on the known development areas and logical boundaries based on system hydraulics. This work was compiled through various elements of work with the Highland Ditch Company, including several site visits and discussions with the Board of Directors (BOD). This study reported on the important elements of a pressurized secondary system for Highland Ditch including:

- A conceptual layout of the secondary supply infrastructure.
- Probable costs of infrastructure design and construction.
- Development and construction approaches.
- Optional funding sources.
- Financial payback, including a forecast of revenues and expenses over the first ten years.

This report provided answers to questions posed by the BOD in sufficient detail to allow the continuance of discussions and hopefully, the ultimate and satisfactory implementation of a pressurized secondary supply system. Secondary supply provides an opportunity for Highland Ditch shareholders, for the potable water purveyors, and ultimately the homeowners under the Highland Ditch service area, to be the long term beneficiaries of secondary water for landscape irrigation.

The conceptualized pressurized pipe system will serve an area of approximately 14,583 acres. The irrigated area is a fraction of the total service area to be irrigated with landscape irrigation systems. These areas include parks, open spaces, rights-of-way, golf courses, streetscapes, commercial lots, schools and public spaces, multi-family housing areas, and individual residential lots. For the water requirement elements of the study, it was assumed that the actual irrigated area was 30% of the service area, or about 4,375 acres. Experience has shown that irrigated area can range from 20% to 40% of a development site, which is a function of the type of construction and local development and landscape requirements. Considering a mixed land use development, the assumption of 30% of the total area irrigated was assumed to be reasonable for this study.

The seasonal irrigation requirement for turf is approximately 28 inches in the project area. The total required flow rate to irrigate 4,375 acres within a 12-hour watering window is approximately 59,820 GPM during peak season (typically in July).

Conceptual design of a transmission system was developed and included preliminary calculations for water storage, pump stations, and pipeline networks. For this feasibility study, the BOD envisioned two major phases based on the known and anticipated development plans in the area. The first Phase, Phase I, was anticipated to be a 3-mile radius circle, centering on Highway 66 and I-25. Phase II is anticipated to be about a 3-mile radius area on the northern end of the service area, just south of Johnstown and Milliken. Additionally, smaller phases would cover the outlying areas to the west (Phase III) and to the east (Phase IV). Phase I includes 1,400 acres or irrigated area, Phase II includes 1,250 acres of irrigated area, Phase III includes 1,300 acres of irrigated area, and Phase IV includes 450 acres of irrigated area.

Two storage reservoirs and two pump stations are proposed to service the landscape demands throughout the area. Currently, the Highland No. 3 Reservoir, which is located near the southwest corner of Highway 66 and I-25, is envisioned as the first reservoir on the system for

Phase I. This reservoir is fully owned by the Highland Ditch Company. Utilizing the existing reservoir is a logical component to this system because it is at the heart of the development in Phase I, is owned by the Company, and has established storage rights. This “transmission network” was conceptualized in order to understand, on a preliminary level, how much pipe is needed, where pipe is to be installed, and what the size and cost might be. A hydraulic model was developed to determine the optimum pipe sizing based on the developed pipe routing and existing and proposed reservoir locations. Both pump stations contribute to the total flow rate for the pressurized irrigation system. It is assumed that both proposed pump stations operate simultaneously. Each station will include some redundancy to allow for maintenance of the pumps and motors without disrupting the service flow rate.

The Phase I pump station was proposed to be located at Highland No. 3 Reservoir. Output from the hydraulic model requires approximately 32,000 GPM at a discharge pressure of approximately 116 PSI. The total required horsepower is anticipated to be approximately 3,200 HP. Eight pumps, each with 400 HP motors, are proposed for this pump station. Four skids, each capable of 8,000 GPM, would be required to meet the total demand of the secondary supply system at build-out level.

The Phase II pump station will be located at the proposed new reservoir near the head of the Erkenbeck Lateral. Output from the hydraulic model requires approximately 28,500 GPM at a discharge pressure of approximately 106 PSI. The total required horsepower is anticipated to be approximately 2,600 HP. Seven pumps, each with 400 HP motors, are proposed for this pump station. Four skids would be required to meet the total demand of the secondary supply system at build-out level from this station with three skids capable of delivering 8,000 GPM and a single skid capable of approximately 4,500 GPM.

The Opinion of Probable Construction Cost was developed for the build-out scenario of a pressurized secondary supply system in the Highland Ditch service area. The grand total Opinion of Probable Construction Cost for Phase I was found to be approximately $12 million (including 10% contingency and 10% engineering fees). The grand total Opinion of Probable Construction Cost for Phase II was found to be approximately $12.4 million (including 10% contingency and 10% engineering fees). Including two other future phases that would mainly involve piping systems, the grand total estimated cost of the proposed secondary supply system for the identified area was found to be approximately $32.4 million.

Based on the findings of the Feasibility Study and the development pressures in the vicinity of the proposed Phase I secondary supply system, the Highland Ditch Company proceeded to further the evaluation of this system. A White Paper was written to summarize the Feasibility Study and to provide this information to interested participants for support of the next level of Preliminary Design.

Preliminary Design

Three developer participants and the local school district were included in the initial Preliminary Design. This became the first phase of the overall plan. The Preliminary Design was developed to serve these initial four sites and to be oversized for future developments within a 3-square-mile area. The results of this Preliminary Design were furnished to the participants in a memorandum in March 2005.

Phase 1 of the HSWC is shown in Figure 1. This area was modified from the Feasibility Study based on the participant input and further estimation of the immediate growth areas. Phase 1 is approximately three miles by three miles bounded by I-25 on the east, Colorado State Highway 66 on the north, and roughly Colorado State Highway 119 on the south. Phase 1 was broken

down into Phase 1A and Phase 1B. Phase 1A includes the developments that have been working with HSWC during the Preliminary Design process and have committed to the advancement of this project to date.

The peak season daily water requirement was calculated for the anticipated build-out in Phase 1 and each development in Phase 1A. The total anticipated irrigated acreage in Phase 1 is approximately 1,530 acres. This area was calculated based on the known irrigated acreage presented by the Phase 1A developments, and an assumption that 40% of the total land area of each development would be irrigated. The known and assumed irrigated area in Phase 1A is approximately 345 acres based on preliminary information provided by each development company.

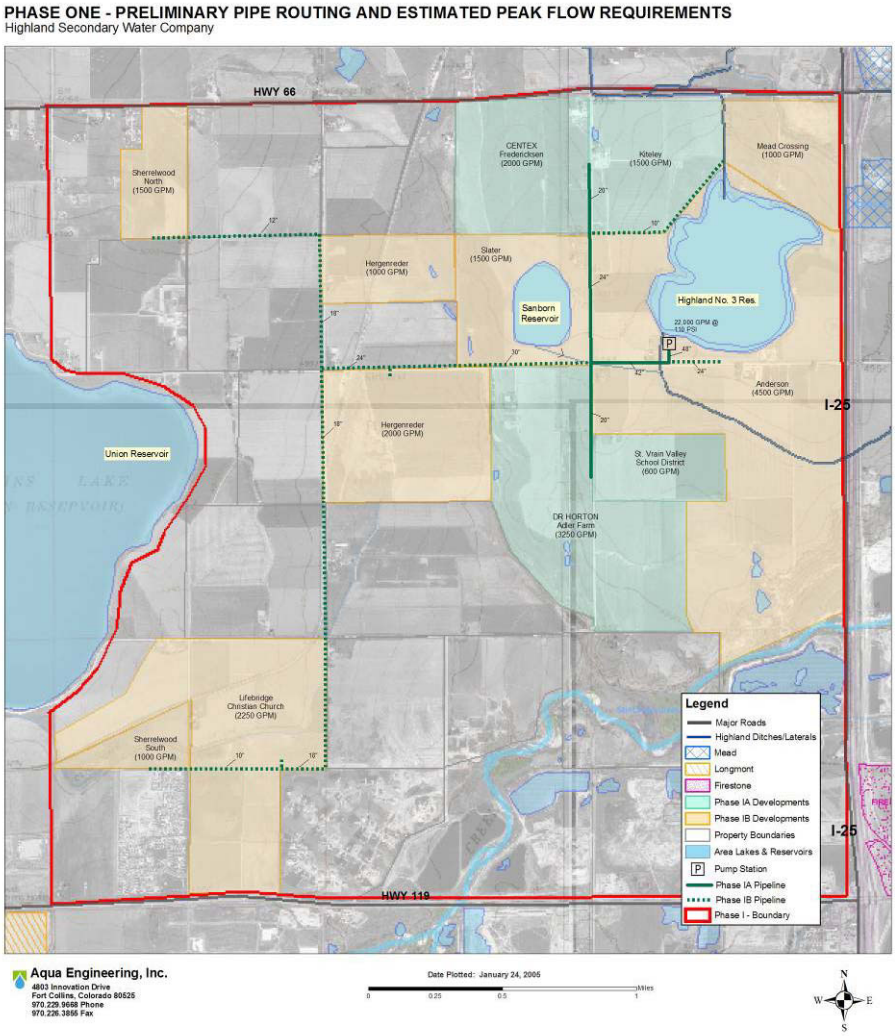

Figure 1. Phase 1 boundary refined during Preliminary Design

The water use requirements were calculated for the Phase 1 build-out and for the Phase 1A needs. The recommended pump size for Phase 1 is 22,000 GPM which correlates to two different calculation methods used: the estimated peak season flow rate for a total irrigated area of approximately 1,500 acres and the estimated sum of the peak season flow rate for each of

the proposed or assumed developments of Phase 1, based on total irrigated area for a 12-hour watering window. The Phase 1A estimated flow rate was determined to be 7,350 GPM.

The pump station will include multiple pumps to provide a range of required flow rates, from incidental watering needs to the peak day demand. The pump station will consist of multiple pump skids that include vertical turbine pumps capable of supplying the required peak season flow rate at the set pressure. The main pumps will be controlled by variable frequency drives (VFD) to provide constant pressure to the system.

The Phase I pump station will have a build-out flow rate of approximately 22,000 GPM at a discharge pressure of approximately 110 PSI. The proposed station includes four pump skids each rated for 5,500 GPM. Each of the skids would include 4 vertical turbine pumps at 150 HP. The initial pump skids will also include smaller pumps to maintain system pressure and meet the low flow demands. The total required horsepower is anticipated to be approximately 2,340 HP. For Phase 1A, two skids will be required for a total flow rate of 11,000 GPM (7,350 GPM required). As additional demands are required, the additional two pump skids will be added to the pump system.

An intake structure is planned to be located in the storage reservoir (Highland No. 3 Reservoir, owned by the Highland Ditch Company) and will help prevent large debris from entering the pump system. The intake screen will be connected to a concrete wet well located below the pump system and building.

A hydraulic model was developed to determine the optimum pipe sizing based on the developed pipe routing and pump station location. Anticipated flow demands in the system were assigned to nodes on the pipe network. The pipe material used for transmission system includes C900 and C905 pressurized PVC pipe. This pipe material is typically used for municipal waterlines and is rated for installation in roadways. The transmission piping will end at the entrance to each development. A master meter will be installed as part of the HSWC system. Downstream of the master meter, the secondary supply distribution system will be installed for the development.

The Opinion of Probable Construction Costs was developed for the Phase 1 build-out scenario as well as the Phase 1A initial system. Acquisition of easements has not been included in the cost estimates because easements will be required from each developer to route the pipe to their development. The estimated construction cost (including contingencies and engineering fees) for Phase 1 was found to be approximately $7.9 million. The Phase 1A estimated construction cost was found to be approximately $3.6 million because of the minimal, initial pipe network and only installing the first two pump skids. Proportional costs were calculated to determine how much each developer and the school district would be required to contribute in order for the project to proceed. The proportional cost was based solely on the anticipated flow rate (GPM) compared to the combined flow rate of Phase 1A.

During the Preliminary Design, preliminary Rules and Regulations were drafted to establish how the end users and the HSWC would work together. These will be completed in the final design phase. Additionally, HSWC Standards and Specifications were produced for the development's distribution systems that would connect to the main transmission system. These standards outline the requirements for the distribution system within each development, in order for HSWC to accept the system after installation. Considerations such as pipe material, burial depth, and location are outlined in the standards.

The outcome of the Preliminary Design and the positive responses of the participants was evidence that HSWC should proceed and the next step was for the newly formed company to develop a Business Plan.

Business Plan

The Highland Secondary Water Company (HSWC) was formed by the Highland Ditch Company BOD in January 2005 for the purpose of providing secondary water for landscape irrigation to residential developments within the historical service area of the ditch company.

After the HSWC was formed, a business plan was developed to evaluate the operations of the company and to help determine the water rate structure. Development of the business plan involved input from a former manager of a similar company in Utah. The intent of this business plan was to help HSWC further refine their approach for operating the company. The business plan was complete enough for the company to begin operation, and should be updated on a continual basis to monitor current and future operation. Four basic financial forms were developed as part of this business plan:

- Buildout
- Income Statement
- Cash Flow Analysis
- Break Even Analysis

The members of what is now the Highland Secondary Water Company, with the assistance of legal counsel, filed with the Secretary of State of Colorado to do business as a Limited Liability Company (LLC). Current Highland Ditch Company owners of record will be provided with four shares of the Highland Secondary Water Company shares for each share of Highland Ditch. So, in other words there will be a 4:1 issuance of stock in HSWC on the basis of Highland Ditch shares. Figure 2 illustrates this process.

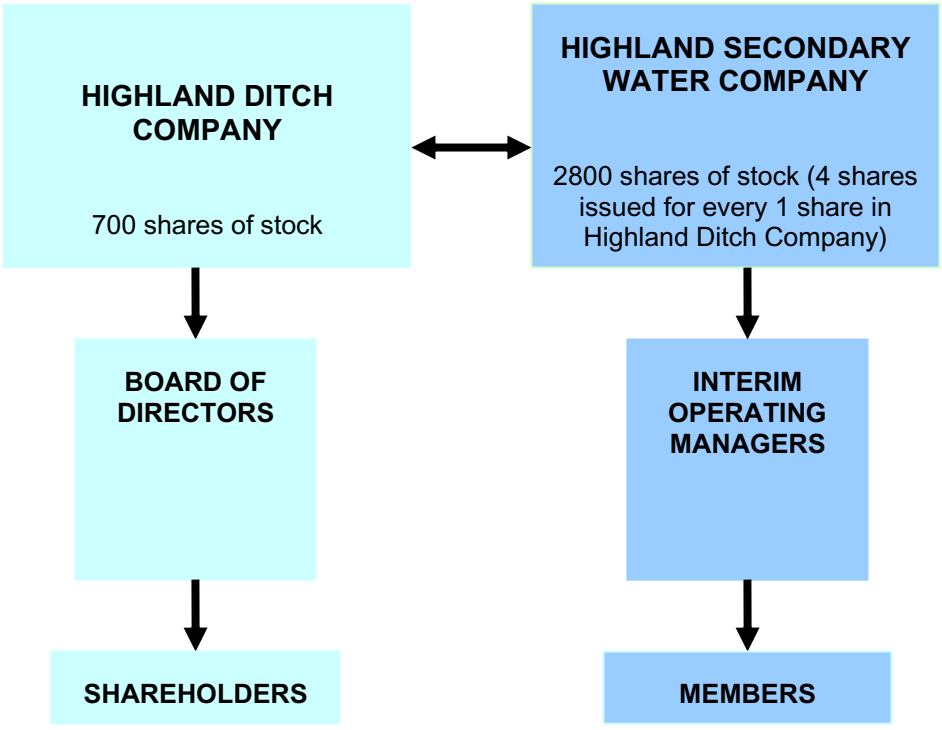

Figure 2. Flowchart for issuance of HSWC stock.

Stock in the new company is not tied to land or the Highland Ditch Company shares, and can be sold on the open market like other stocks. Specifics regarding voting, annual meetings, and company membership and management are yet to be determined for the HSWC.

For the current financial model, it is assumed that HSWC's average water bill will be approximately 80% of a comparable bill from the local potable water purveyor, Longs Peak Water District. The basis for this assumption is that:

- Secondary water supply customers will benefit financially in the form of lower water rates for non-potable water.
- The water rate structure will adequately cover the operation and maintenance costs of the HSWC, even during times when water use on landscapes significantly decreases, such as during extremely wet years and during drought conditions

The water rate structure developed for the financial model assumes a monthly base rate and consumption rate per 1,000 gallons of water consumed for both residences and open space. To insure an adequate cash flow throughout the year, the base rate was assumed to be charged to customers 12 months of the year. The consumption rate is only to be charged during the irrigation season when water is consumed. This approach allows for more adequate cash flow to the HSWC and more evenly distributes the cost of non-potable water to customers.

In the financial model, a base rate of $20 per month was selected for residential use (1-inch tap) and $45 per month was selected for open space use (2-inch tap) because these amounts will adequately cover the fixed costs of operating and maintaining the system, even in years when little to no water is consumed such as during a drought. In the financial model, the consumption rate for both residential and open space uses was selected to be $1.75 per 1,000 gallons of water consumed. Longs Peak consumption rate for potable water is $2.73 per 1,000 gallons. For a typical residential lot, the HSWC water rate structure would amount to an annual fee that is equal to 80% of the fee that would be charged under Longs Peak Water District. This assumes that a typical lot is approximately 10,000 square feet of gross area with approximately 3,500 square feet of irrigated bluegrass – for an average annual consumption of 61,000 gallons. Rates to be charged to homeowners will generate the funds to operate and maintain the system. A projected or pro forma Income Statement was developed and shows in detail the expected revenues and expenses of the company. The Income Statement shows that after the start up transitional years, revenues will be generated to offset expenses and leave a good profit. However, during the start up year, the company will incur expenses to run the system while the revenue will begin to come in gradually. This provides a challenge which will require careful planning on the part of the HSWC managers.

For the first two years, a breakeven analysis is provided, which shows how many houses must be built and serviced for financial breakeven. It is probable that additional costs will be incurred which are not now known, which will decrease the profit projected. Having a large indicated return gives plenty of leeway for additional expenditures. Regarding monthly Cash Flow in the first year, it should be noted that some adjustments may be necessary to balance expenses against income.

The results show that for the given assumptions, operation of the HSWC is feasible in the short-term and almost certainly highly profitable thereafter.

Legal Agreements and Negotiations

For the first Phase of the HSWC regional transmission pump system, three primary agreements have been executed or are in process: Franchise Agreement with the Town of Mead (the first

developed was annexed in to the Town), Agreement with the Longs Peak Water District, and Service Agreement with the developer.

Meetings and negotiations took place between the HSWC and potable water purveyors in the area. To mutually benefit all parties, the potable water purveyors were contacted to help establish reduced water rate turnover requirements from the developers when a secondary water supply system was implemented. Actual ownership of the raw water shares was also a critical component to the systems. The pending agreement with Longs Peak Water District is based on the amount of water that will be turned over for secondary supply systems servicing individual residential lots, or other lots where a potable water tap would usually provide irrigation water. For parks and open spaces, HSWC will own the water rights.

The Franchise Agreement with the Town was required by the Town in order for the HSWC distribution system (paid for and installed by the developer, then turned over to HSWC after completion) to be located in the streets of the development. The agreement requires that HSWC provide the Town with a certain annual percentage of their income from operating this system. This payment is anticipated to be used for repairs of the Town street in the event that the HSWC system causes problems that HSWC does not repair.

The agreement between HSWC and the developer sets the stage for the relationship between the two entities, outlines the service commitment that HSWC is providing, and establishes the details of how the systems work. An example of some of the information contained in this agreement is the intended operation dates of the pressurized secondary supply system: “May 15th through September 30th, unless HSWC, in the reasonable exercise of its discretion modifies the season of use as a result of unusual climatic conditions.” The initial water rates are also outlined in this agreement.

Drought Study

A drought study was conducted to help set forth the operational decisions that would be necessary to help preserve the secondary water for both agricultural and urbanized end users in future possible droughts. The drought study presented a conceptual drought response plan for the Highland Secondary Water Company. A drought response plan includes indicators and associated responses that can be used in future drought years to more effectively manage water use under the secondary supply system. A drought plan defines what various drought indicators (such as reservoir levels) should trigger what drought response mechanisms (such as mandatory landscape watering restrictions). The drought study was developed to provide a road map that the HSWC can use in future drought years to insure effective and equitable management of their water resource. Specifically, the plan discussed:

- An analysis of historical Saint Vrain basin droughts and Highland Ditch Company diversions during key drought years.
- A forecast and analysis of landscape water requirements at urbanization build-out for Phase 1A development.
- Determination of conceptual drought indicators and measurements.
- Development of conceptual drought response mechanisms.

The drought plan concluded that:

- Drought indicators for both river water and reservoir water should be considered to help determine future drought conditions.

- A review of historical stream flows and diversion records for the Saint Vrain Creek and the Highland Ditch indicate four levels of drought conditions (1976, 1955, 1966, and 2002 – in order of increasing drought severity).
- A hypothetical evaluation of HSWC Phase 1A developments indicates that drought response mechanisms should more specifically target late season water demands, which are on average large compared to historical storage water availability.
- Landscape plantings other than bluegrass may help to reduce the critical late season demand.
- Drought response mechanisms should be further evaluated relative to drought indicators to determine what mechanisms most effectively reduce demand.

Final Design – Transmission System

The first phase transmission system is currently under design after being modified to meet the needs of one initial development and the school district. The first developer committed to funding the final design and the capital cost of the transmission system. Many components in the system are being designed for future needs (intake system, building, and electrical service) and many components are being sized only for the initial users (first pump skid, pipelines). Construction of the transmission system is expected in the winter of 2006 for service in the spring of 2007

The final design includes improvements to the existing reservoir outlet ditch, an intake and wet well structure; the Phase 1A prefabricated pump skid, oversized building and floor slab, and pipe system. The intake system, pump system, and building concepts were revisited and several new ideas were incorporated into the final design. These changes will allow the Phase 1A system to be installed and provide water to the initial participants. As future participants join the system, modifications to the infrastructure and expansion will be required.

The pipes have been sized to serve the initial two participants and another development (as requested by the first developer, the second development has been included based on their discussions that they will join the system but they didn't have the capital to be involved in the design and construction of the transmission system presently). As future participants join the system, pipe sizes or looping requirements will have to be increased in order to add capacity to the infrastructure. System expansion, as well as system changes, will be the requirement of future secondary supply system participants. The following significant changes allowed a reduction in the Opinion of Probable Construction Cost to less than $2 million for Phase 1A.

A system concept change was made regarding the intake system and pump station placement. Rather than constructing an intake assembly in Highland Reservoir #3 and raising the finished grade of the property on the southwest corner of the reservoir to bring the pump station to the necessary elevation, an alternative approach was agreed upon. The existing 36-inch outlet pipe from the reservoir appears to have available capacity that can be used to take water from the reservoir for Phase 1A. The new intake system and pump station will be installed on the existing outlet ditch. Eventually, the intake pipe from the reservoir will need to be enlarged for future phases. By proceeding with this option, work around and through the existing dam will not be a factor in this phase of the project, reducing costs and eliminating reviews by the State Engineer's Office.

Rather than construct the building for the build-out size (approximately 25 ft by 75 ft), a 25 ft x 30 ft steel building will be designed to house the first pump skid. As the system grows, the steel building can be expanded.

The pipe sizes from the pump station to each participant's property have been reduced. From the pump station, a 24-inch C905 PVC pipe is proposed west to WCR7. This pipe is designed to carry 4,550 GPM (1,900 GPM to the first development, 1,900 GPM to the future second development, and 750 GPM to the school site). From the intersection of WCR 7 and WCR 28, a 10-inch C900 PVC pipe is proposed to the school site and a 20-inch C905 PVC pipe is proposed north to the development properties.

The pump station will be designed as pre-fabricated, skid-mounted stations including the main pumps, pressure maintenance pumps, variable frequency drives, piping, valves, and electrical controls. Automatic filtration will also be included on the skid, downstream of the pumps. This filter will prevent debris from entering the irrigation systems and help avoid clogging sprinklers or valves. The pump station will be composed of several pump "skids" in order to meet the required total flow rate being pumped and to allow for incremental phasing as the system grows. The Phase 1A pump skid was reduced to only provide water at a rate of 4,550 GPM for the first three participants. This is smaller than the original proposed single skid sizes of 5,500 GPM. Therefore, future skids may be larger than 5,500 GPM to still meet the build-out demand with a total of four pump skids. A SCADA (Supervisory Control and Data Acquisition) system has been included to provide remote monitoring and control as desired by HSWC.

Conclusion

The Highland Ditch Company formed the Highland Secondary Water Company as the entity that will own, operate, and maintain a new regional secondary water supply transmission and distribution system. The secondary water system will provide pressurized irrigation water (non-treated) for landscape irrigation purposes to multi-use developments and a local school site.

This paper described the work that has been completed from the beginning Feasibility Study concept designs through the final design (currently in process). Engineering designs and studies and legal agreements are all covered as part of the process that were required for this project.

Acknowledgements

The authors would like to acknowledge the Highland Ditch Company Board of Directors and the Highland Secondary Water Company Mangers for their ownership of this project and their foresight in planning a regional secondary water system that will benefit their current and future water users.