7 Water Treatment Plant and Source Water Analysis

SECTION 7

Water Treatment Plant and Source Water Analysis

This chapter presents an evaluation of the capacity and condition of the Lebanon WTP and an evaluation of the potential risks to water quality associated with use of the Santiam Canal as a raw water source. Several alternatives for WTP and intake location and configuration are developed, and a recommended plan for supply development, including WTP expansion or replacement, is presented.

Background

The WTP is the sole potable water supply for the city. It treats water withdrawn from the Santiam Canal, which is owned and operated by the City of Albany. The Santiam Canal flows from the South Santiam River. The city's water rights apply to the point of diversion from the South Santiam River. The city holds certificated water rights for 19.0 cfs (12.3 mgd) and permitted rights for an additional 18.0 cfs (11.6 mgd) for a total of 37 cfs (24 mgd).

As summarized in Chapter 4, the required need (MDD) for 2005 is 3.4 mgd and there is potential for a need of 5.4 mgd (including a 2.0 mgd industrial allowance). Projections for the year 2025 indicate a range of need from 4.7 mgd to 6.7 mgd. At buildout within the UGB, the ADD is estimated to be 8.1 mgd and the MDD is estimated to be 14.2 mgd.

WTP Terminology

<u>Net production</u> = water available to be pumped into the city's distribution system. (Net production = gross production – backwash volume.) Net production is synonymous with system demand.

<u>Gross production</u> = amount of filtered water delivered to the clearwell. (Gross production = volume of raw water that is pumped – waste flow from Accelator© – filter-to-waste flow.)

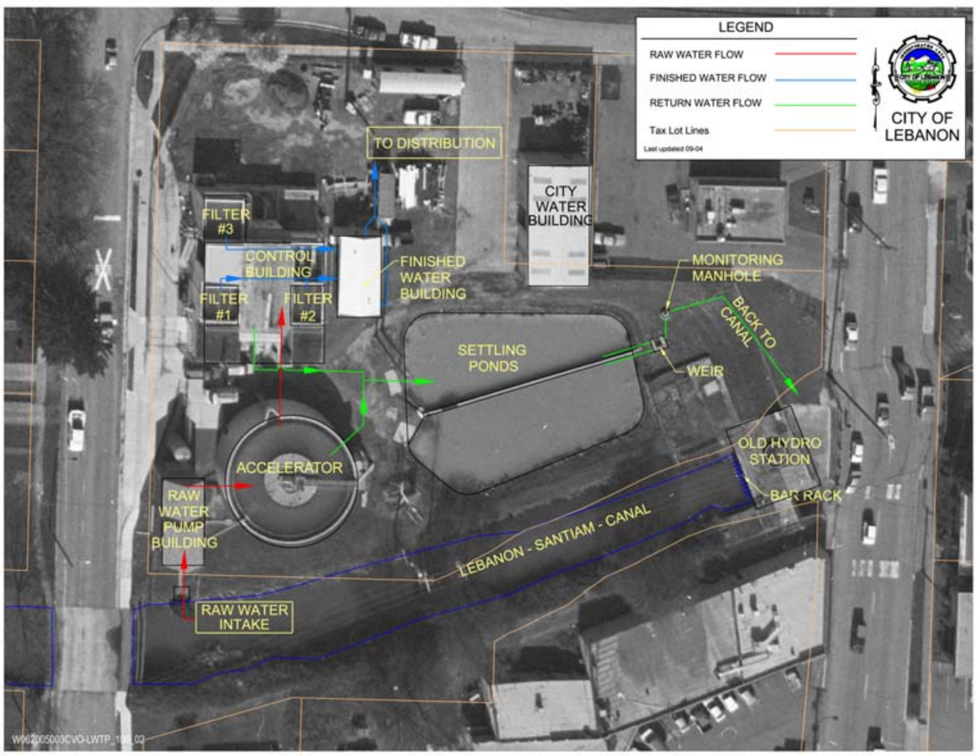
Description of the WTP

The Lebanon WTP was constructed in 1946. It originally consisted of the one solids contact clarifier, which is the Accelator © unit that was manufactured by Infilco Degremont, Inc. In the early 1960s two multi-media filters were added, and in 1981 two more filters were added. In 1985, the city purchased the WTP from Pacific Power & Light. In 1995, the city implemented a major plant upgrade that included electrical upgrades, PLC controls, clearwell baffling, construction of filter No. 5, and abandonment of filters No. 3 and 4 because of structural problems. A caustic soda system for pH adjustment and corrosion control also was added at that time. In 1998, the raw water coagulant was changed from alum to polyaluminum chloride (PACl) to avoid loss of alkalinity during coagulation. In

1999, chlorine gas was replaced with sodium hypochlorite for disinfection, and in 2001, fluoridation of the finished water was started.

An aerial photo and flow schematic of the WTP is shown in **Exhibit 7-1**. The plant is located on a city block, bounded by the Santiam Canal to the south, 2nd Street to the west, A Street to the north, and Main Street to the east. A restaurant occupies a lot at the corner of A and Main Streets, and a building containing two restaurants and a small business occupies the land within the city block but across the Santiam Canal. The City of Lebanon Public Works Department's Water Shop uses an on-site maintenance building and some of the yard area for equipment storage.

EXHIBIT 7-1
Lebanon WTP Flow Diagram
Lebanon Water System Master Plan



The plant achieves flocculation and sedimentation in its single Accelator© unit, followed by filtration through three parallel tri-media filters.

The maximum sustained (for longer than 24 hours) net production rate to date has been approximately 3.75 mgd. The plant has been operated successfully up to 5.5 mgd for 10- to 12-hour test periods. To achieve the 5.5 mgd production rate, a "premium" coagulant was used and continuous on-site monitoring and coagulant control was necessary.

The Oregon Department of Human Resources Comprehensive Performance Evaluation (CPE) of 1993 rated the WTP at 3.2 mgd, with the limiting component being the capacity of the Accelator©. The state's CPE did not specify whether these rates were gross or net production values, but it is assumed that they are gross production values. The CPE credited the plant with 2.5-log *Giardia* removal for flows up to 3.2 mgd. It stated that if the WTP flow rate was increased beyond 3.2 mgd, then the removal credit must be re-evaluated.

The city's records do not indicate that a re-evaluation was performed, although the plant production rate has exceeded this value.

Chlorination contributes the remaining required 0.5-log *Giardia* inactivation to achieve a combined 3.0-log removal/inactivation rate. Although an October 1996 tracer test conducted by OMI indicated adequate disinfection at higher flow rates, this should be confirmed with the Oregon Department of Human Services, Drinking Water Program (ODHS DWP).

The raw water varies in quality seasonally, and is most impacted by storm events. Turbidity averages 15-20 nephelometric turbidity units (ntu) and rarely exceeds 100 ntu. However, during storm events the turbidity can reach 200 to 400 ntu. The last big storm that produced exceptionally difficult-to-treat water was the 1996 flood. During storm events, operators employ a number of tactics to achieve adequate turbidity removal. Although soda ash normally is not added to enhance coagulation, during the first big rain of the fall season soda ash may be added with PACl to improve coagulation.

The last *Water Facility Study* (1989) recommended upgrading and expanding the existing WTP and constructing two wells to provide the city with a back-up water source. Recommended upgrades included abandonment of the Santiam Canal in favor of pumping directly from the South Santiam River, adding a new clarifier (and ultimately replacing the existing Accelator© with a second new clarifier), and addition of a new backwash pond. The city has not implemented all of these recommendations; for example, the city has not installed a river intake, has not added wells, and has not added a second clarifier. However, the backwash ponds were reconfigured and expanded in 1991. And, as described above, significant improvements in electrical systems and control systems were completed in 1995, along with construction of a new filter and addition of baffles to the clearwell.

Evaluation of Existing WTP Facilities

The information in this section is based on a site visit to the plant conducted in May 2005, and discussions with city staff.

Exhibit 7-2 describes the existing processes at the Lebanon WTP.

EXHIBIT 7-2
Summary of Water Treatment Processes

Process	Description	Dimensions	Total Volume (gal)	Total Area (sf)
Coagulant Mixing	PACl is mixed hydraulically in the raw water pump wet well.		–	–
Accelator©	Single circular unit that provides coagulation, flocculation, and sedimentation in separate chambers.	62' I.D. tapered at bottom to 39' diameter	310,000	–
	Coagulation and flocculation chambers	Combination of conical and cylindrical portions	98,000	–

EXHIBIT 7-2
Summary of Water Treatment Processes

Process	Description	Dimensions	Total Volume (gal)	Total Area (sf)
	Sedimentation chamber		212,000	2,820*
Filters	3 filters; media depth = 33"; 34" from top of media to top of trough	Each 16' x 18'	–	864
Clearwell	Two basins separated by concrete wall with a 30" diameter wafer valve.	Overall dimensions 59' x 78' Operated to 11.2'depth. (Overflow at 11.4')	390,000	–
Backwash Ponds	Two ponds with concrete floors, earthen sidewalls, separated by concrete partition.	Irregularly shaped	260,000	8,200

*Area excludes inner mixing chamber, 15' I.D.

Exhibit 7-3 presents the loading rates of the primary processes at varying flow rates. CH2M HILL's conclusions regarding the individual processes follow.

EXHIBIT 7-3
Detention Time or Loading Rate by Process Compared to Industry Recommendations
Flow rates and detention times are for gross production

Process	3.0 mgd	4.0 mgd	5.0 mgd	6.0 mgd	7.0 mgd	Industry Recommendation[A]
Coagulant Mixing	–	–	–	–	–	No recommendation, but typical practice would be a commercially designed in-line mixer or mixing chamber.
Accelator© Flocculation zone detention time (min)	47	35	28	24	20	Mechanical, with 20-30 minutes of detention time
Accelator© Sedimentation zone loading rate (gpm/sf)	0.7	1.0	1.2	1.5	1.7	1.0 gpm/sf [B]
Accelator© Weir loading (gpm/ft)	11	15	18	22	26	10 gpm/ft[B]
Filter loading rate (gpm/sf)	2.4	3.2	4.0	4.8	5.6	3 to 5 gpm/sf is typical for filters of these design characteristics

EXHIBIT 7-3
Detention Time or Loading Rate by Process Compared to Industry Recommendations
Flow rates and detention times are for gross production

Process	3.0 mgd	4.0 mgd	5.0 mgd	6.0 mgd	7.0 mgd	Industry Recommendation[A]
Clearwell detention time (h)	3.1	2.3	1.9	1.5	1.3	Although adequate to meet disinfection requirements, current practice is to provide a minimum of 4 hours of storage at maximum day flow. This allows operators time to respond to an interruption in treatment.

[A] Based on *Ten States Standards* and *Water Quality and Treatment Handbook of Community Water Supplies*, published by McGraw Hill in association with American Water Works Association.
[B] Rates may be exceeded for high rate clarifiers with documented performance.

Intake

Because the intake screen is hydraulically rotated, the rotation stops at low canal flows. To avoid screen plugging, operators must make provision to manually rotate the screen either by using water pressure from a hose or by installing a motor to drive the screen shaft. No other intake problems have been identified at flows up to 5.5 mgd.

Raw Water Pumps

Four raw water pumps are available for supplying raw water to the WTP. The total rated capacity of the pumps is 10,000 gpm (14.4 mgd) with a firm rated capacity of 6,000 gpm (8.6 mgd) with the largest pump out of service. The 1989 *Water Facility Study* stated that the actual pump capacity was lower than the rated capacity because of mechanical wear, but no adjusted capacity was given.

Under current operating practice, only two of the raw water pumps [No. 1 and No. 2, rated capacity of 4000 gpm (5.8 mgd)] are operated and pumps No. 3 and No. 4 serve as emergency back-up. In a maximum capacity flow test conducted in February 2004, operators observed that pumps No. 1 and No. 2 produced a maximum capacity of 5.5 mgd, 95 percent of the rated capacity. If the 95 percent value holds for three pumps, the firm capacity equals approximately 8.2 mgd.

Coagulant Mixing

The coagulant (PACl) currently is mixed hydraulically, in the raw water pump clearwell, through holes drilled in a PVC-pipe insert. Improved mixing is likely to reduce the required coagulant dose. Therefore, CH2M HILL recommends that coagulant mixing be improved if the existing facilities are expanded. Coagulant dose is regulated automatically using a streaming current detector.

Accelator© Flocculation

The existing mechanical flocculation system is adequate for near-term demands; however, the condition of the gear drive and impeller paddles is extremely deteriorated. The city estimates that 50 percent of the metal on the gear drive has corroded, and rust and tubercles are apparent on the paddles. Without mixing, the Accelator© cannot operate effectively. Operators estimate an 8- to 10-week down-time to acquire and install a replacement gear drive.

Accelator© Settling

The settling capacity is inadequate for future flow requirements. The estimated sustainable capacity is approximately 4 mgd. The plant has been operated successfully at 5.5 mgd, with operator supervision, for a 10- to 12-hour period with raw water turbidity less than 10 ntu. This rate required operator control and use of a specialized coagulant; it has not been sustained for a prolonged period, under automated control, with more challenging raw water conditions. The *Ten States Standards*' recommendations for both the loading rate (1.0 gpm/sf) and weir loading (10 gpm/ft) are exceeded at this flow. Unit performance could be enhanced by the addition of tube settlers and radial weirs; however, because of the age of this unit, CH2M HILL recommends replacement with a new flocculation/ sedimentation facility if the WTP is to remain at this site.

Areas with water seepage and calcium deposits (stalactites) are apparent on the underside of the Accelator© basin. Structural analysis will be necessary to assess whether this seepage has begun to impact the underlying reinforcing material. Much of the original piping and valves have been abandoned because of cracking and corrosion. From a structural perspective, typical design life for this type of unit is approximately 50 to 75 years; at nearly 60 years old, the Accelator© has exceeded or is approaching reasonable lifetime expectations.

To provide redundancy, the *Ten States Standards* recommends a minimum of two clarification units for surface water treatment. Should the existing treatment plant be retained and expanded, CH2M HILL recommends replacement of the existing Accelator© with two new clarifiers.

Sludge withdrawal from the Accelator© is accomplished daily by manually opening valves on the sludge withdrawal pipes. Settling tank and backwash pond performance may be enhanced by automating this process so that smaller quantities of sludge could be withdrawn at more frequent intervals.

Filtration

The WTP currently operates three mixed-media filters. In a 1995 facility upgrade, two of the original filters (No. 3 and No. 4) were abandoned for structural reasons, and a new filter (No. 5) was constructed. Filter media depth in all operational filters was increased to 33 inches to improve their performance. On occasion, parts from filter No. 4 have been scavenged to repair filters No. 1 and No. 2.

Filtration capacity is adequate up to 5.0 mgd gross production (4.0 gpm/sf; 1.7 mgd/filter), assuming all three operational filters are functional. If a filter was removed from service for maintenance, gross production capacity would be reduced to 3.4 mgd. Actual water delivery to the city would be less because of the need for backwash water. The filters have been operated up to a gross production capacity of 5.5 mgd for short durations under operator supervision.

For the period from January 2003 to May 2005, average production was 1.9 mgd, and the backwash water volume was approximately 2.5 percent of the finished water volume. This is on the low end of the typical range of 2.5 to 5 percent. At present, there is no turbidity monitor on the filter-to-waste flow following backwash. Operators run filter-to-waste flow for a conservative time period to ensure filter performance following backwash. Turbidity monitors may reduce the required filter-to-waste period and improve efficiency. At higher flow rates, the ratio of backwash water to finished water will rise because more frequent wash cycles will be required to maintain production.

Filter Pipe Gallery

The pipe gallery contains piping and valves original to the facility. External corrosion is apparent, and weak areas and thin spots were found during the operator's efforts to arrest corrosion. Operators report that to address the problem fully, the area must be sealed and treated as a Hazardous Material site because of the chemicals necessary to restore and finish the metal piping. Because the pipe gallery is located over the clearwell, sealing the area is especially critical and may be challenging. Operators report that the original Bailey valves generally work well, but when problems arise, finding replacement parts has become difficult. Should existing facilities be expanded or used over the long term, CH2M HILL recommends an evaluation of pipe condition and requirements for corrosion stabilization.

Backwash System

Two backwash pumps, each at 4,500 gpm capacity, provide 15.6 gpm/sf wash capacity. This is adequate, though on the low end, for backwash needs.

The original, manual control stations have required maintenance and parts are difficult to procure. The control station for abandoned filter No. 4 has been used to supply parts for the functional control stations.

Chemical Systems

Although adequate for current needs, chemical system capacities will need to be increased to meet higher production flows. Operators noted that both the coagulant pump and the anionic polymer pump were operated at full capacity (100 percent stroke and speed) during the 5.5 mgd flow test in February 2004.

At present there is no provision for adding alkalinity (caustic or soda ash) prior to coagulant addition. Some coagulants, such as alum, must react with alkalinity to perform properly, and coagulation problems occur if insufficient alkalinity is present in the raw water and none is added. Furthermore, alkalinity must be added to the finished water for corrosion control. The problem of low alkalinity coupled with high turbidity often occurs seasonally during storm events. To reduce alkalinity loss during coagulation, the coagulant was changed from alum to PACl in 1998. Nevertheless, during storm events, operators sometimes add alkalinity in the form of soda ash along with the PACL. (Ideally, to achieve best performance, alkalinity should be added upstream of the coagulant.) Although still functional, the soda ash equipment is very old. Filling the hopper requires manually carrying 50-pound bags up stairs and pouring the soda ash into a waist-high hopper. To date, this has not been overly burdensome because of the infrequent use of soda ash. With more frequent use, investment in mechanized equipment may become necessary. Although the caustic system has been plumbed to supply caustic with the coagulant, lack of an adequate control system has prohibited its use.

Pre- and post-filtration disinfection is accomplished using sodium hypochlorite. A single storage tank is located in a very confined space in the filter building.

Fluoridation is accomplished using diluted fluorosilicic acid added at the finished water pump volutes. Concentrated fluorosilicic acid is measured on a scale and is diluted in a day tank. Operators report that current capacity of the system is not adequate at maximum day flows. To meet future production requirements, the system will need to be expanded.

Clearwell

The clearwell is adequate to provide sufficient detention time for disinfection, and operators report no capacity problems under current use. However, if storage requirements for backwash and emergency supply are considered, the clearwell is undersized by current standards. At present, the city relies on the clearwell and standby finished water pumps to supply additional water to the system under fire-flow conditions. At 390,000 gallons, the clearwell is approximately half the volume desired for a 4-mgd WTP.

To meet a buildout demand of approximately 12 mgd, CH2M HILL recommends that the clearwell capacity be five times greater than the current volume, or approximately 2,000,000 gallons. A minimum of approximately 1,500,000 gallons would be necessary to meet disinfection requirements, provide storage for backwashing filters, and to provide an operational margin. The operational margin is necessary to allow the plant to operate with infrequent and slow rate changes, rather than requiring production to exactly match the finished water pumping rate.

Inspection and cleaning of the clearwell in 2003 revealed corrosion of some materials associated with the baffles, and weak or crumbling areas within the concrete wall. Regular inspection and remedial measures, including removal of crumbling concrete and replacement with a grout material, are necessary to maintain continued use of the clearwell. Maintenance will require that each clearwell basin be drained for a period.

Finished Water Pumps

Four finished water pumps have a total capacity of 7,500 gpm (10.8 mgd). Firm capacity is 4,500 gpm (6.5 mgd) with the largest pump out of service. Operators suggest that the addition of variable speed drives on the finished water pumps could result in energy savings. See Chapter 9 Distribution System Evaluation for a more detail evaluation of the finished water pump station.

Backwash Ponds

Two ponds receive waste backwash water and waste flows from the Accelator©. Separated by a concrete wall, the ponds have concrete floors and earthen side walls and are approximately 5 feet deep. Pond supernatant overflows to the canal. The total sludge storage volume, at 691 cubic yards, is sufficient to store about 6 month's accumulation of solids. City maintenance crews remove accumulated solids twice annually. Sludge is not dried prior to removal, so the solids must be moved when water content is high. As the plant capacity is increased, backwash pond capacity will need to be increased.

Existing WTP Capacity

Exhibit 7-4 summarizes the capacity of the current facilities. Exhibit 7-4 gives the maximum summer capacities of each unit process based on both the Oregon Drinking Water Program Comprehensive Performance Evaluation (CPE) of 1993 and CH2M HILL's evaluation. Also included in Exhibit 7-4 are the maximum fall/winter capacities that operators have experienced during infrequent "difficult-to-treat" water events, and "firm" maximum capacities based on having the largest equipment component out of service.

EXHIBIT 7-4
Capacity of Existing Plant Processes
All values represent gross production

Process	ODWP CPE [1] Findings Maximum Capacities (Summer)	CH2M HILL Recommended Maximum Capacities (Summer)	Adverse Condition Maximum Capacities (Fall/Winter) [2]	Firm Equipment Capacity [3]	Comments
Rapid Mix	NA	NA	NA	NA	Improved rapid mix is recommended to decrease coagulant dose; however, the capacity of the rapid mix process is not a limiting factor.
Flocculation / Sedimentation (Accelator©)	3.2 mgd	4.0 mgd	1.0 mgd	0.0 mgd	Changes in coagulant and dosing since the 1993 CPE have allowed the Accelator© to successfully operate at flows exceeding 3.2 mgd. The CPE indicated that the removal credit for the plant should be re-evaluated for production rates exceeding 3.2 mgd.
Filtration	5.0-6.2 mgd	5.0 mgd	1.0 mgd	3.3 mgd	Flow range from CPE is based on using maximum filtration rate of 4.0 to 5.0 gpm/sf. CH2M HILL recommends maximum rate of 4.0 gpm/sf for filters of this design.
Clearwell Disinfection	3.2 mgd [4]	> 4.0 mgd	> 4.0 mgd	2.0 mgd	The 4.0 mgd capacity is based on a tracer test conducted by OMI in October, 1996.
Clearwell Emergency Storage	_	< 3.0 mgd	< 3.0 mgd	< 1.5 mgd	The clearwell has been managed successfully at higher production rates. However, greater storage capacity is desirable to allow plant shut down for mechanical failures or water quality problems.

EXHIBIT 7-4
Capacity of Existing Plant Processes
All values represent gross production

Process	ODWP CPE [1] Findings Maximum Capacities (Summer)	CH2M HILL Recommended Maximum Capacities (Summer)	Adverse Condition Maximum Capacities (Fall/Winter) [2]	Firm Equipment Capacity [3]	Comments
Backwash Ponds	_	4.0 mgd	4.0 mgd	2.0 mgd	The ponds are dredged twice annually at current operating levels. Additional pond area is needed for flows exceeding 4.0 mgd.

[1] Oregon Drinking Water Program Comprehensive Performance Evaluation of 1993
[2] Based on operator experience with seasonally occurring “difficult-to-treat” water
[3] Maximum summer capacity with the largest equipment component out of service
[4] The CPE was conducted prior to clearwell baffling.

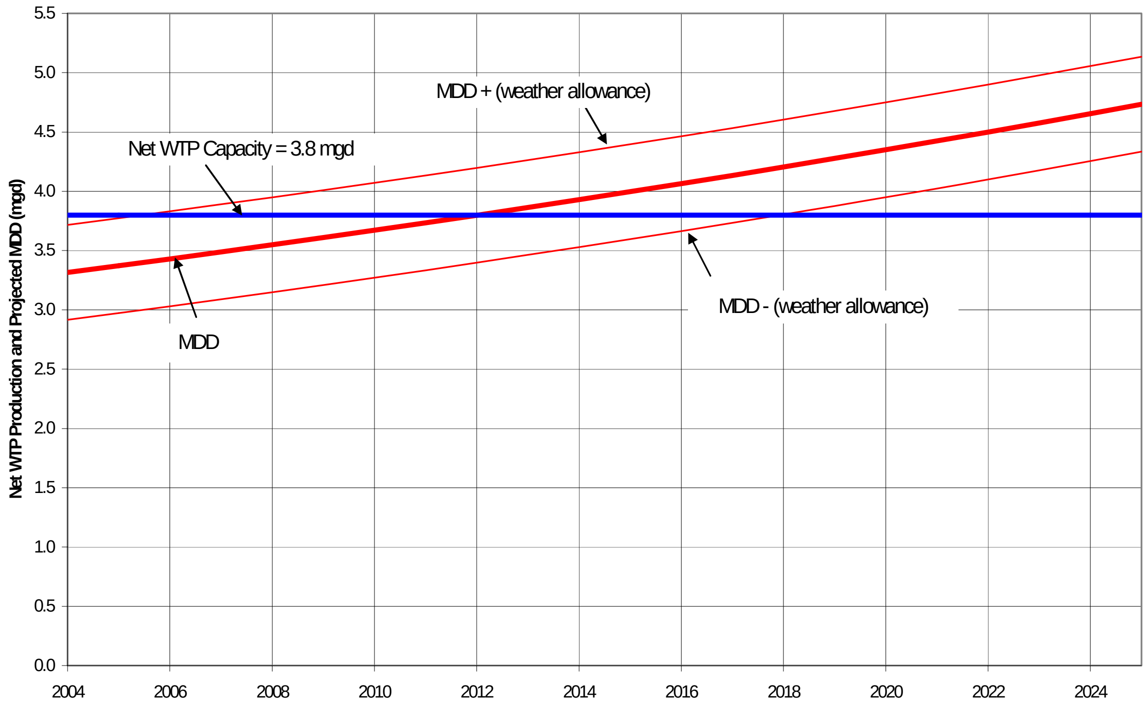
“Difficult-to-treat” water events typically occur following the first large rainstorm of the fall/winter season when runoff into the South Santiam River and Santiam Canal contains elevated levels of naturally occurring organics, such as tannins from leaf litter. Reservoir operations, which lead to high flow in the South Santiam River at these times, also may contribute to poor raw water conditions. When these events occur, the water is difficult to coagulate and settle. Operators reduce flow significantly (approximately 40 percent), and try a variety of coagulation aids in an effort to achieve acceptable turbidity levels for filtration. These events typically last a week or less, and occur when overall demand is low, so stored water in city reservoirs is used to make up any production shortfall.

Under all of the conditions listed in Exhibit 7-4, the most limiting processes are coagulation, flocculation, and settling, which all occur in the single Accelator© unit. The recommended maximum capacity of the Accelator© is 4.0 mgd. Maximum day demands in recent years have approached this capacity (3.75 mgd in July 2003). As mentioned above, during adverse fall/winter conditions operators must use coagulation aids to try to maintain a 1 mgd gross production. Furthermore, the “firm” plant capacity, should the Accelator© fail, is zero mgd: the plant must shut down.

The plant has exceeded a 4.0 mgd flow for limited periods by careful operation. Flows at a rate equivalent to 5.5 mgd (gross production) were treated for 10- to 12-hour periods. The duration of operation was not sufficient to evaluate the impact of prolonged operation on the backwash pond operation.

Assuming 95 percent efficiency in water production, the maximum net WTP capacity, or rate at which water may actually be delivered to the distribution system, is estimated at 3.8 mgd. **Exhibit 7-5** illustrates the net WTP capacity versus the MDD projections developed in Chapter 4. As shown in Exhibit 7-5, if a weather allowance is added to the projected MDD, the treatment plant already may be pressed to produce sufficient water to meet demand during a particularly hot and dry summer. Without the weather allowance, the WTP will begin to reach maximum capacity by 2012.

EXHIBIT 7-5
Net WTP Production and Projected MDD with Weather Allowance



Summary Assessment of Existing WTP Facilities

The existing facilities are marginally adequate for near-term demands.

The city's projected MDD for 2005 is 3.4 mgd. Based on CH2M HILL's evaluation, the plant's gross capacity is limited to approximately 4.0 mgd. This results in a net production capacity of approximately 3.8 mgd. The State of Oregon determined that the gross production capacity is 3.2 mgd, resulting in a net production capacity of approximately 3.0 mgd. The city should contact the state's Drinking Water Program to request 2.5-log treatment approval up to a gross production of 4.0 mgd.

A sudden demand increase, resulting from a new commercial or industrial customer, may quickly exhaust the available capacity and put the city's supply into a deficit condition.

Furthermore, many of the individual facilities within the plant are approaching the reasonable end of their design life. Any plan involving continued long-term use of existing facilities must be carefully considered for the following reasons:

- The Accelator© is nearly 60 years old. Deficiencies in existing parts resulting from corrosion have been identified. If the Accelator© fails, the WTP cannot operate at its rated capacity without impacts to its treatment effectiveness. At a minimum, this unit must be replaced or rehabilitated. At best, a parallel unit would be added in addition to rehabilitating the existing unit to provide treatment redundancy.

- Two of the operating filters are at least 25 years old. This is approaching the range of typical design life. Parts are difficult to procure. Two filters already have been abandoned for structural reasons.
- Corrosion and weak spots in the filter gallery piping have been identified. Treating pipes for corrosion control will be costly and difficult, with limited long-term success. Replacing pipes or valves while the system operates also will be difficult.
- Crumbling concrete in the clearwell requires maintenance to prevent water from corroding underlying reinforcing material.
- Chemical systems, backwash and Accelator© waste handling, and clearwell capacity will need to be expanded to meet future demands. Space within current facilities is very limited, and the overall WTP site is small. Property acquisition may become necessary if existing systems are to be expanded to meet future or buildout demand.
- Existing facilities lack redundancy, and clearwell storage volume is not large enough to provide water for a prolonged, unplanned shut down. The single Accelator© unit and reliance on the Santiam Canal as the sole raw water source are liabilities.
- Original filter controls are beginning to require maintenance. Parts from an unused control unit are salvaged to repair functioning units. New controls may be necessary in the near future.

Surface Water Source Evaluation

Lebanon's sole existing potable water source is the Santiam Canal, which flows from the South Santiam River. The City of Lebanon's 1989 *Water Facility Study* recommended that the canal be abandoned in favor of an intake on the river. This section describes these two surface water sources - the canal and the river- and evaluates potential water quality and operational risks associated with their use.

Drinking Water Source Protection

The 1996 Federal Safe Drinking Water Act (SDWA) Amendments mandated that states conduct "source water assessments" for all federally defined public water systems. The purpose of these assessments is to provide public water systems with the information needed to develop drinking water protection strategies to reduce risks of water contamination. In the past, public water systems have relied almost exclusively on chemical and mechanical technologies to treat water for public consumption. Recent studies have documented the presence of low concentrations of pharmaceuticals, hormones, steroids, and household and industrial compounds in surface water and groundwater throughout the country, indicating that pathways exist between these contaminant sources and drinking water supplies. Standard treatment technologies of coagulation/flocculation/filtration and chlorination are not successful in removing low concentrations of many contaminants; preventing contamination is widely recognized as a crucial tool for providing safe drinking water.

The Oregon Drinking Water Protection Program has three elements:

- Identifying the Drinking Water Protection Area (DWPA) or watershed from which a public water supply originates, and identifying areas within the DWPA where the water supply is most sensitive to contamination
- Providing an inventory of potential sources of contamination
- Determining the susceptibility of the drinking water quality to the potential sources of contamination

Source water assessments for the Cities of Sweet Home, Lebanon, and Albany were completed by DEQ and the ODHS DWP in January 2002. These reports include maps of each municipality's DWPA and inventories of potential sources of contamination, including forestry practices, agricultural practices, underground storage tanks, historical spills, and industrial land uses.

The city ultimately must decide between river and canal locations for the intake of a new WTP. Lebanon's water is impacted by activities in the DWPAs for both Sweet Home and Lebanon. Lebanon's DWPA begins at the City of Sweet Home's raw water intake. Because the Santiam Canal and South Santiam River share the same risks up to the point of diversion of the canal, only the risks associated with activities and land uses downstream of the canal headworks are discussed below.

Description of the Canal

Exhibit 7-6 shows aerial photo segments of the Santiam Canal from its origin on the South Santiam River 325 feet upstream of the Lebanon Dam to the current WTP site. The canal is owned and operated by the City of Albany, and serves as a backup source of municipal water for the City of Albany and the primary source of water for Lebanon. In addition, the canal provides irrigation for agriculture (both permitted by water rights and non-permitted), flow augmentation for urban streams, potential hydropower generation for the City of Albany, and stormwater conveyance. The canal has steep side slopes, and varies in width from approximately 20 to 40 feet along its 18-mile length prior to discharge in the Calapooia River. The proposed canal design capacity used in the City of Albany's 2003 *Water Facility Plan* is 310 cfs, with a maximum of 107 cfs devoted to municipal, urban stream augmentation, and irrigation uses. For the period 1991 to 1998, average monthly flows ranged from 69 cfs in December to 126 cfs in July.

The canal is 3.6 miles from its headwaters (Station 00) to the intake of the Lebanon WTP (Station 190), and therefore has approximately 7.2 miles of shoreline. The canal shoreline passes agricultural land (fields) for approximately 41 percent of its length, and passes urban areas characterized by houses, buildings, parking lots and roads for another 41 percent. The remaining canal shoreline either parallels Lake Cheadle (0.9-mile) or is forested. Within the urban areas, the canal is paralleled within 100 feet by River Road or is adjacent to parking lots for approximately 1 mile. From the headworks to the WTP intake, the canal crosses Highway 20 as well as nine other residential streets. In addition, the canal passes under a railway bridge and 10 private driveways.

Description of the River

The city is considering locating river bank wells or a conventional intake somewhere along an approximately 4-mile stretch of river that originates near the Santiam Canal headwaters. Mean monthly flows on the South Santiam River, recorded from 1996 to 1998 at a gauging station at Waterloo (several miles upstream of Lebanon), ranged from 786 cfs in July to 6,374 cfs in December.

The river is paralleled within 100 feet by River Road for approximately 1.3 miles on the southwest side, and within approximately 200 feet of two sections of Berlin Road for a total of approximately 1.3 miles on the northeast side of the river. Where the river passes through agricultural land and areas with homes, there tends to be a wider, often forested, buffer between developments and the water. The river is crossed once by the Grant Street Bridge and a closely parallel railroad bridge. Upstream of the bridges, approximately 0.5-mile of river shoreline passes a former wood processing facility on the west, and 0.2-mile of river passes ponds that were formerly a quarry.

Description of Risks

The canal and river were assessed to compare risks associated with their use as a raw water supply. Land uses and potential hazards near these water bodies could affect the city's raw drinking water quality. However, monthly mean flows in the river range from 6 times the flow in the canal during summer months to greater than 90 times during winter months. As a result, contaminants entering the river are diluted to a greater extent, and flushed more rapidly than contaminants entering the canal. Potential contaminant hazards are grouped into two categories:

- Spills
- Land uses

In addition to the risks associated with potential contamination, both the river and the canal options have other sources of uncertainty. A river intake or river bank wells may be unfeasible. A river intake will require extensive permitting to comply with the ESA, and a suitable site must have access, river stability, sufficient river depth, desirable river foundation conditions and flow patterns, and other similar characteristics. River bank well sites, discussed further in Chapter 8, must have suitable geology.

A source of uncertainty for continued use of the canal is the contractual obligation between the Cities of Lebanon and Albany. Lebanon currently pays annual operating and maintenance expenses to Albany for use of the canal. These expenses have risen more rapidly than the inflation rate in recent years. If Lebanon no longer uses the canal as a water source, the city's responsibility for continued operation and maintenance is uncertain. Furthermore, should a new intake be developed on the canal, Albany may ask Lebanon to contribute to the cost of the new fish screen and diversion dam recently constructed by Albany.

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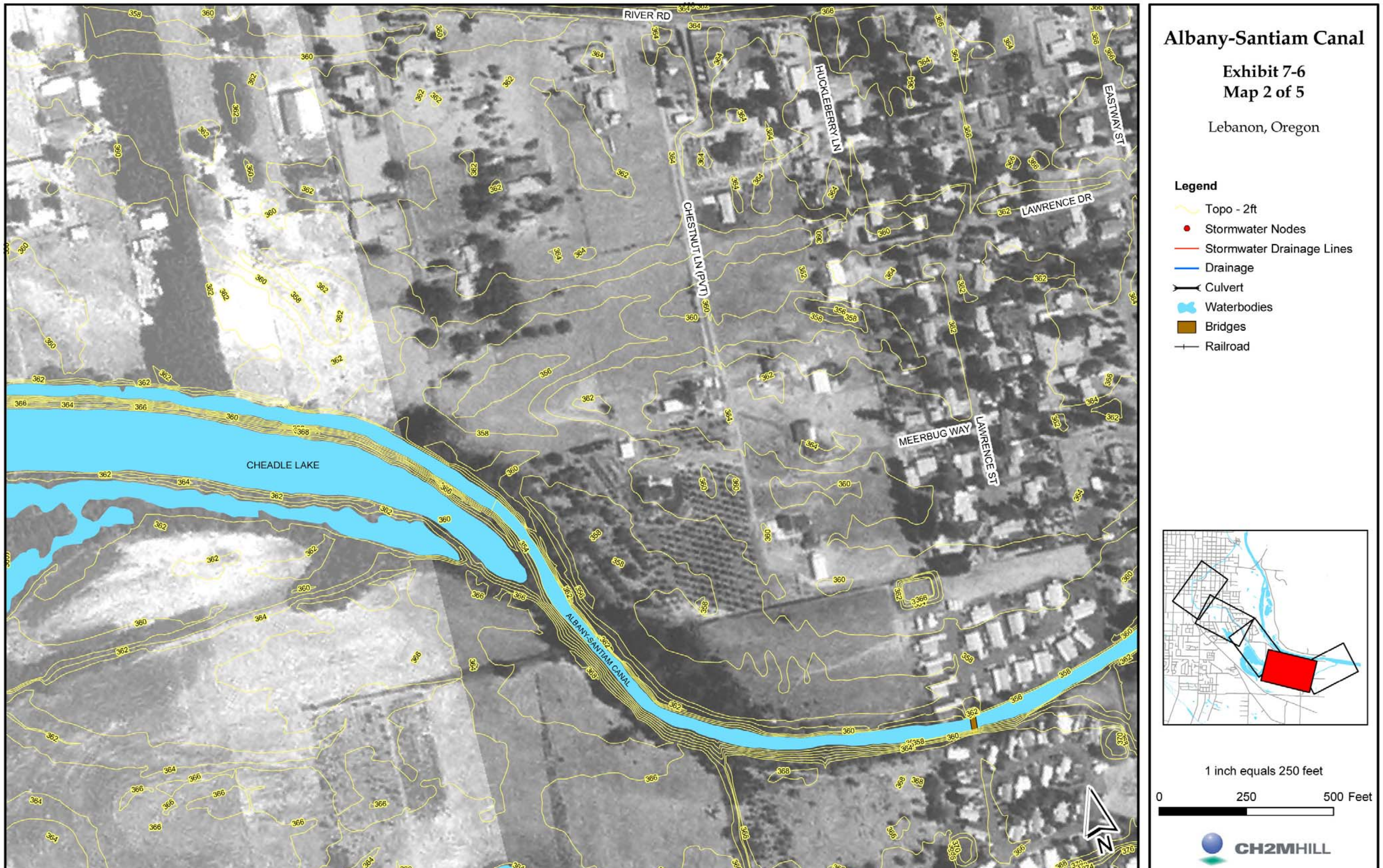

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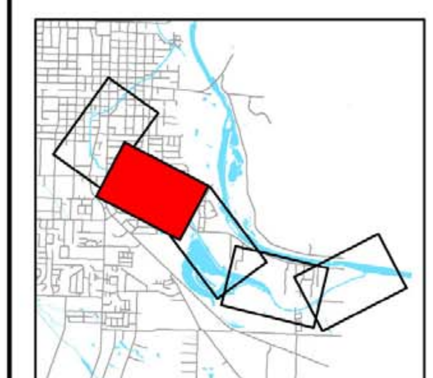
Albany-Santiam Canal

Exhibit 7-6
Map 4 of 5

Lebanon, Oregon

Legend

- Topo - 2ft
- Stormwater Nodes
- Stormwater Drainage Lines
- Drainage
- Culvert
- Waterbodies
- Bridges
- Railroad



1 inch equals 250 feet

0 250 500 Feet

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Spills

City staff recall that the WTP has been shut down three times since 1984: once because a petroleum-based product entered the canal, once because a vehicle entered the canal, and once because an unidentified contaminant from an industry in Sweet Home entered the South Santiam River upstream of the canal headwaters. In all three cases, WTP staff were notified of the hazard, and were able to respond by shutting down operations until the contaminant had been flushed from the canal.

Without notification, WTP operators may miss spill incidents; if a spilled contaminant does not produce a visible sheen, it may not be noticed. Contaminants that do produce visible sheens may not be observed or reported to the plant operators. Should a contaminant be discovered in the clearwell, there is no convenient method for rapidly draining the clearwell.

The canal's proximity to commercial enterprises, roads, parking lots and road/driveway crossings increases the risk of possible contamination from accidental spills. The potential contaminant source inventory in Lebanon's *Source Water Assessment Report*, updated in November 2005, identifies 88 sources of potential contamination downstream of the canal headworks. At least 73 of these sources are classified as high to moderate risk, and all are located in "sensitive areas." Sensitive areas include areas with high soil permeability, high soil erosion potential, high runoff potential and areas within 1,000 feet of the canal. The majority of these sites are areas of potential contamination from spills, leaks, or improper handling of chemicals. In addition, several sites of historical contamination are documented.

As noted in the 1989 *City of Lebanon Water Facility Study* (KCM), road crossings have guardrails to prevent vehicles from entering the canal, but there are no guardrails at private driveway crossings; the vehicle that entered the canal did so after missing a private driveway bridge. According to Oregon Department of Transportation records, on average, 145 accidents per year have occurred within city limits since 2000; an average of five accidents per year involved trucks. No hazardous material spills resulting from traffic accidents within city limits have been reported since 1992. If the city continues to use the canal as its drinking water source, it is advisable to develop and maintain an emergency action plan for responding to spills.

The majority of the area being considered for a river intake or river bank wells along the river is upstream of the Grant Street and railroad bridge crossings, and therefore would be unaffected by an auto or rail accident on the bridges.

Land Use

As noted above, the canal flows through both agricultural and developed areas and is exposed to runoff from each. Potential contaminants include chemicals applied to farm fields and lawns, petroleum products on roadways and parking lots, commercial and household chemicals, and sewage from septic tanks or leaks in sewer lines. Aerial photos from 2000 indicate that more than 60 homes are located within 100 feet of the canal. The 1989 *Water Facility Study* noted incidents of yard waste such as lawn clippings and branches being dumped into the canal. **Exhibit 7-7** shows that this practice still occurs. Fewer than 15 buildings were within 100 feet of the relevant stretch of the river in 2000.

According to the Santiam Canal Assessment conducted for the City of Albany's 2003 *Water Facility Plan* (MWH), the canal receives drainage from roughly 400 acres upstream of the Lebanon WTP intake. This drainage area only represents large tracts of land draining to the canal and does not incorporate all lateral inflows identified in a canal inspection conducted for the assessment in May 2001. From its headwaters to the Lebanon WTP intake, the canal inspection identified fifteen specific lateral sheet inflow locations, and four suspected inflow or outflow areas associated with marshy land or ponds adjacent to the canal. The canal inspection revealed three ditches draining storm water runoff to the canal: one on either side of Franklin Street, and one along the south side of the railroad right-of-way where the railroad crosses the canal. Also, two 4-inch-diameter PVC pipes from roof or yard drains were identified. Albany's *Water Facility Plan* stated that the removal of storm water drainage from the canal is one of Albany's priorities. It is unknown if Albany, the City of Lebanon, or others have implemented changes to eliminate or reduce the sources of runoff identified in the 2001 inspection.

EXHIBIT 7-7
Photograph of grass clippings and branches dumped over a bridge rail onto canal bank (May 2005).
Lebanon Water System Master Plan

The canal inspection also documented the possibility of groundwater seepage from Cheadle Lake to the canal. The lake water surface level is approximately 4 to 6 feet above the canal, and as noted above and shown in Exhibit 7-6 (Maps 2 and 3), the canal parallels the lake within 50 to 150 feet for 0.9-mile. Because the lake was formerly a lumber mill pond, seepage from the lake is a potential source of contaminants that have collected in the lake sediments.

A neighborhood adjacent to the canal approximately 1 mile upstream of the WTP (Station 136) was identified as possibly having septic systems.

Although monitoring by Lebanon staff has indicated that an array of chemical contaminants have consistently been below detection, monitoring records show that three organic compounds [phthalates (di(2-ethylhexyl)), 1,2-dichloropropane, and carbon tetrachloride] and mercury have been detected in the canal or raw water. Whether these detections were a result of sampling error or if they were representative of contamination that had reached the canal is unknown. Although monitoring is an important indicator of water quality, many specific contaminants (synthetic organic chemicals, metals, etc.) are measured only periodically. If contamination occurs intermittently, it might not coincide with sampling, and would remain undetected. Also, monitoring results cannot predict future contamination. According to sources from the ODHS DWP, several public water systems in Oregon with histories of non-detections have found themselves dealing with a contaminant.

The river also receives contaminants from agricultural and urban drainage. The former wood processing site and quarry are potential sources of organic and inorganic pollutants. As mentioned above, however, the much higher flow of the river is likely to dilute contaminants to below detection. The South Santiam River is considered a very good drinking water source by the ODHS DWP, and is used by the communities of Albany and Millersburg, downstream of Lebanon.

Cost of Canal Maintenance

Exhibit 7-8 shows Lebanon's contribution toward canal operation and maintenance and capital costs since the fiscal year beginning July 1, 1999. Annual operating costs have increased, and city staff expect costs ultimately to exceed $100,000 per year.

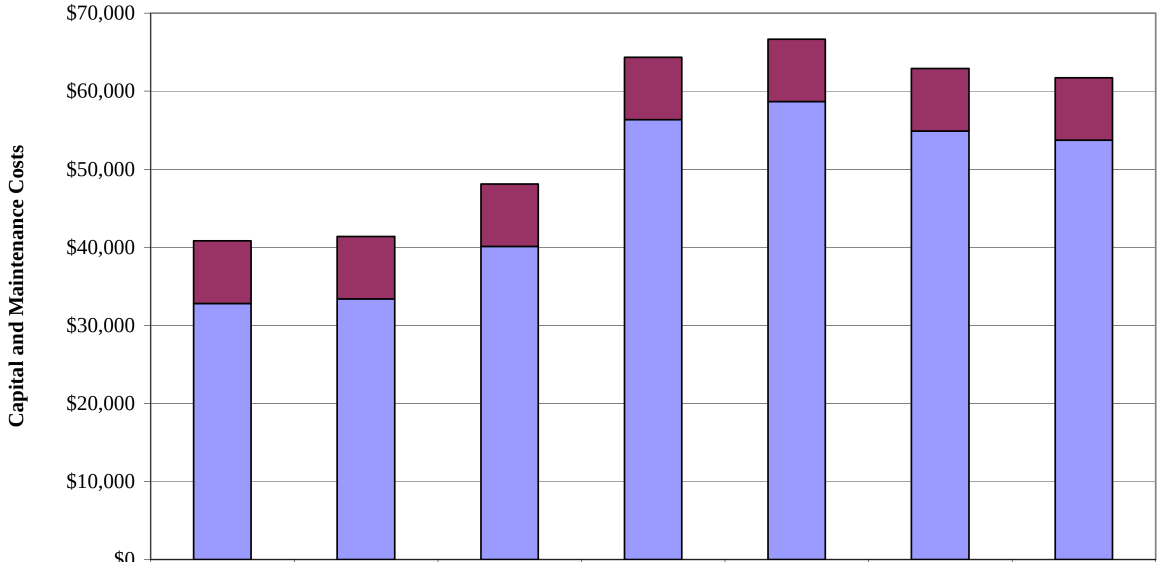
A number of canal improvement projects were identified in the City of Albany's *Water Facility Study* to upgrade flow control structures, ensure canal capacity, restore the channel and improve canal access. **Exhibit 7-9** summarizes these projects and their estimated costs. Two bridge projects (a private driveway and the Franklin Street Bridge) are located in Lebanon. Because Albany no longer relies on the canal as a sole drinking water source, Albany's time frame for completing these projects is unknown.

Recommendations Regarding Use of Santiam Canal or South Santiam River

To eliminate costs associated with use of the Santiam Canal, and to reduce exposure to potential sources of contamination, CH2M HILL recommends that the city investigate locating river bank wells or a conventional surface water intake along the South Santiam River. From a water quality and risk reduction standpoint, river sites upstream of the Grant Street and railroad bridge crossings and former wood processing site at the end of Milton Street and old Morse Brothers quarry sites are more desirable than river sites downstream of these sites.

If river bank wells or a river intake are not feasible, or if the city is obligated to pay canal maintenance costs regardless of whether or not the canal is used as a raw water source, the city may choose to maintain an intake on the canal. The headwaters location eliminates nearly all sources of inflow, and is therefore the best site from a water quality perspective. However, this site requires the longest pipeline to connect the WTP to the distribution system and is therefore the most costly. If this option is unavailable or too expensive, CH2M HILL recommends that an alternative canal site, upstream of Cheadle Lake, be considered. An intake location upstream of Cheadle Lake would eliminate all but three bridge crossings, canal stretches parallel to River Road or susceptible to inflow from Cheadle Lake, and reduce the number of potential contamination sites identified in Lebanon's *Surface Water Assessment* from 88 to fewer than 10.

EXHIBIT 7-8
Canal Cost History



	99-00 actual	00-01 actual	01-02 actual	02-03 actual	03-04 actual	04-05 actual	05-06 adopted
capital	$8,000	$8,000	$8,000	$8,000	$8,000	$8,000	$8,000
maintenance	$32,806	$33,385	$40,115	$56,330	$58,661	$54,895	$53,724

Fiscal Year

EXHIBIT 7-9
Summary of Recommended Canal Improvement Projects, City of Albany
Water Facility Plan, 2003

Project Description	Cost Estimate
Update Control Structures	
Lebanon WTP and Hydropower Intake (Station 192+00)	$300,000
Mark's Slough (Station 253 +00)	$520,000
CZ Tailrace (hospital Slough, Station 280+00)	$350,000
Albany Gates (Station 287 +00)	$480,000
Cox Creek (Station 538 +00)	$400,000
Rock Dam and Siphon (Station 688+00)	$200,000
New Control Gate (Oak Creek, Station 755 +00)	$700,000
Communication for all Structures	$300,000
Master Station	$50,000
Develop Rating Curves for Remote Sites	$100,000
Hydraulic Analysis Allowance for Receiving Drainage Channels	$500,000
Flow Augmentation Allowance	$100,000
Sub-Total	$4,000,000
Ensure Canal Capacity	
Private Driveway Bridge (Station 117+00)	$100,000
Franklin Street Bridge (Station 137+00)	$300,000
KGAL Road culvert (Station 455+00)	$300,000
Sediment Removal	$1,500,000
Raise Canal Banks	$400,000

EXHIBIT 7-9
Summary of Recommended Canal Improvement Projects, City of Albany
Water Facility Plan, 2003

Project Description	Cost Estimate
Lateral Inflow Removal	$300,000
Sub-Total	$2,900,000
Channel Restoration	
Allowance to Repair Bank Damage, Remove Debris and Excess Bank Vegetation, Complete preliminary cheadle Lake Seepage Analysis	$1,000,000
Sub-Total	$1,000,000
Improve Canal Access	
Allowance for Removing Encroachments, Securing ROW, and Removing heavy Bank Vegetation	$500,000
Sub-Total	$500,000
Total	$8,400,000

Selection of Water Treatment Alternatives

CH2M HILL conducted two workshops with city staff to identify alternatives for expanding or replacing the WTP. In the first workshop, held June 29, 2005, criteria for evaluating treatment alternatives were identified and prioritized, and four treatment alternatives were selected for further evaluation. In the second workshop, held August 10, 2005, capital costs of the four favored alternatives were presented, two new alternatives were introduced, and city staff continued discussion to determine the most desirable alternative.

Workshop 1, June 29, 2005

The 10 initial alternatives for construction of a new WTP are shown in **Exhibit 7-10**. Alternatives included two different treatment processes (conventional filtration with high–rate clarification, and membrane filtration) four locations for the raw water intake (three on the Santiam Canal and one on the South Santiam River), and four locations for a new WTP (existing site, two other canal locations, and a river location).

The city's primary goal is to meet or exceed all drinking water regulations for water purity. All 10 identified alternatives meet this goal. Therefore, a pair-wise comparison was used to help staff identify and prioritize other non-cost criteria for evaluating alternatives. Through a brain-storming process, six key criteria were identified and prioritized, as shown in **Exhibit 7-11**. The first four criteria relate to selection of a treatment process (conventional versus membrane filtration). The fifth criterion primarily relates to selection of a WTP site (existing versus new), and the sixth criterion (tied in rank for 5th) relates to the source of raw water (canal versus river). The sixth criterion, quality of source water, ranked fifth because both the canal and the river are thought to be good sources of drinking water.

EXHIBIT 7-10
Lebanon WTP Evaluation: Proposed Alternatives List

No.	Location of Plant	Process
1	Existing site (including possible expansion across canal)	Conventional filtration (using high-rate clarification)
2	Existing site	Membranes (pressure assumed for sizing, but could also consider vacuum)
3	New location on canal, located upstream from existing site for better raw water quality protection and to obtain larger site	Conventional
4	New location on canal	Membranes
5	Canal headworks (possibly purchase property from Albany); reduces risk of spill by eliminating canal)	Conventional
6	Canal headworks	Membranes
7	Existing site, but install new intake on river to avoid canal use	Conventional
8	Existing site with intake on river	Membranes
9	New site for intake and WTP along river	Conventional
10	New site for intake and WTP along river	Membranes

EXHIBIT 7-11
Criteria for Evaluating WTP Process and Location, and Raw Water Intake Location

Rank	Score	Criteria
1	20	Reliability of equipment
2	18	Adequate response to short-term raw water quality changes caused by storm events
3	16	Minimization of labor costs
3	16	Expandability as demand grows
5	10	Ability to continue water production during construction of a new WTP
5	10	Adequate raw water quality and protection

Each alternative was rated based on a ranking of all six criteria. Staff collectively decided if a particular alternative was very favorable, favorable, neutral, undesirable, or very undesirable when a given criterion was considered. Results of this step-by-step evaluation are shown in **Exhibit 7-12**, with the top four rated alternatives highlighted in blue. (The fourth-ranked alternative, membrane treatment at the existing site, was retained for comparison.)

Membrane filtration was identified as the most desirable process in all of the top-ranked alternatives and was used for determining cost estimates. However, conventional filtration processes were not entirely eliminated. At this stage in planning, locating a new WTP and intake were felt to be the most critical decisions. Once decisions about location are made, and as the city moves toward finalizing plans, the issue of type of treatment process may be revisited.

The top-ranked alternative was locating a new WTP at the canal headworks, with raw water intake from the canal. Because this site is outside of the UGB, a Conditional Use Permit would need to be obtained. City staff investigated the feasibility of obtaining this permit and determined that there is a high probability that it can be obtained.

Workshop 2, August 10, 2005

In the second workshop, results from an evaluation of potential groundwater sources were presented, and two additional treatment alternatives using river bank wells in lieu of a conventional river intake were identified. (River bank wells are discussed in Chapter 8, Groundwater Analysis.) In addition, cost considerations were added to the non-cost criteria identified in the first workshop.

EXHIBIT 7-12
Lebanon WTP Alternatives Evaluation

Scoring: 5 = very favorable; 4 = favorable; 3 = neutral; 2 = undesirable; 1 = very undesirable

		Score	16	20	18	10	16	10		
	Location	**Process**	**Minimize labor costs**	**Equipment reliability**	**Responds well to RW quality changes (robustness)**	**Production during construction**	**Expandability**	**RW quality/ protection**	**Total Score**	**Rank**
1	Existing	Conventional	3	3	3	1	1	2	208	9
2	**Existing**	**Membranes**	4	3	4	2	3	2	**284**	**4**
3	Upstream on canal	Conventional	3	3	3	5	2	2	264	7
4	**Upstream on canal**	**Membranes**	4	3	4	5	4	2	**330**	**2**
5	Canal intake	Conventional	3	3	3	5	2	3	274	5
6	**Canal intake (headworks)**	**Membranes**	4	3	4	5	4	3	**340**	**1**
7	Existing, with intake on river	Conventional	3	2	3	1	1	3	198	10
8	Existing, with intake on river	Membranes	4	2	4	2	3	3	274	5
9	New site on river	Conventional	3	2	3	5	2	3	254	8
10	**New site on river**	**Membranes**	4	2	4	5	4	3	**320**	**3**

Potential areas for locating a new WTP site or river bank wells were identified by city staff, and are shown in **Exhibit 7-13**. Identified areas are located on both the eastern and western sides of the river. If water treatment facilities are located east of the river, the city should expedite planning for a second transmission pipeline across the river. Even without the WTP located east of the river, a second transmission line across the river will ultimately become necessary to provide adequate looping and supply as the eastern area develops. Costs for this transmission line are not included in the current CIP.

Exhibit 7-14 presents a summary of costs and benefit/cost ratios calculated by dividing the scoring obtained in the first workshop by projected costs for a 6 mgd system. The Linn County database was used to survey the real market value of 32 of the tax lots being considered for WTP and intake sites by the city. A land cost of approximately $30,000/acre for general land acquisition (equal to real market value plus 10 percent) was estimated. Because the alternatives located at the existing site and at the headworks to the canal identified specific tax lots, the actual real market value (plus the 10 percent adder for contingency) was used for these alternatives.

Because the river bank well options were not ranked in Workshop 1, they are not given a benefit/cost score; however, should river bank wells be feasible, the city could realize a significant cost savings. Capital costs for the treatment and distribution components of all six alternatives were determined using CH2M HILL's Parametric Cost Estimating System (CPES), a costing model based on process components and flow requirements. Detailed summaries of the CPES analyses for each alternative are located in **Appendix B.**

Informal discussions with the City of Albany suggest that if Lebanon no longer uses the Santiam Canal as a raw water source, Lebanon's obligation to pay annual operation and maintenance costs for the canal would be eliminated. However, this assertion has not been confirmed formally. Furthermore, should Lebanon construct a new intake on the canal, Albany may request that Lebanon contribute to the cost of the new fish screen and diversion project being constructed in 2006 at the headworks of the canal. This negotiable cost would apply to Alternatives 1 through 3. Neither canal operation and maintenance costs nor possible costs associated with the fish screen and diversion dam project were included in the cost estimates presented in Exhibit 7-14 because these costs are unknown.

Alternative 1, construction of a new WTP on the existing site, was retained for comparison. However, even if neighboring properties are purchased to expand the existing site to approximately 2.3 acres, the site falls short of the 4 acres recommended for facilities necessary to meet the long-term needs of the city. (The costs shown do not include demolition of buildings not owned by the city that are on the site.) In addition, continuing operation of the existing plant while it is modified and expanded will be difficult.

Of the originally ranked alternatives, Alternative 3, construction of a membrane WTP at the headwaters of the Santiam Canal with an intake on the canal, was identified as the alternative with the most desirable (highest) benefit/cost ratio. The advantages of this alternative include lower land costs if Lebanon can purchase land from the City of Albany, relative ease in water rights permitting, the need for a less expensive intake than a river intake, and all of the water quality advantages of a river intake. Disadvantages include the need for a Conditional Use Permit because the site is outside the UGB, a longer transmission

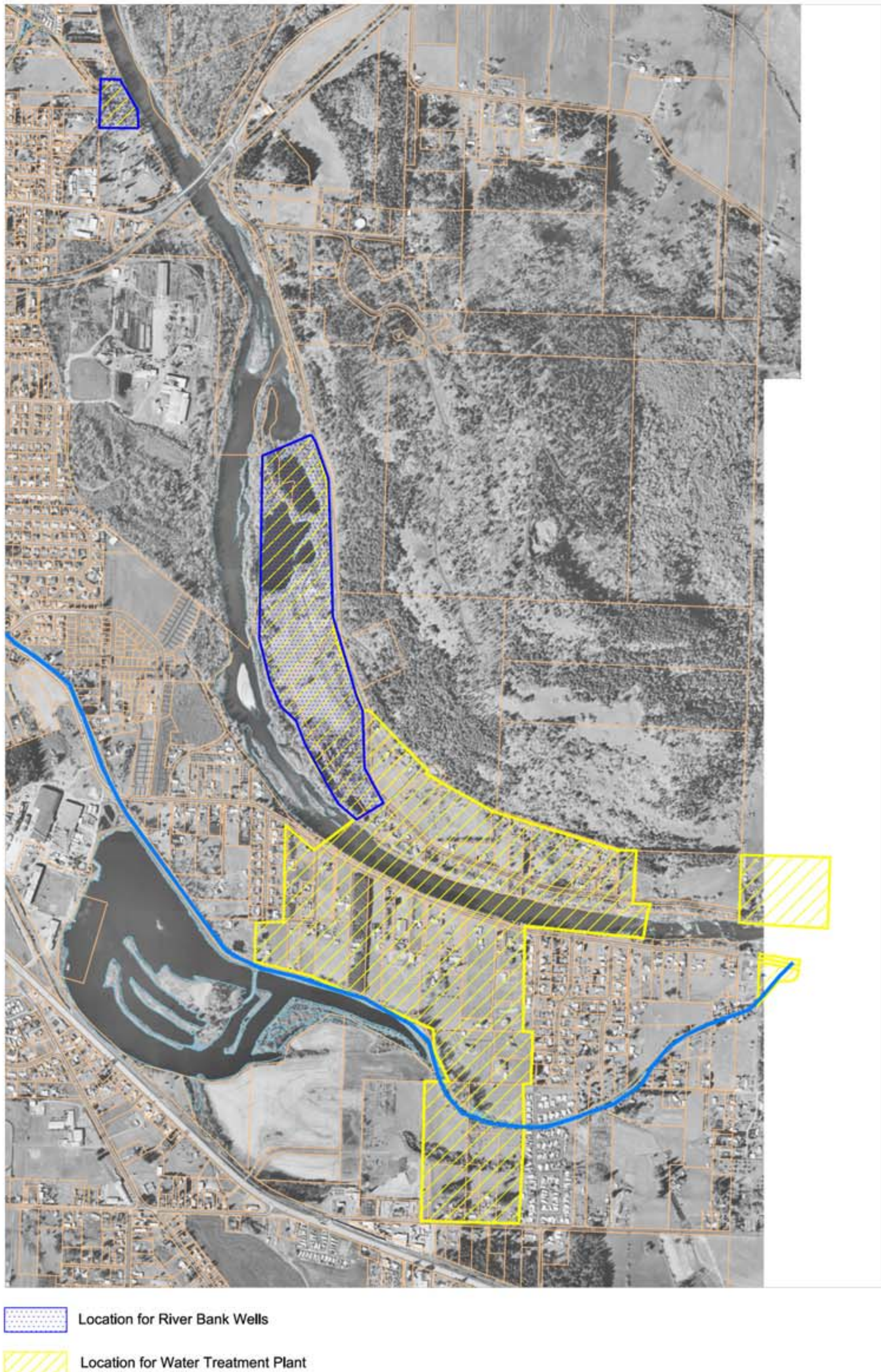


EXHIBIT 7-13
Potential Locations for River Bank Wells
and New Water Treatment Plant
Lebanon Master Plan

EXHIBIT 7-14
Capital Cost Comparison of Selected WTP/Intake Alternatives
Initial Plant Capacity = 6 mgd
Rough Order of Magnitude

	Construction Costs (With Contingency)												
Alternative Description	**Water Treatment Plant**	**Land**	**Raw Water & Finished Water Pipelines**	**Canal or River Intake**	**River Bank Well**	**Engineering Allowance**	**Permitting Allowance**	**Total Cost Estimate**	**Cost Difference from Alternative 1 + = higher ( ) = lower**	**Favorable Cost Factors**	**Cost Adders**	**Score**	**Relative Benefit-Cost Ratio (Score/Cost)**
Membrane filtration on existing site, using existing intake on canal	$9,120,000	$620,000	$0	$1,720,000	$0	$1,620,000	$50,000	$13,130,000	NA	Site already developed; canal requires less expensive intake; backwash ponds can be reused; minimizes raw and finished water transmission pipeline requirements	Requires some demolition; constrained site will increase costs; must acquire high value land	284	216
Membrane filtration, using new site upstream on canal for both the plant and intake	$8,840,000	$120,000	$1,760,000	$1,720,000	$0	$1,850,000	$90,000	$14,380,000	+$1,250,000	Canal requires less expensive intake; not a constrained site	Requires new finished water transmission pipeline, new site development	330	229
Membrane filtration, relocating plant and intake to canal headworks	$8,850,000	$50,000	$2,010,000	$1,720,000	$0	$1,900,000	$130,000	$14,660,000	+$1,530,000	Canal requires less expensive intake; not a constrained site	Requires new finished water transmission pipeline, new site development; permitting for Conditional Use Permit	340	232
Membrane filtration, relocating plant and intake to new site on river	$8,810,000	$120,000	$1,760,000	$2,900,000	$0	$2,060,000	$270,000	$15,920,000	+$2,790,000	Not a constrained site; does not require construction around existing facilities	Requires new finished water transmission pipeline, new site development; new intake on river will be more expensive than intake on canal; permitting for river intake (404/BA)	320	201
Disinfection; water source from river bank wells	$2,590,000	$120,000	$1,760,000	$0	$2,230,000	$1,270,000	$120,000	$8,090,000	($5,040,000)	Not a constrained site; water quality does not require filtration; does not require construction around existing facilities	Includes costs for evaluation and development of river bank wells to produce 6 mgd.	–	–
Membrane filtration, relocating plant to new site; water source from river bank wells	$8,140,000	$120,000	$1,760,000	$0	$2,230,000	$2,100,000	$120,000	$14,470,000	+$1,340,000	Not a constrained site; construction around existing facilities not required; can use relatively high membrane filtration (flux) rate for low solids water from river bank wells	Water quality requires filtration. Includes costs for evaluation and development of river bank wells to produce 6 mgd.	–	–

Notes:

1. Alternative 1 costs do not include costs for demolition of buildings not owned by the city.
2. Land acquisition costs for Alt's 2 through 4 were determined using an estimate of real market value +10% of land only for purchase of 4 acres. Alt 1 costs reflect real market value +10% of land and buildings.
3. Alternatives 2 and 4-6 are assumed to be located in generally the same area. Therefore pipeline and land costs are identical.
4. Permitting: Alt 3 cost reflects need for a conditional use permit. Alt 4 cost reflects complexity of river permitting. Alt's 5 & 6 require water rights permitting.
5. Alternatives 5 and 6 include costs for development of three test wells and six production wells, to achieve a river bank well capacity of 6 mgd, but do not include costs for a welll head protection program.
6. Alternative 5 and 6 were not scored during the workshops because they were introduced at a later stage.

pipeline resulting in higher cost, and the continued operation and maintenance costs for use of the Santiam Canal. In addition, Albany may ask for Lebanon to contribute to the headworks screening project that is scheduled for construction completion in 2006.

Alternative 2, construction of a membrane WTP and intake at a new upstream site on the canal, is similar to Alternative 3. This alternative retains the advantages (relative ease in permitting, less expensive intake) and disadvantages (continued operating and maintenance costs) of canal use. However, in Alternative 2, the cost of land is likely to be somewhat higher and the cost of permitting and transmission piping somewhat lower than Alternative 3. The primary difference between alternatives that makes Alternative 3 more attractive (higher benefit/cost ratio) is the greater risk of chemical contamination associated with the longer canal route of Alternative 2.

Alternative 4, construction of a membrane WTP with an intake in the South Santiam River, had the least desirable (lowest) benefit-cost ratio of the original four most favorable alternatives. Significant contributions to the expense estimate include the high costs associated with acquiring the necessary permits and constructing a river intake. A further drawback of this alternative is the uncertainties associated with locating a river intake. Although potential locations have been identified, an actual suitable location will depend on permit requirements and flow and sedimentation patterns within the river. Additional costs for piping may accrue if the intake must be located at a greater distance from the new WTP than anticipated. However, informal talks with the City of Albany suggest that this alternative will eliminate the annual cost of canal operation and maintenance.

Alternatives 5 and 6 use river bank wells to induce surface flow (75 to 80 percent of total flow) from the South Santiam River and groundwater flow (20 to 25 percent of total flow) to wells constructed in proximity to the river. Both Alternatives 5 and 6 eliminate the cost of a conventional river intake, but add costs for geological investigations (geophysical survey, test wells) and installation of production wells. A preliminary estimate, to be confirmed through testing, is that each river bank well will be able to produce between 1 and 1.5 mgd (690 to 1040 gpm). Therefore, the development of up to six production wells will be required to achieve the same 6-mgd capacity of the other alternatives. [1] Alternative 5 includes the cost for a new clearwell, high-service pump station, and disinfection system necessary if water quality testing from each well demonstrates that only disinfection is required prior to distribution. Alternative 6 captures the additional cost of a new membrane filtration WTP if filtration treatment is required.

To achieve connectivity with a river, river bank wells are generally relatively shallow (50 to 100 feet deep) and are often located in an unconfined aquifer. A well head protection program will be necessary to reduce the risk of contamination from activities near the wells. Costs for a wellhead protection program are not included in Exhibit 7-14. Other potential issues associated with river bank wells include the potential for the wells to lose capacity over time because of aquifer plugging or changes in the river, the potential for wells to

[1] The preliminary concept is to use vertical production wells to achieve the desired 6-mgd capacity. A horizontal production well, such as a Ranney Collector Well, can provide higher capacity, but requires a larger capital investment. The choice between vertical and horizontal production wells may need to be revisited based on the results from geological testing, and evaluations of life cycle costs, and future water demands.

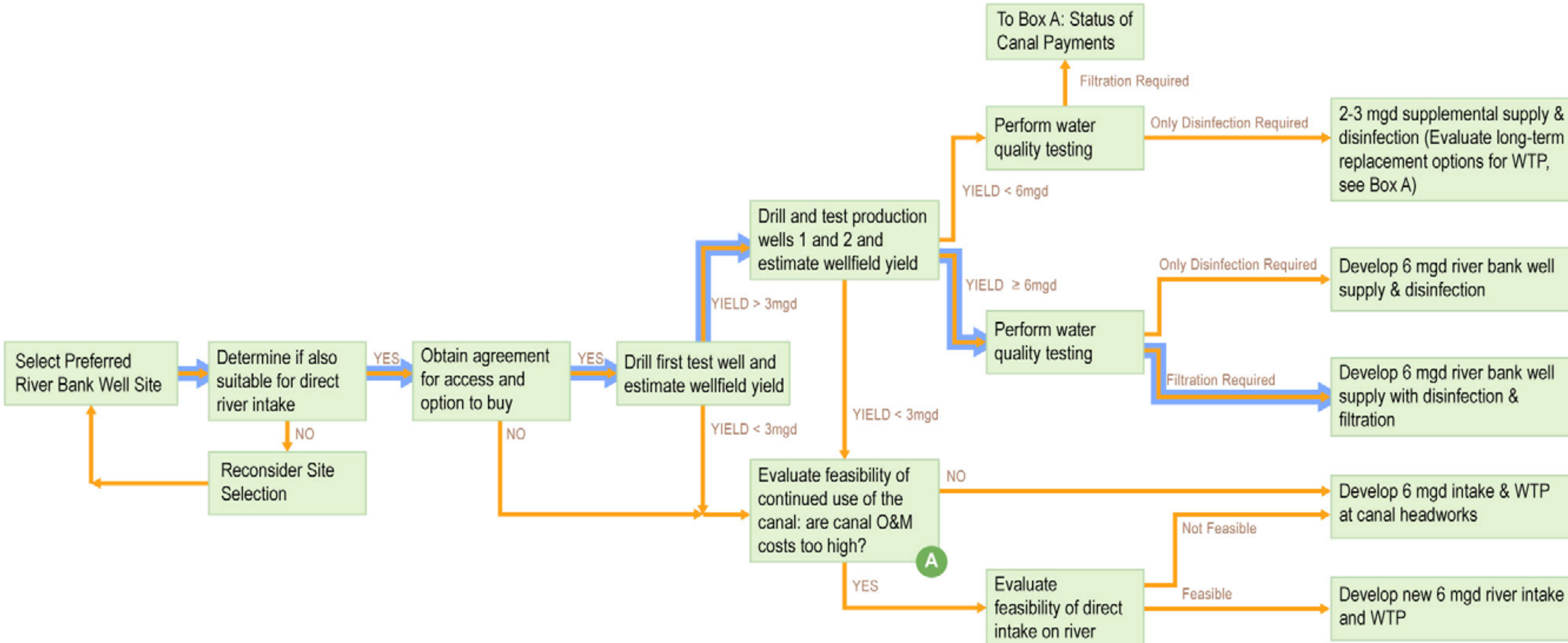
influence the movement of existing contaminant plumes in the downtown area, and the potential for groundwater constituents such as manganese and radon to affect water quality.

Recommendations for WTP and Water Source

Given the age and condition of Lebanon's existing WTP, CH2M HILL recommends that the City of Lebanon begin the process of locating and funding a replacement WTP. Land constraints at the existing WTP site limit options for future expansion at that site. Additionally, the facilities of this WTP are nearing the end of their useful life. As shown in Chapter 4, the city's 2025 MDD plus 2 mgd industrial allowance is estimated at 6.7 mgd; buildout MDD is estimated at approximately 14.2 mgd. Ideally, infrastructure built to meet the 2025 MDD can be expanded to meet the ultimate demand.

Exhibit 7-15 shows a decision flow chart for expanding Lebanon's water supply. During master plan development the city decided that the potential benefits of river bank wells (Alternatives 5 and 6) justify investment in further investigation. The optimum result of this approach would be for river bank wells to provide a sufficient quantity of raw water to meet the city's long term needs and a water quality requiring only disinfection treatment. If both factors prove true, river bank wells provide the least costly alternative.

The CIP, presented in Chapter 10 is based on Alternative 6, which relies upon successful production from river bank wells, but with water quality that requires filtration. This scenario is the highlighted pathway on Exhibit 7-15. Although river bank wells show promise for providing an incremental increase in raw water supply in the short term, treatment requirements and the ability of river bank wells ultimately to supply 14.2 mgd is uncertain. The uncertainties of production and water quality from river bank wells result in uncertainties in the CIP presented in this master plan. CH2M HILL recommends that the city maintain as much flexibility as possible while pursuing river bank well investigation and installation.



Note: Highlighted path is the basis for the capital improvements plan; however, the actual outcome is uncertain pending field investigations.

EXHIBIT 7-15
Supply Development Flowchart
Lebanon Master Plan

CH2MHILL

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To maintain flexibility and the option to pursue a different alternative, a site should be identified that could accommodate a full-scale water treatment plant with access to well sites, a canal intake, or a river intake. Also, the minimal amount of infrastructure associated with river bank wells (disinfection system, clearwell, high-service pump station) should be easily expandable to handle up to 14.2 mgd of water from future wells, or from a surface water intake.

The initial goal of the highlighted scenario would be to develop two production wells. These wells would be used to assess the expected total capacity and water quality of the wellfield. If the total capacity of the wellfield is estimated at greater than 6 mgd, the city will proceed to develop a 6 mgd river bank well supply and an associated wellhead protection program. As each new well is developed, water quality testing must be performed to determine the required level of treatment. Wells must be pumped for an extended period to complete testing, and some tests must be performed during both high river flow conditions and peak demand conditions. Therefore, planning for infrastructure needs must take into account the extended duration of water quality assessment. As noted above, the highlighted path on Exhibit 7-15 assumes that filtration treatment will be required.

If results from production wells indicate that the wellfield yield is likely to be less than 6 mgd, the city must evaluate long-term options for replacement of the WTP, and must decide if the river bank wells should be maintained as a supplemental water supply. The city will need to develop a surface water intake on either the canal or the river. Either intake location would provide similar water quality. However, because of the uncertainties associated with permitting requirements, and costs associated with locating and maintaining a river intake, CH2M HILL recommends that the city pursue locating a new WTP along the canal, upstream of Cheadle Lake and preferably at the headworks. These canal locations take advantage of the headworks screening that will be completed in 2006. Using the river bank wells as a supplemental water supply may be feasible if only disinfection is required prior to distribution. However, if filtration treatment is required the feasibility of continuing to operate the wells is more doubtful.

Planning Steps

The following planning steps are recommended to implement long-term WTP improvements:

1. Evaluate sites for river bank wells and a direct river intake.
2. Purchase or obtain agreement for access and option to buy sufficient property for wells, a clearwell, high-service pump station, and treatment plant.
3. Investigate financing options. Considering financial constraints and demand growth, determine a schedule for bringing a new plant on line.
4. Evaluate the potential for river bank wells by drilling a test well at a selected site, and determining well yield.
5. If test well proves promising, drill and develop two production wells with the goal of ultimately achieving at least 6 mgd capacity from the wellfield.
6. Perform water quality testing to determine the required level of treatment.

7. If yield is poor, revisit the approach of using a surface water intake on the canal or river, and determine if river bank wells should be maintained as a supplemental supply. If well yield is adequate proceed with development of the wellfield.
8. Approximately 3 years prior to the on-line date, begin the design process by conducting pilot studies and/or other evaluations to make process selections, determine sizing of facilities, and update the cost estimate. If filtration is required, the selection between conventional filtration technologies and membrane filtration can be made at this time.
9. Design and construct the treatment facilities.

Short-term Recommendations

The city has indicated that funding limitations may delay construction of a new WTP for 5 to 10 years. The delay presents the city with a significant risk of water shortages (because of accelerated demand growth) and interruptions in supply (because of mechanical failures in the existing plant).

In particular, there is a concern regarding the reliability of the Accelator© unit. It is old and there is evidence of significant corrosion and mechanical wear. If there is a mechanical failure of one of the main systems of this unit, Lebanon will not be able to supply potable water (or possibly, the city will be able to supply potable water but only in limited quantities) for a period of 6 to 10 weeks while replacement parts are manufactured and installed.

Given the severity of this situation, CH2M HILL recommends that the city obtain 1) a replacement gear/impeller to have on hand for immediate replacement, or 2) install a second solids contact clarifier. A preliminary estimate of the capital cost for construction of a new unit, including land acquisition, building demolition, engineering services, and purchase of a new Accelator© unit, but not including reconstruction of the maintenance shop, is approximately $750,000. The most cost-effective alternative appears to be purchase of replacement equipment. The Accelator© manufacturer, Infilco Degremont, Inc., estimates a cost of $30,000 for providing a replacement 5-hp motor, gear reducer, gear box, and variable speed drive, and an additional $30,000 for a replacement impeller shaft and impeller. An allowance of $60,000 has been included in the CIP for the purchase of the Accelator© replacement parts.

Although having replacement equipment on hand is the least costly option, the Accelator© must be taken out of service for a period of time, estimated by operators at up to 2 weeks, for gear replacement. During this period, the city must have an emergency plan for curtailing WTP operation, for notifying customers about the need to boil and conserve water, and for supplying bottled water to critical users such as hospitals and nursing homes.

In addition to addressing the concern about the Accelator©, the city should also consider the specific equipment deficiencies that have been identified by the plant operators. These items are listed below. The importance of addressing these items depends on the timing for replacement of the WTP.

- Replace the raw water flow meter
- Improve coagulant mixing

- Automate Accelator© sludge wasting to the backwash ponds
- Install sumps for cleaning the backwash ponds
- Add a turbidimeter to monitor turbidity within the filter-to–waste flow stream
- Replace Bailey valves in the filter gallery
- Remove corrosion and paint filter gallery piping
- Automate/replace the filter control consoles
- Replace the filter channel level controller
- Install filter-to-waste control
- Replace filter effluent flow meters
- Repair soffits on the control building so that insulation is not sloughed onto the filters
- Increase capacity of the fluoride system by purchasing a new scale and tank
- Add variable frequency drives to the finished water pumps
- Install a bypass from the clearwell to the waste water treatment plant for contamination removal

References

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