CITY OF SISTERS

June 26, 2013

Mr. Bill Fujii
Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem, Oregon 97301

CITY OF SISTERS, WASTE WATER REUSE AND CONSERVATION PROJECT PLANNING STUDY

Dear Mr. Fujii:

The City of Sisters planning study for its waste water reuse and conservation project is submitted herewith to the Oregon Water Resources Department (OWRD). This study was completed with financing under the Oregon Water Resources Department Water Conservation, Reuse and Storage Grant Program.

The study purpose was to determine the feasibility for the City to provide for its future water supply and waste water management needs through a unique program that reuses treated waste water and restores flow in Whychus Creek. The program transfers surface water irrigation rights back to Whychus Creek, their source, and replaces the rights with treated effluent for irrigation. The water right transfers to instream flow may be used to provide additional flows for fish and wildlife and to provide mitigation for new ground water permits needed for future City water supply. Use of treated effluent for irrigation allows the City to manage its future waste water discharges through the year 2033.

The study finds that the proposed program is feasible. The implementation plan to transition from surface water irrigation to effluent irrigation is presented in the accompanying planning study.

Please contact me if you have any questions or inputs to this planning study report. The assistance of the OWRD through the grant made this study possible and is a key element in initiating unique water supply and water reuse management actions through the City's implementation plan.

Sincerely,

Paul Bertagna, Director of Public Works

Enclosure

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CITY OF SISTERS

GSI Water Solutions, Inc.

NEWTON CONSULTANTS INC.
Earth, Water and Rock Specialists

WASTE WATER REUSE & CONSERVATION PROJECT PLANNING STUDY

Transitioning Irrigation from the Lazy Z Property from Surface Water to Treated Effluent

Oregon Water Resources Department
Water Conservation, Reuse and Storage Grant Program

Prepared for:

City of Sisters
Sisters City Hall
520 East Cascade
P.O. Box 39
Sisters, OR 97759

June 26, 2013

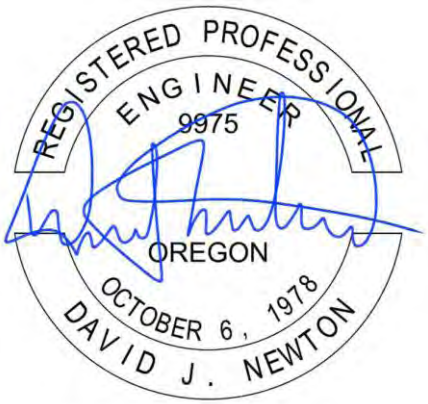
Project No.: 1138-101

WASTE WATER REUSE AND CONSERVATION PROJECT PLANNING STUDY

TRANSITIONING IRRIGATION FROM THE LAZY Z PROPERTY FROM SURFACE WATER TO TREATED EFFLUENT

OREGON WATER RESOURCES DEPARTMENT
WATER CONSERVATION, REUSE AND STORAGE GRANT PROGRAM

June 26, 2013



EXPIRES: 12 / 31 / 13

City of Sisters
Sisters City Hall
520 East Cascade
P.O. Box 39
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EXECUTIVE SUMMARY

The City of Sisters, Oregon (the City) presently recycles its waste water for irrigation uses. The City collects waste water from within its service area, treats the effluent in aeration lagoons, stores it in a large holding pond over the winter and irrigates pine forest and grass areas with the treated effluent in the summer. The effluent collection, treatment and irrigation process is conducted under a Water Pollution Control Facilities permit (WCPF) issued to the City by the Oregon Department of Environmental Quality (ODEQ). This process is also conducted according to the City's updated Recycled Water Use Plan approved by the ODEQ in 2007.

The City is growing. Demand for water supply is increasing and provisions are required for managing increasing waste water discharges in the future. The increasing water demand and waste water discharge brings unique opportunities to the City and to Whychus Creek. The source of supply for increasing water demand is ground water. Hydraulic connectivity between the aquifer system and Whychus Creek requires mitigation of ground water pumping effects on creek flows. Water supply is needed by the City to accomplish the required mitigation, which is done conventionally in the upper Deschutes Basin by vacating irrigated land of water rights and transferring the rights back to their source stream to restore flows as an offset to pumping effects. Provisions for future water supply and waste water management contemplated by the City can also benefit Whychus Creek through flow restoration with surface water rights held by the City.

The present City process of recycling its waste water for irrigation use is successful. Accordingly, the City purchased 240 acres of Lazy Z Ranch property as a component of its plan for additional water supply and for managing additional waste water flows into the future. Under this plan, the City can transfer irrigation water rights on the Lazy Z property back to Whychus Creek, responding to its mitigation obligations and restoring flows in the creek. In exchange for the water right transfers, the City will irrigate the effected lands with treated effluent, expanding its capacity to manage increasing waste water discharges into the future.

The planning study presented in this report was intended to evaluate the feasibility of this plan to transition from surface water irrigation to effluent irrigation on the Lazy Z property. Feasibility depends on several factors including: 1) regulatory requirements; 2) amount of effluent available for future irrigation; 3) existing water rights on the Lazy Z property; 4) crops best-suited for effluent irrigation at the site and their irrigation water demand; 5) timing for conversion of surface water rights to instream rights; 6) suitable effluent irrigation mechanisms and their costs; and 7) financing opportunities for converting surface water rights to instream rights.

Evaluation of the feasibility factors finds that implementation of this plan or phases of the plan is feasible. The Lazy Z property provides more than enough capacity to irrigate 294 acre-feet of effluent under the Case I option in the year 2033 (and enough capacity to irrigate the total estimate effluent volume of 361 acre-feet in 2033). Hay (alfalfa, grass and timothy), poplar trees for wood fiber and ornamental trees can be grown by irrigation with treated effluent and are best suited for the site.

Irrigation can be done with conventional mechanisms including hand lines, K-lines and circle-pivot systems. Whychus Creek is a priority stream for steelhead reintroduction, the existing surface water rights on the Lazy Z property are supplied with Whychus Creek water and various proven administrative and financial mechanisms exist for transferring the water rights back to Whychus Creek as insteam flows for restoration purposes. Timing and opportunities are best accommodated through three phases of plan implementation.

The City plans to proceed with development of this transition plan, which will result in a unique set of benefits relative to future water supply and future waste water discharges in response to growth, and relative to flow restoration in Whychus Creek. However, to proceed, the City must secure adequate financial resources to develop and execute the plan in a timely manner. Financial needs and benefits for executing the three phases are summarized below in the following table:

	Costs		**Benefits**			
	Infrastructure		**Lease**[1]	**Split-Season Lease**	**Restoration Transfer**	**Temporary Transfer**
	Hay	Poplar				
Phase I (48.84 acres)	$786,857	$865,745	$1,026-$1,709	0	$219,780-$317,460	No data
Phase II (37.38 acres)	$636,352	$749,780	$785-$1,308	0	$168,210-$242,970	No data
Phase III (47.79 acres)	$727,417	$846,668	$1,004-$1,673	0	$215,055-$310,635	No data
Total	$2,150,626	$2,503,193	$2,815-$4,690	0	$603,045-$871,065	No data

[1] The DRC pays $7/AF. This range is based on $3 AF/acre and $5 AF/acre leased.

INTRODUCTION

Over time the City of Sisters (the City) must expand its waste water disposal capacity. To this end, the City is developing this planning study to transition from surface water irrigation to effluent irrigation on the City's Lazy Z Ranch property (Lazy Z property). This will fulfill the City's original intent in acquiring the property, expand waste water disposal capacity, and provide instream benefits to Whychus Creek.

The City has a Recycled Water Use Plan (RWUP) that was updated for the Lazy Z property and approved by the Oregon Department of Environmental Quality (ODEQ) in 2007. The City submitted for renewal of its Water Pollution Control Facilities (WPCF) permit in 2011.

This planning study evaluated considerations associated with (a) disposal of treated effluent by irrigation, including regulatory requirements, (b) the amount of treated effluent available over time, (c) surface water rights and phasing of the transition from surface water irrigation to effluent irrigation, and (d) irrigation mechanisms and costs, and financing. The study also assessed whether modifications to the RWUP or the WPCF permit are required.

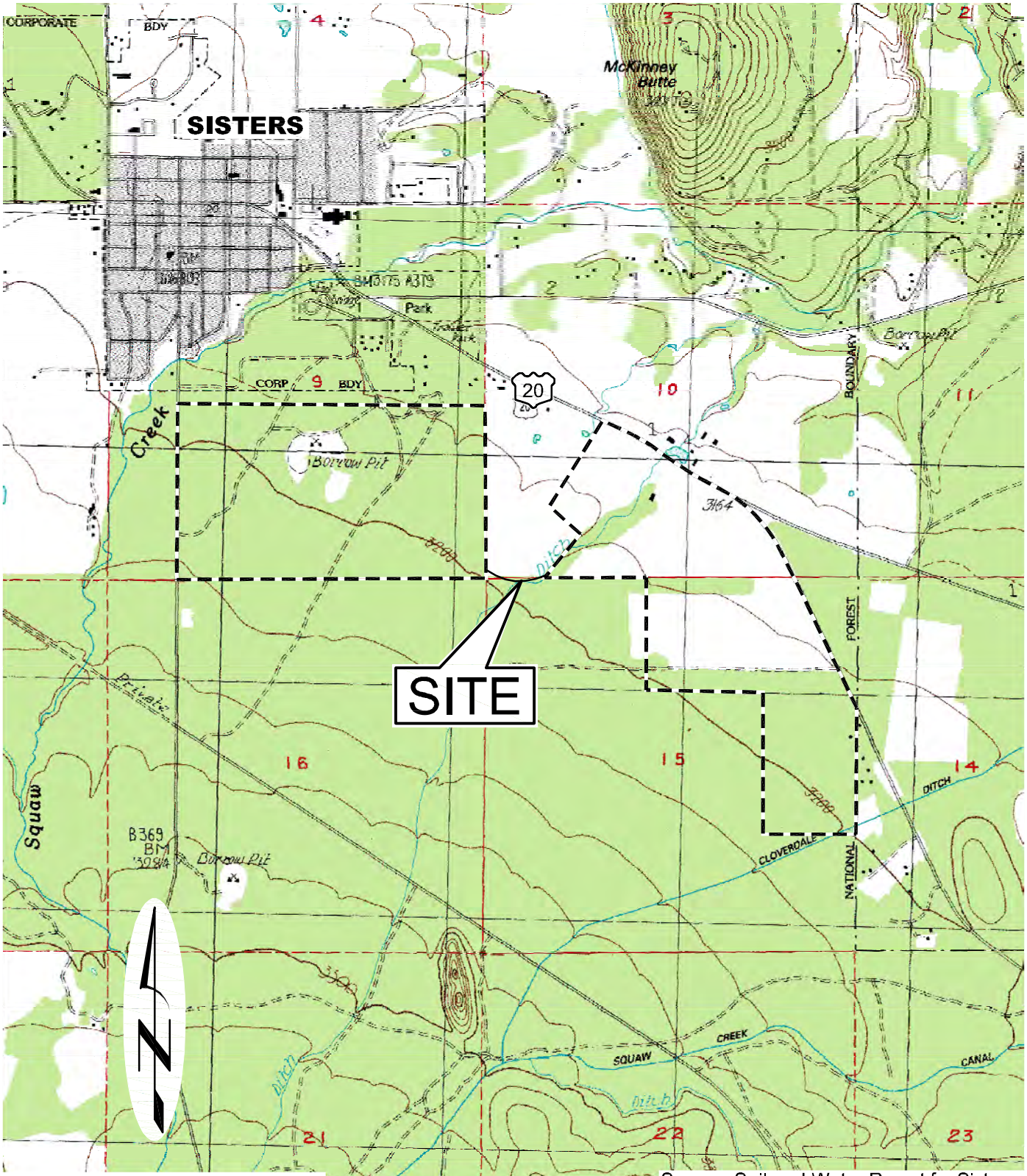
The results of the study are described below and include conceptual design framework, timeline for implementation and opportunities to use the City's Lazy Z property water rights to meet instream water demands and help finance the infrastructure necessary to irrigate with effluent.

The location of the site is shown on Figure 1 (Vicinity Map). The site area, existing waste water treatment facilities and Lazy Z property are shown on Figure 2.

EXISTING FACILITIES

General

The description of existing waste water facilities in this report section is focused on the waste water treatment facility. A brief summary of the City's waste water system is below. A detailed description of the waste water facilities is presented in the document *"Wastewater System Capital Facilities Plan – Final; City of Sisters, Deschutes County, Oregon,"* November 2006 (Facilities Plan).



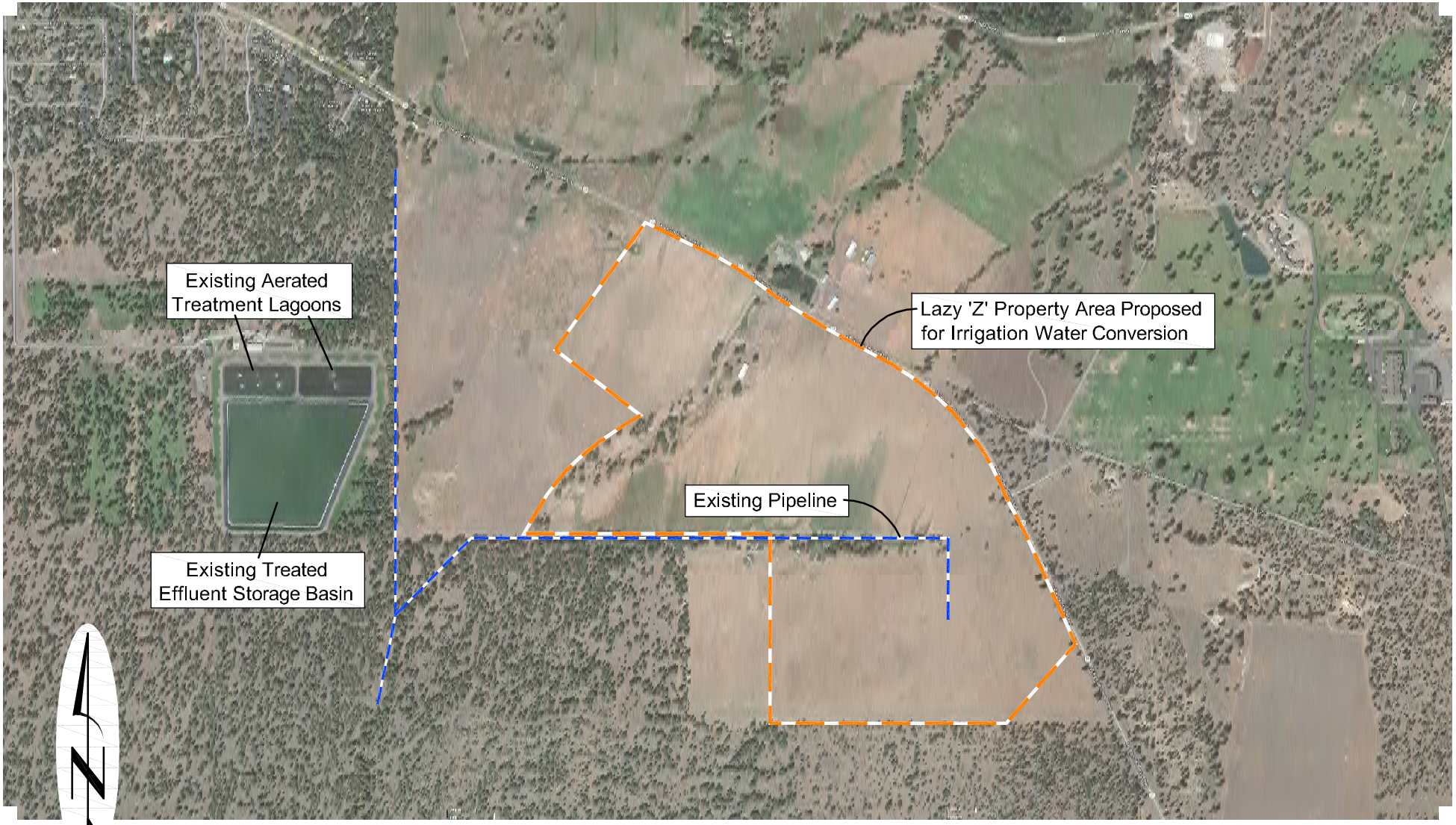
Source: Soil and Water Report for Sisters Wastewater Project, Page 5, Dated Feb 2007, authored by Wert & Associates, Bend Oregon

NEWTON CONSULTANTS INC.
Earth, Water and Rock Specialists
Ph: 541 504-9960 Fax: 541 504-9961

Vicinity Map
Lazy 'Z' Evaluation
Sisters, Deschutes County, Oregon

DESIGNED BY:	DRAWN BY:	DATE:	PROJECT NO.	FIGURE 1
D. Newton	S.Schenck	MAY 2013	1138-101	

G:\1100\1138 Lazy Z\101\Cad\Water\W1138101_F1_Site 08:10 05/24/2013 SS



0' 1000' 2000'

SCALE: 1" = 1000'

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Earth, Water and Rock Specialists
Ph: 541 504-9960 Fax: 541 504-9961

Site Area - Proposed Conversion of Surface Water Irrigation to Treated Effluent Irrigation
Lazy 'Z' Evaluation
Sisters, Deschutes County, Oregon

DESIGNED BY:	DRAWN BY:	DATE:	PROJECT NO.	FIGURE
D. Newton	S. Schenck	MAY 2013	1138-101	2

Waste water Facilities

The City of Sisters constructed its waste water facilities during the period 2000 through 2002. The facilities consist of a gravity sewer system with 106,775 lineal feet of waste water sewers, three waste water pump stations and force mains, two aerated treatment lagoons, a storage lagoon, and an automated system that irrigates 100.3 acres of land with treated effluent. Treated effluent is provided to 11.8 acres of dike and pasture grass, and 88.5 acres of forest land.

Waste water Treatment Facility

The waste water treatment facility and the effluent irrigation sites are located immediately south of the Sisters City limits on the south ½ of Section 9, Township 15 South, Range 10 East, W.M. (Figure 2). A schematic illustration of the facility is shown on Figure 3.

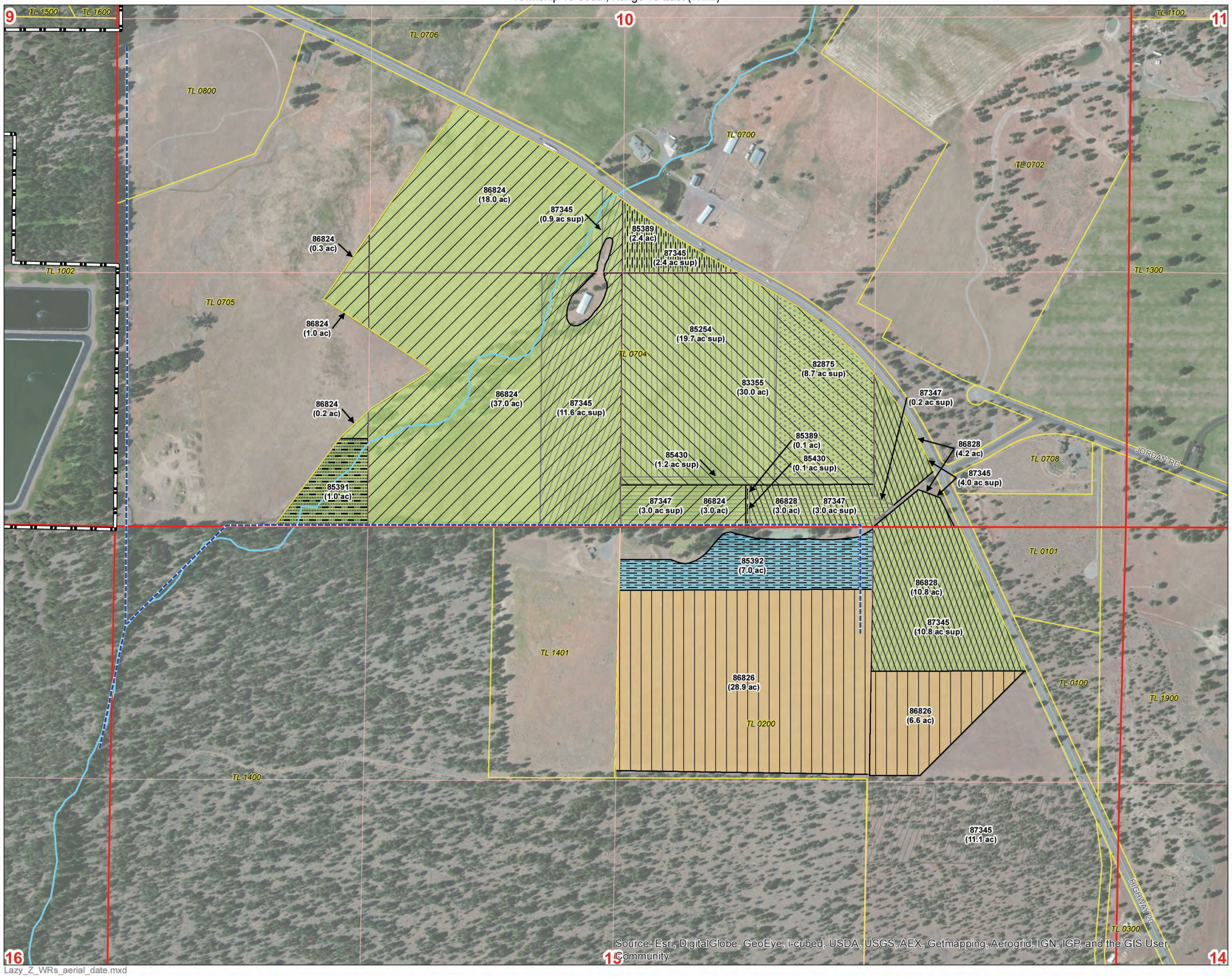
Waste water treatment is provided with two aerated lagoons. The holding capacity of each lagoon is 19.5 acre-feet with a maximum water surface area of 2.41 acres. Treated waste water is then conveyed from the treatment lagoons to a storage lagoon with storage capacity of 213 acre-feet at a maximum water surface area of 18 acres.

The aerated lagoons use mechanical aeration systems to provide oxygen for bacterial respiration and to achieve mixing of the waste water. Mixing of the waste water in the aeration process contributes to suspension of solid particles in the lagoon effluent. Solids removal and additional aerobic treatment are provided in the storage lagoon. A full discussion of the waste water treatment process is presented in the above-cited Facilities Plan.

Waste Water Irrigation Facility

The treated effluent is conveyed from the storage lagoon to pump stations that distribute it to 100.3 acres of land for irrigation reuse. Of the 100.3 3 acres, 88.5 acres are forested land; 11.8 acres are dikes that surround the waste water treatment and storage facilities. The maximum irrigation rates for these two areas are described in a later section of this report.

Township 15 South, Range 10 East (W.M.)



Lazy_Z_WRs_aerial_date.mxd

Lazy Z Water Rights
City of Sisters

LEGEND

Priority Date
- 1880
- 1886
- 1881

Water Right Certificates
- 82875 S (GW)
- 83355 (1880)
- 85254 S (GW)
- 85389 (1880)
- 85391 (1880)
- 85392 (1886)
- 86824 (1880)
- 86826 (1881)
- 86828 (1880)
- 87345 S (GW)
- 87347 S (GW)

All Other Features
- City of Sisters UGB
- Tax Lots
- Uncle John Ditch
- Existing Pipeline
- PLSS Section
- PLSS QQ Section

Figure 3

N

0 250 500 750
Feet

MAP NOTES:
Date: May 19, 2013
Data Sources: Deschutes Co GIS, Deschutes River Conservancy, OGIC

GSI Water Solutions, Inc.

SUMMARY OF REGULATORY REQUIREMENTS

The City of Sisters waste water facility operates under the authority of a Water Pollution Control Facilities (WPCF) permit issued by the Oregon Department of Environmental Quality (ODEQ). The permit allows the current waste water facility to produce and irrigate with an "enhanced" Level I effluent. The only effluent quality limitation in the permit for this level of treatment is that the E. coli in the effluent "shall not exceed a monthly geometric mean of 126 organisms per 100 milliliters. According to the City, it has no plans to upgrade its waste water facility to produce a higher class of effluent.

Site Specific ODEQ Regulations (Administrative Rules) for Recycled Water

The use of recycled water (treated effluent) is governed by Oregon Administrative Rules (OAR) Chapter 340, Division 55. Since the City's current permit was issued in May of 2008, ODEQ updated its administrative rules that restrict the use of recycled water. An "enhanced" Level I effluent is now called Class D effluent.

The effluent quality requirements for Class D effluent state that the recycled water shall "not exceed a 30-day log mean of 126 E. coli organisms per 100 milliliters and 406 E. coli organisms per 100 milliliters in any single sample. A log mean as required by the new rules and a geometric mean, as required by the current permit, produce the same result.

OAR 340-041-0009(5) allows an exceedance of effluent limits for bacteria provided immediate and subsequent monitoring after an exceedance event shows no exceedances. The exception, however, is written to only apply to NPDES permits or storage and irrigation facilities with total coliform limits. The exception does not appear to apply to the type of facility and limitations required in the City's WPCF permit. While not certain, ODEQ may interpret the exception rule to apply to the City's facility. If it does, no violation would be found, for an exceedance of a single sample test if the permittee takes at least five consecutive re-samples at four-hour intervals beginning as soon as practicable (preferably within 28 hours) after the original sample was taken and the log mean of the five re-samples is less than or equal to 126 E. coli.

The original administrative rules, under which the current permit was issued, allowed effluent limits to be met anywhere in the treatment process. This meant that if the limits were met after treatment but prior to storage and irrigation, the requirements were met. The updated rules do not have this same allowance. When the permit is renewed, ODEQ may require that the effluent limits be met just prior to irrigation.

According to the current ODEQ rules, irrigation of Class D effluent is restricted to growing fodder, fiber, seed crops not intended for human ingestion, commercial timber, firewood, ornamental nursery stock, Christmas trees, sod, or pasture for animals.

In addition to the restrictions on the irrigation of Class D effluent, the following requirements also apply:

1. Monitoring for E. coli organisms must occur once per week at a minimum.
2. The following setback distances apply.
    a. Where an irrigation method is used to apply recycled water directly to the soil, there must be a minimum of 10 feet from the edge of the site used for irrigation and the site property line.
    b. Where sprinkler irrigation is used, there must be a minimum of 100 feet from the edge of the site used for irrigation and the site property line.
    c. There must be a minimum of 100 feet from the edge of an irrigation site to a water supply source used for human consumption.
    d. Where sprinkler irrigation is used, recycled water must not be sprayed within 70 feet of an area where food is prepared or served, or where a drinking fountain is located.
3. Access and Exposure.
    a. Animals used for production of milk must be restricted from direct contact with the recycled water.
    b. When using recycled water for irrigation of sod, ornamental nursery stock, or Christmas trees, the personnel at the use area must be notified that the water used is recycled water and is not safe for drinking. The recycled water use plan must specify how notification will be provided.
4. Site Management.
    a. When irrigating, signs must be posted around the perimeter of the irrigation site stating recycled water is used and is not safe for drinking.
    b. Irrigation of fodder, fiber, seed crops not intended for human ingestion, sod, commercial timber, firewood, ornamental nursery stock, or Christmas trees is prohibited for three days before harvesting.

The City could propose to blend its recycled water with other irrigation water in order to irrigate more land. Before blending recycled water, however, the owner must obtain written authorization from the ODEQ. In obtaining authorization, the waste water treatment system owner must submit to the ODEQ, at a minimum the following:

1. An operations plan,
2. A description of any additional treatment process,
3. A description of blending volumes, and
4. A range of final recycled water quality at the compliance point identified in the NPDES or WPCF permit.

Land Use Requirements for Recycled Water

The regulations requiring a recycled water use plan are ambiguous as it applies to the City. The City has a WPCF permit that authorizes reuse and it has an approved recycle water use plan for its current operation. OAR 3400-055-0016(2)(a) states that, except for use of recycled water authorized by a NPDES or WPCF permit, a waste water treatment system owner may not provide any recycled water for distribution or use or both until a recycled water use plan meeting the requirements of OAR 340-055-0025 has been approved in writing by the ODEQ. Upon approval of the plan, the permittee must comply with the conditions of the plan. OAR 3400-055-0016(2)(c) states that for use of recycled water previously authorized under a NPDES or WPCF permit but without a department approved recycled water use plan, the waste water treatment system owner must submit a recycled water use plan to the ODEQ within one year of the effective date of these rules. It would appear that the City would not have to submit a recycled water use plan because it has a WPCF permit authorizing use and it has an approved plan. It is highly unlikely, however, that ODEQ will allow use of recycled water on the Lazy Z Ranch property without an updated recycled water use plan. Most likely, the City will need to update the recycled water use plan to identify the location of treated effluent use.

Assuming that a new recycled water use plan will be required, the following requirements relative to land use will apply:

> OAR 340-055-0016(3) states that: A recycled water use plan will not be approved for the land application of recycled water on land zoned exclusive farm use until the requirements of ORS 215.213(1)(bb) and 215.283(1)(y) for recycled water are met. Since the ODEQ rules were adopted in 2008, the specific citations in ORS 215 have been re-codified. ORS 215.213(1)(bb) is now ORS 215.213(1)(y); ORS 215.283(1)(y) is now ORS 215.283(1)(v). The two statutes have to do with whether or not the county has or has not adopted marginal lands provisions. In any case, however, both statutes require compliance with in ORS 215.246 to 215.251. A summary of these requirement are provided in a ODEQ fact sheet and are repeated as follows:
>
> a. Subject to issuance of a permit or approval by ODEQ, land application of industrial process water, recycled water and biosolids is an allowed use on EFU zoned land. Because land application is listed as an allowed use in ORS 215.213(1), counties may not impose additional land use restrictions or conditions on land application practices, beyond those specified in the statute.
>
> b. Other facilities or uses on the same EFU tract are included in the allowed use if they are accessory to and reasonably needed for land application to occur on the

proposed site. The statutes also disallow certain uses, e.g. utility facility service lines.

c. Before a county land use decision is made on a land application proposal, the applicant responds in writing to public comments received by the county that identify alternative sites or methods for managing the industrial process water, recycled water or biosolids. The applicant's response describes how the alternative sites or methods were considered and why they were not selected. The land use decision cannot be remanded or reversed, unless the applicant fails to provide a written response when required.

d. ODEQ is required to determine, through its review and approval process, that the practice of land application will not reduce the productivity of the subject land.

e. Land application of biosolids is exempt under the Act when transported by vehicle to EFU land. A ODEQ Land Use Compatibility Statement (LUCS) is not required.

f. Land application of materials that are not described in the Act are not subject to the Act's provisions, e.g. confined animal feeding operation wastes.

g. Land division, for purposes of land application, is not allowed in EFU zones.

h. Restrictions apply in changing the use of land where land application practices has occurred.

ODEQ has adopted a process for assuring that the requirements of these land use statutes are met. Also from the ODEQ fact sheet, the process is as follows:

a. The applicant obtains the required ODEQ application and LUCS forms, and submits the LUCS to the county planning office for its review and approval.

b. The county conducts its land use review process in accordance with the requirements under the Act.

c. The county completes the LUCS form and returns it to the applicant with the attached findings:

   - The proposed activity constitutes land application for purposes of agricultural, horticultural, silviculture production, or for irrigation in connection with a use allowable in EFU zoned land under ORS 215.
   - Any proposed facilities necessary for the land application practice to occur on the subject site are accessory to and reasonably necessary as allowed by the Act.

- Approval of the LUCS is subject to ODEQ's issuance of the necessary environmental approvals or permits.

d. The applicant submits the ODEQ application and approved LUCS to ODEQ for processing. ODEQ processes the application and conducts a technical review in accordance with its rules. The review, depending on what material is applied to the land, may include the following:

- Pollutant and nutrient testing
- Determination of agronomic rate
- Determination of agronomic or pollutant loading
- Determination of water assimilation capacity
- Site assessment and evaluation
- Crop type and cropping system
- Application methods and equipment requirements
- Site access and harvest restrictions
- Monitoring requirements
- A written determination that the land application activity will not reduce the productivity of the land in question.

e. ODEQ submits all Recycled Water Reuse Plans to the DHS for comment (OAR 340-055-0015(2)), and consults with DHS on any effluent quality limitations (OAR 340-055-0015(4)).

f. Applicants intending to land apply recycled water are required to submit a "Registration of Recycled Water Use" form (http://www1.wrd.state.or.us/pdfs/reclaimform96.pdf) to the Oregon Water Resources Department (ORS 537.131, 537.132 and 537.610(h)). Either agency can supply applicants with this form, however it requires a ODEQ signature.

g. DEQ issues an approval or denial to the applicant, and provides a copy to the county planning office.

In situations where a LUCS is denied or appealed:

a. When ODEQ receives a county-denied LUCS, the applicant is informed that ODEQ cannot process the application until county approval is provided.

b. If a county land use decision is appealed after ODEQ receives an approved LUCS, ODEQ's policy is to process the application unless ordered otherwise by a court stay or invalidation of the county decision.

c. A county may withdraw or modify its LUCS decision before the permit is issued.

d. If a county-approved LUCS is successfully appealed after ODEQ issues a permit, ODEQ may revoke or suspend the permit, or delay its decision until the appeals process is exhausted. In making its decision, ODEQ consults closely with the applicant and county government.

Other General Requirements for Recycled Water

The following requirements must also be met when reusing recycled water. Most of these are likely already met by the City under its current, approved recycled water use plan.

1. Bypassing. The intentional diversion of waste water from any unit process in the waste water treatment system for a beneficial purpose is not allowed, unless with the unit process out of service the recycled water meets the criteria of this division for a specific class and beneficial purpose described in the recycled water use plan.

2. Alarm devices. Alarm devices are required to provide warning of power loss and failure of process equipment essential to the proper operation of the waste water treatment system and compliance with this division.

3. Standby power. Unless otherwise approved in writing by the ODEQ, a waste water treatment system providing recycled water for use must have sufficient standby power to fully operate all essential treatment processes. The ODEQ may grant an exception to this section only if the waste water treatment system owner demonstrates that power failure will not result in inadequately treated water being provided for use and will not result in any violation of an NPDES or WPCF permit limit or condition or Oregon Administrative Rule.

4. Redundancy. A waste water treatment system that provides recycled water for use must have a sufficient level of redundant treatment facilities and monitoring equipment to prevent inadequately treated recycled water from being used or discharged to public waters.

5. Distribution system requirements. Unless otherwise approved in writing by the department, all piping, valves, and other portions of the recycled water use system that is outside a building must be constructed and marked in a manner to prevent cross-connection with a potable water system. Unless otherwise approved in writing by the department or as required by the rules of this division, construction and marking must be consistent with sections (2), (3), (4), and (5) of the 1992 "Guidelines for the Distribution of Nonpotable Water" of the California-Nevada Section of the American Water Works Association.

6. Cross-connection control. Connection between a potable water supply system and a recycled water distribution system is not authorized unless the connection is through an air gap separation approved by the ODEQ. A reduced pressure principle backflow

prevention device may be used only when approved in writing by the ODEQ and the potable water system owner.

7. Annual report. The City must submit an annual report to the ODEQ describing the effectiveness of the system to comply with the approved recycled water use plan, the rules of this division, and the permit limits and conditions for recycled water.

Ground Water Protection Requirements

Recycled water will not be authorized for use unless all ground water quality protection requirements in OAR chapter 340, division 40 are met. The requirements in OAR chapter 340, division 40 are considered to be met if the waste water treatment system owner demonstrates recycled water will be used or land applied in a manner and at a rate that minimizes the movement of contaminants to ground water and does not adversely impact ground water quality. Generally, if the recycled water is irrigated at rates consistent with the needs to the crop being irrigated, compliance with the ground water quality requirements are deemed to be met.

Other Considerations

The current ODEQ rules do not require the City to have a contract if it decides to provide its recycled water to another party for use. Regardless of this omission, if the City does decide to provide its recycled water, it is highly recommended that a well-conceived contract be established between the City and the other party to ensure the City's interests are protected.

EFFLUENT AVAILABLE FOR IRRIGATION

The opportunity for the City to transition from irrigation with surface water to treated effluent over time depends on the projected volume of treated effluent. The section below estimates the total volume of treated effluent that would be available for irrigation on the Lazy Z lands from the present time to the year 2033.

Background

The City currently uses treated effluent to irrigate lands near its waste water treatment facilities. These lands include grasses on the lagoon system dikes and forest lands (Ponderosa pine trees). The analysis for estimating the total volume of available treated effluent water in 2033 for irrigation at the Lazy Z lands was completed with the following assumptions:

1. The dikes are irrigated at 14.375 inches per season; the forest is irrigated at 7.15 inches per season; and the remainder is irrigated at the Lazy Z lands.

2. The dikes are irrigated at 28.75 inches per season; the forest is irrigated at 14.30 inches per season; and the remainder is irrigated at the Lazy Z lands.
3. All available water is irrigated at the Lazy Z lands; none on the dike or forest.

The irrigation volumes of 14.375 and 28.75 inches per year for the dikes (Case 1 and 2) were provided by the City of Sisters; the irrigation volume of 14.30 inches per season (Case 2, forest) is the maximum amount allowed by ODEQ to be irrigated on the forest land. The volume of 7.15 inches per season for the forest in Case 1 was suggested by the City as a reasonable amount to sustain the Ponderosa pine trees on the forest land. Although Ponderosa Pine trees grow naturally in the Sisters area and near the site without artificial irrigation, the trees presently irrigated with treated effluent were planted and nurtured with artificial irrigation. As such, the trees require continued irrigation to survive, which is the basis for the seasonal irrigation volume of 7.15 inches suggested by the City.

Estimations of future effluent flows for potential irrigation were presented in the report *"Waste Water Capital Facilities Plan Update",* dated October 2011 (hereinafter referred to as Report); however, these estimates of future flows were only to the year 2025. The flow estimates were based on a population growth rate of 3.13% which was taken from the City of Sisters Comprehensive Land Use Plan. This growth rate was also used to estimate the availability of treated effluent for irrigation presented in this report. .

Analysis

The following table summarizes the effluent irrigation water usage for 2010 and 2011.

Table 1. Effluent Irrigation Water Usage for 2010 and 2011

		Irrigation Volume, Acre-Feet	Irrigated Acreage, Acres	Net Application, inches
2010	Dike	40.12	11.8	40.80
	Forest	146.21	88.5	19.83
	Total	186.33	100.3	
2011	Dike	38.32	11.8	29.23
	Forest	142.2	88.5	14.46
	Total	180.52	100.3	
2012	Dike	31.43	11.8	23.97
	Forest	115.72	88.5	11.77
	Total	147.15	100.3	

Pursuant to discussions with City staff, the estimated volume of treated effluent available for irrigation in 2033 is based on the average of the 2010 and 2011 irrigation usage projected from 2011 to 2033 according to an assumed population growth rate of 3.13%. Irrigation data for 2012 was not used because an estimated 40 acre-feet were carried over to the following irrigation season and not irrigated.

Using the above information, the following table shows the volume of treated effluent that may be available for irrigation at the Lazy Z lands under the three cases listed above:

Table 2. Treated Effluent Available for Irrigation

	Case 1		**Case 2**		**Case 3**	
	Application Rate, Inches per Season	Total Amount, Acre-Feet	Application Rate, Inches per Season	Total Amount, Acre-Feet	Application Rate, Inches per Season	Total Amount, Acre-Feet
Total Estimated 2033 volume	-	361	-	361	-	361
Dike Irrigation (11.8 Acres)	14.375	14	28.75	28	0	0
Forest Irrigation (88.5 Acres)	7.15	53	14.30	105	0	0
Available for Lazy Z Lands	-	294	-	228	-	361

The following table summarizes the potential amount of available treated effluent for irrigation at the Lazy Z property at 5 year increments: 2018, 2023, 2028, and 2033.

Table 3. Treated Effluent Available for Irrigation, 5 Year Increments

Year	Estimated Total Available, Acre-Feet/Year	Estimated Available Water Available to Lazy Z Ranch, Acre-Feet/Year		
		Case 1	Case 2	Case 3
2013	195	128	62	195
2018	228	161	95	228
2023	266	199	133	266
2028	310	243	177	310
2033	361	294	228	361

The irrigation application rate for the Lazy Z lands will depend on the type of crop grown, which will be addressed in subsequent sections of this report.

WATER RIGHT ANALYSIS

Lazy Z Property Water Rights Summary

The City purchased a portion of the Lazy Z property that contains both surface and ground water rights for irrigation uses. There are four ground water rights and seven surface water rights appurtenant to the City's Lazy Z property. The priority dates of the Lazy Z surface water rights held by the City are generally senior in priority dates. These senior rights are some of the last water rights to be "regulated off" from Whychus Creek during low water flows. The following information details each of the water rights appurtenant to the City's Lazy Z property and the current status and are shown on Figure 4.

Surface Water Rights

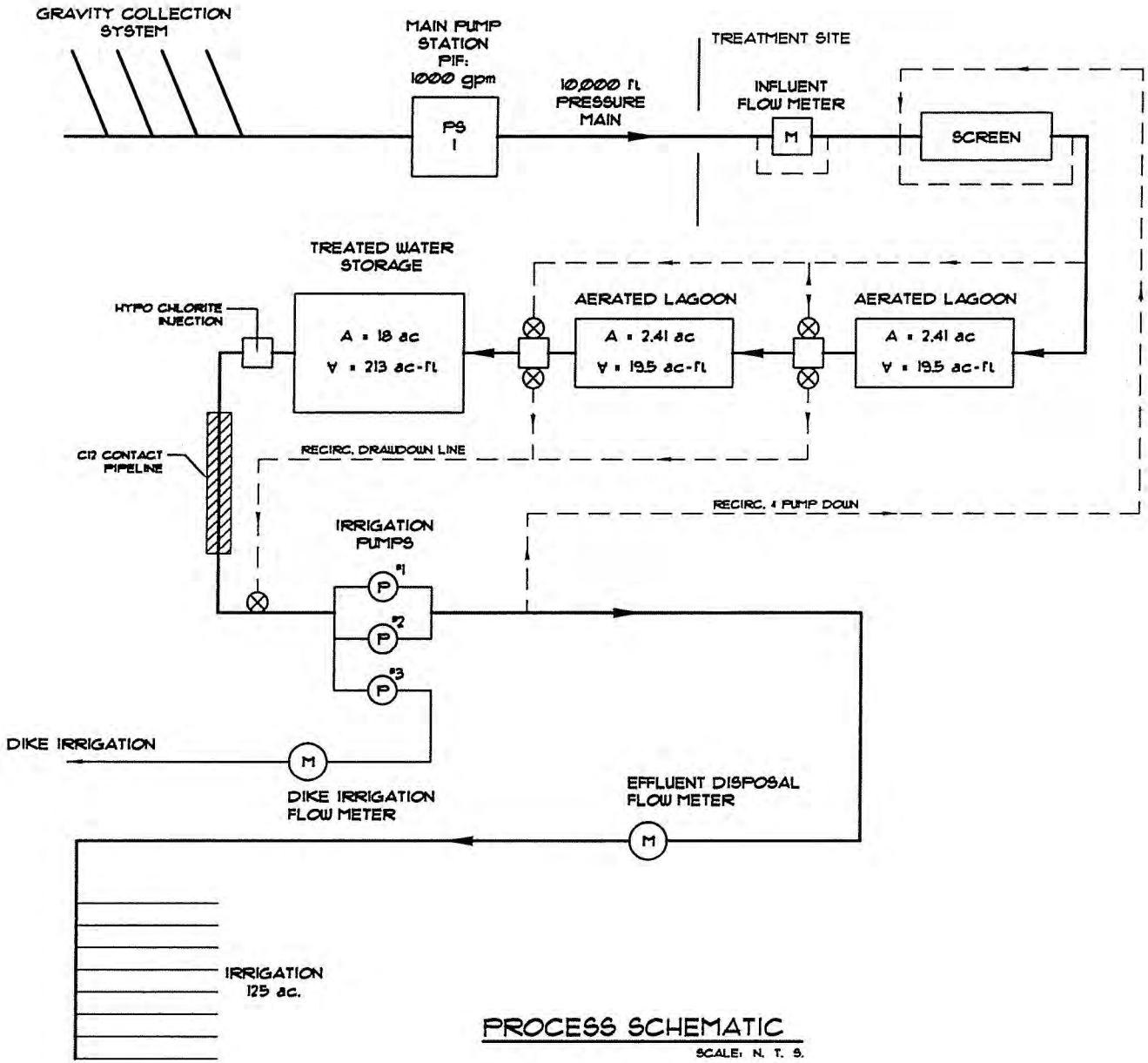
Transfer Application T-11318 and Conserved Water Application CW-71

On November 17, 2011, Three Sisters Irrigation District (TSID) and the water right holders on the Uncle John Ditch (which serves the City's Lazy Z property) submitted a transfer application (T-11318) to the Oregon Water Resources Department (OWRD) requesting a change in point of diversion. The point of diversion is proposed to be changed from the current in-creek push-up dam that diverts water into the Uncle John Ditch to TSID's main diversion, which has Oregon Department of Fish and Wildlife approved fish passage.

Additionally, on January 12, 2012 OWRD received a conserved water application (CW-71) from the "landowners of the Uncle John Ditch". The pending conserved water application proposes that the piping of 3.8 miles of open ditch (Uncle John Ditch) and the point of diversion change in transfer application T-11318 will conserve 2.49 cubic feet per second (cfs) from all of the

included Lazy Z water rights. The City's portion of conserved water is proposed to be a total of 0.76 cfs.

The transfer and conserved water project affect all of the City's surface water rights appurtenant to the Lazy Z property. On November 27, 2012, OWRD issued a draft Preliminary Determination proposing to approve the transfer request. To date, no orders have been issued regarding the conserved water application. The following water rights are appurtenant to the City's Lazy Z property.



PROCESS SCHEMATIC

SCALE: N. T. S.

PROJECT: WASTEWATER FACILITIES PLAN

TITLE: T.P. SCHEMATIC

PROJECT NO.: 05.63

DATE: 11-02-05

Figure 4

HGE INC
ARCHITECTS, ENGINEERS, SURVEYORS & PLANNERS
375 Park Avenue Coos Bay, OR. 97420
(541) 269-1166
19 N.W. Fifth Avenue Portland, OR. 97209
(503) 222-1687

Certificate 83355 (Squaw Creek Decree)
The water right allows the use of up to 0.62 cfs, from Whychus Creek (formerly Squaw Creek), for primary irrigation of 30.0 acres with a priority of 1880. The water rights approved through the Squaw Creek Decree do not have an assigned volume per acre (duty).

Current Status:
Upon OWRD's issuance of the final order approving transfer T-11318, water right Certificate 83355 will be cancelled. A new confirming certificate will be issued once beneficial use is demonstrated from the new point of diversion, consistent with the order approving the transfer. The rate the water right is projected to be reduced by upon approval of CW-71 is 0.136 cfs, leaving a remaining rate of 0.48 cfs.

Certificate 86824 (Squaw Creek Decree)
The water right allows the use of up to 1.23 cfs, from Whychus Creek for primary irrigation of 59.5 acres with a priority of 1880. The water right does not have an assigned duty.

Current Status:
Upon OWRD's issuance of the final order approving transfer T-11318, water right Certificate 86824 will be cancelled. A new confirming certificate will be issued once beneficial use is demonstrated from the new point of diversion, consistent with the order approving the transfer. The rate the water right is projected to be reduced by upon approval of CW-71 is 0.271 cfs, leaving a remaining rate of 0.96 cfs.

Certificate 85389 (Squaw Creek Decree)
The water right allows the use of up to 0.08 cfs, from Whychus Creek for primary irrigation of 2.5 acres with a priority of 1880. The water right does not have an assigned duty.

Current Status:
Upon OWRD's issuance of the final order approving transfer T-11318, water right Certificate 85389 will be cancelled. A new confirming certificate will be issued once beneficial use is demonstrated at the new point of diversion, consistent with the order approving the transfer. The rate the water right is projected to be reduced by upon approval of CW-71 is 0.018 cfs, leaving a remaining rate of 0.06 cfs.

Certificate 86828 (Squaw Creek Decree)
The water right allows the use of up to 0.57 cfs, from Whychus Creek, for primary irrigation of 18.0 acres with a priority of 1880. The water right does not have an assigned duty.

Current Status:
Upon OWRD's issuance of the final order approving transfer T-11318, water right Certificate 86828 will be cancelled. A new confirming certificate will be issued once beneficial use is demonstrated at the new point of diversion, consistent with the order approving the transfer. The rate the water right is projected to be reduced by upon approval of CW-71 is 0.126 cfs, leaving a remaining rate of 0.44 cfs.

Certificate 85391 (Squaw Creek Decree)
The water right allows the use of up to 0.10 cfs, from Whychus Creek for primary irrigation of 3.0 acres with a priority of 1880. The water right does not have an assigned duty.

Current Status:
Upon OWRD's issuance of the final order approving transfer T-11318, water right Certificate 85391 will be cancelled. A new confirming certificate will be issued once beneficial use is demonstrated at the new point of diversion, consistent with the order approving the transfer. The rate the water right is projected to be reduced by upon approval of CW-71 is 0.022 cfs, leaving a remaining rate of 0.08 cfs.

Certificate 86826 (Squaw Creek Decree)
The water right allows the use of up to 0.71 cfs, from Whychus Creek, for primary irrigation of 35.5 acres with a priority of 1881. The water right does not have an assigned duty.

Current Status:
Upon OWRD's issuance of the final order approving transfer T-11318, water right Certificate 86826 will be cancelled. A new confirming certificate will be issued once beneficial use is demonstrated at the new point of diversion, consistent with the order approving the transfer. The rate the water right is projected to be reduced by upon approval of CW-71 is 0.156 cfs, leaving a remaining rate of 0.55 cfs.

Certificate 85392 (Squaw Creek Decree)
The water right allows the use of up to 0.14 cfs, from Whychus Creek, for primary irrigation of 7.0 acres with a priority of 1886. The water right does not have an assigned duty.

Current Status:
Upon OWRD's issuance of the final order approving transfer T-11318, water right Certificate 85392 will be cancelled. A new confirming certificate will be issued once beneficial use is demonstrated at the new point of diversion, consistent with the order approving the transfer. The rate the water right is projected to be reduced by upon approval of CW-71 is 0.031 cfs, leaving a remaining rate of 0.11 cfs.

Ground water Rights

There are 4 ground water rights appurtenant to the City's Lazy Z property. Three rights are for supplemental irrigation only and the fourth is for both primary and supplemental irrigation.

Certificate 85254 (Permit G-3095, Application G-3489)
The water right allows the use of up to 0.246 cfs from a well in Whychus Creek basin, with a priority date of May 13, 1966. The use is for supplemental irrigation of 19.7 acres. The diversion is limited to 1/80th of a cfs per acre and is further limited to a diversion not to exceed 3 acre-feet (AF) per acre.

<u>Current Status:</u>
This certificate is in the name of Lloyd Brogan and was issued on December 26, 2008. There are no transactions currently pending on this water right.

Certificate 82875 (Permit G-8148, Application G-8548)
The water right allows for the use of up to 0.11 cfs from a well in Whychus Creek basin and has a priority date of November 25, 1977. The use is for supplemental irrigation of 8.7 acres. The diversion is limited to 1/80th of a cfs per acre and is further limited to a diversion not to exceed 3 AF per acre.

<u>Current Status:</u>
This certificate is in the name of Lloyd Brogan and was issued on November 17, 2006. Currently there are no transactions pending on this water right.

Certificate 87345 (Permit G-4841, Application G-5295)
This water right allows for the use of the up to 0.039 cfs for primary irrigation of 3.1 acres and 0.108 cfs for supplemental irrigation of 29.7 acres. The source is a well in Whychus Creek basin and has a priority date of August 25, 1970.

<u>Current Status:</u>
The City still holds the rights to 3.1 acres of primary irrigation under Certificate 87345 but the purchase agreement for the Lazy Z stated that 3.1 acres of this right would be transferred to the seller (David Herman) in the future. To date no transfer application requesting a change in place of use (off City property) has been submitted to OWRD.

Certificate 87347 (Permit G-3095, Application G-3489)
This water right allows for the use of up to 0.094 cfs from a well in Whychus Creek basin and has a priority date of May 13, 1966. The use is for supplemental irrigation of 7.5 acres. The

diversion is limited to 1/80th of a cfs per acre and is further limited to a diversion not to exceed 3 AF per acre.

Current Status:
This water right was issued on December 9, 2011. There does not appear to be any transactions occurring currently related to this water right.

Conclusion

The City holds 155.5 acres of senior surface water rights for primary irrigation on the Lazy Z property; in addition they hold a few ground water rights which are mostly supplemental to the surface water. Currently all the surface water rights are involved in a point of diversion transfer and an allocation of conserved water project. Currently the City is irrigating two sections of the property and the remaining section is included in a one-year instream lease.

POTENTIAL CROPS AND IRRIGATION DEMAND

Purpose and Data Sources

Key considerations in evaluating the feasibility of irrigation with treated effluent include types of crops and their water demand, regulatory limits and opportunities, and economic factors important to the City. This section describes an evaluation of potential crops based on these considerations. Several information sources were used for evaluating allowable and likely crop choices for the Lazy Z property, including:

- ODEQ Oregon Administrative Rules (OAR)340-055-0012;
- Oregon State University Extension Service (OSU) personnel and Extension Miscellaneous 8530 Report, "Oregon Crop Water Use and Irrigation Requirements" 1999;
- Wert & Associates, Inc. Report "Soil and Water Reuse Report for Sisters Wastewater Project" Sisters, Oregon, February 2007 (Wert);
- Deschutes County Soil and Water Conservation District;
- Richard Zimmerlee, International Agri-Business Consultant; and
- Available online sources for climate and agricultural crops and potential seasonal growing conditions related to the Site.

The above sources provided useful, detailed information regarding potential crop types for the Lazy Z property and potential for crop value upon harvest.

Regulatory Limitations Relative to Potential Crops

An initial review of OAR 340-055-012(4)(a) identifies allowable crops for a class D effluent; stating *"Any beneficial purpose defined in subsection (3)(a) of this rule; [((3)(a) allows fodder, fiber, seed crops not intended for human ingestion, or commercial timber]; (B) Irrigation of firewood, ornamental nursery stock, Christmas trees, sod, or pasture for animals"*. These allowable crops may not be produced for human consumption; although, as discussed below, additional restrictions may be applied as well.

Constraints & Opportunities for Crop Types

Locality

The OSU extension service (OSU) was contacted to determine a list of crops that are compatible with the Lazy Z property, considering location, elevation and soil type. Based on the location, OSU narrowed the crops more suited for cultivation on the Lazy Z property to two basic groups: 1) hay, including grass hay and alfalfa hay, orchard grass and timothy hay; and 2) cereal grains. Cereal grains include oats, barley, wheat and triticale. Both general categories of grasses and cereal grains would be a marketable crop for animal feel, specifically cows, cattle and possibly horses.

OSU also provided insight as to the likely period of irrigation for the two crop categories. The grass hay, alfalfa hay and timothy hay will take water from essentially the beginning of the irrigation season, weather dependent, to November 1 of each year. The nutrient uptake and need for irrigation could be variable in April and October of each year depending on temperature, precipitation and overall climate conditions; however, a relatively full irrigation season for application of water is likely.

Localized Climate Zones and Frost Free Days

A summary table of frost free days throughout the major areas of Central Oregon is presented below:

Table 4. Frost Free Days in Central Oregon

Location	Elevation, feet, MSL	Average Last Frost	Average First Frost
Bend	3500	July 1-10	Sept 1-10
Madras	2398	June 11-20	Sept 11-20
LaPine	4234	July 1 -10	August 21-31
Prineville	2998	July 1 -10	August 21-31
Redmond	3031	July 21-31	Sept 1-10
Sisters	3200	July 11-21	August 11-20
http://www.plantmaps.com/interactive-oregon-usda-plant-zone-hardiness-map.php			

Based on above table, Sisters has the shortest period of frost free days of the locations throughout Central Oregon. The shorter period of frost-fee days reflects a greater limitation to crop types for the Lazy Z lands that are most effective in responding to the City's potential reuse project. Because of the very limited period of frost free days, upgrading effluent quality to produce Class A effluent would likely not provide any benefit because the high quality crops requiring Class A effluent cannot be grown in the Sisters area.

Crop Types

Grass Hay and Alfalfa

Grass hay and alfalfa hay were generally characterized by OSU staff as a fairly straight forward crop to cultivate on the Lazy Z property as there are many hay crop growers in the Sisters area and throughout Central Oregon. Grass hay and alfalfa hay tend to have up to three harvest cuttings per irrigation season with a likely total seasonal average of 4 to 6 tons per acre. According to OSU staff, harvest cuttings typically mature in June to July, with subsequent harvest cuttings occurring approximately 6 weeks after each previous harvest; with each harvest cutting being similar in yield.

Timothy Hay

Timothy hay was characterized by OSU staff generally as either early or late maturing varietals. The early maturing timothy hay tends to mature faster and the crop produces smaller crop heads with a typical first cutting harvest in July. Late maturing timothy hay tends to mature slower and produces larger crop heads with a typical first cutting harvest in August. Timothy hay usually has only two cutting harvests per irrigation season, with the first cutting producing in the range of 4 to 5 tons per acre, with the second cutting producing 1 to 2 tons per acre, regardless of the maturation varietal.

Cereal Grain

Cereal grains, on the other hand, are limited in the need for irrigation, as the crops tend to mature faster and are harvested usually beginning in August. Because of this, the cereal crop would likely not need irrigation after the first part of August, allowing time for the crop to cure prior to harvest. There would be no growing crop after harvest to assimilate the recycled water. Because of this, cereal crops are not a likely suitable crop for irrigation of the City's effluent.

Additional Crop Constraints

Crop types were narrowed by OSU based on the likely growing conditions of the site, specifically the likely temperature and average frost free days that significantly reduce the crops that are capable of being grown on the site. Discussions with OSU led to the understanding that Central Oregon is highly variable with localized climate zones, with the area of Sisters being the more restrictive areas for viable crop types.

These limitations as described by OSU staff negates crops that qualify under DEQ regulations, such as seed crops (carrot seed, grass seed, etc.) that are grown in other areas of Central Oregon with longer frost free days to allow for crop maturation for harvest. Grass hay, alfalfa hay and timothy hay were identified as being hardy crops that can withstand ice encasement and have growing seasons that generally can accept irrigation water throughout the available irrigation season. Cereal grain crops are tend to be hardy crops that can likely withstand the growing conditions in the Sisters area, however, cereal grains have a limited duration growing season.

Poplar

The City of Woodburn developed a small poplar plantation around 1999 to dispose of their treated effluent. According to the City of Woodburn, its poplar irrigation program indicates it has very stringent effluent limits relative to discharge to the Pudding River and irrigation of treated effluent in the summer is essential. The plantation has 80 acres of poplars. About 26 acres were harvested 3 to 4 years ago, for which the City obtained about $15 per wet ton of chipped material after harvesting, chipping and shipping of the material to the pulp mill in Toledo, Oregon. Curtis Stultz, Woodburn waste water superintendent, did not readily have cost figures for growing the poplar trees, but stated that the operation is not a money maker for the City[1]

In 2007, the cost of producing poplar for pulp ranged between $24 and $30 per dry metric ton ($21.34 and $26.67 per American ton).[2] Poplar wood moisture content is about 50% to 58% so

[1] Personal conversation with Curtis Stultz on February 8, 2013 and subsequent e-mail of the same date.

[2] Brian J. Stanton, Hybrid Poplar Feedstock Production: Economic Opportunity for Renewable Energy in North America, Power Point Presentation, Atlanta, Georgia, May 2007. Website: http://www.tappi.org/content/Events/07renew/07ren05.pdf.

the price received by the City of Woodburn, in dry tons, is about half of that derived from wet tons, or about $7.50 per dry ton. It is highly unlikely that The City of Sisters would receive the same price for its poplar production because the transportation costs would be higher due to the longer distance to the pulping plant. Poplar chips harvested by the City of Woodburn were transported to the pulp mill in Toledo, Oregon which was about 100 miles away. The City of Sisters is between 150 and 180 miles from Toledo, depending on which route is taken. If the pulp mill in Springfield would buy the City's poplar chips, the travel distance would be about 100 miles, the same as it was for Woodburn to Toledo. In another case, poplar chips harvested near Boardman are transported about 50 miles to Wallula, Washington. In any case, it is reasonable to expect that using treated effluent to grow poplars in Sisters could cost substantially more money than could be derived from the sale of the product.

Ornamental Nursery Stock

This could be a viable crop for the City of Sisters. The amount of water required for nursery stock will depend on the type of stock and its size (large plants would use more water than smaller, younger plants). The City would likely need to utilize soil moisture probes to determine crop water requirements over a given growing season. Managing nursery stock would also likely require more oversight by City employees to ensure proper irrigation, recognize and control pests and to plant and transplant stock. Irrigation methods would likely be similar to that used for poplar.

Hops

Hops require at least 120 frost free days so it is not a viable crop for the Sisters area.

Water Demand

A review of the OSU Extension Miscellaneous 8530 Report, 1999 (EM8530) separates the state into 27 distinct regions and provides tables for likely crop water need and the generalized growing season for up to 17 generalized crops for each of the 27 regions. The Sisters area resides in the western-most portion of region 17, which includes Bend in the northwest portion of the region, Brothers in the eastern portion and Christmas Valley in the far south-central portion of the region. Of the crops identified and recommended by OSU personnel, the general irrigation seasons and net irrigation water demand are shown below in Table 5.

Table 5. Net Irrigation Water Demand

Crop	5 of 10 yrs (inches)	6 of 10 yrs (inches)	7 of 10 yrs (inches)	8 of 10 yrs (inches)	9 of 10 yrs (inches)	19 of 20 yrs (inches)	Typical Growing Season
Alfalfa Hay	20.03	21.07	22.01	23.08	24.59	25.59	April 10 to Oct. 1
Grain (Spring)*	15.87	16.68	17.55	18.35	19.6	20.35	April 1 to Aug. 16
Grain (Winter)**	16.22	16.97	17.88	18.66	20.05	21.18	March 15 to Aug. 10
Pasture	22.17	23.31	24.73	25.95	27.84	29.18	April 12 to Oct. 24

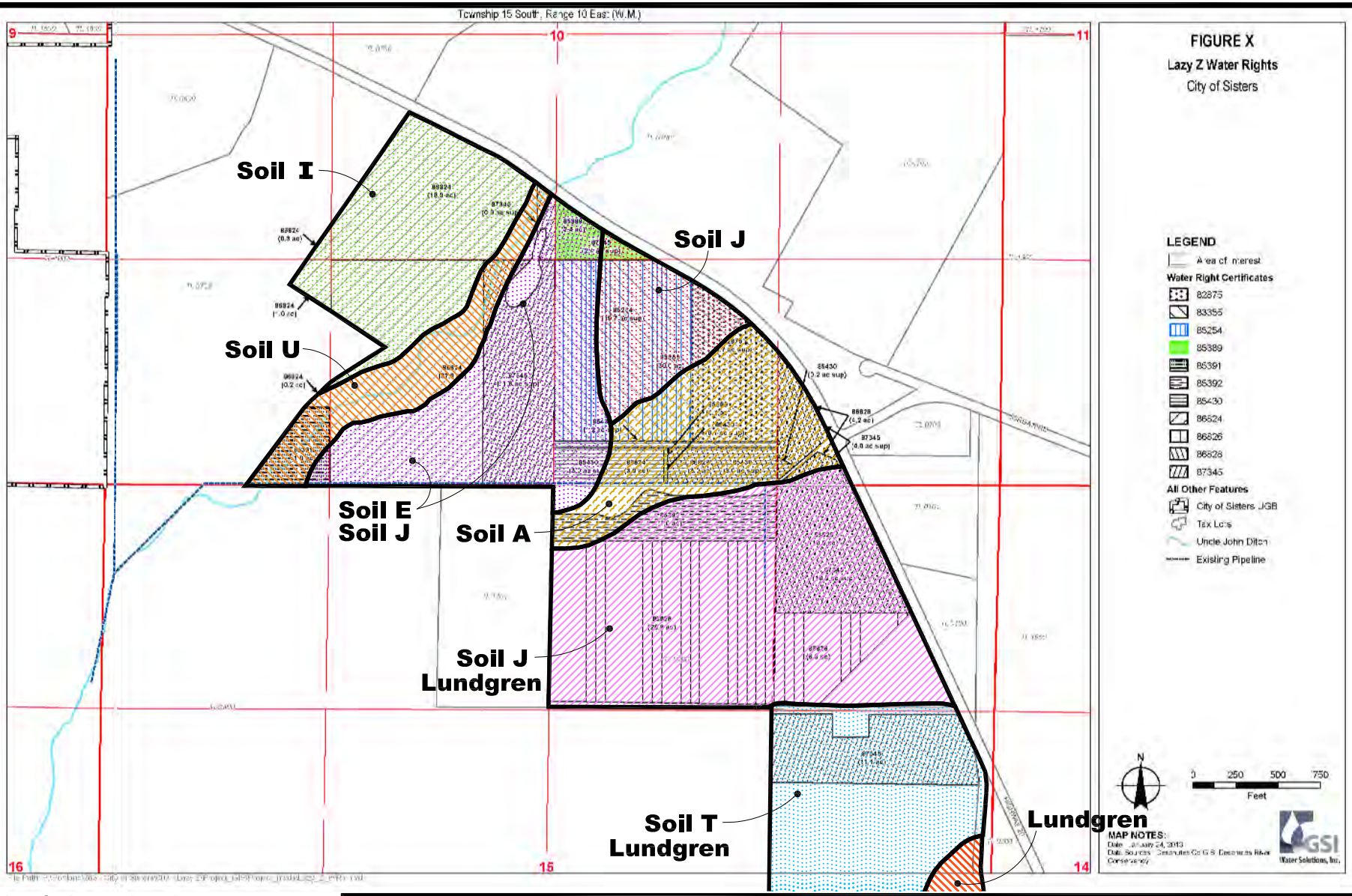
*Representative of spring planted cereal grains, according to OSU personnel.
**Representative of winter planted cereal grains, according to OSU personnel.

Based on the above data, the likely choices for the site are hay and grasses, including alfalfa hay, grass hay and pasture grass. Pasture grass would likely allow for more application of treated effluent with the longest application period. The "design" application rate for the irrigation system will depend on how the City wishes to manage the site. Management options are discussed further in subsequent sections of this report.

Irrigation Constraints

The report by Wert & Associates, Inc. *Soil and Water Reuse Report for Sisters Wastewater Project, Sisters, Oregon,* February 2007 (Wert), noted varying soil types across the site with the potential for high seasonal ground water in some areas. Irrigation periods in the spring may be limited in these areas. A map showing these potential limited irrigation areas are shown on the attached Figure 5. Consideration of irrigation timing should account for potential high ground water conditions in these areas during the spring season. The soil types A, E and I identified by Wert, as shown on Figure 5, have potential for seasonal high water tables above a depth of 40 inches below the ground surface.

Additionally, Wert identified areas that have been previously used for irrigation and harvest of crops where surface soils have been cleared of gravel and cobble-sized rocks. These areas are referred to by Wert as the "Present Sprayfield". This area has been irrigated with wheel lines in the past and would likely not need modification to the soil horizon for sprinkler irrigation by wheel lines or pivots. The identified sprayfield areas are shown on the attached Figure 6 that was presented in Wert.



Wert identified soils that show seasonal high water tables above 40" are Soils A, E, and I.

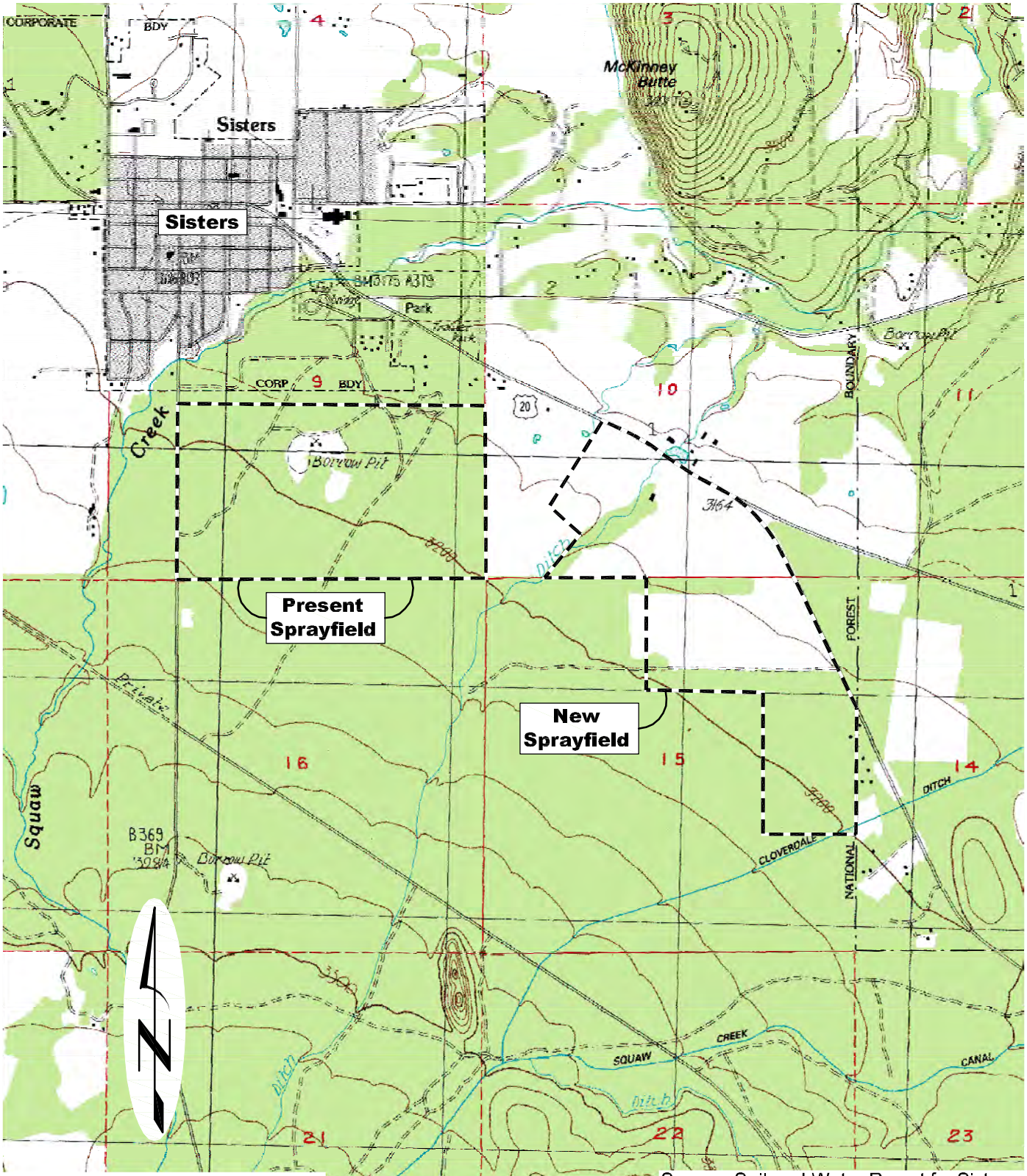
Source: Soil and Water Report for Sisters Wastewater Project, Page 30, Dated Feb 2007, authored by Wert & Associates, Bend Oregon

NEWTON CONSULTANTS INC.
Earth, Water and Rock Specialists
Ph: 541 504-9960 Fax: 541 504-9961

Wert Identified Soil Areas
Lazy 'Z' Evaluation
Sisters, Deschutes County, Oregon

DESIGNED BY:	DRAWN BY:	DATE:	PROJECT NO.	FIGURE 5
J. Newton	S.Schenck	MAY 2013	1138-101	

G:\1100\1138 Lazy Z\101\Cad\Water\W1138101_F1_Site 08:51 06/25/2013 SS



Source: Soil and Water Report for Sisters Wastewater Project, Page 5, Dated Feb 2007, authored by Wert & Associates, Bend Oregon

NEWTON CONSULTANTS INC.
Earth, Water and Rock Specialists
Ph: 541 504-9960 Fax: 541 504-9961

Wert Identified Sprayfield Locations
Lazy 'Z' Evaluation
Sisters, Deschutes County, Oregon

DESIGNED BY:	DRAWN BY:	DATE:	PROJECT NO.	FIGURE 6
J. Newton	S.Schenck	MAY 2013	1138-101	

G:\1100\1138 Lazy Z\101\Cad\Water\W1138101_F1_Site 08:10 05/24/2013 SS

Areas identified by Wert and referred to as "New Sprayfield" have been flood irrigated in the past for pasture. Apparently, gravel and cobble-sized rocks have not been removed from this area. Irrigation in this area could likely be done for pasture with hand lines or pivots (minimal rock removal may be required to allow for efficient travel of the pivot wheel tracks). Cultivation of a harvested crop could be impeded by gravel and cobble-sized rocks.

Economic Considerations

Production Costs

OSU personnel provided estimated costs to produce alfalfa hay and grass hay on a per acre basis annually. The estimated cost[3] to produce alfalfa hay is $135 per ton of alfalfa harvested; the estimated cost to produce grass hay is $155 per ton of grass hay harvested (OSU stated that although timothy hay was not specifically estimated for the cost to produce, that its cost to produce would likely be similar to grass hay). These estimated costs are based on an OSU-calculated value in 2008 dollars. Based on an average rate of inflation between 2008 and 2012 of approximately 6.6%[4]; the enterprise cost may have risen from $135 per ton harvested for alfalfa to $144; and from $155 per ton harvested for grass hay to $165.

OSU is currently conducting a study on the nitrogen uptake requirements for grass crops. This study is currently underway and nearing completion by OSU and may be useful to allow for a beneficial balance of nitrogen in effluent water and fertilizer introduced nitrogen. The results of this OSU study could allow for a reduction in the required fertilizer applied to the Site and subsequently reduce fertilizer costs.

Market Value

OSU provided current and expected market value ranges for alfalfa hay and grass hay based on winter 2012-2013 pricing. Currently alfalfa hay pricing for beef cattle is typically $180 to $200 per ton; grass hay pricing is typically $230 to $250 per ton. Current pricing of timothy hay was estimated by OSU to typically range $250 to $300 per ton.

The Central Oregon Hay Report (COHR) is available online and updated and released weekly on Thursday and reports the price range for alfalfa and orchard grass (includes grass hay and pasture grasses), the website is:

http://www.ams.usda.gov/mnreports/ml_gr313.txt.

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[3] OSU referred this as the "enterprise cost", which includes all input costs to grow and harvest a grass crop; including, but not limited to, soil preparation, seed, fertilizer, maintenance, irrigation and harvest.

[4] Data Source: Organization for Economic Cooperation and Development, http://stats.oecd.org/Index.aspx?DatasetCode=MEI_PRICES.

The current reported range for alfalfa as of the February 14, 2013 COHR is $220 to $250 per ton (good to premium grade); orchard grass is listed as $245 to $250 per ton (premium grade only shown); oat (cereal grain) is $145 per ton (fair grade only shown); timothy hay is not reported on the COHR.

Condition & Yield of Harvested Crops

Regarding the condition of possible harvested crops from the Lazy Z lands and the potential for marketability, OSU and an agri-business consultant (Richard Zimmerlee) were contacted to further investigate the potential value of harvested crops. Harvested feed crops, as discussed above, can vary depending on the nutrient capacity of the crop and also the general nature of the crop. Based on the above stated average sale price of harvested crops, cereal grains tend to bring the lowest value on a per ton basis; whereas, grass hay, alfalfa hay and timothy hay tend to bring greater value on a per ton basis.

Variability in the condition of the harvested crop will have an effect related to the market value as well (this was stated by both OSU staff and Mr. Zimmerlee); which includes weed potential, nutrients contained within the crop, size and condition of crop heads, etc. The general condition of the crop will likely dictate the potential sale, with domestic markets being more tolerant of moderate to lower quality feed crops, and international markets requiring premium quality feed crops. Generally, international feed crop markets maintain higher crop values.

Crop Nutrient Uptake

Discussions were conducted with OSU staff to ascertain further limitations that could affect marketability arising from the use of effluent water for irrigation, considering that the City of Redmond in the past has had some difficulty with cultivation and sale of crops grown from irrigated effluent. OSU worked with Redmond to conduct chemical analysis of alfalfa hay cultivated from effluent irrigated crop. This work found the crops to have elevated levels of nitrate. OSU stated that the nature of effluent irrigation containing nitrogen can concentrate nitrate in the feed crop, adversely affecting its marketability.

Limits on the marketability of feed crop with elevated nitrate, according to OSU staff, can limit the sale of the feed material and exclude cows and cattle that have a low tolerance for nitrate. OSU stated that horses have a higher tolerance for elevated nitrate in feed and, if feed crops display elevated nitrate at levels that could preclude cattle or cows, it could limit the marketability of feed crops for horses, or other similar nitrate tolerant livestock-or, if possible attempt to control nitrate build-up in harvested crops to allow for more wide acceptance of livestock that could accept the harvested crop.

Available Feed Crop Markets

Discussion was held with OSU regarding timothy hay based on its potential for high value crop production. OSU stated that timothy hay has a limited market based on its tendency for high calorie and carbohydrate content. Based on the high calories and carbohydrates the best markets for timothy hay, generally, are feed stores and horse race tracks-establishments that catering to working animals or livestock that may benefit from higher caloric and carbohydrate rich feed.

Deschutes County Soil and Water Conservation District Input

Deschutes County Soil and Water Conservation District (DCSWCD) was contacted to obtain information relative to crop selection and agricultural budget information. Discussion with Rex Barber of the DCSWCD indicated that the DCSWCD could not provide any specific information relative to the Lazy Z lands. However, Mr. Barber owns and operates a large agricultural farm near Lower Bridge on the Deschutes River approximately 5 miles west of Terrebonne, Oregon. His experience and knowledge in this regard brought hands-on information relative to cultivation of crops at the Lazy Z lands and the potential to market crops grown with treated effluent. Mr. Barber indicated, in his opinion, that the likely market for crops grown from treated effluent would be narrow, consisting mainly of hay or alfalfa hay crops. Regulatory limitations on crops only for non-human consumption would limit the ability to grow a larger variety of crops at the Lazy Z lands.

International Agri-Business Consultant Input

Discussion was held with Richard Zimmerlee, an international agri-business consultant, to investigate the potential for marketing crops grown from treated effluent. Mr. Zimmerlee has over 40 years of experience in managing and marketing agricultural crops, including international contracting and sales of specialized animal feed crops. Also discussed with Mr. Zimmerlee were additional potential business opportunities that could be authorized under ODEQ OARs for effluent reuse water.

The discussions indicate several limitations apply to crops grown from effluent reuse water versus fresh water. Although animal feed crops are authorized under ODEQ OARs, Mr. Zimmerlee stated that dairy cow farmers would resist the use of effluent-irrigated livestock feed, and that feed grown from such water would likely incur a 25% to 50% reduction in sale prices from the going rate of comparable crops grown from fresh water. These restrictions and limitations may further reduce the potential sale of feed crops grown on the Lazy Z lands.

Additional agricultural opportunities beyond grown-for-sale crops were discussed with Mr. Zimmerlee, including potential for a transitional nursery. A transitional nursery is typically an intermittent nursery used to acclimate nursery stock (ornamental trees, flowering plants, etc.) to

local conditions for plants grown in different climates. The viability of a transitional nursery is contingent on general economic conditions, in that, transitional nurseries are commonly associated with building of new residential and commercial sites that consume landscape plants, trees, etc. A transitional nursery may be of some benefit on a limited basis to provide for the City of Sisters Parks and streetscape tree establishment programs.

Constructed Wetlands

ODEQ would likely only allow lined wetlands without an extensive ground water analysis. The agency's ground water quality protection rules require point sources to employ the highest and best practicable methods to prevent the movement of pollutants to ground water. A lined wetland may be viable from a regulatory standpoint, but much less so from an economic standpoint.

According to evaporation data in Wert, 51.7 inches/year of evaporation should be expected, on average, in Sisters. These data were derived from U.S. Department of Commerce-National Oceanic and Atmospheric Science Department. This is assumed to be pan evaporation. Actual evaporation from a shallow lake or pond is expected to be between 70% and 80% of the pan evaporation. Using a percentage of 70%, then, the actual annual evaporation for a constructed wetland would be 36.2 inches per year.

Currently, the City produces about 183 acre-feet of effluent and, in 2033 is estimated to 361 acre-feet. The following table shows the estimated acreage and cost for wetlands required to dispose of current and estimated 2033 quantities of effluent.

Table 6. Estimated Acreage and Cost for Wetlands

Year	Wetland Acreage Required, Acres	Estimated Construction Cost, $
2013	64.7	$2,521,691
2033	119.7	$4,668,361

Conclusions

Based upon the following summary of information, the best cropping option for the Lazy Z lands is a fodder crop, primarily a grass hay crop.

1. **Regulatory Aspect:** Allowable crops for irrigation with Class D recycled water as imposed by Oregon Administrative Rules (OAR) 340-055 are: fodder, fiber, seed crops not intended for human ingestion, or commercial timber, firewood, ornamental nursery stock, Christmas trees, sod, or pasture for animals.

2. **Site Conditions Aspect:** (location, elevation, soil types, shallow seasonal ground water) Based on the site conditions the Lazy Z property is suitable for irrigation of crops with limitations for areas to be irrigated by the potential for seasonal high ground water. Additional limits based on the amount of gravel to cobble-sized rock in surface soils may limit the areas that could allow cultivation of a harvest crop, however, do not limit these gravel and cobble areas from being irrigable for pasture. Additional limits of Lazy Z property for crop irrigation may be complicated by farming the lands during spring start up or harvest periods when a farmer may not require irrigation water, requiring Sisters to store treated effluent until crops require irrigation water.

3. **Economics Aspect:** The discussions with Mr. Zimmerlee indicates that a reduction in market value of harvested crops from the Site could be incurred in the range of 25 to 50% below the going rate for feed crops. Further limitations are foreseeable based on the available market for feed based on the end use (i.e. dairy cows would not likely purchase effluent irrigated feed crops for dairy cow feed; elevated nitrate in feed crop could further limit livestock that could accept the feed crop). Additional limits on crop irrigation and harvest may be reflected by obstacles the City of Redmond, Oregon has had to address. Redmond has been conducting crop irrigation with effluent since the mid-1990's and for several years has found it difficult to lease the land to be farmed-complicating the City's ability to use effluent for agronomic reuse purposes. Redmond has had periods of elevated nitrate in feed crops that limits the marketability of harvested crops and sale value.

4. **Crop Nutrient Aspect:** The potential for feed crops harvested from the Lazy Z property to have elevated levels of nitrate in the feed if not managed properly, as an identified concern from OSU staff regarding effluent irrigated feed crops, can have a significant impact on the marketability of harvested feed crops. Based on this limitation, additional laboratory testing of crops grown on Lazy Z lands to determine the nutrient condition during the growing season could allow for a greater control of crops and improved marketability. Additional laboratory testing may contribute to additional costs for crop cultivation and may require a more stringent fertilizer application program to maintain proper nutrient balance in feed crops grown on the Lazy Z lands.

5. **Crop Variability/Rotation:** Based on the variable growing seasons of cereal grains and timothy hay, it may be viable to cultivate a mix of crops on the Lazy Z lands to maximize allowable areas for irrigation and crop harvest potential. With the potential of early season shallow ground water on areas of the Lazy Z lands, a later-maturing crop (such as late maturing timothy hay) may be appropriate for these lands, maintaining a longer growing season without more intensive initial irrigation. During the early portion of the irrigation season, the areas without shallow seasonal ground water to be planted with a cereal grain that would take irrigation water as early as practicable, while being limited in duration by the extent of the total growing season.

OPPORTUNITIES AND TIMING – CONVERTING SURFACE WATER RIGHTS TO INSTREAM RIGHTS

Opportunities to Convert Surface Water Right to Instream Rights

For the last ten to fifteen years, there has been significant interest in restoring instream flows to Whychus Creek. Like many streams in the Deschutes Basin, Whychus Creek is over-appropriated, meaning during certain times of the year the amount of water in the stream is less than the sum of water use authorizations. Generally, during dry summer months, only water rights issued before 1895 are fully met in Whychus Creek.

Historically, Oregon Department of Fish and Wildlife's instream water right (ISWR) has served as an informal goal for both stream flow and water quality purposes. The ODFW ISWR is based on temperature criteria for redband trout (18 degrees) and current data show that it closely correlates with the minimum flow necessary to achieve these temperature criteria in Sisters. Due to a very junior priority date, the ODFW ISWR's are not met. To realize meaningful flow restoration in Whychus Creek, senior water rights must be transferred instream temporarily or permanently either through lease, purchase, or through an allocation of conserved water through the State's Conserved Water Program.

Table 7. Whychus Creek Instream Water Rights

Whychus Creek Instream Water Rights															
Source	From	To	Priority Date	Instream Rates (cfs)											
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Whychus Cr	Indian Ford Creek	Mouth	10/11/1990	33	33	50	50	50	33	33	33	33	33	33	33
Whychus Cr	S. Fk Whychus	Indian Ford Creek	10/11/1990	30	20	20	20	20	20	20	20	30	50	30	30

Fisheries provide the primary driver for flow restoration in Whychus Creek. Low stream flows limit habitat availability and fish movement. Water quality provides the second driver for flow restoration in Whychus Creek. Whychus Creek upstream of river mile 21 is listed as water quality limited for temperature. Low stream flow is a major factor contributing to temperature impairments in this reach. Public interest in restoring flows increased with the recent reintroduction of summer steelhead and spring Chinook above the Pelton Round Butte Dam Complex on the mainstem Deschutes River and into Whychus Creek. As part of their new Federal Energy Regulatory Commission license to operate the dam complex, Portland General Electric and the Confederated Tribes of the Warm Springs Reservation are facilitating fish passage and are investing in upstream restoration to increase the likelihood of success. Multiple partners in the basin are heavily invested in ensuring the success of the reintroduction. In addition, summer steelhead is listed as a threatened species under the Endangered Species Act. Historically, Whychus was an important tributary for steelhead in the Deschutes Basin.

Another driver for instream flow transactions in the Deschutes Basin is the State's Ground water Mitigation Program, established in 2002. In 1998, a United States Geological Services Ground water Study confirmed that ground water and surface water in the study area within the Deschutes Basin are directly linked, and that the removal of ground water will ultimately diminish stream flow. In response, OWRD established the Deschutes Basin Ground water Mitigation Program, which requires "mitigation" for all new ground water permits in the study area. Mitigation is typically generated by transferring existing surface water rights instream. This has created a new demand, varying throughout the basin, for instream flow transactions that can generate temporary and permanent ground water mitigation credits.

Transactions and Market Characterization

Over the last twelve years, there have been approximately 445 acres of Whychus and tributary irrigation water rights transferred permanently instream. About half of these water rights were transferred purely for restoration purposes, and half generated permanent mitigation credits. The mitigation transfers were generally to provide landowners the opportunity to pump ground water under a new permit. To our knowledge, permanent mitigation credits were not sold to other buyers.

On a temporary basis, the DRC annually leases instream 1,150-1,400 acres of Whychus and tributary water rights. A large percentage of this is leased from Three Sisters Irrigation Districts from farmers who choose not to use water in a certain year. Approximately 250 of these leased acres produce temporary mitigation credits. In addition, the Three Sisters Irrigation District has implemented an aggressive program of water conservation, transferring 8,500 acre-feet of water from 15 conserved water projects.

There are several funders actively financing instream restoration in Whychus Creek, including the Pelton Fund, the Oregon Watershed Enhancement Board, and the BPA/National Fish and Wildlife Foundation's Columbia Water Transactions Program. The Pelton Fund was set up specifically to provide habitat restoration funds to support the Confederated Tribes of the Warm Springs Reservation and Portland General Electric's reintroduction of anadromous fish. This Fund has a limited duration, and will likely be spent out in the next five to ten years. The DRC aims to meet its initial streamflow restoration goal of 33 cfs in Whychus Creek below the confluence of Indian Fork Creek in the next five or so years. While it is likely that there will still be public investment in instream restoration in Whychus Creek, it may become a less robust market in five to ten years. The market for mitigation credits will continue to be tied to development and growth demands.

Types of Transactions Available

There are several "instream transactions" that can be utilized to add value to the City's Lazy Z water rights while irrigating the Lazy Z property with effluent. There are both permanent and temporary transactions that are available.

Permanent Transactions

Permanent instream transfers allow for water rights, subject to transfer, to be placed instream. This mechanism allows the "new" instream water right to retain the priority of the originating water right. As the City's Lazy Z water rights are senior in priority, the ensuing instream rights would also be senior and therefore of high value. Water right transfers, including instream, are a relatively lengthy process as the water rights are thoroughly examined to verify use, ownership, enlargement and potential injury to holders of existing water rights on the system. The process can take anywhere from nine months to several years.

Water conserved from an efficiency project, known as an Allocation of Conserved Water, generates a new water right that can be transferred instream or on-farm like any water right subject to transfer, or some of the water can be used to firm-up a deficient water right. Allocations of Conserved Water automatically protect a portion of the subject water right, minimum 25 % instream, but an applicant can choose to transfer up to 100 % of the conserved water instream.

Temporary Transactions

Instream leasing is a mechanism to place water instream temporarily (1 to 5 years) as a beneficial use. Instream leases can be renewed an indefinite number of times. Under a lease, the water right is never severed from the land so the right automatically reverts to the authorized place of use when the lease is expired or cancelled by the applicant. Leasing instream is a relatively quick process with applications generally being approved within a couple of months.

Split-season leasing is another temporary transaction that can be used to place water instream. This transaction allows the water right holder to protect the right instream for a portion of the season of use and apply water on-farm for a portion of the season of use. This is a useful mechanism but requires the applicant to measure and report the water use regularly throughout the season; this condition often creates a barrier to water right holders choosing this path.

Time-limited instream transfers allow the water right holder to place the water right instream for any period of time, generally for periods greater than a lease would be established for, i.e. 10 to 50+ years. A benefit of a time-limited transfer is that the water right holder can protect the water

instream for a significant amount of time yet still remain the water right holder when the transfer expires. Unlike a lease, a time-limited instream transfer cannot be terminated unless conditions are written into the transfer ahead of time.

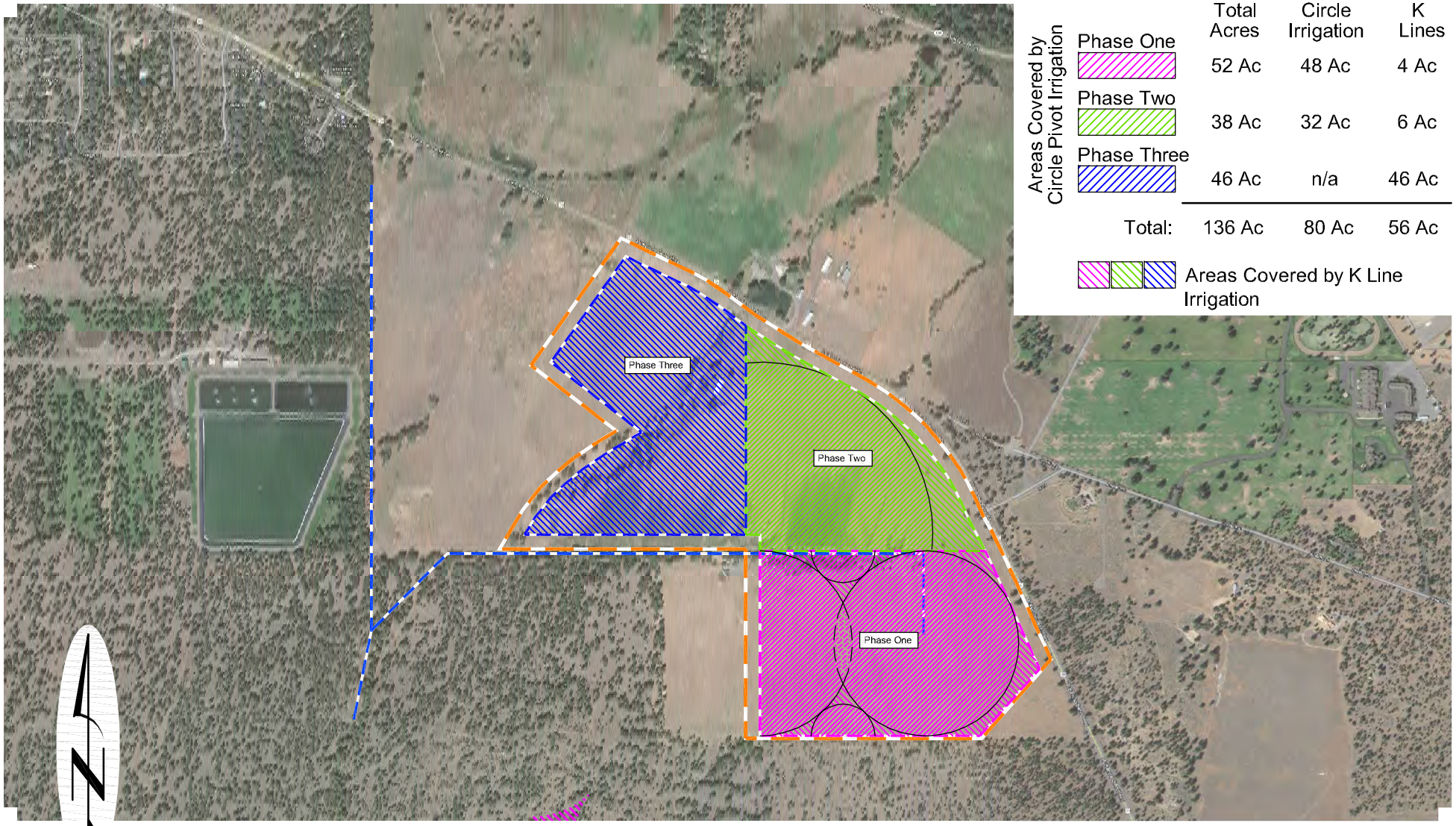
Since the City holds a ground water permit that requires mitigation under the Deschutes Basin Ground water Mitigation Program it may choose to use some portion of the Lazy Z water rights for mitigation. Currently, permanent mitigation credits can be generated from permanent instream transfers and temporary mitigation can be generated through instream leasing, time-limited transfers and potentially through split-season leasing. Any temporary credits generated must be through the DRC mitigation bank and currently those temporary credits have an annual fee of $105 per credit.

Timing of Opportunities

According to the analysis of effluent available for irrigation detailed earlier in this report, it is anticipated that there will be 128 acre-feet (AF) of effluent available in 2013. This volume, 128 AF, is the volume available under Case 1 (See Table 3), where the City continues to irrigate the forest and dikes at half the rate of current irrigation and moves the other half of the water to the Lazy Z. If applied on the City's Lazy Z property, this volume could irrigate approximately 51.2 acres applied at a rate of 2.5 AF per acre. This could allow the City to remove the equivalent number of acres of surface water irrigation from the land and protect the water instream either permanently or temporarily.

Through this feasibility study, 3 phases have been identified as likely group targets for effluent application and water right removal (see Figure 7). In each phase the mandatory set-back for irrigating with effluent was mapped and the new acreage footprint calculated. Figure 7 shows this phasing without the water rights overlay. When calculating the number of acres the City will have available for irrigating with effluent, the acreage totals accounted for the set-backs required for effluent irrigation. For example, Phase I has a total surface water right footprint of 53.3 acres, once the set-backs are accounted for there are 48.84 acres available for the City to apply effluent. Table 8 summarizes water rights and available acreage by phase.

Phase I is an area that the City identified as the most readily available for application of effluent due to existing infrastructure; this area has approximately 53.3 acres of senior Whychus Creek water rights appurtenant to it. Accounting for the mandatory set-backs, there are approximately 48.84 acres available to irrigate with effluent. Applying irrigation at a volume of 2.5 AF/acre allows for 122.1 AF of effluent irrigation on the 48.84 acres. The projected available effluent for 2013, 128 AF, is more than sufficient for irrigating Phase I.



Areas Covered by Circle Pivot Irrigation	Total Acres	Circle Irrigation	K Lines
Phase One	52 Ac	48 Ac	4 Ac
Phase Two	38 Ac	32 Ac	6 Ac
Phase Three	46 Ac	n/a	46 Ac
Total:	136 Ac	80 Ac	56 Ac

Areas Covered by K Line Irrigation

0' 1000' 2000'

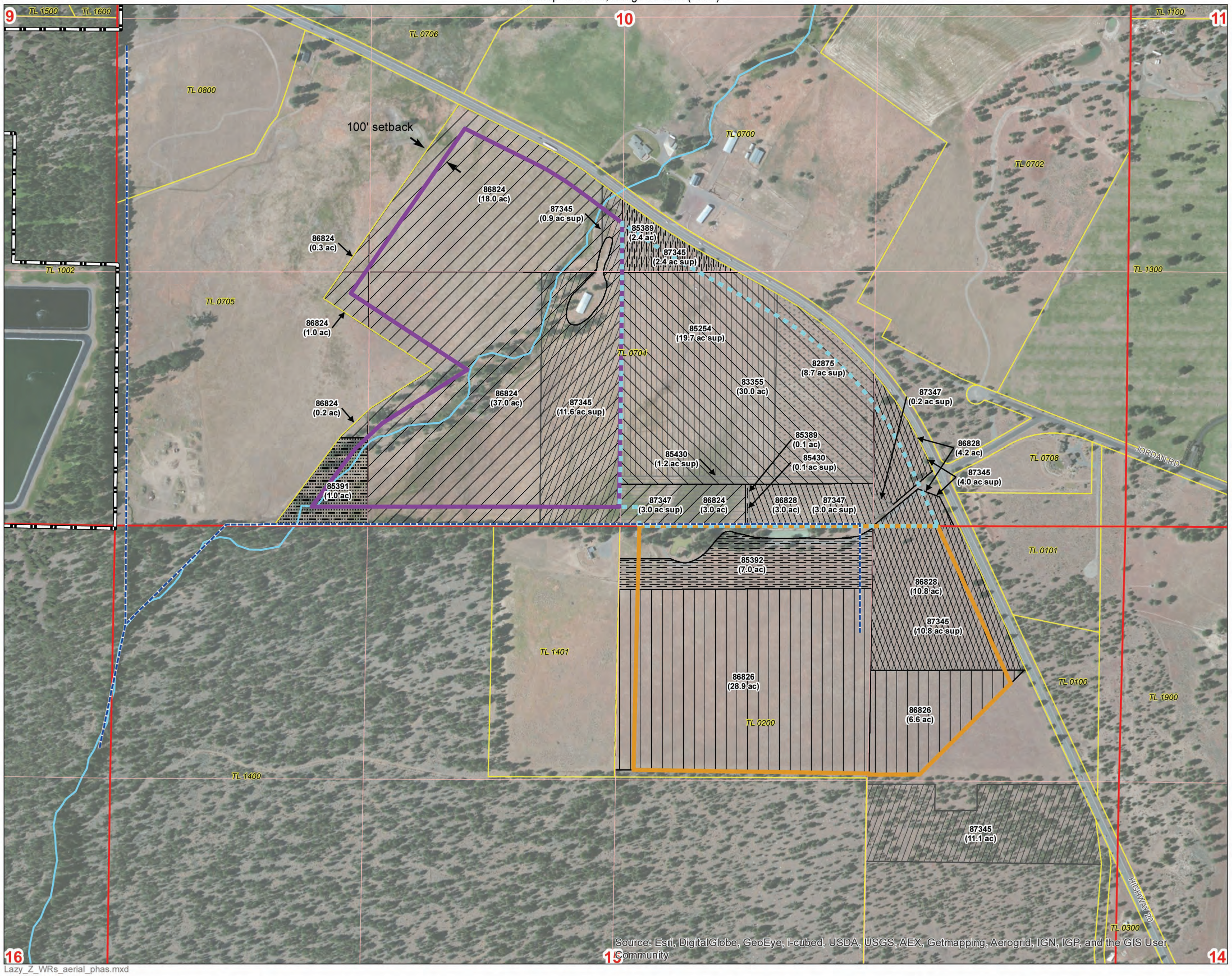
SCALE: 1" = 1000'

NEWTON CONSULTANTS INC.
Earth, Water and Rock Specialists
Ph: 541 504-9960 Fax: 541 504-9961

Task 4; Irrigation Mechanisms Scenarios - Phases 1-3
Lazy 'Z' Evaluation
Sisters, Deschutes County, Oregon

DESIGNED BY:	DRAWN BY:	DATE:	PROJECT NO.	FIGURE
D. Newton	S. Schenck	MAY 2013	1138-101	7

Township 15 South, Range 10 East (W.M.)



Lazy_Z_WRs_aerial_phas.mxd

Lazy Z
Proposed Phasing
City of Sisters

LEGEND

Proposed Phasing
- Phase 1
- Phase 2
- Phase 3

Water Right Certificates
- 82875 S (GW)
- 83355 (1880)
- 85254 S (GW)
- 85389 (1880)
- 85391 (1880)
- 85392 (1886)
- 86824 (1880)
- 86826 (1881)
- 86828 (1880)
- 87345 S (GW)
- 87347 S (GW)

All Other Features
- City of Sisters UGB
- Tax Lots
- Uncle John Ditch
- Existing Pipeline
- PLSS Section
- PLSS QQ Section

Figure 8

N

0 250 500 750
Feet

MAP NOTES:
Date: May 19, 2013
Data Sources: Deschutes Co GIS, Deschutes River Conservancy, OGIC

GSI Water Solutions, Inc.

Table 8. Water Rights and Available Acreage by Phase

	Water Right	Acres of Surface Water Rights	Priority Date	Rate (cfs)	Volume (AF) 5 AF/acre	Acres Available for Effluent Irrigation *
Phase 1 Water Rights – Primary						
Primary Irrigation	c.86828 (T-11318/CW-71)	10.8	1880	0.32	54.0	8.95
	c.86826 (T-11318/CW-71)	35.5	1881	0.71	177.5	33.29
	c.85392 (T-11318/CW-71)	7.0	1886	0.14	35.0	6.60
		53.3		**1.17**	**266.5**	**48.84**
Phase 2 Water Rights - Primary						
	Water Right	**Acres of Surface Water Rights**	**Priority Date**	**Rate (cfs)**	**Volume (AF) 5 AF/acre**	**Acres Available for Effluent Irrigation**
Primary Irrigation	c.83355 (T-11318/CW-71)	30.0	1880	0.62	150.0	27.37
	c.86828 (T-11318/CW-71)	7.2	1880	0.23	36.0	5.78
	c.85389 (T-11318/CW-71)	2.5	1880	0.08	12.5	1.23
	c.86824 (T-11318/CW-71)	3.0	1880	0.06	15.0	3.00
		42.7		**0.99**	**213.5**	**37.38**
Phase 3 Water Rights - Primary						
	Water Right	**Acres of Surface Water Rights**	**Priority Date**	**Rate (cfs)**	**Volume (AF) 5 AF/acre**	**Acres Available for Effluent Irrigation**
Primary Irrigation	c.86824 (T-11318/CW-71)	56.5	1880	1.13	282.5	46.50
	c.85391 (T-11318/CW-71)	3.0	1880	0.1	15	1.29
		59.5		**1.23**	**297.5**	**47.79**
	Total:	***155.5***		***3.39***	***777.5***	***134.01***

**Acreage accounts for required set-backs*

Phase II has approximately 42.7 acres of irrigation water rights; with the mandatory set-backs, there are approximately 37.38 acres available for effluent application. Applied at a rate of 2.5 AF/acre, 93.45 AF would accommodate irrigation of Phase II. According to the estimated available effluent under Case 1 (refer to Table 3 on), somewhere between 2023 and 2028 the City would have enough effluent to water the entirety of Phases I and II without the use of appurtenant surface water rights.

In Phase III, there are approximately 59.5 acres of irrigation water rights. This equals approximately 47.79 acres available for effluent application, accounting for mandatory set-backs. The effluent needed to irrigate this phase (based on 2.5 AF/acre) is approximately 119.48 AF. The projections for available effluent end in 2033 and estimate that 294 AF of effluent will be available for irrigating on the City's Lazy Z property at that point (Table 3, Case 1). Accounting for effluent used to irrigate Phases I and II, there will be approximately 78.45 AF of effluent available to irrigate Phase III in 2033; that equates to 65 % of the acreage in Phase III available for irrigating with effluent.

If the City chooses to permanently remove their surface water rights from the Lazy Z property as effluent becomes available, it will important to do so in a strategic manner. It would be prudent to remove water rights in portions large enough that it makes financial sense for potential restoration funders, for example, greater than 20 acres in the transaction. The phasing outlined in this report is based on current and future planned infrastructure locations and an approximately even split of appurtenant surface water rights. If water rights are to be removed it can occur in different parcel sizes than identified in the current phasing or they can be removed prior to sufficient effluent being available for irrigation, if the City chooses.

EFFLUENT IRRIGATION MECHANISMS

Purpose and Data Sources

Effluent irrigation can be accomplished in a number of ways. Considerations in selecting a method of irrigation generally include type of crop, whether a crop is harvested or grazed, labor and cost of conducting irrigation, operation and maintenance requirements, and regulatory restraints on application of effluent to irrigated area. This section describes evaluation of alternative mechanisms for irrigation of Lazy Z lands with treated effluent.

The evaluation included consideration of irrigation information from several sources including the following:

- Oregon Administrative Rule (OAR) 340-055-0022 and 340-055-0025(2) (d);
- John Rowley, Nelson Irrigation Company, Walla Walla, Washington;
- Central Oregon pump and irrigation contractors familiar with the Site area and likely choices for commercially available irrigation equipment.

Regulatory Limitations Relative to Irrigation Mechanisms

OAR 340-055-0022 of the regulations pertaining to the use of recycled water has the following requirements for Ground water Quality Protection:

> *Recycled water will not be authorized for use unless all groundwater quality protection requirements in OAR chapter 340, division 40 are met. The requirements in OAR chapter 340, division 40 are considered to be met if the wastewater treatment system owner demonstrates recycled water will be used or land applied in a manner and at a rate that minimizes the movement of contaminants to groundwater and does not adversely impact groundwater quality.*

Generally, ODEQ has determined that the movement of contaminants to ground water will be minimized if recycled water is applied in a uniform manner at agronomic rates. ODEQ is unlikely to accept flood irrigation as providing a uniform application rate; recycled water must be applied via spray or drip irrigation.

OAR 340-055-0025(2)(d) states "If Class B, C, or D, or non-disinfected recycled water is to be used for irrigation, a recycled water use plan must include a description of site management practices including, but not limited to, the timing of application and methods used to mitigate potential aerosol drift."

Evaluation Criteria - Irrigation Mechanisms

Considering the available volume of treated effluent and discussions with the City, the crops preferred for irrigation on the Lazy Z lands are harvestable hay/alfalfa/grass and poplar trees. Evaluation of irrigation mechanisms includes consideration of these crop types.

The following table lists the basic design considerations for the Lazy Z lands irrigation system and the basis for those considerations.

Table 9. Basic Design Considerations for Irrigation System

Design Consideration	Design Basis
General Irrigation	
Cost Effective	Obviously, the City wishes to maintain its cost for disposing of its effluent as low as possible.
Low Operation/Maintenance	The City has limited staff for operating its sewerage facility; it needs to minimize the amount of time staff spends operating and maintaining its irrigation system.
Very uniform application.	In order to avoid groundwater contamination pursuant to DEQ rules and to provide sufficient water to all areas under cultivation, the recycled water needs to be applied uniformly at agonomic rates.
Unlikely to plug	The City stores effluent during the non-irrigation season and into parts of the irrigation season. During this storage period, the effluent will grow algae that could plug the irrigation nozzles. Nozzle need to be designed to avoid plugging which otherwise would cause non-uniform application of recycled water.
Flexible. i.e. expandable, adapatable to odd site shapes.	It is likely that the irrigation system will be installed in segments as additional areas become cultivated. Recycled water will gradually replace areas covered by existing water rights which may cover odd shapes. The irrigation system will need to be able to adapt to these new areas and shapes.
Unlikely to cause drift	Some irrigation systems could cause recycled water to be carried off the irrigation site during windy conditions. DEQ rules require that this be avoided.
Resistant to freezing problems.	Even during the growing season in Sisters, nights and mornings frequently are subject to sub freezing conditions. The irrigation system must not be damaged and be able to operate under these conditions.
Additional Considerations for Poplar Irrigation	
Easily removable or protected during harvest	During tree harvesting, the irrigation system must be removalble or otherwise be able to be protected.
Uniform application within tree columns	As the trees mature, tree trunks could block or impair the ability to provide a uniform application of recycled water. These system must be able to provid a uniform application to all trees.

Effluent Irrigation Mechanisms

Based on the above criteria for irrigation mechanisms relative to agronomic land application of treated effluent, the following types of irrigation equipment could apply to the Lazy Z lands:

- Hand Lines: composed primarily of relatively light weight aluminum pipes with a single sprinkler head on each pipe segment and coupled together at each end with simple self-locking coupler ends to allow for modular lengths of continuous (straight) hand lines; can be coupled with angle sections to make simple turns. Disadvantages: unless sufficient hand lines are provided to cover the entire irrigation area, the lines must be manually moved, perhaps several times a day. In any case, if hand lines were provide to cover the entire area they would require manual labor to move the lines for crop rotation or for crop harvesting; after harvest is complete hand

lines must be replaced for continued crop irrigation; and susceptibility of livestock or wildlife knocking over the sprinkler risers.

- Large Gun Sprinklers on hose reels: large gun sprinklers distribute water over relatively long distances with high trajectories. The high trajectories have a high potential to cause air borne water droplets that would likely drift on to adjacent properties. It is likely that ODEQ would require an increased buffer distance if it allowed large gun sprinklers. For this reason, this irrigation mechanism is not recommended.

- Wheel Lines: composed primarily of lightweight aluminum pipes with a single sprinkler head on each pipe segment mounted on an aluminum spoke wheel to allow for easy traverse of series of wheel lines across a relatively level field. Each end is coupled together with simple self-locking coupler ends to allow for modular lengths of continuous (straight) wheel lines. Disadvantages: wheel lines require an irrigable field to be relatively flat and square or rectangular in shape and have minimal rocks; wheel lines tend to be very susceptible to wind movement and disruption of irrigation application.

- Circle Pivot: composed of large rubber wheel sections of overhead pipe with drop sprinklers that rotate about a center point (or pivot). A circle pivot can be operated to move across fields with moderate slope with clear wheel tracks. The one advantage to a circle pivot is that it requires minimal manual labor to operate. The disadvantages to circle pivots include high cost of installation, and, to irrigate field configuration other than a circle, it must be combined with other methods (hand lines, K Lines, etc.) to irrigate corners or areas not traversable by the circle pivot.

- Permanent Set Lines: may be composed of underground pipe installation with surface exposure of permanent riser sprinklers, or automated pop-up sprinklers, or individually installed 'plug-in' sprinklers. Disadvantages to permanent set lines are that, during plowing/disking of fields or during harvest, permanent set lines would likely be damaged and could lead to significant maintenance on an annual basis.

- Removable Set Lines: these are composed primarily a hand lines or *K Lines* (see below). Disadvantages to removable set lines are they need to be moved out of the way of equipment during harvest, field plowing/disking and reset prior to continued irrigation. K Lines can be moved with a vehicle and do not have the significant labor required to move and set hand lines.

- K Lines: composed of a non-rigid hose that connects a string of sprinklers mounted in self-contained polymer pods that can be moved with a vehicle (i.e. ATV, tractor, pickup truck). Standard length includes 5 sprinkler pods and can be coupled to make a continuous string of up to 10 sprinkler pods in a single K Line string. K Lines,

having sprinkler pods, provide protection from livestock or wildlife rubbing or knocking the pods out of position for irrigation.

Sprinkler heads for each of the above mechanisms are anticipated to be impact or rotary type sprinklers. These types of sprinklers are typical for these types of mechanisms.

Sprinklers

Impact Sprinklers

The basic operation of an impact sprinkler is relatively simple. As water leaves the sprinkler nozzle it comes in contact with a spring-loaded drive arm. This arm is shoved aside by the force of the water. The spring then returns the arm to its original position and it again comes into contact with the water and also a stop or shoulder on the sprinkler body. The impact against the shoulder causes the entire head assembly (and sprinkler stream) to rotate slightly. This constant impact and movement will cause the head to rotate a complete circle and slowly water the entire area within that circle. In addition, each time the water makes contact with the sprinkler arm, a small amount of "splash" is created that falls near the sprinkler head.

Advantages to impact sprinklers are uniform coverage of the area to be irrigated and with most impact sprinklers made of brass or stainless steel bodies, the sprinklers tend to have a long service life. Interchangeable nozzles within the sprinkler head allows for variability in the irrigation water volume and adjustability for varied input water pressure.

Disadvantages of impact sprinklers are the potential for high maintenance cost related to the exposed nature of the rotation mechanism with possible operation impedance by debris or contact with vegetation, and corrosion or deterioration of the rotation mechanism causing failure of the sprinkler head. Additionally, if an impact sprinkler becomes entangled with debris or becomes clogged, disabling rotation, an impact sprinkler will tend to spray in a single direction. If left unrepaired, this can cause oversaturation or erosion of soil in area of water impact.

Rotary Sprinklers

Rotary sprinklers (or more specifically, gear-driven rotary sprinklers), operate by water turning a small turbine (water wheel or fan) in the base of the unit which drives a series of gears that cause the head to rotate. The gear drive mechanism is protected from soil and debris by a screen.

The advantage of the Nelson rotary sprinkler is that the sprinkler heads can be fed by polyethylene pipe laterals or portable pipes including aluminum, polyethylene or PVC which would allow the sprinkler system to be removed during harvesting of poplar trees, if they are the chosen crop. Additionally, rotary sprinklers have the gear-driven portion (the unit within the

sprinkler that allows for sprinkler rotation) enclosed within the sprinkler providing protection from clogging or impacted by external debris.

Some potential drawbacks may come with these sprinklers. Nelson Irrigation Company (Nelson) of Walla Walla, Washington manufactures and sells rotary sprinkler heads of various types. Discussion with Nelson indicates they do not have experience with use of the rotary sprinklers to irrigate recycled water with high concentrations of algae. In addition, there could be problems during freezing conditions. According to John Rowley, "if the irrigation water temperature in use is greater the 55 degrees F, the R2000 will resist Rotator failure in most conditions. If the water temperature is below 40 degrees F, in some of the conditions, there will be freezing up of the sprinkler and rotation failure. Overall the R2000 will resist rotation failure in freezing temperatures if water is above 55 degrees and there are low winds. Wind speed is also an important factor, High winds (greater than 7 MPH) will cause rotation failure in freezing temps."

Sprinkler Options Summary

Before considering a sprinkler system, it is recommended that a small set be purchased and installed on an existing irrigation site for a season. This would allow the City to determine if nozzle plugging and sprinkler freezing would be a problem, as sprinklers of all types may be subject to potential freezing conditions.

The poplar plantation at Woodburn, Oregon uses the R-10 sprinkler heads. John Rowley of Nelson, recommends the R-2000 sprinkler head, which is also rotary, because it can be fitted with a one-eighth inch nozzle which may be less prone to plugging due to algal concentrations in the recycled water. This head would apply recycled water at 0.4 inches/hour.

Based on discussions with other municipalities that conduct effluent irrigation, rotary sprinklers were identified as a likely best choice for sprinkler irrigation of effluent.

Conclusions

Based upon the following summary of information, and discussions with City of Sisters personnel, irrigation mechanisms with minimal labor to operate are preferred. With that in mind, limitations on irrigation mechanisms for either hay/alfalfa/grass or poplar trees, distinct irrigation mechanisms are described below:

Hay/Alfalfa/Grass

Irrigation mechanisms that are best applied to a hay/alfalfa/grass crop would be circle pivots, K Lines, and permanent set lines (permanent set lines will only work on a harvested crop if in-ground sprinklers are mounted outside of the harvest area, as harvest equipment or plow/disking of the field would likely damage the equipment). The K Lines would likely be a best choice for ease of movement to irrigate the corner areas not irrigable by circle pivots.

Poplar Trees

Irrigation Mechanisms that are best applied to a poplar tree crop would be had lines or K Lines. With the harvest duration of poplar trees being on the order of 9 to 12 years, K Lines could be pulled into and out of position with an ATV, tractor, etc. and set for the crop duration. Hand lines could be laid in rows and removed prior to tree harvest; however, wildlife may knock the sprinkler risers requiring periodic attention to reset the sprinkler risers.

COST ANALYSIS – IRRIGATION MECHANISMS

Identified Irrigation Mechanisms

A generalized cost estimate has been prepared based on the irrigation mechanisms identified under the section *Cost Analysis – Irrigation Mechanisms*. Newton conduct research for installation costs of irrigation mechanisms from Cascade Pump and Irrigation of Bend, Oregon. The estimated costs for irrigation mechanisms included the following key items below:

- Discussions with City of Sisters personnel on irrigation equipment that requires minimal supervision and maintenance cost;
- Capital costs to for initial purchase and installation of irrigation equipment based on the phase scenario included on the attached Table 10 7;
- Estimates of annualized power demands to operate the system;
- Potential annual operation and maintenance cost;
- Cost improvements provided by HGE, Inc. to allow for delivery of effluent irrigation water to each project phase (see table below):

Table 10. Reuse Improvements *

Phase I	
Mobilization	$32,600
Clearing and Grubbing	$3,500
Gravel Roadway Construction 3,250 ft.	$65,000
Excavation and Class 3 BF, 3,250 ft.	$81,250
Rock Excavation	$5,000
Foundation Stabilization, 120 CY	$3,600
18" HDPE Force Main, 3,250 ft.	$121,875
18" Culvert Installation	$2,500
Forcemain Appurtenances	$42,700
Aggregate Base and Surfacing, 20 CY	$600
Total Phase I	**$358,625**
Phase II**	
Irrigation Line Controllers	$13,333
Conduit	$13,333
SCADA Modifications	$13,333
Total Phase II	**$400,000**
Engineering Contingencies	$150,000
PROJECT TOTAL	**$908,625**

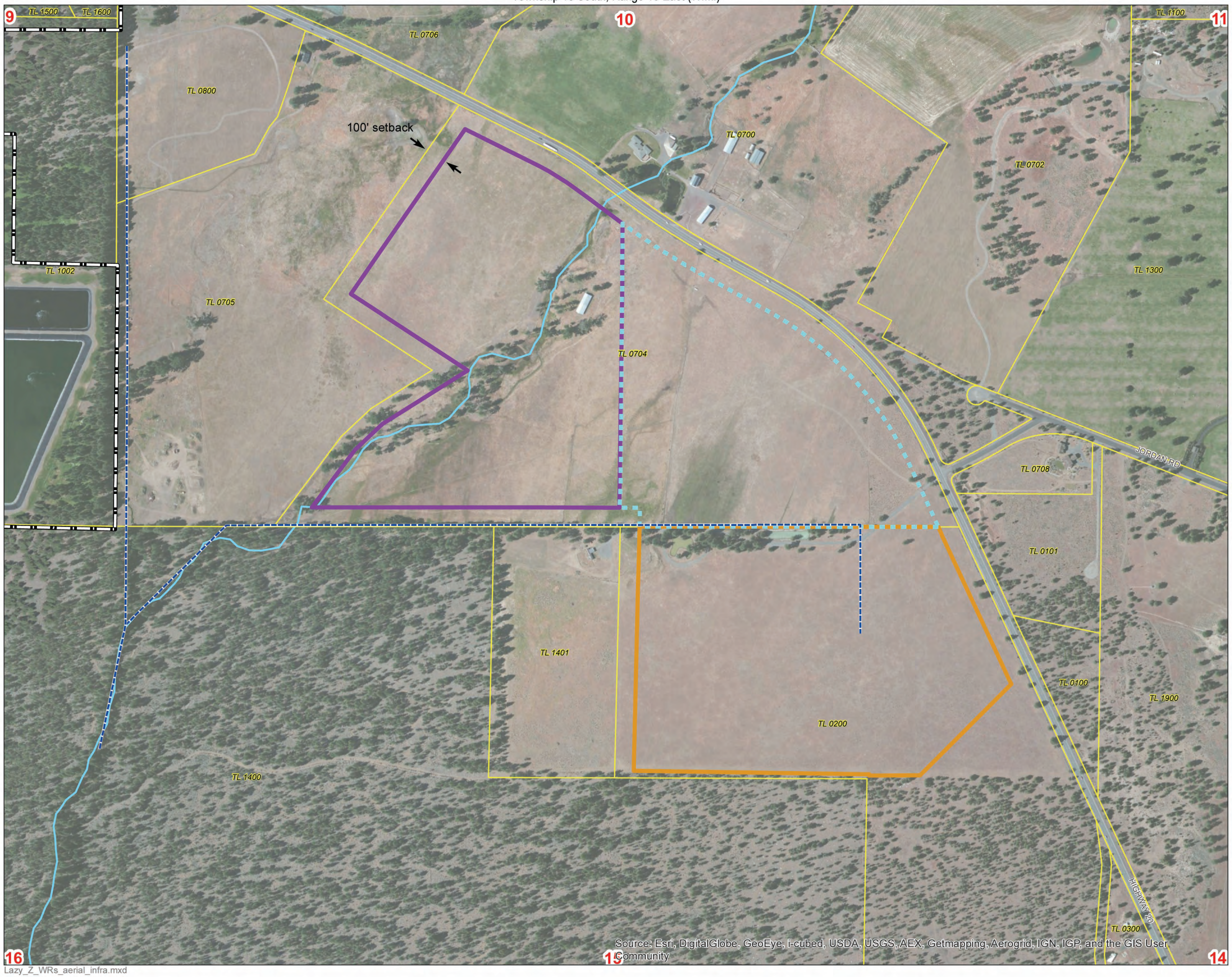
*Values for the reuse improvements were provided by HGE, Inc. in a letter to Paul Bertagna, Sisters Public Works Director, dated May 6, 2013.
**Phase II cost was provided as a lump sum value and was divided equally among each component. The cost will likely change extensively depending on equipment desired, conduit lengths, and the extent of SCADA modifications.

Preferred Irrigation Mechanisms

The rate of recycled water application is limited to the agronomic requirement of the crop. Exceeding the agronomic rate creates the potential for waste water to migrate into the ground water and cause contamination. The agronomic rate varies based upon the type of crop, the time of year, and actual weather conditions which are impossible to predict from year to year. The irrigation system on the Lazy Z Ranch should include a system to measure soil moisture content so that application rates can be adjusted as needed based upon actual conditions. Irrigation of Hay/Alfalfa/Grass

Irrigation of hay/alfalfa/grass crops has been estimated in each phase of the project, with a specific layout of likely irrigation methods presented on the attached Figure 9. In this scenario the primary areas for irrigation of phase 1 and phase 2 have been provided, with the potential cost for irrigation of phase 3 being based on the average per acre cost of phases 1 and 2.

Township 15 South, Range 10 East (W.M.)



Lazy_Z_WRs_aerial_infra.mxd

Lazy Z Existing Infrastructure and Proposed Phasing

City of Sisters

LEGEND

Proposed Phasing

- Phase 1
- Phase 2
- Phase 3

All Other Features

- City of Sisters UGB
- Tax Lots
- Uncle John Ditch
- Existing Pipeline

Figure 9

N

0 250 500 750

Feet

MAP NOTES:

Date: May 19, 2013

Data Sources: Deschutes Co GIS, Deschutes River Conservancy, OGIC

GSI Water Solutions, Inc.

Irrigation mechanisms to irrigate a hay/alfalfa/grass crop need to be easily moved from the irrigation field to allow for crop harvest, which can occur between 2 to 6 times annually. Emphasis on minimal maintenance and ease of removal and resetting of the irrigation system was necessary. The mechanisms identified for the primary areas within the phases are circle pivots, with K Lines being used to fill in the small areas that a circle pivot could not accommodate.

Based on this scenario of circle pivots and K Lines to provide irrigation for a hay/alfalfa/grass crop, the following cost summary table was developed:

Table 11. Cost Summary for Irrigation of Hay/Alfalfa/Grass

Phase 1				
Irrigation Mechanism	**Acres**	**Cost/Acre**	**Total Cost**	**Annualized O & M***
Circle Pivots(4)	48	$6,854.00	$328,992.00	$16,449.60
K Lines	4	$6,060.00	$24,240.00	$8,544.00
Reuse Improvements (HGE, Inc)			$433,625.00	
Summary Phase 1		**$6,457.00**	**$786,857.00**	**$24,993.60**
Phase 2				
Irrigation Mechanism	**Acres**	**Cost/Acre**	**Total Cost**	**Annualized O & M***
Circle Pivots (1)	32	$3,906.00	$124,992.00	$6,249.60
K Lines	6	$6,060.00	$36,360.00	$9,756.00
Reuse Improvements (HGE, Inc)			$475,000.00	
Summary Phase 2		**$4,983.00**	**$636,352.00**	**$16,005.60**
Phase 3				
Irrigation Mechanism	**Acres**	**Cost/Acre**	**Total Cost**	**Annualized O & M****
Circle Pivots K Lines	46	$5,720.00	$727,417.93	$20,499.60
Summary Phase 3		**$5,720.00**	**$727,417.93**	**$20,499.60**

*Annualized O & M costs are based on an annual equipment cost of maintenance & repair of approximately 5% of materials cost. Labor to operate irrigation of hand lines is based on 1 person 2 hours per day 7 days per week for 140 day irrigation season at a pay rate of $30/hour/person. Four annual harvest removal and reset costs (assumes 4 crop cuttings per irrigation season) are assumed to require 2 persons 8 hours for removal, and 2 persons 8 hours for re-set of hand lines for each of the four harvest events. Labor to operate irrigation with K Lines is based on 1 person 1 hour per day 7 days per week for 140 day irrigation season at a pay rate of $30/hour/person. Four annual harvest removal and reset costs of K Lines (assumes 4 crop cuttings per irrigation season) is assumed to require 1 person 8 hours for removal; and 1 persons 8 hours for re-set of hand lines.

**Annualized O & M costs are based on an average Annual O & M for Phases 1 and 2 above.

NOTE: Costs for irrigation equipment and installation are based on estimates provided by Cascade Pump and Irrigation of Bend, Oregon based on similar acreage size projects where applicable.

The above costs were evaluated on a per acre cost for each phase of effluent irrigation. The cost per acre associated with circle pivots changes between phase 1 and phase 2 based on the portions of partial pivots and the added cost for installation of each circle pivot center.

The potential for phase 3 equipment costs could be off set if the pivot track from the phase 2 pivot could be extended to allow pivot rotation across the phase boundary to phase 3.

The estimated annual power cost per phase is shown in the table below assuming a cost of $0.06 per kilowatt-hour (KwH):

Table 12. Estimated Annual Power Cost for Irrigation (Hay/Alfalfa/Grass)

Estimated Annual Power Cost for Irrigation		
Phase 1		
Irrigation Mechanism	**Acres**	**Cost @ $0.06/KwH**
Circle Pivots(4)	48	$6,854.00
K Lines	4	$193.00
Summary Phase 1		**$7,047.00**
Phase 2		
Irrigation Mechanism	**Acres**	**Cost**
Circle Pivots (1)	32	$3,527.00
K Lines	6	$386.00
Summary Phase 2		**$3,913.00**
Phase 3		
Irrigation Mechanism	**Acres**	**Cost**
Circle Pivots		
K Lines	46	$5,601.78
Summary Phase 3		**$5,601.78**

Irrigation of Poplar Trees

Irrigation of a poplar tree crop has been estimated in each phase of the project, with a generalized layout of likely irrigation methods based on the acreage of each irrigable phase as shown on the attached Figure 7. In this scenario the primary areas for irrigation of phase 1 and phase 2 have been provided, with the potential cost for irrigation of phase 3 being based on the average per acre cost of phases 1 and 2.

Irrigation mechanisms to irrigate a poplar tree crop need only be removable for harvest on a likely 9 to 12 year cycle. During harvest, the entire irrigation system should be removed, and then replaced after tree crop harvest. Emphasis on minimal maintenance and complete removal and resetting of the irrigation system was necessary. The mechanisms identified for the primary areas within the phases are hand lines or K Lines.

Based on this scenario of hand lines or K Lines to provide irrigation for a poplar tree crop, the following cost summary table was developed:

Table 13. Cost Summary for Irrigation of Poplar Tree Crop

Phase 1				
Irrigation Mechanism	**Acres**	**Cost/Acre**	**Total Cost**	**Annualized O & M***
Hand Lines	52	$2,250.00	$117,000.00	$16,650.00
K Lines		$6,060.00	$315,120.00	$7,695.60
Reuse Improvements (HGE, Inc)			$433,625.00	
	Summary Phase 1	**$4,155.00**	**$865,745.00**	**$24,345.60**
Phase 2				
Irrigation Mechanism	**Acres**	**Cost/Acre**	**Total Cost**	**Annualized O & M***
Hand Lines	38	$2,250.00	$85,500.00	$15,075.00
K Lines		$6,060.00	$230,280.00	$16,914.00
Reuse Improvements (HGE, Inc)			$475,000.00	
	Summary Phase 2	**$4,155.00**	**$790,780.00**	**$31,989.00**
Phase 3				
Irrigation Mechanism	**Acres**	**Cost/Acre**	**Total Cost**	**Annualized O & M***
Hand Lines	46	$2,250.00	$103,500.00	$15,975.00
K Lines		$6,060.00	$278,760.00	$6,793.80
	Summary Phase 3	**$2,250.00**	**$846,668.33**	**$11,384.40**

*Annualized O & M costs are based on an annual equipment cost of maintenance & repair of approximately 5% of materials cost. Labor to operate irrigation of hand lines is based on 1 person 2 hours per day 7 days per week for 180 day irrigation season at a pay rate of $30/hour/person. A single harvest removal and reset cost (approximately once every 9-12 years) is assumed to require 2 persons 8 hours for removal; and 2 persons 8 hours for re-set of hand lines. Labor to operate irrigation with K Lines is based on 1 person 1 hour per day 7 days per week for 180 day irrigation season at a pay rate of $30/hour/person. A single harvest removal and reset cost of K Lines (approximately once every 9-12 years) is assumed to require 1 person 8 hours for removal; and 1 persons 8 hours for re-set of hand lines. Single poplar harvest event is not included in the Annualized O & M cost above

NOTE: Costs for irrigation equipment and installation are based on estimates provided by Cascade Pump and Irrigation of Bend, Oregon based on similar acreage size projects where applicable.

The above costs were evaluated on a per acre cost for each phase of effluent irrigation.

The estimated annual power cost per phase is shown in the table below assuming a cost of $0.06 per kilowatt-hour (KwH):

Table 14. Estimated Annual Power Cost for Irrigation (Poplar Trees)

Estimated Annual Power Cost for Irrigation		
Phase 1		
Irrigation Mechanism	**Acres**	**Cost @ $0.06/KwH**
Hand or K Lines	48	$1,932.84
	Summary Phase 1	**$1,932.84**
Phase 2		
Irrigation Mechanism	**Acres**	**Cost**
Hand or K Lines	32	$1,352.94
	Summary Phase 2	**$1,352.94**
Phase 3		
Irrigation Mechanism	**Acres**	**Cost**
Hand or K Lines	46	$1,546.26
	Summary Phase 3	**$1,546.26**

Table 15. Water Rights and Available Acreage by Phase

City of Sisters: Lazy Z Water Re-Use Study (2013)

	Water Right	Acres of Surface Water Rights	Priority Date	Rate (cfs)	Volume (AF) 5 AF/acre	Acres Available for Effluent Irrigation *
Phase 1 Water Rights - Primary						
Primary Irrigation	c.86828 (T-11318/CW-71)	10.8	1880	0.32	54.0	8.95
	c.86826 (T-11318/CW-71)	35.5	1881	0.71	177.5	33.29
	c.85392 (T-11318/CW-71)	7.0	1886	0.14	35.0	6.60
		53.3		**1.17**	**266.5**	**48.84**
Phase 2 Water Rights - Primary						
	Water Right	**Acres of Surface Water Rights**	**Priority Date**	**Rate (cfs)**	**Volume (AF) 5 AF/acre**	**Acres Available for Effluent Irrigation**
Primary Irrigation	c.83355 (T-11318/CW-71)	30.0	1880	0.62	150.0	27.37
	c.86828 (T-11318/CW-71)	7.2	1880	0.23	36.0	5.78
	c.85389 (T-11318/CW-71)	2.5	1880	0.08	12.5	1.23
	c.86824 (T-11318/CW-71)	3.0	1880	0.06	15.0	3.00
		42.7		**0.99**	**213.5**	**37.38**
Phase 3 Water Rights - Primary						
	Water Right	**Acres of Surface Water Rights**	**Priority Date**	**Rate (cfs)**	**Volume (AF) 5 AF/acre**	**Acres Available for Effluent Irrigation**
Primary Irrigation	c.86824 (T-11318/CW-71)	56.5	1880	1.13	282.5	46.50
	c.85391 (T-11318/CW-71)	3.0	1880	0.1	15	1.29
		59.5		**1.23**	**297.5**	**47.79**
	Total:	***155.5***		***3.39***	***777.5***	***134.01***

**Acreage accounts for required set-backs*

FINANCING OPPORTUNITIES – CONVERSION OF SURFACE WATER RIGHTS TO INSTREAM RIGHTS

Valuation & Feasibility of Transactional Opportunities

This section provides some historical information on water transactions and a range of estimates for potential transactions the City may consider. The valuation of water contains many variables and needs to be looked at on a case-by-case basis. Important variables include specifics of the water rights in question, including location, priority date, rate and duty (allowable application volume per-acre over an irrigation season), as well as current market demand for the water. In some cases, third-party appraisals are required. Thus, this discussion should be viewed as a tool for the City to consider their options, not as a firm valuation of water rights. Extensive due diligence is required as part of individual water transactions. This section also briefly discusses the current feasibility and utility of each opportunity.

Permanent Transactions

Permanent Restoration Transfer

Several Whychus Creek surface water rights have been acquired over the last several years within the range of $4,500-$6,500/acre. The value of surface water rights for restoration are heavily-dependent on the specifics of the water right, including point of diversion and return flow from source stream, priority date, rate and duty. It is also contingent on what a restoration funder is willing to pay to purchase the water rights, based on variables like how important the outcome is to the funder and the price of other options available to generate the water instream. Any permanent purchase of water rights requires extensive due diligence on the transferability of the right and its value. While permanent transfers can take several years to get finalized through the State, it is possible to get paid up-front upon execution of a purchase agreement with a funder.

There is a well-defined and active market for permanent restoration transfers in Whychus Creek. It is anticipated that funders exist in the near term to invest in this activity. In the next decade, as restoration interests get closer to reaching the current instream water right target in Whychus Creek, and as the Pelton Fund gets spent out, this market may decline. Permanent restoration transfers represent the highest value opportunity for the City.

As a policy, Three Sisters Irrigation District does not allow district water rights to exit the district, including permanent instream transfers. In 2001, the owners of the Lazy Z Ranch (Lazy Z Partners, LLC) entered into an agreement with the Three Sisters Irrigation District to include 442 irrigated acres within the property into the irrigation district's service area. This "Inclusion

Agreement" also allowed for 201.2 acres of water rights, within the 442 acre area, to be excluded from the irrigation district. To date, 63 acres have been "excluded" from the irrigation district which leaves 138.2 acres remaining that are available to be removed from the irrigation district. Thus, the City presently has the ability to exclude 138.2 of its 155.5 acres from the irrigation district, opening up the potential to permanently transfer those water rights instream. Further conversation with the district would be required to assess the feasibility of excluding the remaining 17.3 acres of water rights on the City's Lazy Z property.

Permanent Mitigation Transfer

No data on the acquisition of permanent mitigation exists to our knowledge. Several landowners have transferred surface water rights instream to generate permanent mitigation credits, but to our knowledge those mitigation credits have not been sold to mitigation buyers.

While there is not currently an active market for permanent instream transactions that result in mitigation credits in Whychus Creek, transferring Lazy Z water rights instream for its own mitigation needs may be a cost-effective way for the City to fulfill its own mitigation obligations. The City would need to consider its projected mitigation obligation, assess the costs of alternative ways to meet these needs, and consider the opportunity cost of holding onto the water rights.

Allocation of Conserved Water

Restoration funders have invested in Allocation of Conserved Water projects within Three Sisters Irrigation District. OWRD requires that 25% of the savings are protected as an instream water right. Restoration funders can invest in efficiency projects to protect a higher percentage of the conserved water instream.

Attracting conservation investment by restoration funders as part of a long-term effluent irrigation plan, however, is uncertain. Potential restoration buyers will likely question the value of investing up-front in infrastructure to irrigate more efficiently with surface water when that water may ultimately be transferred instream. The cost of setting up a surface water sprinkler irrigation system in advance of an effluent system would also need to be considered.

The USDA Farm Bill has an EQIP Program that is designed to cost-share with landowners on on-farm efficiency projects. While that program has been successfully used in Three Sisters Irrigation District, municipalities are not eligible to apply to the EQIP program.

Temporary Transactions

Temporary Instream Transfer (10-50+ years)

To date, there has been no investment by restoration funders in temporary instream transfers in Whychus Creek. The level of interest from restoration funders in this type of transaction is uncertain. A temporary transfer would likely attract greater investment than an annual lease because it ensures water is instream for a longer period of time. Because it provides no assurances, however, that the water will be permanently protected instream, it would likely not approach the value of a permanent instream transfer. Funders would most likely value this approach more highly if it played a functional role within a longer-term restoration strategy in Whychus Creek.

This approach would build in long-term flexibility for the City to make future decisions about its surface water rights, but the interest in and value of the water would be markedly less than a permanent instream transfer due to the future uncertainty of the water.

Instream Leasing

The Deschutes River Conservancy actively funds leasing in Whychus Creek, and pays $7/acre-foot for water that is protected instream. Because Whychus Creek is over-appropriated, the actual volume of water protected instream per acre of irrigation varies widely by priority date. Depending on the priority dates of the water rights the DRC has leased historically, the payment has ranged from $21-$38/acre. For the purposes of this report, based on the priority dates of the City's Lazy Z water rights, we estimate that the City would receive at least 5 acre-feet per acre, or $35/acre. The DRC is unable to pay public entities for leased water. If, however, the City submitted a lease as a temporary mitigation project, the DRC could compensate for the lease.

District patrons who lease instream are still obligated to pay annual assessments to the Three Sisters Irrigation District. These assessments are based on the acre-feet per acre delivered on-farm, or protected instream in the case of instream leases. Thus, the City may choose to lease less than 5 AF/acre instream, which would reduce the City's assessment, but would also reduce the potential lease payment.

The DRC has done split-season leases with Three Sisters Irrigation District, and pays the same $7/acre foot for water protected instream. Because the water is leased for only part of the season, the compensation is lower than a full-season lease. However, since the DRC is unable to generate temporary mitigation credits from split-season leases, it would be unable to compensate the City for a split-season lease. The City would also incur additional costs with a split-season lease because the OWRD requires weekly monitoring and measurement of water use.

Instream leasing maximizes the City's flexibility with its surface water rights, and protects the beneficial use of the water rights, however does not provide significant offset to operating costs.

Summary

A permanent restoration transfer of Lazy Z water rights is the highest-value opportunity for the City with a high certainty of funding, particularly in the next five years. A permanent mitigation transfer could satisfy potential mitigation obligations, but would not generate revenue to offset infrastructure and operating costs associated with the effluent irrigation system. A time-limited transfer may generate some revenue, but the level is uncertain and, from the perspective of restoration funders, would likely depend on the utility of the transfer within a long-term restoration strategy. Instream leasing and split-season leasing offers flexibility with water rights on an annual basis, and protects the beneficial use of the water rights. It does not, however, generate significant financial value to offset operating costs, and may not have utility as a long-term solution once effluent irrigation is in place.

Figure 10 diagrams potential water transaction pathways for Phases I and II.

Figure 10. Potential Transaction Pathways for Phases I and II

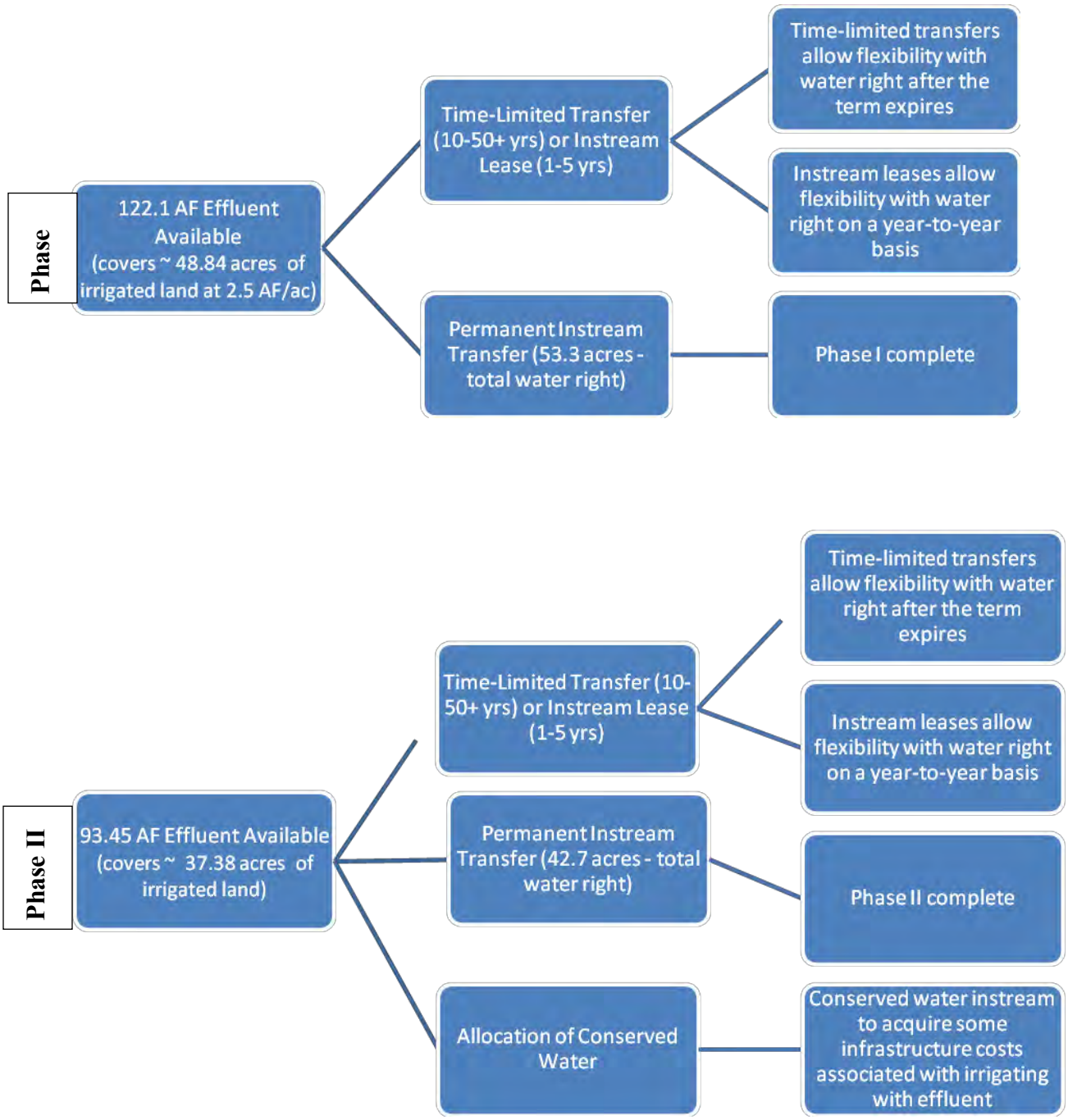


Table 16 summarizes capital costs from Tables 12, 13 and 14 above and potential value of different water transaction opportunities by phase.

Table 16. Summary of Capital Costs and Potential Benefits

	Costs		**Benefits**			
	Infrastructure		**Lease** [5]	**Split-Season Lease**	**Restoration Transfer**	**Temporary Transfer**
	Hay	Poplar				
Phase I (48.84 acres)	$786,857	$865,745	$1,026-$1,709	0	$219,780-$317,460	No data
Phase II (37.38 acres)	$636,352	$749,780	$785-$1,308	0	$168,210- $242,970	No data
Phase III (47.79 acres)	$727,417	$846,668	$1,004-$1,673	0	$215,055- $310,635	No data
Total	$2,150,626	$2,503,193	$2,815-$4,690	0	$603,045- $871,065	No data

Conclusion

Over time the City of Sisters will need to expand its waste water disposal capacity onto its Lazy Z property. This study examines the regulatory framework, mechanics, and timeline of such a transition and evaluates to what extent transferring the City's Lazy Z water rights instream can off-set the required infrastructure improvements.

The study estimates that 128 acre-feet of effluent are presently available for transition to irrigation on the Lazy Z. This will increase incrementally to 294 acre-feet by 2033. Hay, poplars, and ornamental nursery stock were identified as the most suitable crops for this property. Irrigation infrastructure for these crops was recommended and cost estimates for the systems supplied.

The study identified three phases, or areas of the property, for transition to effluent irrigation. Phase I (49 acres) could be transitioned with existing effluent. By 2033, effluent is projected to be available to cover all of Phases I & II (86 acres) and 65% of Phase III (48 acres). These phases are currently covered with 155.5 acres of senior Whychus Creek water rights. There are

[5] The DRC pays $7/AF. This range is based on $3 AF/acre and $5 AF/acre leased.

several permanent and temporary water transactions the City could pursue with these surface water rights. Permanent instream transfers for restoration are the highest value opportunity for the City that could help offset costs of effluent irrigation. Permanent instream transfers for mitigation could be used to meet mitigation obligations associated with one of the City's ground water permits. Instream leases or temporary transfers retain flexibility with the water rights and could provide temporary mitigation credits but do not generate significant revenue to offset operating costs.