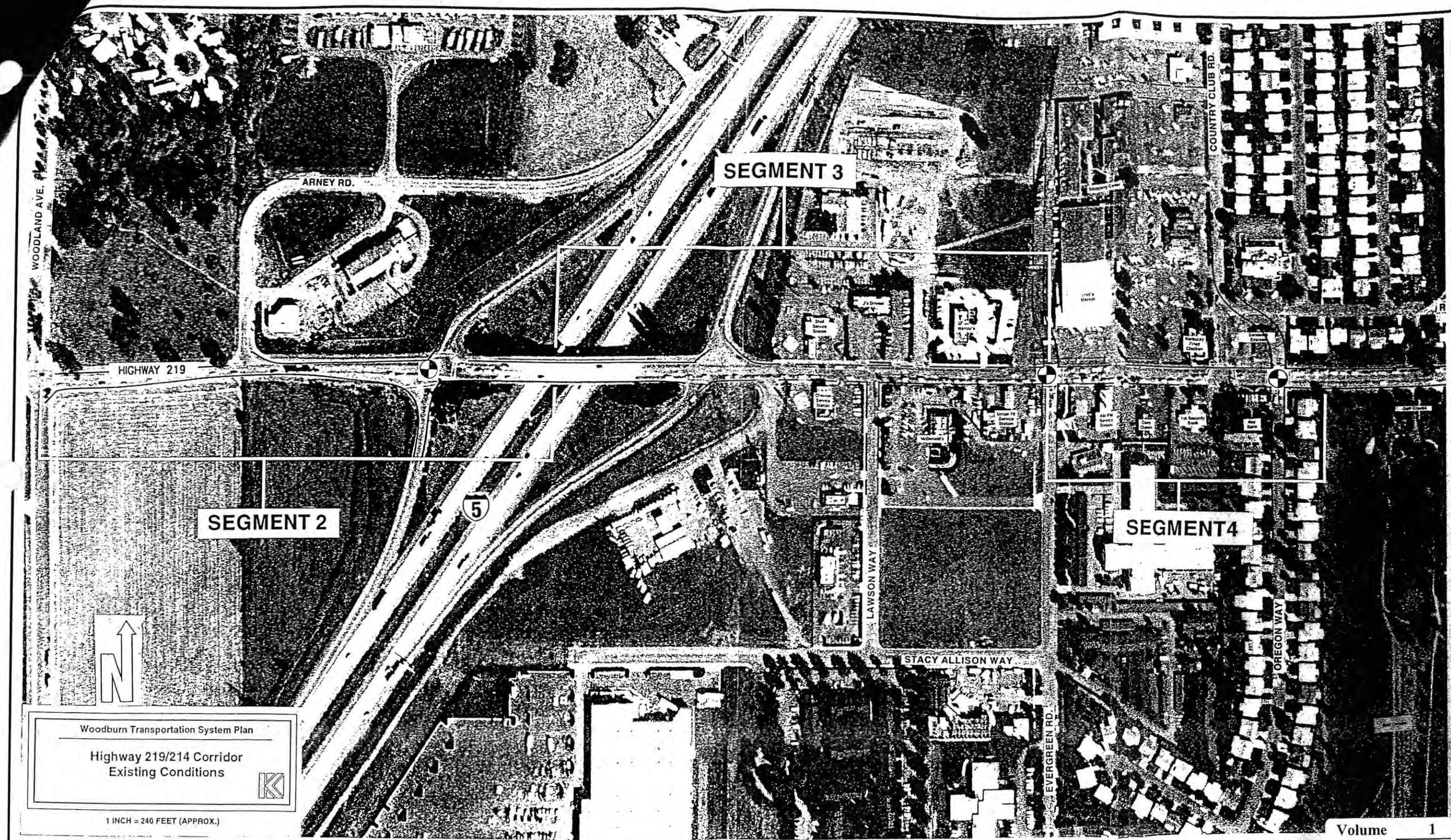

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HIGHWAY 219/214 EXISTING ACCESS
WEST CITY LIMITS TO OREGON WAY

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FIGURE 26

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8.5.2 Segment 2: Woodland Road to Interstate 5

Traffic Operations

Under existing conditions, approximately 9,500 vehicles per day use this section of roadway. In the future it is forecast that 23,000 vehicles per day will use this segment. In order to accommodate this volume of traffic, it is expected that in the future, Arney Road will be extended to Woodland Road, and the existing Arney Road intersection will be converted to a right-in-right-out intersection. The previous alternatives/needs analysis (Technical Memorandum #4) also showed that in the future, if the existing diamond interchange configuration is maintained, the southbound I-5 ramp and Highway 214 bridge over I-5 will need to be widened to include second left turn lanes on the southbound and westbound approaches, with the Highway 214 eastbound approach also widened to include an additional through lane and a right turn lane.

Considering the OHP Access Management Policy, it is important to note that signals at the Woodland Road/Highway 214 and southbound I-5/Highway 219 intersection, will be approximately 1,150 feet apart. This separation is slightly less than the 1,320 foot (1/4 mile) separation called for in Category 5 of the Access Management Policy (see Table 11). Given the signal spacing in this section, and in other sections of Highway 214, as traffic signals are installed on Highway 219/214 it will be necessary to perform a detailed corridor operations analysis to verify that traffic operations with the traffic signals will be acceptable, in particular accommodating vehicle progression through a series of signals east and west of I-5.

Access Issues and Potential Modifications

Highway 219 between Woodland Road and I-5 is approximately 1,150 feet in length with no private driveways in this segment. The only access in this section of roadway is Arney Road, which intersects from the north approximately equal distance between the southbound I-5 ramp intersection and Woodland Road. Arney Road serves some freeway commercial development north of Highway 219 and a significant amount of undeveloped commercially-zoned land north of Highway 219.

As there are no existing driveways in this section, the driveway density is equal to zero, which clearly meets the guidelines for Category Urban 5 of less than 18 driveways per mile (see Figure 26). It is expected that no driveways will be added in this segment in the future.

8.5.3 Segment 3: Interstate 5 to Evergreen Road

Traffic Operations

Under existing conditions, during the peak traffic periods, this is a very congested section of Highway 214, with one of the poorest intersections within the City of Woodburn identified at the intersection of the northbound I-5 ramps and Highway 214. Significant vehicle queuing occurs at this intersection as well as at the intersection of Highway 214 with Evergreen Road. Currently approximately 19,500 vehicles per day travel on this section of roadway. In the future it is forecast that as many as 35,000 vehicles per day will travel on this segment.

In the near future, it is recommended that the northbound Interstate 5 ramps/Highway 214 intersection will be signalized. A signal is warranted at this location based on existing traffic volume. This intersection is approximately 900 feet west of the intersection of Evergreen Road/Highway 214, which is currently signalized. In this case, these two traffic signals would be spaced closer than the 1/4 mile spacing standard called for in Category 5 of the OHP Access Management Policy. In addition, a traffic signal at the northbound I-5 ramps would be spaced approximately 750 feet from the existing traffic signal at the I-5 southbound ramps. This spacing is also less than the 1/4 mile spacing specified in the Access Management Policy guidelines. A detailed signal operations analysis in this corridor (Evergreen Road to Woodland Road) is necessary to verify that with traffic signals installed at Woodland Road, and the northbound I-5 ramps, acceptable traffic progression can be maintained.

The accident analysis revealed that there were 29 accidents during the three year study period at the I-5 ramps onto and off of Highway 214. This incidence of accidents is most likely caused by the congestion, queuing, and low sight distance for vehicles turning onto northbound I-5 from westbound Highway 214. With an improved interchange, it is likely that the incidence of accidents will decrease.

Access Issues and Potential Modifications

This segment of Highway 214 is approximately 900 feet in length and is highly developed with freeway commercial uses. On the south side of Highway 214, there are five driveway locations along this segment serving three businesses (see Figure 26). Two of the three businesses are service stations which, as currently developed, require two driveways at each site for circulation. The public street access located approximately 200 feet east of the northbound I-5 ramp intersection, serving the property south of Highway 214, should be closed, with an internal street connection to Stacy Allison Way to direct site traffic to Oregon Way.

On the north side of Highway 214 through this section, there are six driveways serving three businesses adjacent to Highway 214. In addition, there are two major access points serving development located 400-500 feet north of Highway 214. It is recommended that two of the six driveways along this segment of Highway 214 be closed. The public access serving the property to the north of Highway 214 was recently realigned to intersect Highway 214 directly across from Evergreen Road. With this local access relocation complete, it would be possible to develop an east/west roadway parallel to Highway 214 on the north side to intersect with the new roadway being constructed opposite Evergreen Road (see Figure 26). Consideration should be given to extending this access road east of Evergreen Road parallel to Highway 214 to intersect with Country Club Road.

Under existing conditions, on the north side of Highway 214, there are approximately 35 driveways per mile); on the south side of Highway 214 there are approximately 29 driveways per mile (see Table 10). In both cases the driveway density exceeds the guidelines outlined in the Access Management Classification System. On the north side of Highway 214, if driveways are consolidated as described, driveway density would decrease to 23 driveways per mile which is closer to the Access Management Policy guidelines.

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8.5.4 Segment 4: Evergreen Road to Oregon Way

Traffic Operations

This section of Highway 214 operates in a similar fashion to the previously described section. During the peak period there is a great deal of congestion and vehicle queuing at the major intersections. The Highway 214/Oregon Way/Country Club Road is a signalized intersection, separated from Evergreen Road by 650 feet. As previously shown in Table 11, this spacing is less than the Oregon Highway Plan guidelines of 1,320 feet for a Category 5 Urban roadway.

Over the three year accident analysis period, there were 12 accidents at Evergreen Road, eleven accidents at Country Club Road, and five accidents at Oregon Way. These accidents were most likely caused by the close proximity of the intersections, the offset alignment of Country Club Road and Oregon Way, as well as the congestion in the area. The recent realignment of Country Club Road and Oregon Way into a single intersection should reduce the incidence of accidents in this segment in the future.

Access Issues and Potential Modifications

This segment of Highway 214 is approximately 650 feet in length and is developed with freeway commercial uses. Traffic signals are located at the Evergreen Road and Oregon Way/Country Club Road intersections. On the south side of Highway 214 there are six driveways serving four separate properties. There is one shared driveway between a service station and the Dairy Queen on the south side of Highway 214. The most easterly driveway on this segment of Highway 214 should be consolidated with the adjacent driveway in order to remove this driveway from the influence of the Country Club Road/Oregon Way intersection.

On the north side of Highway 214 through this segment, Country Club Road was recently realigned to intersect Highway 214 at Oregon Way. There are two private driveways along this segment of Highway 214. In addition to these two driveways the Old Country Club Way intersection should be closed associated with the Country Club Road realignment. This public street intersection is within 150 feet of Oregon Way and is well within the influence of the Highway 214/Oregon Way intersection. In addition, the driveway which currently exists between the Old Country Club Way intersection and the new realigned Country Club Road intersection should also be closed. This property is best served from the north realigned off of Country Club Road. No other driveway relocations are recommended at this time. Figure 23 shows the existing driveway spacing in this section of Highway 214.

Under existing conditions, as shown again in Table 12, driveway density on the north side of Highway 214 is 25 driveways per mile; and on the south side the driveway density is approximately 50 driveways per mile. In the future, if driveways are consolidated as identified, the north side driveway density would decrease to eight driveways per mile which would meet Access Management Policy guidelines. The south side driveway density would decrease to 42 driveways per mile, which is still relatively high.

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8.5.5 Segment 5: Oregon Way to Broughton Way

Traffic Operations

Under existing conditions, average daily traffic (ADT) on this segment of roadway is 17,000 vehicles per day. In the future, it is forecast that average daily traffic will grow to 33,000 vehicles per day. The recent accident analysis showed no accidents in this segment during the three year study period.

Access Issues and Potential Modifications

This segment of Highway 214 is approximately 1,800 feet in length and is well defined with curbing on both the north and south sides of the road (see Figure 27). There is a sidewalk along the entire south side. Within this section, the only access to Highway 214 is Cascade Drive, located on the south side of the road approximately 700 feet east of Oregon Way. It is expected that when the now vacant commercially-zoned parcel at the southwest corner of the intersection of Highway 214/Cascade Drive develops, access to this property will be provided via Cascade Drive. In the 600 feet of Highway 214 just east of Cascade Drive, there are four driveways on the south side of Highway 214. Three of these driveways serve the Woodburn Fire Station, with a fire truck-actuated signal at one driveway. One of these access points is a curb cut to vacant commercially-zoned land.

The north side of Highway 214 between Oregon Way and Broughton Way has no local access except for a 50 foot curb cut approximately 280 feet east of Cascade Drive (see Figure 27). This 50 foot curb cut serves a small triangular vacant commercially-zoned property which is land-locked because of residential development directly to the north. Although this driveway meets the current standards for driveway spacing, care must be taken as this property develops to ensure adequate sight distance and internal circulation on the property.

Under existing and future conditions, driveway density in this section of Highway 214 satisfies the OHP Access Management Policy (see Table 12).

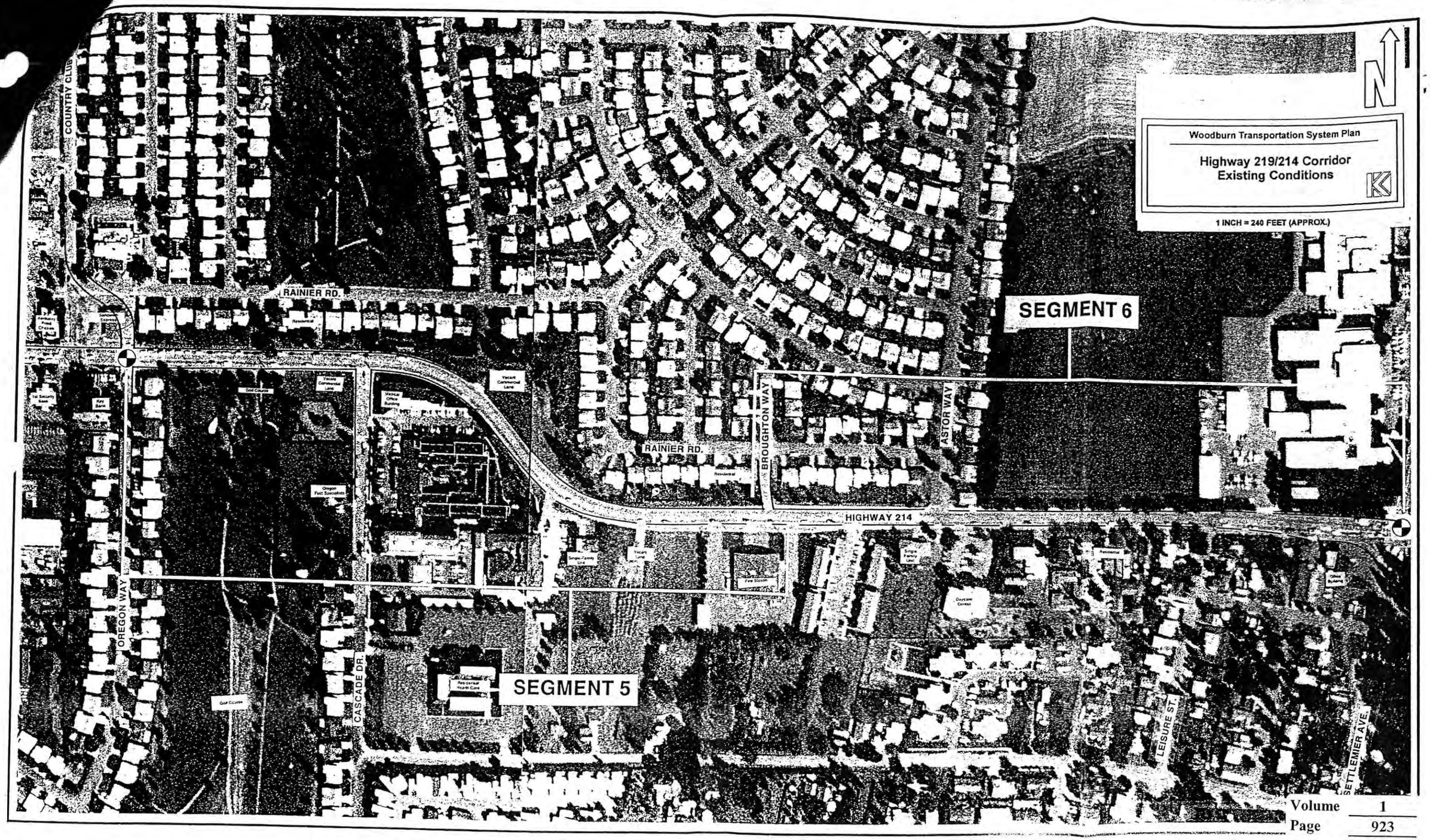
8.5.6 Segment 6: Broughton Way to Settlemier Avenue/Boones Ferry Road

Traffic Operations

The average daily traffic on this segment, under existing and future conditions it approximately the same as the previous section. Currently the average daily traffic is 17,000 vehicles per day, and this is expected to grow to 33,000 vehicles per day. Under existing conditions the intersection of Highway 214/Settlemier Avenue/Boones Ferry Road operates at level of service C. It is anticipated that in the future, with improvements made to the signal timing and lane channelization, this intersection will operate at LOS E.

The traffic signal spacing between this intersection and those traffic signals adjacent to it is greater than the quarter mile spacing called for in the Access Management Policy guidelines.

The accident review showed that during the three year study period, 1992-1994, there were 18 accidents at this intersection. Compared to other intersections in Woodburn, this is a relatively high incidence of accidents. Most likely, the incidence of accidents can be reduced by restriping



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HIGHWAY 214 EXISTING ACCESS OREGON WAY TO SETTLEMIER AVE./BOONES FERRY RD.

CITY OF WOODBURN TRANSPORTATION SYSTEM PLAN	FIGURE 27
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the southbound approach to the intersection to include one left turn lane, one through lane and one right turn lane (as recommended in Woodburn TSP Technical Memorandum #4).

Access Issues and Potential Modifications

This segment of Highway 214 is over 1,700 feet in length and includes one public street access, Astor Street, on the north side of Highway 214, and one public street access, Leisure Street, on the south side of Highway 214 (see Figure 27). In addition to Leisure Street on the south side of Highway 214, there are nine private driveways in this 1,700 foot section. There are four single family residential units in this section, one office building, a children's day care center and an apartment complex.

As the south side of the road develops in the future, it could be possible to eliminate four of the five residential driveways in the vicinity of Leisure Street. In addition, the two driveways serving single family homes across from Astor Way could be consolidated into one driveway in the future. Prior to redevelopment, driveway density will remain at 28 driveways per mile (see again Table 12), which exceeds the Access Management Policy guidelines.

On the north side of Highway 214 between Broughton Way and Settlemier Avenue/Boones Ferry Road, there are two private driveways. Generally, the area is developed with residential properties which front on a street parallel to Highway 214, and with the remaining portion of Highway 214 fronting on the golf course. One single family residential driveway exists near Astor Street near the north side of Highway 214, and a second driveway serving commercial property is located 110 feet east of Leisure Way. As the driveway density is six driveways per mile (which is less than the guidelines), no additional access schemes are recommended for this segment of Highway 214.

8.6 Highway 99E Analysis

Access to Highway 99E was studied between Lincoln Street, the south terminus of the previous ODOT road improvement project along Highway 99E, to the south city limits (see again Figure 25). This section of roadway is approximately 4,000 feet long. Through this section, the highway consists of undefined driveway locations with a few short sections recently reconstructed with curb and sidewalks. Also through this section, Highway 99E is a five-lane roadway section with scattered older commercial development along its entire length. This area is expected to redevelop in the future. As this redevelopment occurs, care must be taken to improve the delineation of driveways, and in some cases, consolidate or close existing driveways.

Currently there are traffic signals at the intersections of Highway 99E with:

- Lincoln Street, and
- Young Street (Highway 214).

For the purposes of this access analysis, Highway 99E was divided into five subsections:

- Segment 1: Lincoln Street to Aztec Street,
- Segment 2: Aztec Street to Laurel Street,
- Segment 3: Laurel Street to Highway 214,

- Segment 4: Highway 214 to Cleveland Street, and
- Segment 5: Cleveland Street to South City Limits.

Highway 99E between Highway 161/Highway 214 and Highway 214 is 1.17 miles long (longer than the limits of the access management study corridor). In this segment of roadway, the ODOT accident data for the period (1990 - 1993) showed a steady decline in the number of accidents per year in this segment of roadway. The calculated accident rate for 1993 was 2.6 accidents per million vehicle miles. This rate is below the statewide average rate for similar road segments of 3.6 accidents per million vehicle miles.

8.6.1 Segment 1: Lincoln Street to Aztec Drive

Traffic Operations

Under existing conditions, average daily traffic on this segment is approximately 21,000 vehicles per day. In the future it is forecast that average daily traffic will grow only slightly to 22,000 vehicles per day. Currently the intersection of Lincoln Street/Highway 99E operates at LOS C or better.

The traffic signal at Lincoln Street is approximately 3,000 feet away from the traffic signal at Young Street which exceeds the ¼ mile spacing guideline in the Access Management Policy guidelines.

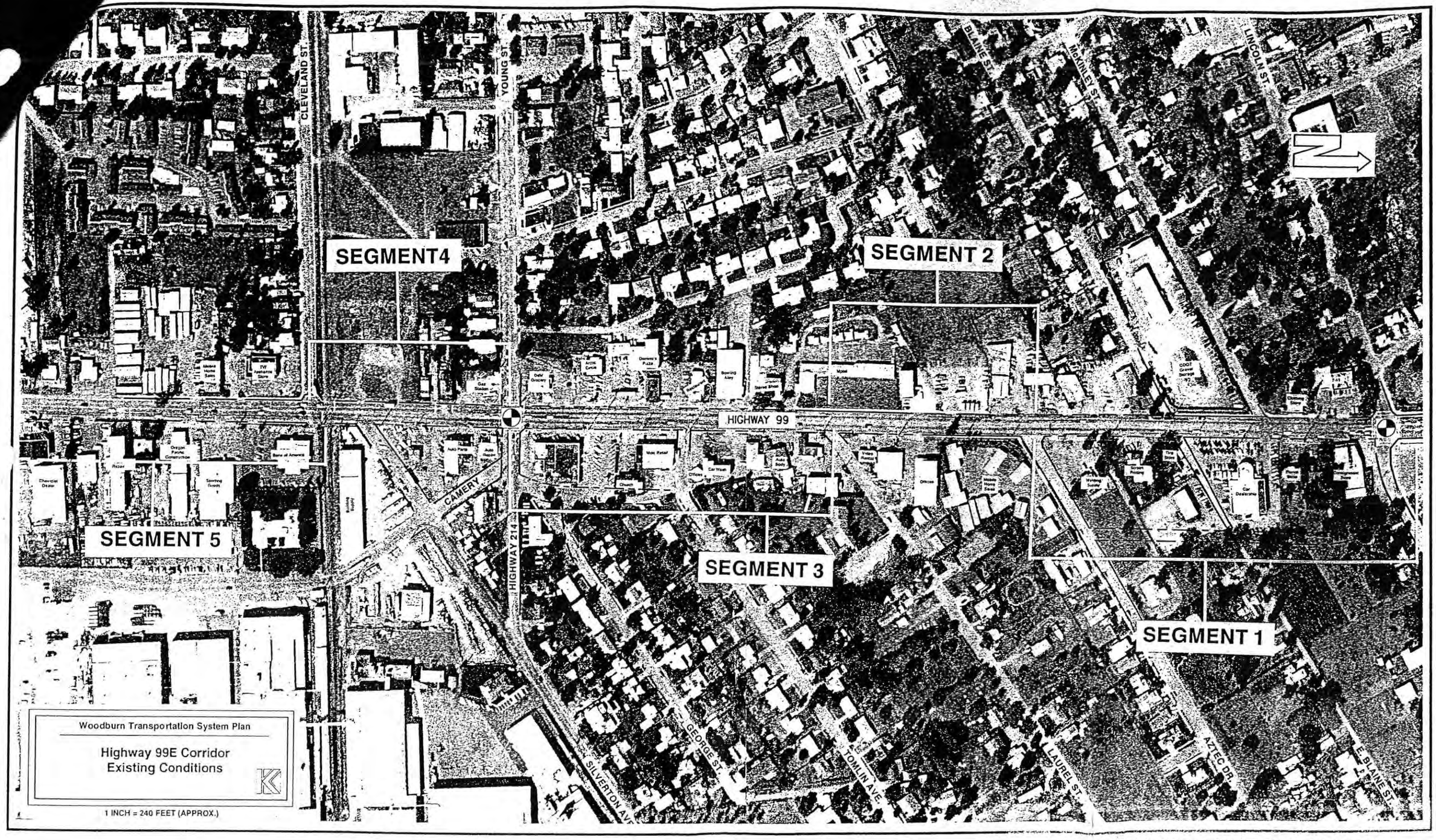
The accident analysis showed that over the three year study period, there were 14 accidents at the Lincoln Street intersection. Compared to other intersections in Woodburn, this intersection has an intermediate-level accident history.

Access Issues and Potential Modifications

This segment of Highway 99E is approximately 1,000 feet in length (see Figure 28). There are seven private driveways along the west side of Highway 99E through this segment. These seven access locations should be consolidated into no more than four private driveways in this segment. As shown in Table 12, this would decrease driveway density from 37 driveways per mile to 21 driveways per mile.

In addition, there are two public street accesses. There is little opportunity for developing parallel streets or frontage roads along the west side of Highway 99E through this segment.

On the east side of Highway 99E there are ten private driveways (53 driveways per mile) which vary in curb cut widths of 12 feet to 82 feet. The two driveways on the northeast corner of Highway 99E/Lincoln Street should be closed. One of these driveways is located within the curb return of the Highway 99E/Lincoln Street intersection which results in a very hazardous and confusing circulation for motorists in the area. The 82 foot curb cut located on the east side of Highway 99E is not usable and therefore should be closed. In addition to the two driveways on the north end of Highway 99E near Lincoln Street, two driveways in the location of Aztec Drive should be closed. If the driveway consolidation were implemented, driveway density in this section would decrease from 53 driveways per mile to 31 driveways per mile, which exceeds the Access Management Policy guideline of 18 driveways per mile.



HIGHWAY 99E EXISTING ACCESS
LINCOLN STREET TO
SOUTH CITY LIMITS

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FIGURE 28

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The East Blaine Drive intersection exists approximately midway between Lincoln Street and Aztec Drive on the east side of Highway 99E. This street could be improved and extended to the east, intersecting a possible parallel frontage road to Highway 99E located approximately 300-350 feet east of Highway 99E between Lincoln Street and Aztec Drive.

8.6.2 Segment 2: Aztec Drive to Laurel Street

Traffic Operations

Existing ADT in this section of roadway is 16,000 vehicles per day. In the future it is forecast that traffic volumes will grow to 22,000 vehicles per day.

Access Issues and Potential Modifications

This segment of Highway 99E is approximately 1,100 feet in length with a majority of the west side of Highway 99E recently reconstructed with new curbs and a full sidewalk. There are three private driveways on the west side of Highway 99E in this segment. The only modification recommended in this section is possible consolidation of one driveway on the north end. Regardless of whether or not this consolidation is made, the future driveway density would satisfy the Access Management Policy guidelines (see Table 12).

Nearly 300 feet of frontage on the east side of Highway 99E, south of Aztec Drive, has been reconstructed with a new curb and sidewalk. No private driveways exist in this segment. South of the end of the new curb and sidewalk to Laurel Street, there are four private driveways in this approximately 700 foot section. Two of the four driveways could be closed and access to the properties provided via Laurel Street. If, as properties redevelop, driveways were consolidated, the driveway density could decrease from 19 driveways per mile to ten driveways per mile, which would satisfy the OHP Access Management Policy guidelines.

In addition, there is potential for developing an east side frontage road parallel to Highway 99E between Aztec Drive and Laurel Street. This frontage road would be a definite benefit to the area, particularly as the area redevelops.

8.6.3 Segment 3: Laurel Street to Highway 214

Traffic Operations

Existing average daily traffic in this area is 16,000 vehicles per day. Similar to the previous segment, it is expected that this traffic volume will grow to 22,000 vehicles per day.

Under existing conditions, the intersection of Highway 99E/Highway 214/Young Street operates at LOS C or better. In the future it will be necessary to construct an extended exclusive westbound right turn lane in order to ensure acceptable traffic operations. With the modified lane striping, it is forecast that the intersection will operate at LOS D.

The incidence of accidents at this intersection is relatively high. During the study period there were 41 accidents at this intersection; second only to the intersection of Highway 99E/Highway 214/Highway 211 where there were 58 accidents during the three year study period.

The intersection of Highway 99E/Highway 214/Young Street is a signalized intersection. This intersection is located approximately 3,000 feet south of the Lincoln Street traffic signal.

Access Issues and Potential Modifications

This section of Highway 99E is approximately 900 feet in length. Much of the curb and curb cuts in this area are in disrepair or non-existent. There are eleven private driveways on the west side of Highway 99E between Laurel Street and Highway 214. These private driveways vary in width from 25 to 84 feet. Five of the eleven driveways could be eliminated or consolidated by means of a shared access. There is adequate set back in many of the businesses through this area that will allow some internal circulation between properties. This study section has the highest driveway density of all the study segments: there are 65 driveways per mile. In the future, if driveways are consolidated the driveway density could decrease to 35 driveways per mile (Table 12).

There are ten private driveway locations on the east side of Highway 99E between Laurel Street and Highway 214. In addition, Tomlin Street exists approximately midway between Laurel Street and Highway 214. The curb cuts for the private driveways vary between ten and 35 feet in width. Five of the ten driveways could be closed or consolidated with adjacent driveways without major impact to the business operation in this area. In addition, some curb and sidewalk installation is required on Highway 214, east of Highway 99E. The curbing is required to delineate and reduce the wide access that exists east of Highway 99E and north of Highway 214. Consideration should be given to developing a parallel frontage road to Highway 99E between Highway 214 and Laurel Street in the future as this area begins to redevelop.

This section has the second highest driveway density of all study segments. Currently, there are 59 driveways per mile. If the driveways were consolidated in the future, the density could decrease to 29 driveways per mile, which still exceeds Access Management Policy guidelines for Category 5 roadways.

8.6.4 Segment 4: Highway 214 to Cleveland Street

Traffic Operations

Currently, no accident, or traffic level of service problems have been identified in this segment. Existing average daily traffic is 11,000 vehicles per day. In the future, average daily traffic will grow to approximately 18,000 vehicles per day. If the South Arterial is constructed, it can be expected that there will be still higher traffic volumes in this segment.

Access Issues and Potential Modifications

This section of Highway 99E is approximately 550 feet in length. The only development on the west side of Highway 99E in this section consists of a card lock gas station at the southwest corner of Highway 99E and Highway 214 and a converted motel/apartment complex immediately south of the gas station. There is some vacant developable land between the motel/apartments and the railroad. There are five private driveways on this 550 foot section of Highway 99E. One private access, to the gas station, is not usable with the current layout in the area. In addition, there are two accesses to the vacant portion of land just north of the

railroad track. As this land develops it appears reasonable that the major access should be across from Silverton Avenue. However, this may result in some safety problems due to the close spacing between the access and the railroad.

There are three private driveways located on the east side of Highway 99E between Highway 214 and Cleveland Street. These three driveways occur between Highway 214 and Silverton Avenue, and they serve commercial development. Two of these three driveways could be closed without impacting existing commercial operations. A formal curb should be developed on Silverton Avenue east of Highway 99E providing some separation between Highway 99E and the access to this property.

8.6.5 Segment 5: Cleveland Street to South City Limits

Traffic Operations

Similar to the previous study segment, currently no traffic level of service or safety problems have been identified in this segment of roadway. The existing and future average daily traffic volumes are similar to the previous section: 11,000 and 18,000 vehicles per day respectively. It can be expected that with the construction of the South Arterial, more traffic will use this segment of roadway and traffic conditions will change.

Access Issues and Potential Modifications

This section of Highway 99E is approximately 550 feet in length. The only development on the west side of Highway 99E in this section consists of a card lock gas station at the southwest corner of Highway 99E and Highway 214/Young Street and a converted motel/apartment complex immediately south of the gas station. There is some vacant developable land between the motel/apartments and the railroad. There are five private driveways on this 550 foot section of Highway 99E. One private access, to the gas station, is not usable with the current layout in the area. In addition, there are two accesses to the vacant portion of land just north of the railroad. As this land develops it appears reasonable that the major access should be across from Silverton Avenue. However, this may result in some safety problems due to the close spacing between the access and the railroad.

There are three private driveways located on the east side of Highway 99E between Highway 214 and Cleveland Street. These three driveways occur between Highway 214 and Silverton Avenue, serving commercial development. Two of these three driveways could be closed without impacting existing commercial operations. A formal curb should be developed on Silverton Avenue east of Highway 99E providing some separation between Highway 99E and the access to this property.

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Section 9

Transportation System Plan

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9.0 Transportation System Plan

9.1 Introduction

This section of the city of Woodburn Transportation System Plan recommends the transportation improvements needed to carry the city forward into the future. The improvements have been identified as an outcome of the existing conditions analysis, alternatives analysis, and access management analysis. In all cases the recommendations are sensitive to the adopted goals and policies of the City of Woodburn staff and Transportation Task Force.

9.2 Roadway Plan

A critical component of the Woodburn TSP is an updated roadway plan, identifying an appropriate functional classification of streets and associated design standards, and new and improved streets to meet future capacity and circulation needs.

9.2.1 Functional Classification

For the updated Woodburn Transportation System Plan, the major change from the street functional classification plan in the 1985 plan was dividing the collector street designation into two categories. The first designation is a service collector, those collector streets which tend to provide more mobility than land access and thereby would tend to carry a larger volume of traffic. The second class of collector is the access street. These streets tend to provide more land access and less mobility. The traffic volume on these streets would tend to be less than on a service collector.

Specific definitions for the different street classifications in the updated functional classification plan for Woodburn is as follows:

Arterials —Streets which provide for traffic flows between activity centers.

- Major Arterial—Streets and highways which provide service to traffic entering and leaving the area and traffic to major activity centers in Woodburn.
- Minor Arterial—Streets which feed the major arterial system and support moderate length trips and service to activity centers.

Collectors—Streets which link local streets with the arterial system.

- Service Collector—Streets which provide significant linkages with arterials and tend to accommodate a higher volume of traffic.
- Access Street—Streets which provide primarily single family residential local street access and tend to accommodate lower volumes of traffic.

Local Streets—Streets whose primary function is to provide access to abutting land uses.

Figure 29 shows the functional classification plan for each of the roads within the Woodburn Urban Growth Boundary. The major street designations are as follows:

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Major Arterial

Highway 219/214
Highway 99E
Highway 211

Minor Arterial

South Arterial
Boones Ferry Road/Settlemier Avenue
Front Street
Hardcastle Avenue
Young Avenue (Highway 99E to Front Street)

Service Collector

Parr Road
Lincoln Street (East City limits to Front Street)
Evergreen Road
West Hayes Street (Settlemier Avenue to Evergreen Road)
Arney Road
Progress Way/Industrial Avenue
Park Avenue (Lincoln Street to Highway 214)
Gatch Avenue (Young Street to Lincoln Street)
Cleveland Street (Highway 99E to Front Street)
Woodland Drive (Arney Road to Highway 219)

Access Street

Woodland Drive (Arney Road to Willow Avenue)
Cascade Drive (Highway 214 to West Hayes Street)
Astor Way (Country Club Road to Highway 214)
Country Club Road (Astor Way to Boones Ferry Road)
Hazelnut Drive
Brown Street (Cleveland Street to South Arterial)

Truck traffic should be focused on Highways 219/214, 211, 99E and the future South Arterial. Any hazardous materials routing should be focused on I-5 in the north-south direction, and the South Arterial in the east-west direction. The specific alignment of the South Arterial (north or south alignment) will be determined as part of a refinement study to identify a final location and configuration for an I-5 interchange improvement.

Figure 29 also shows potential local street connections in the future to provide better neighborhood access and circulation. This includes extending existing dead-end streets where possible as well as developing connected local street systems within new developments.

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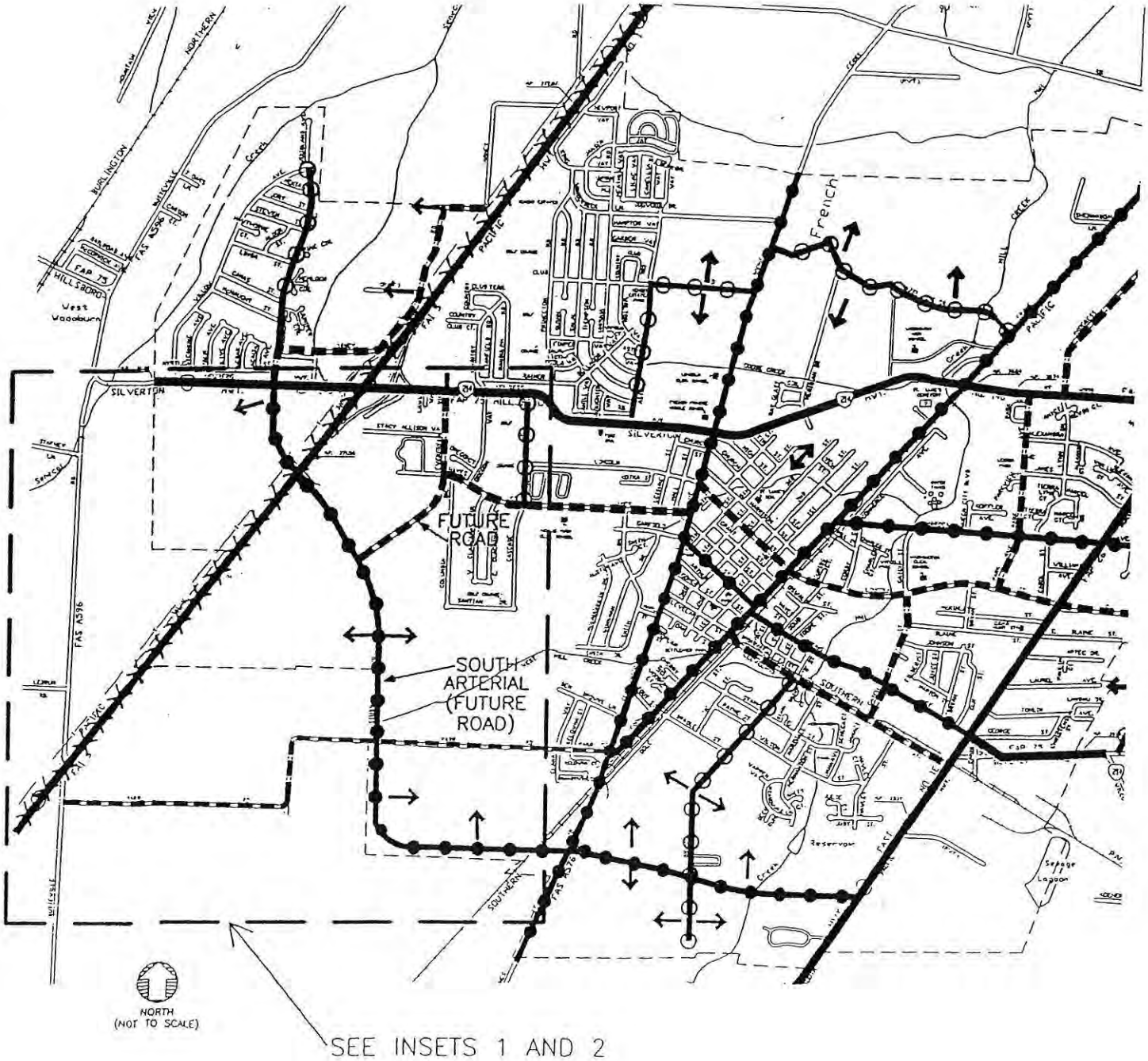

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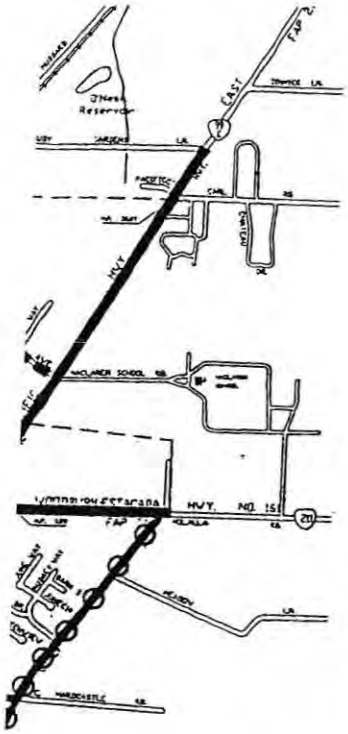
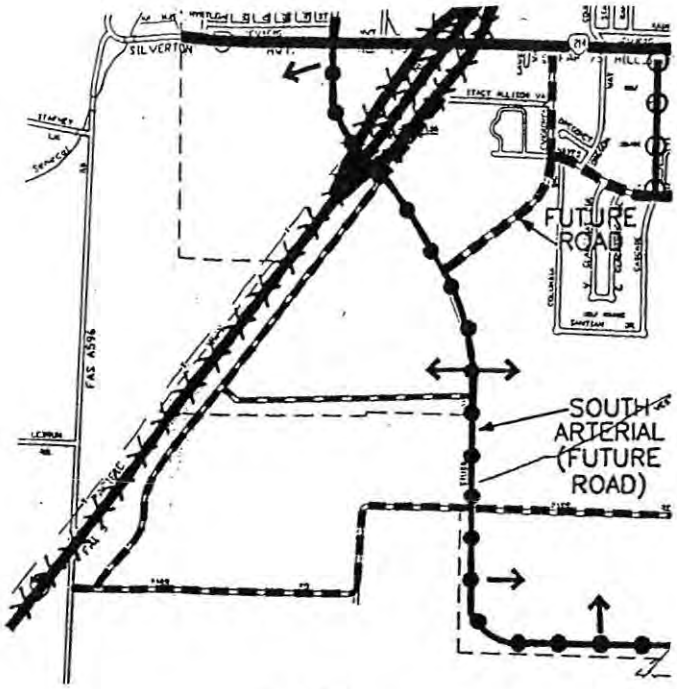
LEGEND

- MAJOR ARTERIAL
- MINOR ARTERIAL
- FREEWAY
- SERVICE COLLECTOR
- ACCESS STREET
- POTENTIAL LOCAL STREET CONNECTIONS

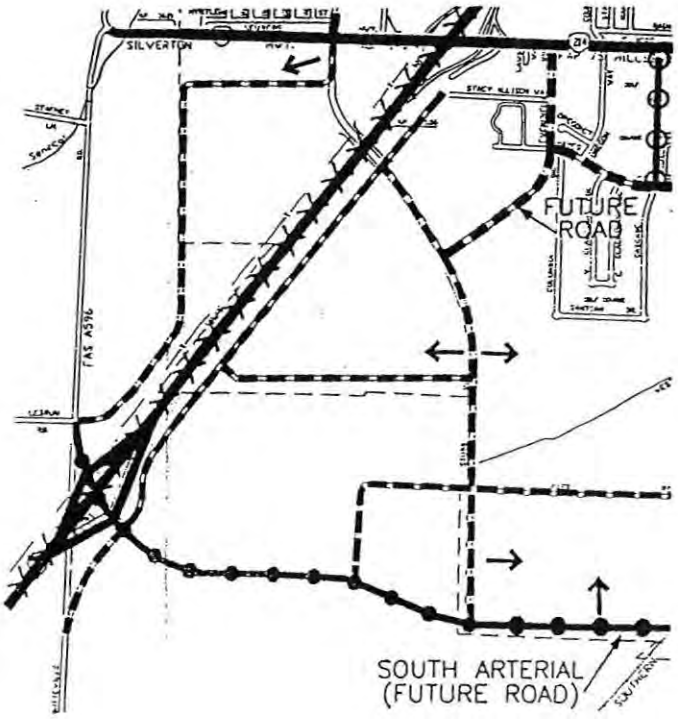
NOTES:

1. INCOMPLETE FUNDING PLAN, NO CONSTRUCTION DATE SCHEDULE 214/219, AND SOUTH ARTERIAL IMPROVEMENTS.
2. CONFIGURATION FOR I-5 INTERCHANGE AND SOUTH ARTERIAL IMP IN REFINEMENT STUDY.





INSET 1
I-5 SPLIT DIAMOND INTERCHANGE
ROADWAY SYSTEM OPTION



INSET 2
2nd I-5 INTERCHANGE
ROADWAY SYSTEM OPTION

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INTERCHANGE, HIGHWAY

S TO BE RESOLVED

STREET FUNCTIONAL CLASSIFICATION PLAN

CITY OF WOODBURN
TRANSPORTATION SYSTEM PLAN

JUNE 1996

FIGURE 29

9.2.2 Street Standards

Figure 30 presents typical cross sections for the different street functional classifications. The cross sections reflect the desire to develop multi-modal roadway facilities in Woodburn in the future, incorporating sidewalks and bike lanes where possible. The identified cross sections are intended for planning and design purposes for **new** road construction, and where it is physically and economically feasible to improve existing streets.

The typical street sections present standards for both traditional subdivision width local residential streets, as well as "skinny" streets with restricted width. A developer would have the prerogative of developing skinny streets in their development to reduce cost and provide more of a pedestrian environment, particularly applicable to more compact residential areas (often referred to as neo-traditional development). Skinny street sections also could serve as a deterrent to through or speeding traffic on local streets. The identified skinny street sections are consistent with similar standards adopted by the City of Portland and Washington County.

The widest road sections are associated with major and minor arterials, with five travel lanes desirable on new or improved major arterials (two through lanes in each direction plus a center left turn lane), and three lanes on minor arterials (one through lane in each direction plus a center left turn lane). These roads could have raised median development in lieu of a center left turn lane in certain locations, per final access management plans developed for such facilities. A service collector could have either two or three lanes, while all access streets would be two lane facilities. On-street parking would be discouraged on arterial and service collector streets, but allowed on access streets. Bike lanes would be an integral part of all new arterial and service collector streets. Sidewalks on both sides of all new arterial and collector streets will be required. Major reconstruction of existing arterials and collectors will include sidewalks and bikeways if right-of-way conditions permit.

9.2.3 Required Street Upgrades

Freeways

An element of the TSP is an improvement to the existing I-5/Highway 214 interchange. In the short-term, the following improvements are required:

Southbound I-5 Ramp/Highway 214 Intersection: Add a second left turn and right turn lane on the southbound I-5 off-ramp; restripe the eastbound intersection approach to include a through lane and a right turn lane; add a second left turn lane to the westbound approach.

Northbound I-5 Ramp/Highway 214 Intersection: Signalize; add a second right turn lane on the northbound I-5 off-ramp; add a second left turn lane to the eastbound approach; add a second through lane to the westbound approach.

In the longer-term, a reconfiguration of the interchange is proposed. A specific improvement (including but not limited to the following: improve existing interchange, split diamond interchange or second interchange at Butteville Road) will be identified through a follow-up interchange refinement study to the TSP. The specific alignment for the western portion of the South Arterial will also be identified in this study. The South Arterial will have a grade separation with I-5, and have a direct connection to I-5 under either the split diamond or second

interchange alternatives. The alignment of the South Arterial will need to be coordinated with site development plans on both sides of I-5.

For the purposes of illustrating how the South Arterial and connecting roadways would tie into the overall street, transit, pedestrian, bicycle, and golf cart facilities, the existing interchange with a northerly alignment for the South Arterial is used to illustrate the functional classification and associated pedestrian and bicycle facilities along this roadway and connecting streets. The I-5 split diamond interchange option (with a north alignment for the South Arterial) and the second plan configurations with I-5 interchange (with a south alignment for the south alignment for the South Arterial are shown as plan insets).

Major Arterials

Highway 219/214

Highway 214 is proposed to be widened to a five-lane facility from Woodland Avenue on the west to Highway 99E on the east, with the potential for such widening extending east of Highway 99E to the east city limits. A final access management plan for this roadway should be developed associated with future project development studies for such improvements, based on the access management concepts identified in the access management analysis conducted as part of the Woodburn TSP development. Improved signal coordination along this roadway is also proposed.

In addition to the before-mentioned improvements to the I-5 ramp intersections, there are two other major intersection improvements required along Highway 214 in the short-term, irrespective of this roadway being widened to five lanes. These improvements include:

Highway 214/Settlemier Avenue—Optimize the signal timing to minimize delay; add a second left turn lane on the northbound approach; and restripe the southbound approach to the intersection to include one left turn, one right turn, and one through lane.

Highway 214/Highway 99E—Add a second left turn lane to the eastbound intersection approach; restripe the westbound intersection approach to include one left turn lane, one through lane and one right turn lane; and add a second left turn lane to the northbound intersection approach.

Highway 99E

Highway 99E would remain a five-lane facility, with access management and sidewalk improvements on the section south of Lincoln Street. A final access management plan should be developed for this section as part of future project development studies, based on the acdcess management concepts developed as part of the Woodburn TSP study. As for Highway 214, improved signal coordination on this roadway is proposed.

At the Highway 99E/Young Street intersection, the reconfiguration of the east approach to the intersection is required, in particular realigning Cannery and George Streets away from the intersection. A westbound right turn lane on this approach is also required.

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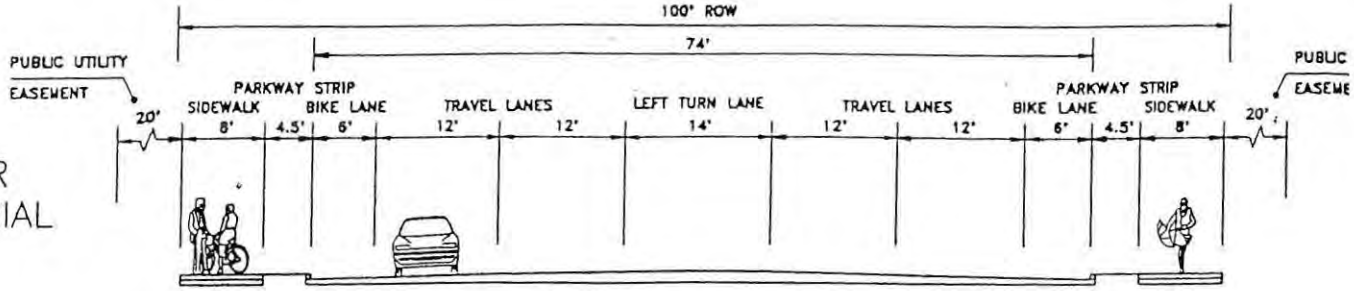
MAJOR ARTERIAL



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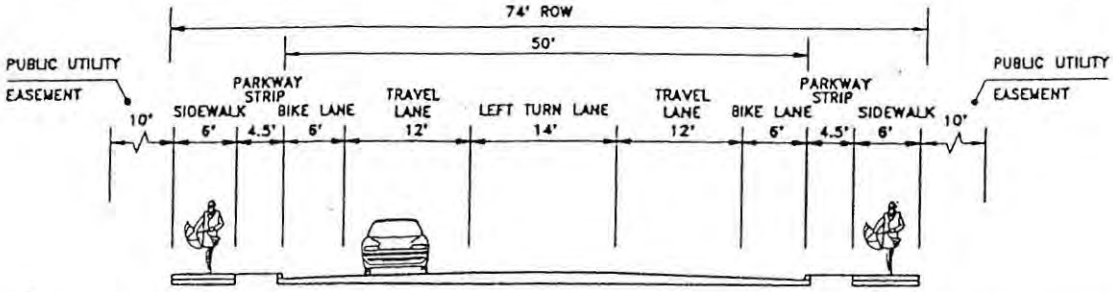
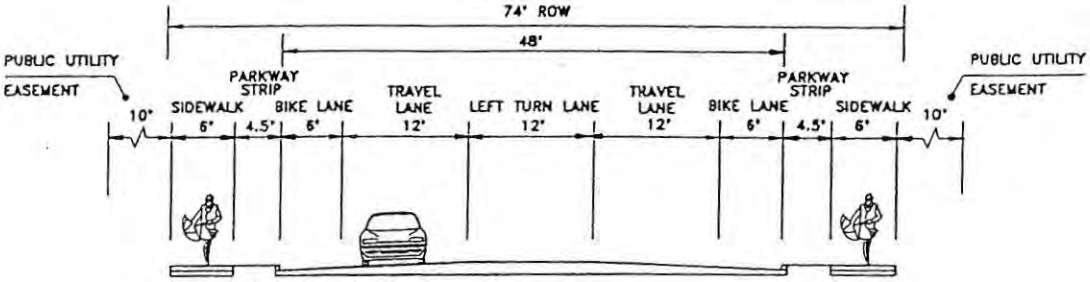
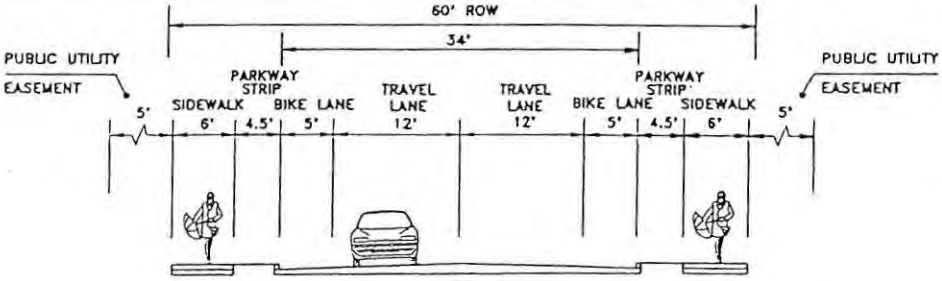


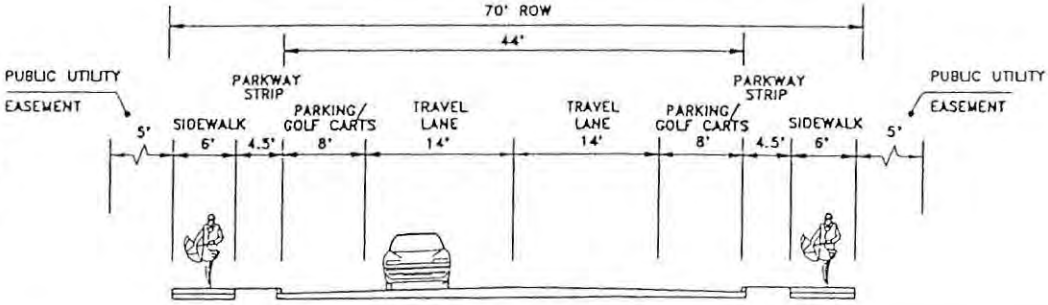
SERVICE COLLECTOR



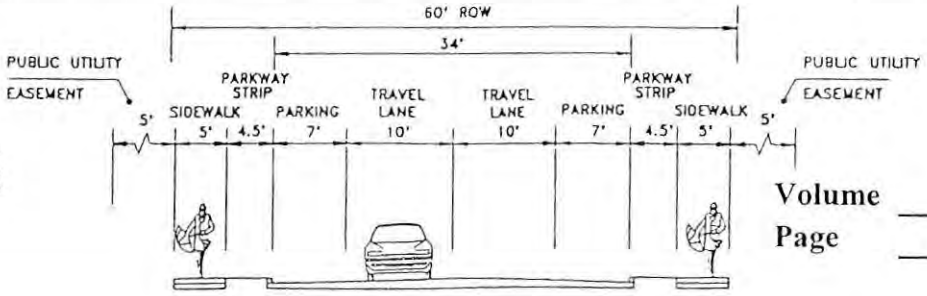
ACCESS STREET W/BIKE LANES

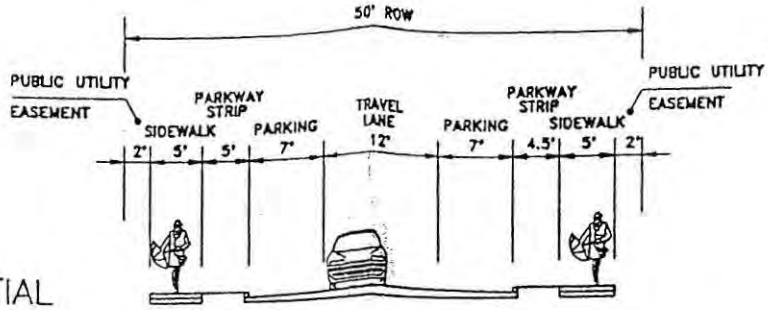


ACCESS STREET W/PARKING OR GOLF CARTS

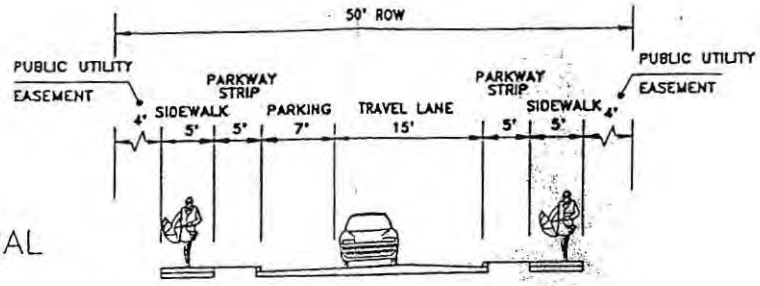


LOCAL RESIDENTIAL STREET W/PARKING BOTH SIDES

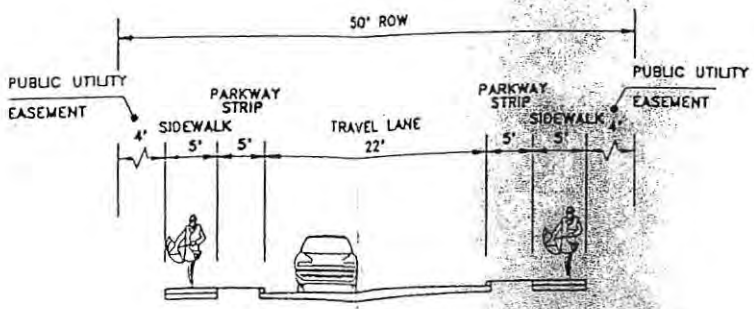




LOCAL RESIDENTIAL W/PARKING BOTH SIDES – "SKINNY" STREET



LOCAL RESIDENTIAL W/PARKING ONE SIDE – "SKINNY" STREET



LOCAL RESIDENTIAL W/ NO PARKING

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STREET TYPICAL CROSS SECTION

CITY OF WOODBURN
TRANSPORTATION SYSTEM PLAN
JUNE 1996

FIGURE 30

Highway 211

Highway 211 is envisioned to be either a three or five lane section east of Highway 99E in the future, pending the level of development along the roadway and the increase in traffic volumes.

Minor Arterials

The major minor arterial improvement in the TSP is the construction of a South Arterial between Highway 219 on the west and Highway 99E on the east. This roadway could tie into a new or modified I-5 (pending the results of an interchange refinement study). The road would be five lanes between Highway 219 and Evergreen Road, and three lanes east of Evergreen Road. This roadway would promote infill of existing vacant residentially zoned land in the southern part of the City within the UGB.

Front Street from Boones Ferry Road to Cleveland Street, from Hardcastle Avenue to Highway 214, and north of Woodburn High School is proposed to be improved to a widened 2-3 lane section. Likewise, Boones Ferry Road north of Highway 214 is envisioned to be improved to a three lane facility.

Service Collectors

Evergreen Road would be extended to the south to intersect the South Arterial wherever it is located. Service collector improvements are proposed along certain existing streets to create minor widening to develop bike lanes and sidewalks. In particular, West Hayes Street, Parr Road, and Arney Road should be widened. Also Cooley Road should be extended south of Lincoln Avenue to create a new north-south road east of Highway 99E.

Access Streets

Access streets in need of widening to accommodate bike lanes include Woodland Avenue north of an extended Arney Road, and Brown Street south of Bradley Street.

9.2.4 State Highway Access Management Strategies

There are operational and policy approaches to meeting the OHP Access Management Policy guidelines. From an operational perspective, the City of Woodburn and ODOT could (where appropriate) consider:

- planning for and developing a parallel road system which would provide local access to businesses adjacent to Highways 219/214 and 99E and reduce local traffic volumes on Highway 99E;
- planning for and developing intersection improvement programs in order to regularly monitor intersection operations and safety problems;
- purchasing right-of-way and closing driveways;
- installing median barrier and driveway access controls; and/or
- installing two-way left turn lanes.

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Purchasing right-of-way and closing driveways, without a parallel road system and/or other local access can seriously effect the viability of the businesses impacted. Thus, if this approach is taken, either a parallel road system, or shared access needs to be developed prior to "land-locking" a business.

There are also trade offs which need to be considered when considering the advantages and disadvantages of installing a median or two-way left turn lane. A median will prevent motorists from crossing the highway mid-block in order to access businesses on the opposite side of the street. But a median could also increase the volume of left turning or U-turning traffic at the signalized intersections, which could have a negative effect on intersection operations. Alternately research has shown that two-way left turn lanes have a greater effect on reducing accidents than medians[1]. However there are obviously conflicts and confusion which can occur when motorists are using two-way left turn lanes in areas with a high driveway density. To assess the need for median access control, driveway density, average daily traffic, queuing information, and detailed mid-block accident data is needed. As the mid-block accident data was not available for this study, the assessment was not performed.

From a policy perspective, as part of every land use action, the City of Woodburn and ODOT should evaluate the potential need for conditioning development with the following items in order to maintain and/or improve traffic operations and safety along Highways 219/214 and 99E in Woodburn:

- Crossover easements should be provided on all compatible parcels (topography, access, and land use) to facilitate future access between adjoining parcels. Figure 31 shows how this process would, in the long run, facilitate compliance with the ODOT Access Management Classification System.
- Conditional access permits should be issued on developments which have proposed access points that do not meet the designated access spacing policy and/or have the ability to align with opposing driveways. With a conditional access permit, when there is an opportunity to rectify this condition, the ODOT would have the right to require this correction.
- Right-of-way dedications should be provided to facilitate the future planned roadway system in the vicinity of the proposed development.
- Half-street improvements (sidewalks, curb and gutter, bike lanes/paths, and/or travel lanes) should be provided along site frontages which do not have full-buildout improvements in place at the time of development.

9.2.5 City Street Access Management Strategies

From a policy perspective, the City of Woodburn will manage access on new arterial and collector streets within its jurisdiction to provide efficient traffic movement and enhance safety. Policies would include criteria for street and driveway access, design of access and utilization of shared access when feasible. The City also intends to implement these policies along existing arterial and collector streets when significant redevelopment takes place.

1 FHWA, Technical Guidelines for the Control of Direct Access to Arterial Highways, August, 1975

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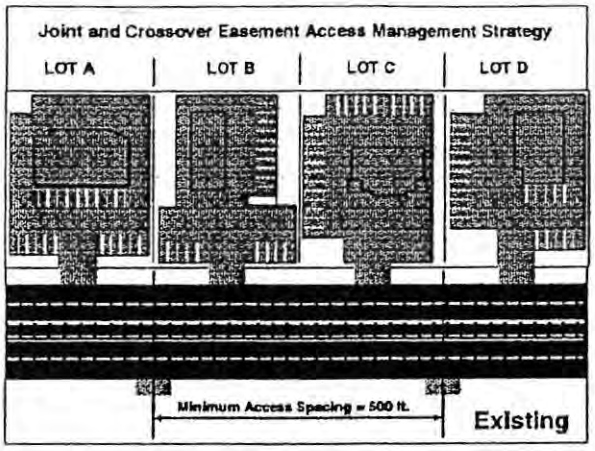
Proposed Access Management Strategy



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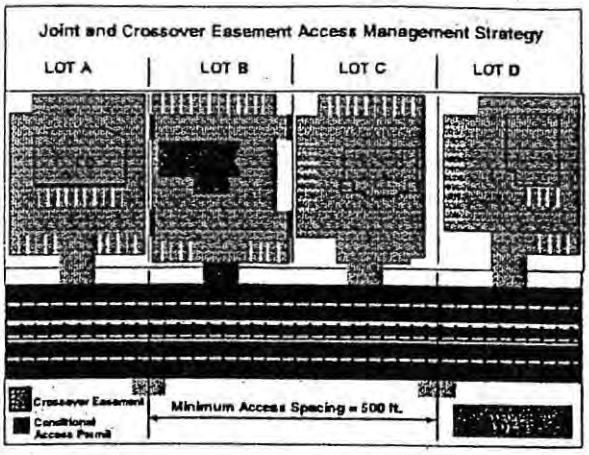

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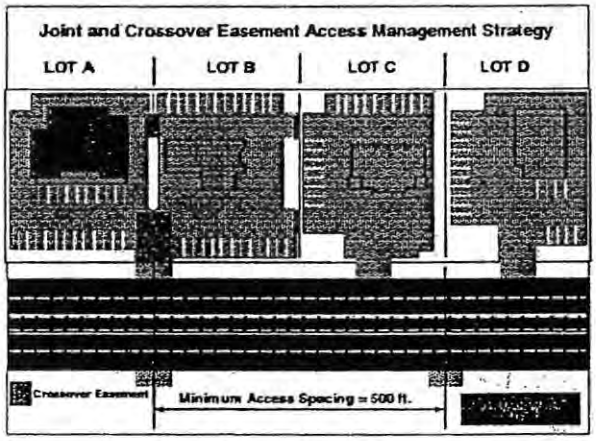

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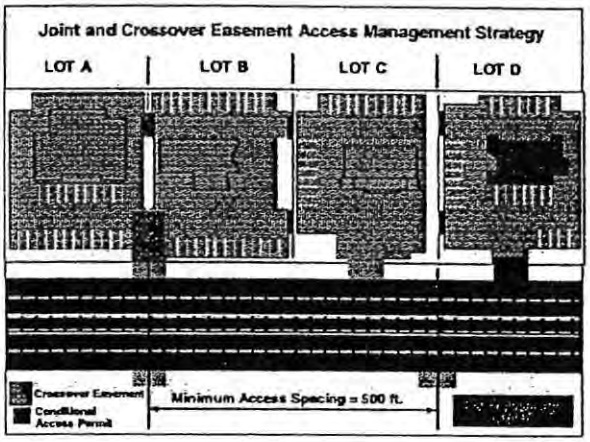

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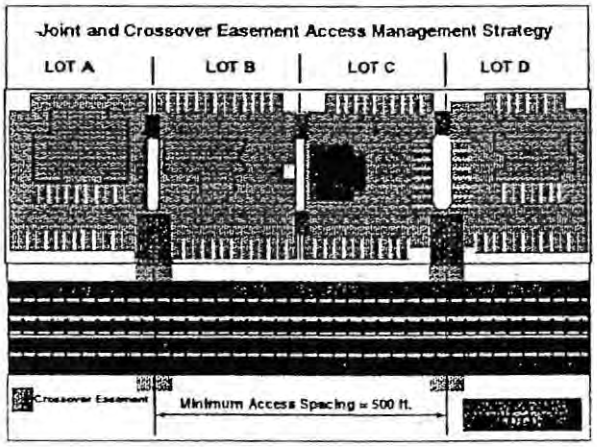

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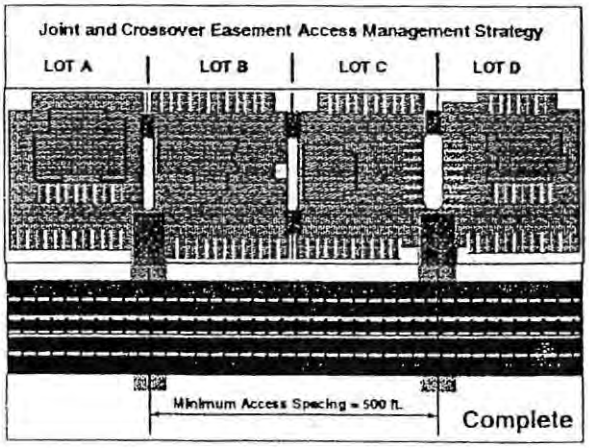

Step 6

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EXAMPLE OF CROSSOVER EASEMENT & CONDITIONAL ACCESS POLICY/PROCESS

CITY OF WOODBURN TRANSPORTATION SYSTEM PLAN APRIL 1996	FIGURE 31

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9.3 Transit Plan

The transit plan for the City of Woodburn includes both improved intracity transit service as well as developing an intercity shuttle bus service. Pending long-terms for intercity passenger rial service in the future, there is also the possibility of developing a downtown transportation center. Figure 32 illustrates the basic fixed route transit services in the plan.

9.3.1 Intracity Transit Service

The existing Woodburn fixed route transit system, operated by the City of Woodburn, is recommended to be initially expanded by converting the existing single bus route to two-way operation. Service frequency would be every 60 minutes, with service expanded to weekends. Over time, as ridership develops, service frequency could be expanded to every 30 minutes, at least during peak periods. As the residential area along north Boones Ferry Road, and the commercial area along Arney Road develop, minor deviations from the existing route should be considered to serve these areas. Bus service should also be extended to the Woodburn Industrial Park via Progress Way and Industrial Avenue. To operate a two-directional bus route at 60 minute headways, one added bus will have to be acquired. If service is increased to every 30 minutes, three added buses will be required.

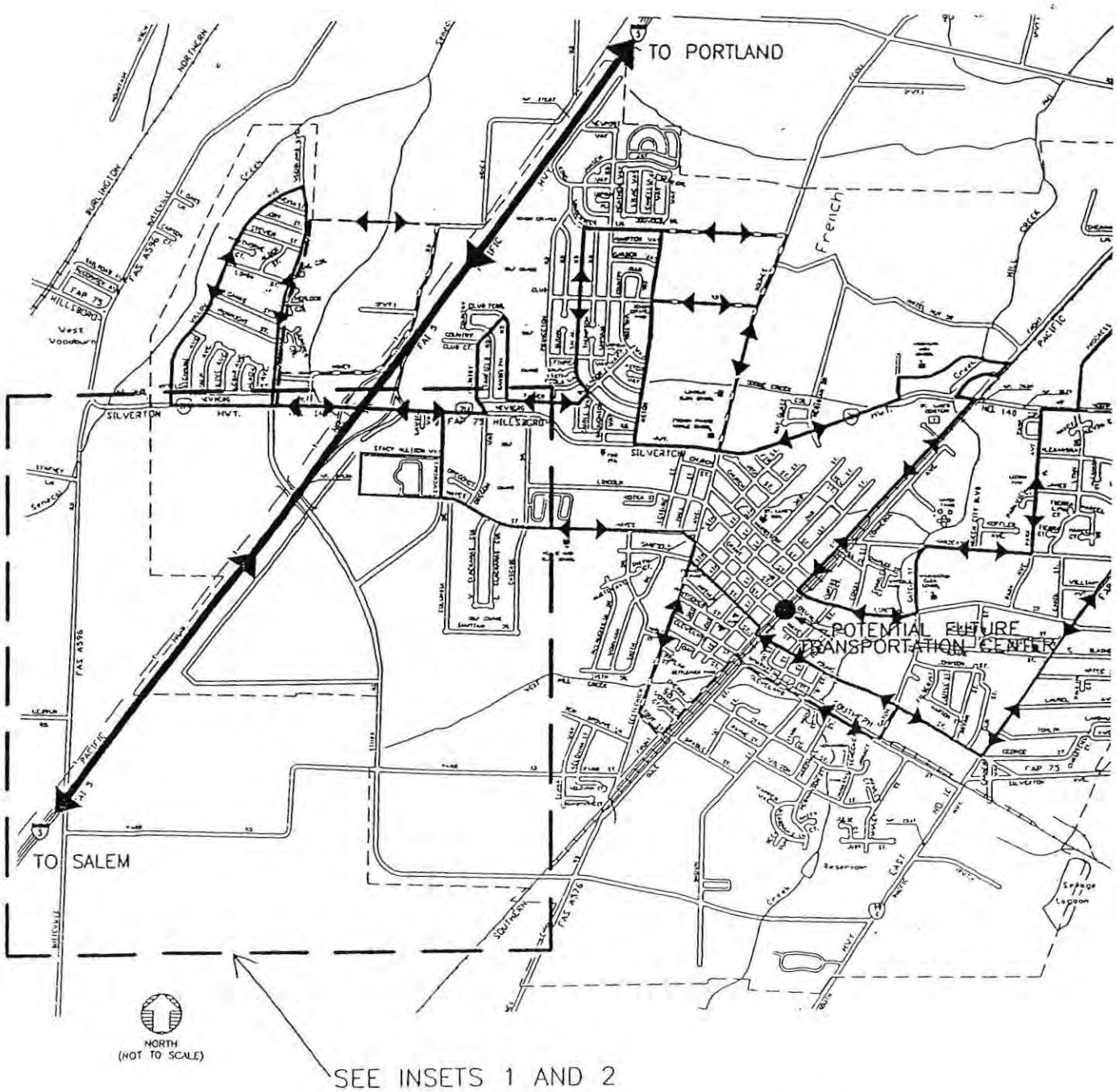
In addition to the fixed route bus service, the existing paratransit service provided by the City should continue to be provided, as well as a continuation of the Woodburn Taxi operation.

In the longer-term, as Woodburn continues to develop, and particularly if the City obtains an intercity passenger rail stop, consideration should be given to expanding the fixed route bus system to include two routes: east and west of the railroad tracks. Both routes would be oriented to a downtown transportation center, where intercity bus (and possibly) rail service would connect with the local system. A downtown transportation center should be located along Front Street, with at the minimum an auto passenger dropoff/pickup area provided. A limited park-n-ride facility could also be provided.

9.3.2 Intercity Transit Service

An added component of the Woodburn transit plan is the initiation of shuttle bus service between Woodburn and Portland and Salem. Top priority should be given to establishing service to downtown Portland, with an intermediate stop at the Tualatin park-n-ride. The second priority would be to establish service from Woodburn to downtown Salem, also serving the state office building area east of downtown. For each service, two round trips during both weekday AM and PM peak periods should be provided, with one midday round trip. 45-passenger buses are recommended for these intercity services, with two buses required for the Portland route, and one bus required for the Salem route. Consideration should be given to start-up of the Portland service with only one bus, with adding a second bus if ridership for this service develops.

To access the intercity shuttle bus service, a park-n-ride should be established in Woodburn, with a maximum of 300 spaces. The park-n-ride ideally should be located in the vicinity of the I-5/Highway 214 interchange, such that local traffic from both sides of the interchange could easily access this facility. To reduce park-n-ride-oriented traffic through the interchange, this facility might best be located off the proposed South Arterial, where there is vacant land



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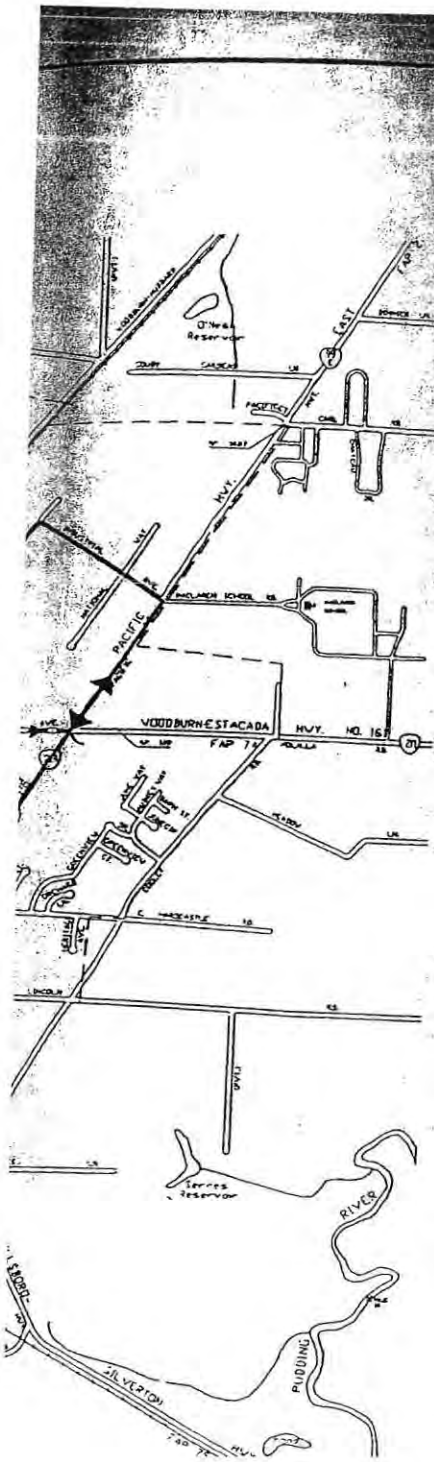
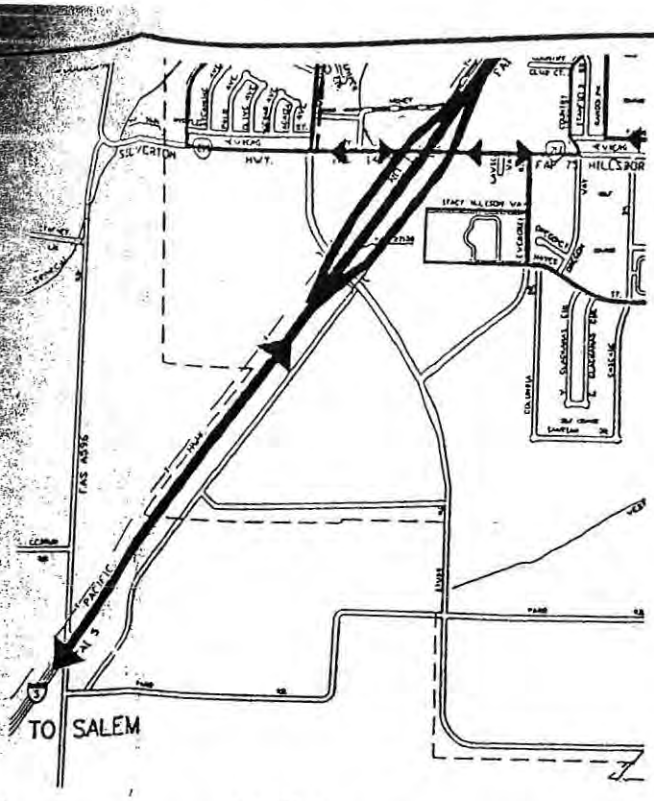
NOTES:

1. TWO INTERCITY BUS ROUTES (EAST US WEST SIDE OF SO
IN LONG-TERM, POSSIBLY CONNECTED TO DOWNTOWN TRA
2. PARK-IN-RIDE FOR INTERCITY SHUTTLE BUS SERVICE IN
INTERCHANGE.
3. INCOMPLETE FUNDING PLAN, NO CONSTRUCTION DATE SCH
214/219, AND SOUTH ARTERIAL IMPROVEMENTS.
4. CONFIGURATION FOR I-5 INTERCHANGE AND SOUTH ARTER
IN REFINEMENT STUDY.

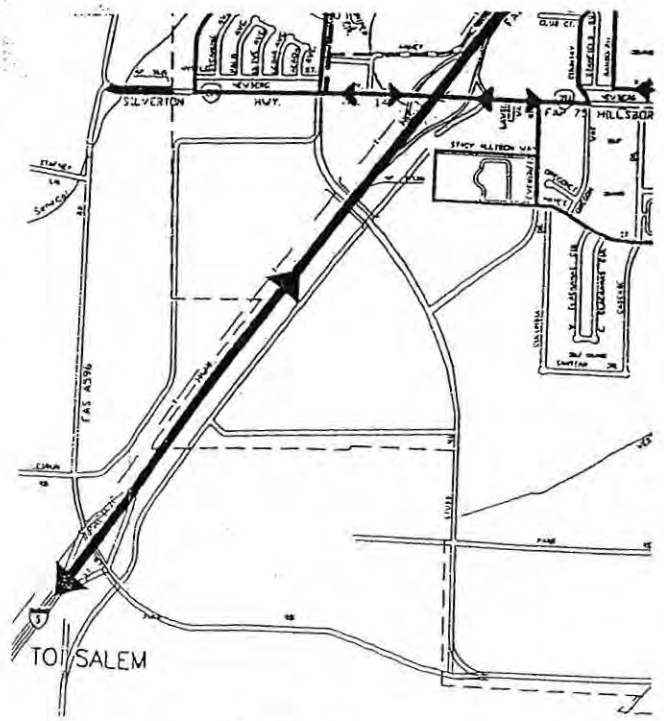
LEGEND

- INTERCITY BUS ROUTE AND DIRECTION OF TRAVEL
- OPTIONAL BUS ROUTING IN FUTURE AS AREA DEVELOPS
- INTERCITY SHUTTLE BUS SERVICE





INSET 1
I-5 SPLIT DIAMOND INTERCHANGE
ROADWAY SYSTEM OPTION



INSET 2
2nd I-5 INTERCHANGE
ROADWAY SYSTEM OPTION

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I PACIFIC RAILROAD) POSSIBLE
TATION CENTER.

' OF I-5/HIGHWAY 214

FOR I-5 INTERCHANGE, HIGHWAY

PROVEMENTS TO BE RESOLVED

1373FBS2

PUBLIC TRANSPORTATION PLAN

CITY OF WOODBURN
TRANSPORTATION SYSTEM PLAN

JUNE 1996

FIGURE
32

currently available. If a downtown transportation center is eventually developed, with the intracity bus service transfers at that location, consideration should be given to extending the intercity shuttle service into the city to serve this center as well.

An extension of Salem Transit bus service to Woodburn could replace or supplement the need for intercity shuttle bus service between Woodburn and Salem.

9.3.3 Further Study

The transit system analysis conducted as part of the Woodburn TSP study was a fairly cursory analysis, based on generalized transit demand assumptions in the future, and with no consideration on long-term vehicle maintenance and system administrative facility requirements. Modifications to the existing City paratransit system were also not explored. It is recommended that the City of Woodburn conduct a more detailed study of transit system improvements, by pursuing a separate "Transit Development Program" study. Funds for such studies are available from Federal Transit Administration Section 18 funding grants (administered by the ODOT Public Transit Division). An alternate funding source could be the ODOT TGM program, if extended beyond the next two years.

9.4 Pedestrian Facilities Plan

The recommended pedestrian facility plan is shown in Figure 33. As shown in this figure it is recommended that sidewalks be constructed throughout the City to develop and maintain a comprehensive sidewalk system. Most importantly it is recommended that as new developments are constructed or as road improvements are made existing sidewalks be connected to new sidewalks. Sidewalks should be included in any reconstruction of arterials or collectors. In addition it is recommended that an off-street pathway system be developed along existing creek corridors to facilitate non-automotive travel to schools and recreational, commercial and employment areas within Woodburn.

9.5 Bicycle Facilities Plan

As shown in Figure 34, the recommended bicycle facility plan includes constructing bicycle lanes on most all roadways classified as service collector roads or higher. The figure also shows the existing bicycle lanes. When constructed this bicycle facility plan will provide a comprehensive system of bicycle lanes throughout Woodburn. This system will also interconnect with the recommended off-street pathway system allowing cyclists to travel off the main roadways to gain access to schools and recreational commercial, and employment facilities in Woodburn. Bike lanes should be incorporated into any arterial or collector reconstruction projects.

9.6 Golf Cart Facilities Plan

The recommended golf cart facility plan is shown in Figure 35. This plan was developed to allow golf carts access to downtown Woodburn, the retail development west of Senior Estates in the southeast quadrant of the interchange, and the off-street pathway system.

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9.7 Rail Facilities Plan

As part of the transit facilities plan, and in order to encourage intermodal travel, it is recommended that as the opportunity arises, the City of Woodburn strive toward the developmet of a passenger rail stop in downtown Woodburn. This would facilitate the development of a multi-modal transportation facility in the downtown area which would encourage travelers to use Woodburn Transit to travel to the rail station and the train to travel to other destinations outside of Woodburn.

Regarding rail grade crossings, the city will make every effort to ensure that when appropriate rail grade crossings will be modified to ensure safe crossings for motorized and non-motorized modes of transportation. Modifications will be made in accordance with the guidelines described in the *Manual on Uniform Traffic Control Devices* (published by the United States Federal Highway Administration).

9.8 Air, Water, and Pipeline Transport Facilities Plan

As there are no significant, air, water or pipeline transportation facilities in Woodburn, no transportation system planning was performed for these modes.

9.9 Transportation Demand Management Plan

To encourage a reduction in the use of motor vehicles in the future, the City should adopt in its zoning ordinance requirements by developers to provide bicycle/carpool parking and carpool matching services, as well as incentives to employers to provide transit fare subsidies and flexible work hours, as well as promote telecommuting opportunities. Possible text modifications to the ordinance to incorporate these provisions is presented in Section 11. Institution of improved intracity bus service as well as new intercity bus service as identified in the Woodburn TSP also serve as TDM strategies.

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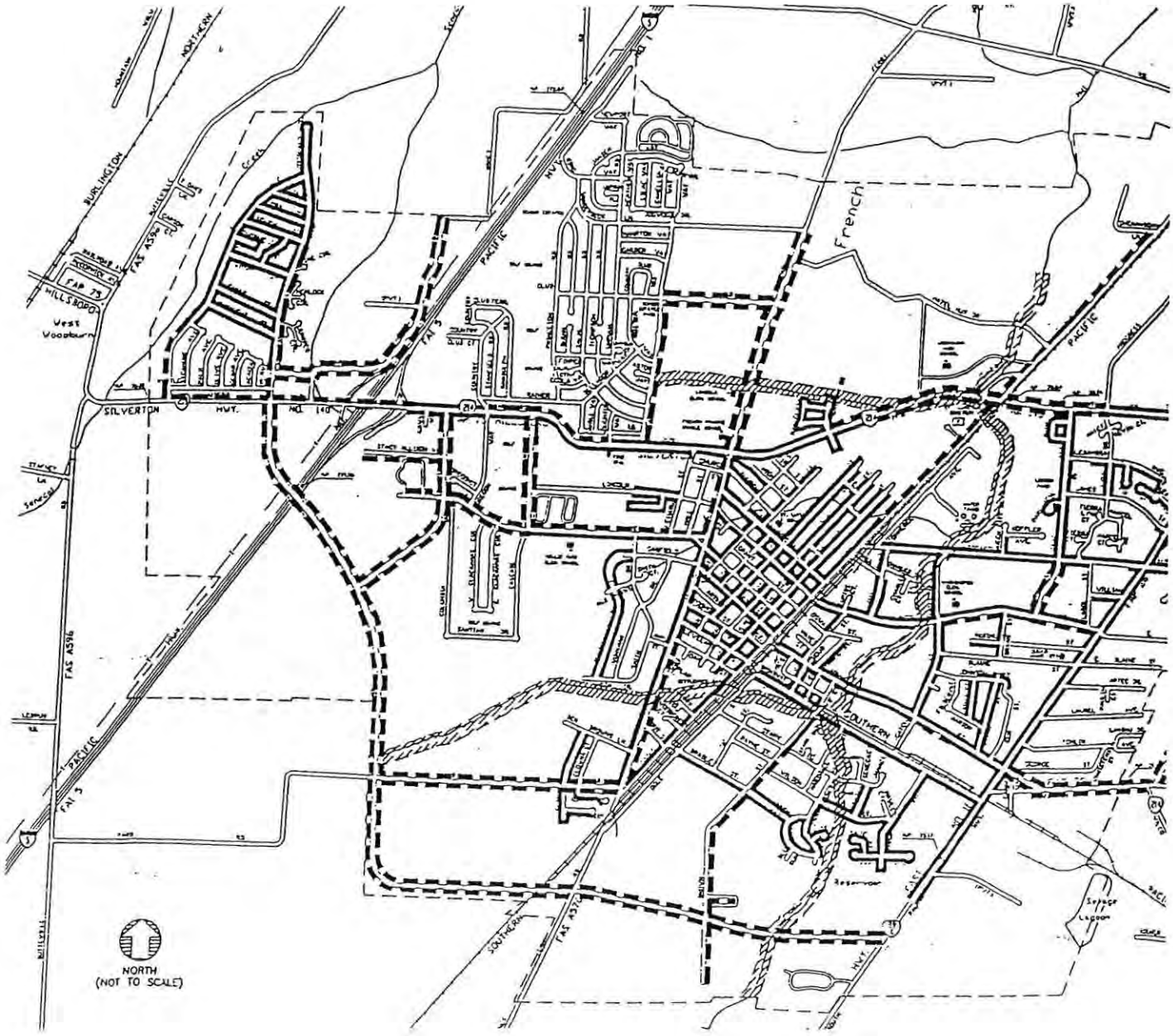

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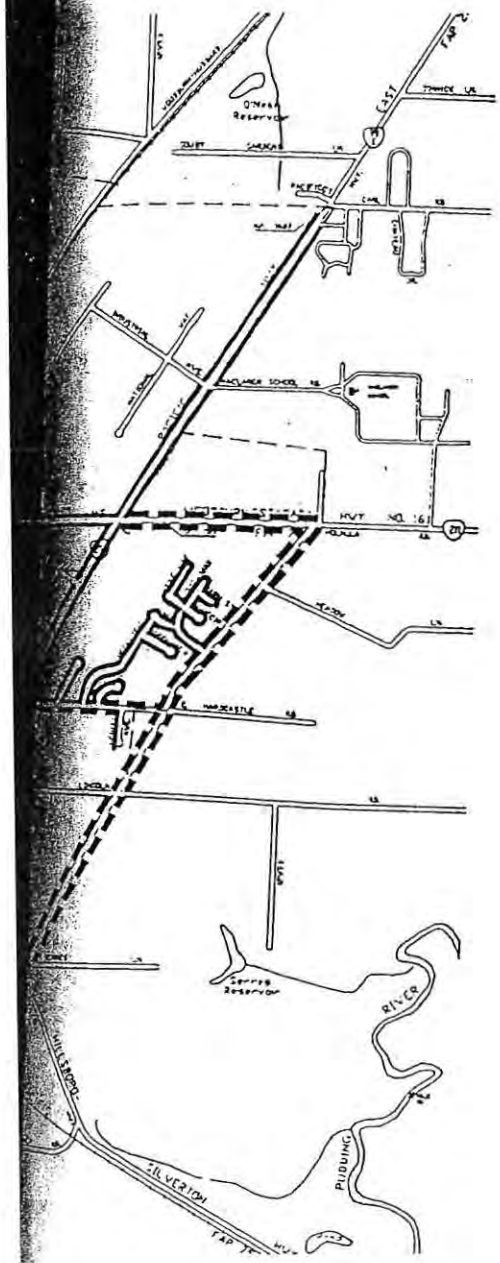
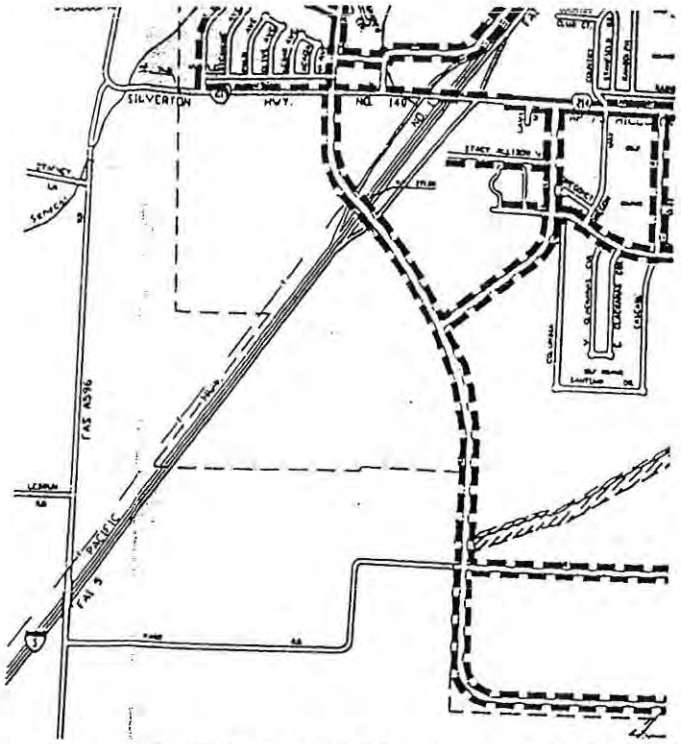
LEGEND

- EXISTING SIDEWALKS
- NEW SIDEWALKS
- NEW OFF-STREET PATHWAYS

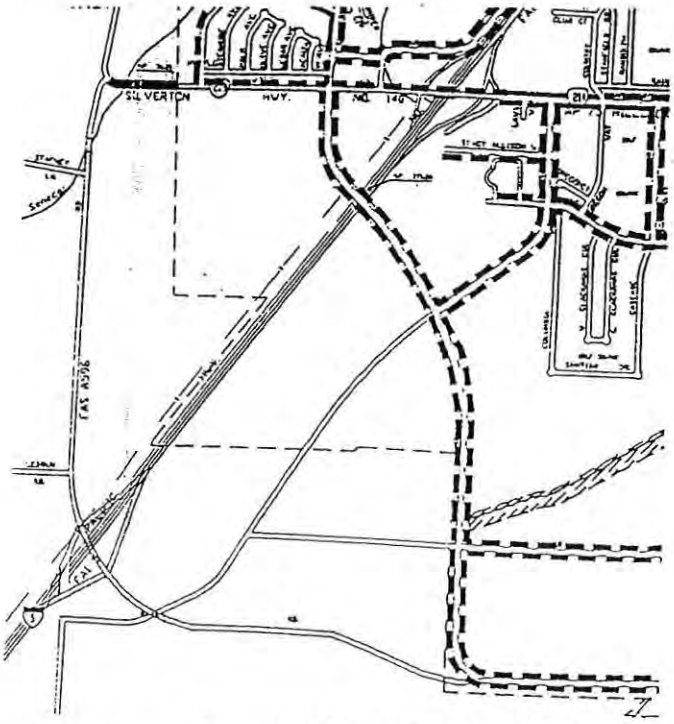
NOTES:

1. INCOMPLETE FUNDING PLAN, NO CONSTRUCTION DATE FOR I-5 INTI AND SOUTH ARTERIAL IMPROVEMENTS.
2. CONFIGURATION FOR I-5 INTERCHANGE AND SOUTH ARTERIAL IMPRO IN REFINEMENT STUDY.





I-5 SPLIT DIAMOND INTERCHANGE
ROADWAY SYSTEM OPTION



2nd I-5 INTERCHANGE
ROADWAY SYSTEM OPTION

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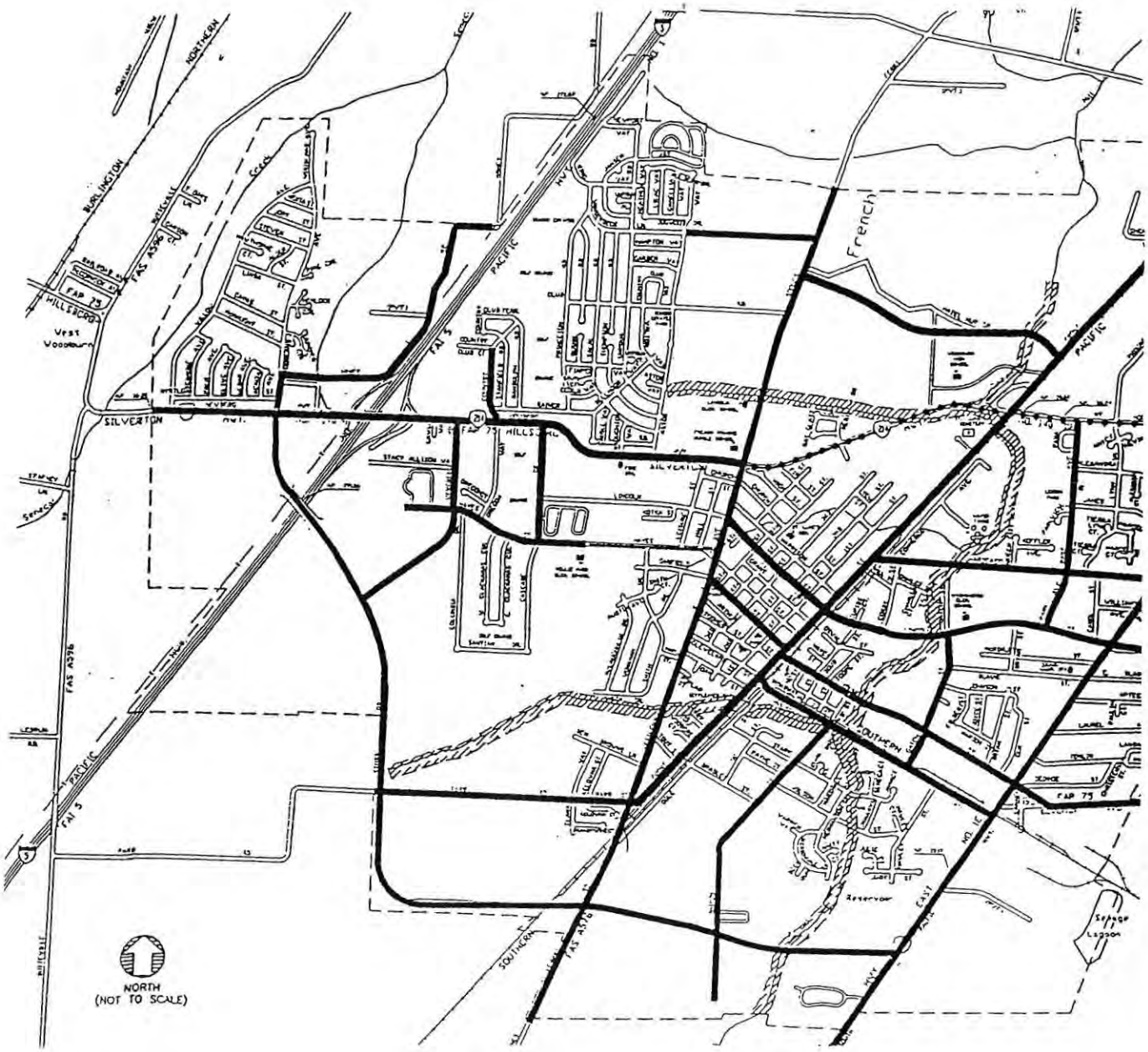
TERCHANGE, HIGHWAY 219/214.

OVEMENTS TO BE RESOLVED

PEDESTRIAN FACILITY PLAN

CITY OF WOODBURN
TRANSPORTATION SYSTEM PLAN
JUNE 1996

FIGURE
33

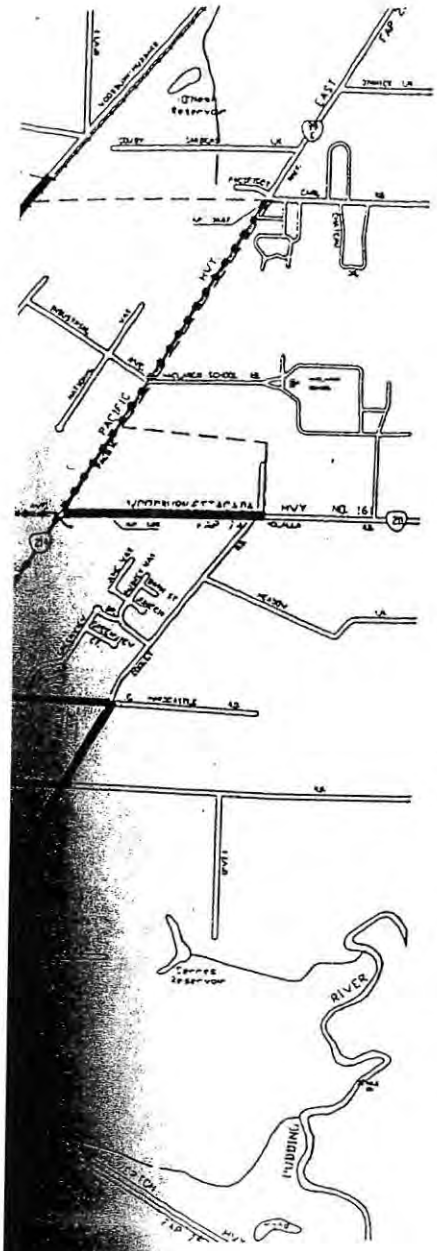


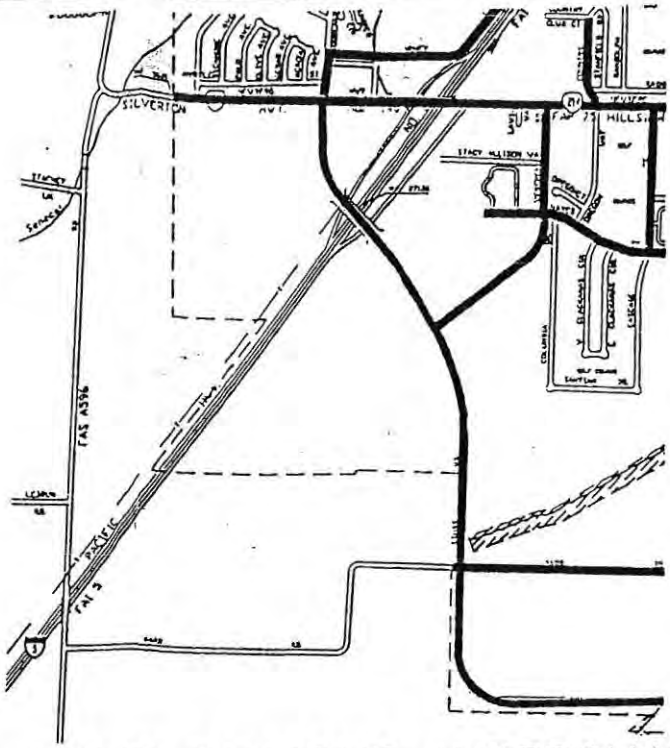
NOTES:

1. INCOMPLETE FUNDING PLAN, NO CONSTRUCTION DATE FOR AND SOUTH ARTERIAL IMPROVEMENTS.
2. CONFIGURATION FOR I-5 INTERCHANGE AND SOUTH ARTER IN REFINEMENT STUDY.

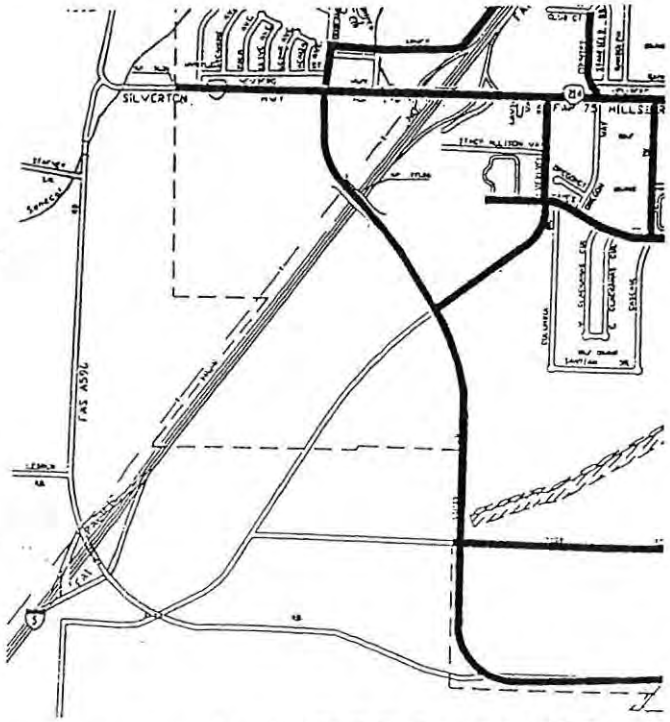
LEGEND

- EXISTING ON-STREET BIKE ROUTES
- NEW ON-STREET BIKE ROUTE
- OFF-STREET BIKE PATH





I-5 SPLIT DIAMOND INTERCHANGE
ROADWAY SYSTEM OPTION



2nd I-5 INTERCHANGE
ROADWAY SYSTEM OPTION

HIGHWAY 219/214.

BE RESOLVED

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BICYCLE FACILITY PLAN

CITY OF WOODBURN
TRANSPORTATION SYSTEM PLAN

JUNE 1996

FIGURE
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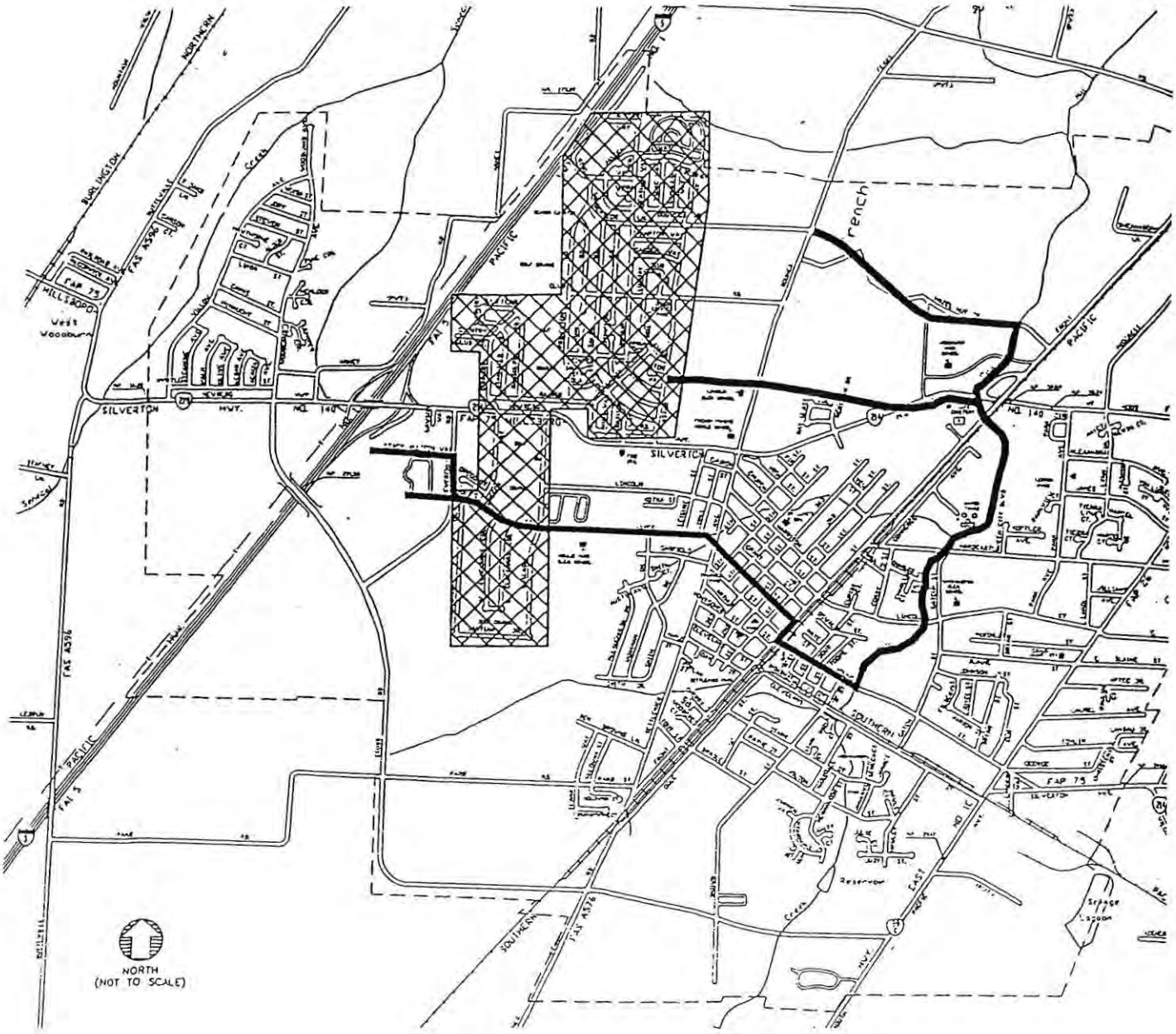


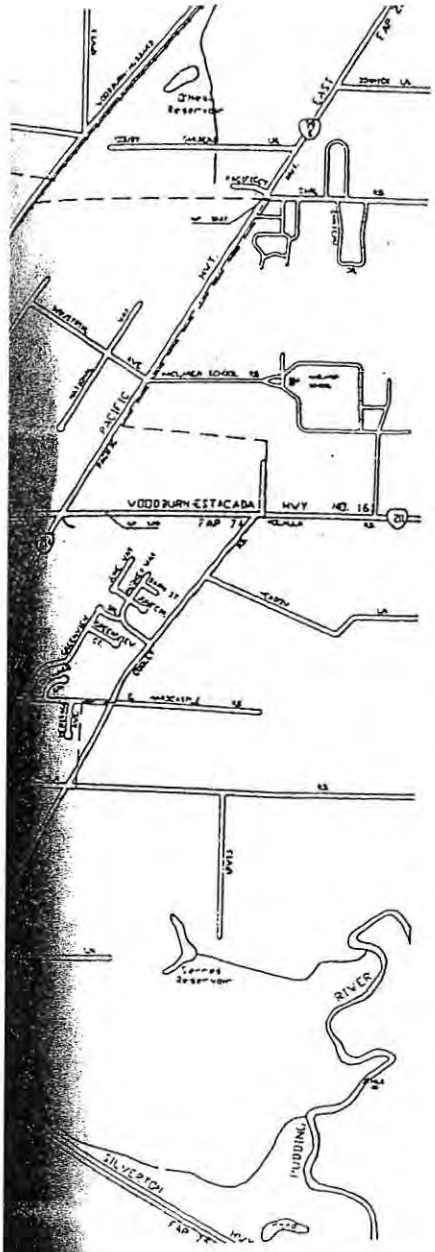
NOTES:

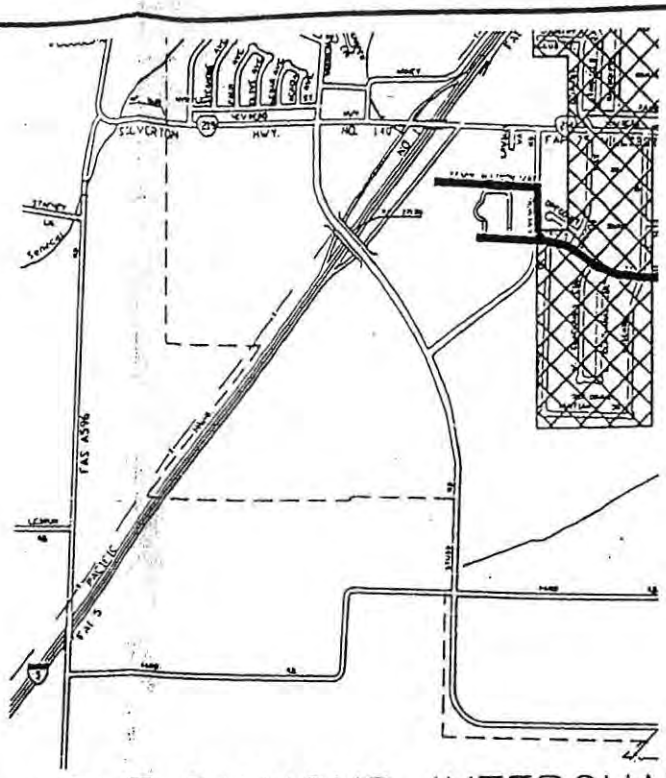
1. INCOMPLETE FUNDING PLAN, NO CONSTRUCTION DATE FOR I-5 AND SOUTH ARTERIAL IMPROVEMENTS.
2. CONFIGURATION FOR I-5 INTERCHANGE AND SOUTH ARTERIAL I IN REFINEMENT STUDY.

EG

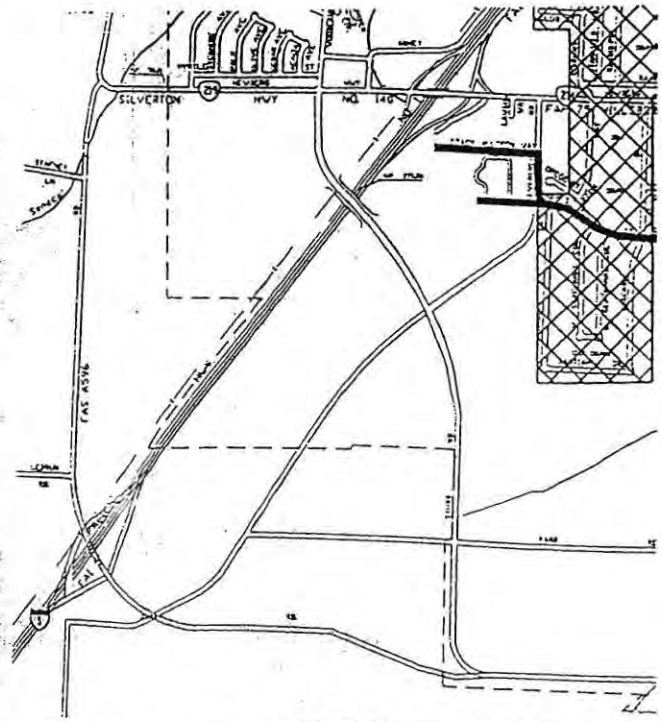
AREA WHERE GOLF CARTS PERMITTED ON LOCAL STREETS

NEW STREETS/PATHWAYS WITH DESIGNATED GOLF CART USE





I-5 SPLIT DIAMOND INTERCHANGE
ROADWAY SYSTEM OPTION



2nd I-5 INTERCHANGE
ROADWAY SYSTEM OPTION

1373FGLF

HANGE, HIGHWAY 219/214,

ENTS TO BE RESOLVED

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GOLF CART FACILITY PLAN

CITY OF WOODBURN
TRANSPORTATION SYSTEM PLAN

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Section 10

Transportation Financing Plan

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10.0 Transportation Financing Plan

10.1 Introduction

The Goal 12 Transportation Planning Rule (*OAR 660-12-040*) requires that Transportation Systems Plans for cities with populations over 2,500 persons include a transportation financing program. Transportation financing programs must include a list of planned transportation facilities and improvements, and an estimate of the timing and costs of proposed projects. They must also include an analysis of the ability of existing and potential funding mechanisms to fund proposed transportation improvements.

According to the *1993 Oregon Roads Finance Study*, nearly one-third of Oregon's road miles are in poor condition. City transportation financing needs for the next 20 years total nearly $8 billion. Over 40 percent of this need is unfunded at this time. Woodburn almost certainly shares some of this unfunded transportation need. Growth pressures combined with the general anti-tax sentiment of Oregon voters make the development of adequate and equitable funding mechanisms an important part of an overall transportation strategy.

The City of Woodburn will probably need to find new financing mechanisms to address transportation systems maintenance and improvements over the next 20 years. This memorandum provides an analysis of transportation financing options for the City of Woodburn. It describes transportation financing mechanisms used by the City, identifies and evaluates potential financing alternatives and programs, and describes funding guidelines associated with selected programs.

The analysis of financing options began with a review of the City's budget and Capital Improvement Plans. This review identified the current status of transportation financing in Woodburn. To identify existing and potential funding programs existing studies were reviewed and phone interviews were conducted with people knowledgeable about transportation finance. Existing and potential funding mechanisms were evaluated against standard criteria:

1. Legal authority;
2. Financial capacity;
3. Administrative cost;
4. Equity;
5. Political acceptability; and
6. Stability.

Transportation funding sources are summarized in Chapter 3.

In the financing program the terms *funding* and *financing* are distinguished. *Funding* describes any mechanism that generates revenue for transportation-related projects. *Financing* more narrowly refers to ways to spread out the impact of collecting funds through the issuance of debt obligations that are repaid over time, with interest. In other words, all transportation projects are funded by some means; some funding is financed by borrowing money to pay for the projects. Funding can occur on a pay-as-you-go basis or through various financing mechanisms.

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10.2 Existing Transportation Funding in Woodburn

Transportation-related expenditures in Woodburn, including transit, are $1.4 million (approximately 17%) of Woodburn's proposed 1995-96 budget of $20 million.

10.2.1 Road-Related Funding

Table 13 summarizes recent road-related transportation funding in Woodburn, for the last five fiscal years (1990-91 to 1994-95). This table consolidates revenues and expenditures tracked by separate funds in the City of Woodburn budget. Table 13 reports on the State Revenue Sharing, Street, City Gas Tax, Special Assessment, Street/Storm Drain Capital Improvement, and Transportation Impact Fee Funds.

Table 13

Road-Related Funding in Woodburn

	1990-91 Received	1991-92 Received	1992-93 Received	1993-94 Received	1994-95 Received
Revenues					
Working Capital Carryover	238,540	284,559	274,044	339,841	341,629
Interest from Investments	26,524	9,985	8,270	10,603	14,169
State Highway Trust Fund	486,165	530,628	580,618	638,150	689,686
State Revenue Sharing	56,505	70,376	64,340	66,500	71,500
Federal ISTEA Revenue	0	0	0	0	0
City Gas Tax	94,729	103,873	101,900	99,552	107,139
Fees and Assessments	156,400	216,258	39,221	28,129	344,028
Bond Proceeds	0	0	0	0	0
Other Revenues	43,415	9,008	186,773	29,877	36,383
Total Revenues	1,102,278	1,224,687	1,255,166	1,212,652	1,604,534
Expenditures					
Personal Services	192,676	217,102	231,230	252,660	279,507
Materials and Services	179,210	217,678	211,934	247,698	288,551
Capital Outlay	335,141	366,860	356,062	197,665	322,692
Bond & Assessment	6,495	0	150	0	0
Transfers/Contingencies/UNAP	104,696	149,000	169,000	175,000	215,000
Total Expenditures	818,218	950,640	968,376	871,023	1,105,750

Source: City of Woodburn Budget, 1990-1991, 1991-1992, 1992-1993, 1993-1994, and 1994-1995.

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Table 13 also reports as expenses transfers to the Street Equipment Replacement Reserve, Transit Equipment Replacement Reserve, and the Technical and Environmental Service Funds (these funds accumulate minor amounts of interest revenue that is not included in Table 13). Transit fund revenues and expenditures are reported separately in Table 14.

Table 13 shows that the State Highway Trust Fund and other shared state revenue is the largest contributor to road-related revenue in Woodburn, contributing $486,000–$690,000, or about 50% of total road-related revenue. Locally-generated revenue includes the city's $0.01/gallon gas tax, LID bonds funded by assessments to property owners that benefit from improvements, Transportation Impact Fees paid by new development, and a gas and electrick utility privilege tax. Together, these revenues contribute 11–26% of road-related revenue.

The city's gas tax is a stable source of revenue, ranging from $95,000–107,000 in the past five fiscal years, an average annual increase of 2.5%. LID assessments and Transportation Impact Fees (TIFs) vary widely with construction of specific projects and the amount of new development that pay impact fees. The City's TIF is a System Development Charge designed to assess new development for the costs of off-site transportation infrastructure needed to meet increased demand generated by the new development. A consultant developed a method for allocating the cost of road improvements to new development. The City Council adopted the TIF at 25% of the level recommended by the consultant; the fee will increase 1% per year for five years. At the end of the five year period the City Council will re-evaluate the TIF; FY96 is the third year of this five-year period.

Capital Outlay expenditures typically account for 23–41% of total annual city expenditures. Recent projects funded by LIDs include the K-Mart/Bi-Mart traffic signal on Highway 214 ($123,000) and Cleveland Street improvements ($308,000). Capital improvements to the Woodland Drive/Highway 214 intersection ($394,000) were funded by an Economic Development grant and property owner reimbursements. Remaining capital expenditures are for road resurfacing and various other improvements.

Expenditures for Personal Services (wages, salaries, and benefits) and Materials and Services typically account for 45–58% of total annual city expenditures. The largest line item included in Materials and Services is for Street Light Installation and Operation, followed by Road Supplies and Materials. Materials and Services also includes a wide variety of smaller expenditure items, such as gasoline, uniforms, office supplies, insurance, and paint. Transfers/Contingencies/Unappropriated funds are largely transfers to Technical and Environmental Services, for management of the Public Works Department and Garage, and to the Street Equipment Replacement Fund, which accumulates money to replace street equipment.

Remaining expenditures are for administration of bond sales and property owner assessments, transfers to the Street Equipment Replacement Reserve Fund and the Technical and Environmental Services Fund, contingency set-asides, or unappropriated expenses.

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10.2.2 Transit-Related Funding

The Transit System Fund accounts for 4% of Woodburn's $3.4 million General Fund budget proposed for FY 1995-96. Table 14 summarizes revenues and expenditures in the Transit System Fund over the past five fiscal years (1990-91 to 1994-95), which reports separate accounts for the city's fixed-route transit and dial-a-ride services. Property tax typically provides 24–37% of total transit revenue in Woodburn. State grants and a special transportation grant (reported as Revenue From Other Agencies) are the second largest revenue source, typically providing 17–22% of total revenue. Transit fares, reported in Other Revenues, account for about 7-14% of annual transit revenue, reaching the highest percentage in FY 1994-95.

Table 14

Transit Funding in Woodburn

	1990-91 Received	1991-92 Received	1992-93 Received	1993-94 Received	1994-95 Received
Revenues					
Working Capital Carryover	49,175	53,776	63,392	69,615	68,782
Property Taxes	40,061	42,592	48,907	41,360	56,385
Interest from Investments	5,010	3,747	3,256	2,469	4,072
Revenue from Other Agencies	61,862	33,688	127,577	31,019	30,656
Transit Fares	14,576	16,377	18,799	17,614	25,075
Total Revenues	170,684	150,180	261,931	162,077	184,970
Expenditures					
Personal Services	56,143	65,159	61,858	62,766	68,941
Materials and Services	26,934	21,611	25,476	26,529	29,054
Capital Outlay	33,831	20	104,984	0	0
Transfers/Contingencies/UNAP	-	-	-	4,000	7,000
Total Expenditures	116,908	86,790	192,318	93,295	104,995

Source: City of Woodburn Budget, 1990-1991, 1991-1992, 1992-1993, 1993-1994, and 1994-1995.

The $104,984 capital outlay in FY 1992-93 was for a bus that provides most of the transit service in Woodburn; this purchase was primarily funded by a state grant. In other years, expenditures for Personal Services and Materials and Services account for almost all transit expenditures.

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10.3 Summary Of Outlook For Existing Transportation Funding Sources

The State Highway Fund should be a relatively stable source of revenue for Woodburn. Because these funds are distributed to cities based on population, Woodburn's share could increase or decrease depending on whether its population increases faster or slower than the state average. It is expected that Woodburn's population will grow at a rate greater than the state average. Nonetheless, Woodburn's share of state funds will probably not increase as fast as its street maintenance requirements will, as the system expands to serve the growing population and through traffic. State Revenue Sharing funds are likely to decrease gradually in real terms. ODOT's forecast of ISTEA revenue available to the state shows funds are not expected keep pace with inflation.

Revenue from the City's $0.01/gallon Gas Tax may also gradually erode by increasing less than inflation. Since the tax is based on quantity rather than price, tax revenues will not increase with as gasoline prices rise. In fact, a large increase in gasoline prices could *decrease* tax revenue by reducing demand. Population growth and increased through traffic may cause Gas Tax revenue to increase faster than inflation in some years. Actual change in real Gas Tax revenues depends on the inflation rate, population growth, gasoline demand, and changes in the tax rate. We do not have enough information about these variables to accurately forecast the change in Gas Tax revenue relative to inflation.

Bonds financed by Local Improvement Districts (LIDs) and fees from the Systems Development Charge (SDC) will remain important sources of transportation revenue in Woodburn. Future bond revenue depends on the willingness of property owners to form LIDs to levy assessments. Typically, LIDs are formed to finance projects that benefit existing or new commercial development, while SDCs are assessed only to new residential and commercial development. Population growth in Woodburn will increase SDC revenue and should contribute to continued support for LIDs because growth will increase the value of existing commercial property and create demand for new commercial development. To the extent that these funding sources charge the full cost of the transportation improvements, they should allow Woodburn to construct capital improvements to serve commercial and residential development.

ODOT's forecast of ISTEA revenue available to small cities shows funds are not expected to keep pace with inflation. The actual amount Woodburn receives depends on whether the City has projects that qualify for ISTEA funding, the extent to which the City pursues the funds, and the level of competition for the funds from other small cities in Oregon. Since Woodburn has only occasionally received ISTEA funds in the past, it is not expected a significant increase in the share these funds contribute to transportation revenue.

Property tax revenue to the City General Fund should increase faster than inflation due to continued rapid appreciation of real property values and new development in Woodburn. Property tax revenue will likely remain a significant source of revenue for transit operations. The forecast decline in the state's Special Transportation Fund should be offset by continued ISTEA funding for transit capital improvements and increasing revenues available for state matching grants. Woodburn has been successful in securing these funds for equipment purchases in the past and should continue to do so. State funds available for transit operation are expected to decline in real terms over the next 20 years unless taxes for transit are increased. The current Statewide Transportation Improvement Program (STIP) includes state revenue for transit operations in Woodburn—$86,700 in FY95 and $16,700 annually in the following three fiscal years. The STIP also includes $65,000 for Woodburn to purchase a transit vehicle in

FY96. Farebox revenue will probably continue to provide only a small share of transit revenues.

In summary, it is expected that federal and state sources of transportation revenue to gradually decline in real terms over the next 20 years. Revenues from ISTEA and the State Highway Fund, even under the optimistic forecast of ODOT, are not expected keep pace with inflation. Woodburn's gas tax and utility privilege tax should remain a relatively stable source of revenue in this period, particularly if it is raised a few cents as gas prices rise. Population growth should help provide continued support for LID-financed improvements, SDCs assessed on new development will allow the City to put some money toward future improvements, and population growth will give the City a slightly bigger share of the State Highway Fund, which should remain at a near-constant level statewide.

10.4 Cost Estimates for Transportation System Improvements

Needed transportation improvements in the City of Woodburn were identified in the Transportation System plan presented in Section 9. Estimated costs for these improvements, were developed, with improvements grouped by the time period in which they should be constructed; 0 to 5 years, 5 to 10 years, 10 to 20 and 20+ years (Tables 15 - 18). In all, about $62 million (in 1995 dollars) of road and transit service improvements for the City of Woodburn over the next 20 years have been identified.

Transportation improvements include changing the functional classification of some city streets and bringing certain streets up to the City standards for their classification. This process includes adding sidewalks and bike lanes to some streets. Tables 15 - 18 present the total cost estimate for bringing certain streets up to City standards, including sidewalks and bike lanes and also identify the cost for adding only sidewalks to certain streets with physical constraints to pavement widening.

In addition to costs for transportation improvements, the City of Woodburn envisions future operation and maintenance costs for street overlay, drainage, and lighting to be $750,000 annually over the next 20 years.

10.5 Financing Needed Transportation Improvements

Potential federal sources of transportation funding are listed in Table 19 and state sources are listed in Table 20.

The projects identified represent an ambitious program of roadway and transit capital improvements for the City of Woodburn. Constructing these improvements will require a significantly higher level of transportation expenditures than Woodburn has spent in the past. In the past five fiscal years, Woodburn spent a total of $935,216–1,310,745 each year for road improvements and transit service. Including $750,000 as the average annual operation and maintenance costs, the improvements identified will require Woodburn to spend per year in the next five years, per year in the following five years, and per year in the following ten years.

It is expected that Woodburn will want to pursue funding sources for transportation improvements from the following sources:

Table 15

Proposed Transportation Improvements: Next 5 Years

Project Title	Estimated Cost (1995 $)	Potential Funding Source
Roadway System Capacity Improvements		
I-5 Interchange-Reconn. Study	$300,000	W, S, C
Realign Arney Road to Intersect Woodland Drive/Restrict Arney Road Access on Highway 214	$365,000	D
Extend Meridian Drive to Intersect Hazelnut Drive	$700,000	D
Improvements to Meet Woodburn Street Design Standards		
Arney Road - Existing Arney Road to UGB	$1,480,000	D
Boones Ferry Road - Highway 214 to UGB	$1,730,000	W, D, C
Country Club Road - Boones Ferry Road to Astor Way	$590,000	D
Front Street - Hardcastle Avenue to Highway 214	$950,000	W
Intersection/Access Management Improvements		
Added Signal - Highway 214/NB I-5 Ramp	$100,000	W
Added Signal - Highway 214/Woodland Drive	$120,000	D
Added Signal - Highway 214/Front Street	$120,000	D
Intersection Channelization - I-5/Highway 214	$500,000	W, D
Intersection Channelization - Settlemier Avenue/Front Street/Parr Road	$440,000	W
Intersection Channelization - Highway 214/Settlemier Avenue	$70,000	W
Signal Coordination Along Highway 214-Woodland Drive to Cascade Drive	$100,000	D
Sidewalks		
West Hayes Street - Evergreen Road to Cascade Drive	$60,000	W
Park Avenue - Lincoln Street to Hardcastle Avenue	$50,000	W
Brown Street - Cleveland Street to Bradley Street	$25,000	W
Off-Street Pathways		
Mill Creek Corridor - Hazelnut Drive to Young Street	$620,000	W, D
Public Transit System Improvements		
Increase Intracity Bus Service Frequency - Additional Vehicle	$110,000	W, S
Increase Intracity Bus Service Frequency - Operating Cost (2 years)	$280,000	W, S
Total Cost	$8,710,000	
Cost/Year	$1,742,000	

Funding Sources: S - State, W - City of Woodburn, C - Marion County, D - Developer

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Table 16

Proposed Transportation Improvements: Next 6-10 Years

Project Title	Estimated Cost (1995 $)	Potential Funding Source
Roadway System Capacity Improvements		
South Arterial - Woodland Drive to Boones Ferry Road	$6,550,000[1]	W, D
I-5 Interchange - Design/Environmental Studies	$1,000,000	W, S, D
Widen Highway 214 - Woodland Drive to Cascade Drive	$2,460,000	W, S, D
Extend Evergreen Road to South Arterial	$1,100,000	D
Improvements to Meet Woodburn Street Design Standards		
Front Street - High School to UGB	$1,800,000	W, D
Brown Street - Bradley Street to South Bypass	$1,030,000	D
Evergreen Road - Highway 214 to Stacy Allison Way	$550,000	W, D
Parr Road - Front Street to UGB	$1,370,000	W, D, C
West Hayes Street - Cascade Drive to Settlemier Avenue	$800,000	W
Intersection/Access Management Improvements		
Signal Coordination Along Highway 99E	$100,000	W, S
Added Signal - Highway 214/Park Avenue	$120,000	W
Sidewalks		
Front Street - Cleveland Street to Parr Road	$100,000	W
Off-Street Pathways		
Goose Creek Corridor - Mill Creek to Astor Way	$430,000	W
Public Transit System Improvements		
Intercity Bus Service Phase 1 (to Portland) - One Vehicle	$150,000	W, S
Intercity Bus Service Phase 1 (to Portland) - Operating Cost (5 Years)	$400,000	W, S
Park-n-Ride (Phase 1) (150 spaces)	$500,000	W
Intracity Bus Service - Operating Cost (5 years)	$700,000	W, S
Total Cost	**$19,160,000**	
Cost/Year	$3,832,000	

Funding Sources: S - State, W - City of Woodburn, C - Marion County, D - Developer

1 Cost estimate of northerly South Arterial alignment (with split diamond or existing interchange).

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Table 17

Proposed Transportation Improvements: Next 11-20 Years

Project Title	Estimated Cost (1995 $)	Potential Funding Source
Roadway System Capacity Improvements		
I-5 Interchange	$13,500,000[1]	W, S
Widen Highway 214 - Cascade Drive to Park Avenue	$1,520,000	W, S
South Arterial - Boones Ferry Road to Highway 99E	$3,070,000	W, S
Cooley Road Extension	$2,350,000	W, D
Improvements to Meet Woodburn Street Design Standards		
Hardcastle Avenue - Cooley Road to Front Street	$2,360,000	W
Young Street - Highway 214 to Front Street	$1,130,000	W
Lincoln Avenue - UGB to Highway 99E/Gatch Street to Front Street	$1,480,000	W
Intersection/Access Management Improvements		
Intersection Channelization - Highway 214/Highway 211/Highway 99E	$230,000	W, S, D
Sidewalks		
Astor Way - Highway 214 to Country Club Road	$100,000	W
Lincoln Street - Highway 99E to Gatch Street	$75,000	W
Various Local Streets (0-20 Years)	$100,000	W
Off-Street Pathways		
Mill Creek Corridor - Young Street to South Arterial	$360,000	W
West Mill Creek Corridor - Mill Creek to UGB	$440,000	W
Public Transit System Improvements		
Intracity Bus System - Added Vehicles	$330,000	W, S
Intracity Bus System - Operating Cost (10 years)	$2,900,000	W, S
Intercity Bus Service Phase 2 (to Salem) - Additional Vehicles	$150,000	W, S
Intercity Bus Service Phase 2 (to Salem) - Operating Cost (10 years)	$800,000	W, S
Intercity Bus Service Phase 1 - Operating Cost (10 years)	$800,000	W, S
Park-n-Ride - Phase 2 (100 spaces)	$300,000	W
Total Cost	$31,995,000	
Cost/Year	$3,199,000	

Funding Sources: S - State, W - City of Woodburn, C - Marion County, D - Developer

1 Cost estimate for I-5 split diamond interchange.

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Table 18

Proposed Transportation Improvements: Next 21+ Years

Project Title (Time Period)	Estimated Cost (1995 $)	Potential Funding Source
Improvements to Meet Woodburn Street Design Standards		
Cascade Street - West Hayes Street to Highway 214	$500,000	W
Cleveland Street - Brown Street to Highway 99E	$920,000	W
Woodland Avenue - Highway 214 to Willow Avenue	$940,000	W
Total Cost	**$2,360,000**	

Funding Sources: S- State, W-City of Woodburn, C - Marion County, D - Developer

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Table 19
Summary of Transportation Funding Programs: Federal Sources

Program Name	Description	Potential for Woodburn Urban Area
Intermodal Surface Transportation Efficiency Act (ISTEA)	ISTEA is designed to provide flexibility in federal funding of transportation projects. ISTEA established several funding programs including teh: 1) National Highway System; 2) Interstate Program; 3) Surface Transportation Program; 4) Congestion Management and Air Quality Improvements Program; and 5) National Scenic Byways Program. Federal funding for transity under ISTEA is discussed with the Special Transportation Grant Program under State Sources because these federal funds are combined with state and local funds.	As a grant/transfer program, ISTEA provides opportunities to fund selected projects meeting the program's funding criteria. As with all grants, cost to local residents are low, political acceptability is high, and financial capacity and stability are less predictable than for many local funding sources. Woodburn should coordinate with the ODOT Region2 planner, and the Mid-Willamette Valley Council of Governments to identify projects that are suitable for funding under ISTEA.
Surface Transportation Program (STP)	The Surface Transportation Program was uathorized by Title I of the ISTEA. The STP funds are allocated to the State and suballocated to cities and counties on a formula basis by the Oregon Transportation Commission. STP funds may be used for any road that is not functionally classified as a local or rural minor collector and must be included in the Transportation Improvement Program to receive STP funds.	Each eligible city is suballocated as a portion of the State's STP funds. Cities can propose projects through their regional ODOT offices. The project sponsor (County, City, or State) must request inclusion of the project in the annual Statewide Transportation Improvement Program. The STP provides opportunities to fund selected projects that meet program criteria. Woodburn should coordinate with the ODOT Region 2 planner, and the Mid-Willamette Valley Council of Governments to identify projects that are suitable for funding under ISTEA.
Transportation Enhancement Program (Part of STP)	The ISTEA includes provisions that require the State to set aside a portion of its Surface Transportation Program (STP) funds for projects that will enhance the cultural and environmental value of the State's transportation system. Eligible transportation enhancement projects must be directly related to the intermodal transportation system. This program funds enhancements including pedestrian and bicycle facilities; preservation of abandoned railway corridors; landscaping and other scenic beautification; control and removal of outdoor advertising; acquisition of scenic easements and scenic or historic sites; scenic or historic highway programs; historic preservation; rehabilitiation and operation of historic transportation buildings, structures, or facilities; archaeologocial planning and research; and mitigation of water pollution due to highway runoff.	Enhancement project applications are submitte dto the applicant's ODOT Region Manager. Proposed projects are then screened and prioritized by the Transportation Enhancement Committee. Approved projects receive funding under the State's transportation enhancement activities program. Transportation enhancement projects are selected as part of the State Transportation Improvement Program (STIP) development This program provides opportunities to fund selected projects that meet program criteria. Woodburn should coordinate with the ODOT Region 2 planner, and the Mid-Willamette Valley Council of Governments to identify projects that are suitable for funding under ISTEA.
Highway Enhancement System (HES)	The FHWA Highway Enhancmeent System Program provides funding for safety improvement projects on public roads. Safety improvement projects may occur on any public road and must be sponsored by a county or city. To be eligible for Federal aid, a project should be part of either the annual element of a Regional Transportation Plan or the annual listing of rural projects by ODOT, although they do not have to be part of the approved State Highway Improvement Program to receive HES funding.	The HES provides opportunities to fund selected projects that meet program criteria. Woodburn should coordinate with the ODOT Region 2 planner, and the Mid-Willamette Valley Council of Governments to identify projects that are suitable for funding under ISTEA.

Table 19
Summary of Transportation Funding Programs: Federal Sources (continued)

Program Name	Description	Potential for Woodburn Urban Area
Timber Receipts (USFS)	The United States Forest Service shares 25 percent of national forest receipts with counties. By Oregon law (ORS 294.060), Marion County then allocates 75 percent of the national forest receipts to the road fund and 25 percent to local school districts. Marion County has received an average of $3.5 million per year in timber revenues between FY86 - FY90. The County Share of forest revenues is a gradual decline due to the "spotted owl compromise" under which counties are guaranteed revenues on a schedule set by Congress that gradually reduces this support over the next decade, reaching $2.1 million in FY03.	U.S. Forest Service revenues have permitted Marion County to make significant capital improvements to its road system. With respect to Woodburn, timber revenues get mixed in with other sources to the Marion County Road Fund. Marion County has occasionally participated in cost-sharing with the city on project within Woodburn's city limits. Opportunities for county cost-sharing are discussed on a project-by-project basis, and Woodburn should continue to seek county cost-sharing where possible. Though its political feasibility has not been explored, there is an argument to be made that part of the County's allocation of federal timber receipts should be spent inside Woodburn because residents of Woodburn are also residents of Marion County. To some extent that already occurs: County Road Funds are used on County roads inside the UGB. They could also be used, however, on major city streets.
Community Development Block Grants (CDBG)	Community Development Block Grants (CDBG) are administered by the Department of Housing and Urban Development (HUD) and could potentially be used for transportation improvements in eligible areas.	CDBG has the potential to provide funding for eligible projects, but, the prospects for increased municipal revenues for CDBG are limited. Long-term stability of this source is uncertain. Cities have traditionally used CDBG funds for projects other than transportation. Although CDBG funds could be used for transportation, the City may have other priorities for this funding source. Overall potential of this source for transportation funding is low.

Source:Compiled by ECO Northwest

Table 20
Summary of Transportation Funding Programs: State Sources

Program Name	Description	Potential for Woodburn Urban Area
State Highway Fund	The State Highway Fund composed of gas taxes, vehicle registration fees, and weight-mile taxes assessed on freight carriers. In 1994, the state gas tax was $0.24 per gallon. Vehicle registration fees were $15 annually. Revenues are divided as follows: 15.57 percent to cities, 24.38 percent to counties, and 60.05 percent to the State Highway Division. The city share of the State Highway Fund is allocated based on population. Both Marion County and Woodburn use their allocations to fund street maintenance. ORS 366.514 requires at least one percent of the State Highway Fund received by the State Highway Division, counties and cities be expended for the development of footpaths and bikeways. The Highway Division adminsiters the bicycle funds, handles bikeway planning, design, engineering and construction, and provides technical assistance and advice to local governments concerning bikeways.	Woodburn has received an average of about $569,000 annually from this source in recent years Marion County will receive about $12.2 million in FY95. Revenues from this source are relatively stable, but, because the State Highway Fund is not indexed for inflation, the relative share could decrease if taxes are not increased. The per capita allocation of State Highway Fund revenues will probably not increase significantly. The City should continue to use this source to fund street maintenance. Though its political feasibility has not been explored, there is an argument to be made that part of the County's allocation from the Oregon Highway Fund should be spent inside Woodburn because vehicle registrations inside Woodburn help generate those revenues, and Woodburn roads are used substantially by vehicles registered elsewhere in Marion County. To some extent that already occurs: County Road Funds are used on County roads inside the UGB. They could also be used, however, on major city streets. The bikeway program provides opportunities to fund bicycle and pedestrian projects that meet program criteria. The City should work with ODOT Region 2 Planner identify projects that are suitable for funding under this program.
Special Public Works Fund (SPWF)	The State of Oregon allocates a portion of revenues form the state lottery for economic development. The Oregon Economic Development Department provides grants and loans through the SPWF program to construct, improve and repair infrastructure to support local economic development and create new jobs. The SPWF provides a maximum grant of $500,000 for projects that will help create a minimum of 50 jobs.	Cities and counties can use SPWF funds for transportation projects. One potential use for SPWF funds is to develop infrastructure in office or industrial parks. As with all grant programs, stability and long-term potential of this source is uncertain. Woodburn should contact OEDD to pursue funding from this source.
Transportation Access Charges	The most familiar form of a transportation access charge is a bridge or highway toll. Transportation access charges are most appropriate for high-speed, limited access corridors; service in high-demand corridors; and bypass facilities to avoid congested areas. Congestion pricing, where drivers are charged electronically for the trips they make based on location and time of day, is the most efficient policy for dealing with urban congestion. It not only generates revenue for maintenance and improvements, but also decreases congestion and the need for capital improvements by increasing the cost of trips during peak periods. The Oregon Revised Statutes allow ODOT to construct toll bridges to connect state highways and improve safety and capacity. The Statues also allow private development of toll bridges. Recent actions by the Oregon legislature provide authority for developing toll roads. State authority for congestion pricing does not exist; new legislation would be required.	Toll roads are relatively uncommon in Oregon and would not receive public support unless the benefits *improved access, safety, or decreased travel times) were clearly perceived by users. Despite its clear benefits, congestion pricing will be a tough sell in Woodburn. Congestion pricing, if pursured by the City of Woodburn, should cover all major roads and be viewed first as a congestion management strategy, and only secondarily as a revenue source.

Table 20
Summary of Transportation Funding Programs: State Sources (continued)

Program Name	Description	Potential for Woodburn Urban Area
Traffic Control Projects	The State maintains a policy of sharing isntallation, maintenance, and operational costs for traffic signals and luminaire units at intersections between State highway and city streets (or county roads). Intersections involving a State highway and a city street (or county road) which are included on the state-wide priority list are eligible to aprticipate in the cost sharing policy. The Oregon State Highway Division establishes a statewide priority list for traffic signal installations on the State Highway Ssytem. The priority system is based on warrants outlined in the Manual for Uniform Traffic Control Devices. Local agencies are responsible for coordinating the statewide signal priority list with lcoal road requirements.	The Traffic Control Projects program provides opportunities to fund projects that meet programcriteria. Woodburn should coordinate with the ODOT Region 2 planner, and the Mid-Willamette Valley Council of Governments to identify projects that are suitable for funding under ISTEA.
Special Transportation Grant Program	The *Community Transportation Program (CTP)* provides grants for passenger transportation services for senior citizens, people with disabilities, and the general public. The CTP combines two programs that were previously run separately; the *Special Transportation Grants (STG)* program, the *Small and Rural Area Capital Assistance Program.* The *Special Transportation Fund (STF)* program provides ongoing revenue to transportation districts to finance transportation services for people over 60 years of age or people with disabilities. The fund may be used for the creation, maintenance or expansion of transportation services for the elderly and disabled. Counties, transportation districts, cities and nonprofit organizations are eligible for these funds. Private passenger transportation companies may also participate through service agreements with local governments. Eligible activities include planning, capital investments, operating assistance, system development, and transportation demand management projects.	The Community Transportation Program is financed by a combination of State, Federal, and local matching funds. The program has two matching ratios. The matching ratio for capital purchase/construction projects and planning projects is: CTP Financing, 80 percent; and grant recipient 20 percent. The matching ratio for net operating expenses of an operating assistance proposal is; CTP Financing, 50 percent, and recipient, 50 percent. The Special Transportation Fund is distributed to eligible districts and counties in the following ways: - Three-fourths of the fund on the basis of population. - A minimum allcoation of $15,000 - Annual adminsitrative allotment of $2,000. - Remaining funds deposited in the State STG account. The CTP program provides opportunities to fund pbulic transportation services to senior citizens and disable individuals.

1. State or Marion County funds. Obtain more projects or funds from the State for improvements to state highway facilities. Options for cost sharing with the County for mutually beneficial projects should be explored.
2. For the projects that are needed as a result of proposed development, the property owners or developers that directly benefit where appropriate should fund all or a portion of the project cost.
3. For projects that do not tie directly to new development or directly benefit property owners that are willing to pay for the project, spread the cost should be provided from existing transportation funding sources such as TIF fees.
4. Use general obligation bonds backed by property tax revenue, where this source is determined by City staff and the governing body to be fair and viable.

The likely funding sources for transportation improvements in Woodburn by jurisdiction level: (state, county, and local) are presented below. Following this discussion are three tables that describe specific transportation funding sources at the federal, state, and local level, and the potential for these sources to fund projects in Woodburn.

10.5.1 Federal and State Sources

For a small city like Woodburn, a key point to understand about federal funding is that the State passes through much of the funding to local jurisdictions. Woodburn would access those funds primarily by working with ODOT, especially ODOT planners in Region 2. The key factor for major transportation improvements is getting them included as part of the State Transportation Improvement Plan that gets adopted every two years.

ODOT maintains interstate and state highways—in Woodburn, I-5 and Highways 99E, 211, 214, and 219. Therefore, state and federal funds administered through ODOT are the primary sources of funding for improvements to I-5 and Highways 99E, 211, 214, and 219—projects that involve these highways account for $1.3 million in the next 5 years, $11.3 million in the following 5 years, and $15 million in the following 10 year period. In addition, the City may be able to secure federal or state funding for improvements that would reduce congestion or otherwise improve traffic flow on state-maintained roadways. The City should take an active role in representing the transportation priorities of Woodburn to ODOT during its process of formally incorporating priorities into its State Transportation Improvement Program.

ODOT typically funds half of the traffic signals on state highways. If this arrangement can be made for each of the traffic signals identified in the Woodburn Transportation Improvement program, ODOT would provide $320,000 for traffic signals.

State funding is available for funding bike lane modifications in Woodburn. State law requires 1% of the State Highway Fund received by cities be expended for the development of footpaths and bikeways—for Woodburn this amounts to $4,800–6,250 annually.

Another state source of revenue is lottery funds that are allocated to the Special Public Works Fund and the Immediate Opportunity Fund. These funds provide grants and loans to construct and improve infrastructure that supports local economic development. Woodburn should pursue lottery funding through the Oregon Economic Development Department.

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Federal ISTEA programs fund selected transportation projects that meet program criteria. The Surface Transportation Program provides funds for any street that not classified as a local or rural minor collector. The Transportation Enhancement Program provides funds for enhancing pedestrian and bicycle facilities, landscaping and other scenic beautification, and improvements to scenic or historic sites. This program may be a source of funds for projects that include adding bike lanes, sidewalks, and/or off-street paths, and possibly for projects in historic areas such as downtown Woodburn. The Highway Enhancement Program provides funds for safety improvement projects on public roads. To receive ISTEA funding from these programs, a project must meet the criteria and be included in the Statewide Transportation Improvement Program. Woodburn should work with Region 2 planners at ODOT to identify projects eligible for ISTEA funds and to have these projects included in the Transportation Improvement Program.

Woodburn should continue to seek federal and state grants for transit operation and equipment purchases. Given Woodburn's past success at securing grants for equipment purchases, the City may be able to fund all of the equipment purchases identified in this chapter with federal and state grants. ODOT's forecast of funds in the Special Transportation Fund indicates that state funds available for local transit operations will dwindle over the next 20 years.

10.5.2 County Sources

The City of Woodburn and Marion County occasionally participate in cost sharing on individual projects. There is no formal process for the City to seek cost sharing—decisions are made on a project-by-project basis. Woodburn may be able to secure an occasional cost-sharing arrangement or grant from Marion County. Currently, Marion County maintains roadways outside the city limits but inside the UGB. Woodburn should seek to coordinate with Marion County on transportation improvements in this area to direct County funds to identified transportation projects where possible.

10.5.3 Local Sources

Woodburn should continue to pursue federal, state, and county funds for transportation projects. External funding sources are not likely to fund all the improvements identified in the list of transportation improvement needs. Woodburn will need to find local sources to fund some if not most of the transportation improvements.

Woodburn should continue to seek funds from property owners that directly benefit from transportation improvements and from new development. Roadway system capacity Improvement projects may place new streets near properties that currently lack automobile access—access that is necessary for the properties to develop. In these cases there is a very direct benefit to property owners and a direct relationship to future development on the properties, making these improvements eligible for funding through Local Improvement Districts and Transportation Impact Fees (TIF). Other roadway improvements should help improve access to existing businesses; in these cases Woodburn should pursue LID financing. When the Woodburn City Council evaluates the TIF after its five-year trial, they should consider increasing the fee to cover more of the full cost of projects needed to serve new development. Woodburn may want to issue revenue bonds backed by TIF revenue to construct projects in advance of new development it will serve.

If additional local revenue sources are needed, Table 21 shows the range of possibilities that the City could consider. Increasing the "local option" gas tax may be politically attractive because it places some of the burden on non-residents. At current levels of gasoline consumption, every 1¢ cent per gallon increase will generate around $100,000 in annual revenue.

Given the high level of annual expenditures needed to construct the transportation projects identified, it is likely that existing sources of transportation revenue will fall short. In this case Woodburn should carefully evaluate projects to look for lower-cost alternatives and to make sure the projects are needed. If additional funding sources are still needed, Woodburn may want to consider implementing the Street Utility Fee described in Table 19. While this fee charges residents and local businesses based on the transportation demand they generate, it will probably not have strong political support. The City may use property tax revenue and/or issue General Obligation bonds backed by property tax revenue to finance transportation improvements. Given population growth in Woodburn, there will likely be many competing uses for property tax revenue.

Increases in property values and continued development in Woodburn should increase property tax revenues available to the City General Fund for transit operation funding. This increased revenue should come close to meeting the increased operating costs associated with improvements in transit service. Improvements in transit service will have to compete with other City services such as police, library, and parks for property tax revenues. Significant increases in service will probably be tied to identification or implementation of supplemental funding sources. Farebox revenue will probably continue to contribute only a small share of transit funding in Woodburn.

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Table 21
Summary of Transportation Funding Programs: Local Sources

Program Name	Description	Potential for Woodburn Urban Area
Special Assessments/Local Improvement Districts	Special assessments are charges levied on property owners for neighborhood public facilities and services, with each property assessed a portion of total project cost. They are commonly used for such public works projects as street paving, drainage, parking facilities, and sewer lines. The justification for such levies is that many of thes epublic works activities provide services to or directly enhance the value of nearby land, thereby providing direct and/or financial benefit to its owners. Local Improvement Districts (LIDs) are legal entities established by the City to levy special assessments designed to fund improvements that have local benefits. Through a local improvement district (LID), streets or other tranpsortation improvements are constructed and a fee is assessed to adjacent property owners. The City of Woodburn has generated an average of $29,000 annually from special assessments in the last four fiscal years.	Special assessments require property owners pay assessments for transportation infrastructure. If based on trip generation rates, this approach is somewhat equitable; however, individuals have different transportation needs and habits. Designing a fee structure that recognizes these differences would be difficult to administer. With respect to LIDs, as long as the projects directly benefit the local residents, LIDs are a relatively equitable means of funding tranpsortation improvements. Woodburn should continue to use special assessments to finance transportation improvements wherever property owner support appears possible.
Systems Development Charges (Impact Fees)	Systems Development Charges (SDCs) are fees paid by land developers intended to reflect the increased capital costs incurred by a municipality or utility as a result of a development. Development charges are calculated to include the costs of impacts on adjacent areas or services, such as increased shcool enrollment, parks and recreation use, or traffic congestion. Numerous Oregon citiefs and counties presently use SDCs to fund transportation capacity improvements. SDCs are authorized and limited by ORS 223.297 - 223.314. The City of Woodburn generated $14,000 in FY93-94 from transportation impact fees, and over $200,000 in FY95.	The basic principle for setting a transportation SDC is to charge each new development its proportional share of the cost of constructing enough new road and other system improvements to accommodate traffic from all new development causing the need for improvement. The financial capacity of a systems development charge depends on the volume of development and the amount of the SDC. Fees are seldom set to recover the full cost of developing off-site road capacity ot accommodate the new development. Woodburn should continue to use transportation imapct fees to finance transportation improvements. The TIF is currently 26% of the level recommended by the consultant that developed the mothod for assessing the fee; a 100% TIF would have generated $56,000 in FY93-94.
Local Gas Tax	A local gas tax is assessed at the pump and added to existing state and federal taxes. Tillamook and The Dalles are two Oregon cities that have a local gas tax. Multnomah and Washington Counties also have gas taxes. Woodburn currently has a $.01 per gallon gas tax that has generated an average of $103,000 per year ove rhte last five fiscal years.	Local gas taxes typically range from $.01 to $.03. Woodburn could expect to generate about $100,000 annually per penny increase in the gas tax, based on recent gas tax revenue. A gas tax increase may require city-wide voter approval.
Local Parking Fees	Parking fees are a common means of generating revenue for public parking maintenance and development. Most cities have some public parking and many charge nominal fees for use of public parking. Cities also generate revenues from parking citations. These fees are generally used for parking-related maintenance and improvements.	Parking fees are a reasonable means of paying for a scare resource (parking spaces) in densely developed areas. The City's ability to generate enough additional revenue from this course to address unfunded transportation needs is limited.

Table 21
Summary of Transportation Funding Programs: Local Sources (continued)

Program Name	Description	Potential for Woodburn Urban Area
Street Utility Fee	Most city residents pay water and sewer utility fees. Street user fees apply the same concepts to city streets. A fee would be assessed to all businesses and households in the city for use of streets based on the amount of use typically generated by a particular use. For example, a single-family residence might, on average, generate 10 vehicle trips per day compared to 130 trips per 1,000 square feet of floor area for retail uses. Therefore, the retail use would be assessed a higher fee based on higher use. Street service fees differ from water and sewer fees because usage cannot be easily monitored. Street user fees are typically used to pay for maintenance more than for capital projects. A street utility fee currently generates about $1.3 million annually in Medford. The amount of the fee is based on the type of land use which relates to trip generation. Single-family residences pay $2.00 per month in Medford. In Ashland, a fee of $1.60 per month generates $200,000 per year.	Woodburn could expect from $208,800 to $261,000 in revenue from a street user fee of $2.00 per month for residences. With about 5,441 residences, the residential share would be $130,500 (12*2*5,441) and the commercial share would probably produce between 60 to 100 percent of the amount paid by residential properties, or $78,300-$130,500 (information on the square feet of non-residential development in the City is not available). Street user fees would be a very stable revenue source. They could be expected to increase at a rate comparable to population in Woodburn. Street utility fees could provide a substantial, stable revenue stream for the City. This is a relatively equitable approach that assesses fees based on trip generation.
Vehicle Registration Fees	Counties can implement a local vehicle registration fee. The fee would operate similar to the state vehicle registration fee. A portion of the County fee would be allocated to Woodburn.	A vehicle registration fee would produce a relatively reliable revenue stream. A vehicle registration fee would be a stable and equitable approach to funding transportation improvements.
Property Taxes	Local property taxes could be used to fund transportation. The City policy, however, has been to use property taxes to fund public safety, libraries, parks, transit and other miscellaneous services.	In Oregon and Woodburn, Ballot Measure 5 places a $15 per $1,000 in assessed value ceiling on property taxes. The potential for using property tax revenues for transportation purposes is limited in Woodburn more by the need for voter approval than by Ballot Measure 5.
Revenue Bonds	Revenue Bonds are bonds whoe debt service is financed by user charges, such as service charges, tolls, admissions fees, and rents. If revenues from user charges are not sufficient to meet the debt service payments, the issuer generally is not legally obligated to levy taxes to avoid default, unless they are also backed by the full faith and credit of the issuing governmental unit. In that case, they are called indirect general obligation bonds. Revenue bonds could be secured by a local gas tax, street utility fee, or other transportation-related stable revenue stream.	The City could sell revenue bonds using one of several income streams pledged to repay the bonds. Bond underwriters analyze the reliability of the revenue stream when rating the bonds and assigning an interest rate. The city should use or develop an income stream that is indexed to transportation facility use before using revenue bonds to fund transportation projects.

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Section 11

Land Use Ordinance Modifications

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11.0 Land Use Ordinance Modifications

11.1 Introduction

The Transportation Planning Rule (OAR Chapter 660, Division 12) stipulates that each local jurisdiction in the State of Oregon adopt an approved transportation plan and make amendments to its land use regulations in order that transportation plans be properly implemented. The primary goal of the required ordinance amendments is to make future developments more pedestrian and transit friendly. The Rule was originally adopted by the Land Conservation and Development Commission (LCDC) in April 1991. In 1993, an amendment to the rule extended the implementing measures compliance deadline for local jurisdictions to May, 1994. In May, 1995, the urban portions of the Transportation Planning Rule were updated to include greater emphasis on bicycle, pedestrian, changed building orientation, and transit friendly developments.

This section introduces proposed land use ordinance concepts designed to bring the City of Woodburn into compliance with the rule. Sources used to prepare this report include recommendations of the American Planning Association (APA) Transportation Rule Working Group, the Oregon Department of Transportation's (ODOT) Best Management Practices manual (August 1992 draft), the City of Newberg's Pedestrian Oriented Commercial Development Workbook, and Tri-Met's Planning and Design for Transit.

This section outlines the state-mandated land use regulations to implement the Woodburn Transportation System Plan, and recommends methods for satisfying those requirements. Specific Woodburn plan and ordinance text modifications are in Appendix E.

11.2 Requirements of the Transportation Planning Rule

Section 660-12-045 of the Transportation Planning Rule sets forth several land use regulation issues that must be addressed to implement a Transportation Systems Plan. Key issues are discussed below.

Protection Of Transportation Facilities And Corridors

Ordinance regulations are required to protect transportation facilities and corridors including:

- access control measures;
- standards to protect future operations;
- a process for coordinated review;
- a process for providing notice to public agencies; and
- regulations assuring that development standards are consistent with transportation system capacity.

Land Use And Subdivision Regulations

Land use and subdivision regulations are required for the following:

- bicycle parking for multifamily, commercial, and institutional development;

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- sidewalks and bikeways that provide safe and convenient access within new development and from it to nearby residential areas, transit stops, and activity centers; and
- internal pedestrian connections provided in new office parks and commercial development

Transit Facilities

Land use and subdivision regulations are required for transit facilities. Ordinances shall provide:

- bus stops and other facilities where appropriate;
- preferential access to transit through building orientation and clustering for new retail, office, and institutional buildings near planned transit stops;
- preferential parking for carpools and vanpools;
- opportunities to redevelop parking areas for transit-oriented use;
- road systems that include pedestrian and bicycle access to identified transit routes; and
- designation of types and densities of land use adequate to support transit.

Reduced Reliance On The Automobile

In Metropolitan Planning Organization (MPO) areas, local governments are required to adopt regulations that reduce reliance on automobiles including:

- allowing transit-oriented development along transit routes;
- adopting a demand management program;
- adopting a parking plan; and
- requiring major industrial institutional retail and office uses to provide a transit stop along transit trunk routes.

Improvements For Bicycle And Pedestrian Travel

Identification of improvements to facilitate bicycle and pedestrian travel in developed areas are required, including:

- improvements providing direct, convenient, and safe bicycle and pedestrian travel within and between residential areas and activity centers.

11.3 Suitability of Existing Ordinances

The Transportation Planning Rule requires that cities and counties reduce reliance on the automobile and promote alternative modes of travel, such as walking, cycling, and transit. The rule also stipulates that local development ordinances be consistent with the objectives of the rule. Generally, this requirement has required that new standards and policies be added to local ordinances to assure that new development and new facilities are pedestrian and transit friendly.

As in other communities, new standards have been developed in Woodburn to address street widths, sidewalks, connections between buildings and developments and other related design

concepts. These concepts are implemented through site review procedures and through subdivision and partitioning procedures.

There are sections of the Woodburn Zoning Ordinance that need to be made more clear and objective to avoid staff use of discretion. Planning Commission review and the opportunity for a de novo hearing provide a check for the discretionary process, however this review can result in procedural delays. Establishment of more clear and objective standards and streamlining the staff-level review process could simplify the development review process.

11.4 Recommendations - General Issues

The following sections address the specific requirements of the Transportation Planning Rule. Each section provides background information of relevant issues, recommendations, and a reference to proposed amendments to the Comprehensive Plan, Zoning Ordinance, Subdivision Standards, or other amendments as deemed necessary.

Issue: Incorporation Of New Standards In Zoning And Land Division Ordinances

Background/Options: The Woodburn Zoning Ordinance needs to incorporate the development standards that are currently outlined in the Woodburn Draft Transportation System Plan. Some of the standards, notably those pertaining to street widths, cul-de-sacs, alley ways, block widths, block lengths, and related development issues need to be updated.

The Zoning Ordinance needs to make more references to the Subdivision Standards document.

Recommendation: Amend the zoning ordinance by adding a new Section 8.011 - Transportation Planning Design Standards and Procedures. Revise the Subdivision Standards by modifying Section 12.

See Appendix E: New Zoning Ordinance, Section 8.011-Transportation Planning Design Standards and Procedures and Appendix E: Subdivision Standards Amendments, Section 12J.

11.5 Recommendations - Protection of Transportation Facilities, Corridors, and Sites

Issue: Access Control Measures and Standards to Protect System Operation and Airports

Rule Requirements: OAR 660-12-045 (2) (a-c)

Background/options: Access control is a critical component of maintaining operation of the transportation system. The Oregon Department of Transportation (ODOT) manages access control on State Highways 211, 214, and 99E through Woodburn. Currently, ODOT relies on ORS 374.310(3) and OAR 734-50-030(2) and -065 to manage access. Guidelines for access are provided in the Access Management Classification System of the 1991 Oregon Highway Plan.

The City of Woodburn accepts dedicated rights-of-way as part of the subdivision or partition plan review process. Standards for right-of way widths are specified for each street classification in the Subdivision Standards but such standards need to be included in the Zoning Ordinance and as part of the site plan review process.

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Recommendation: Apply the standards and include them in the site plan review section of the Zoning Ordinance (Appendix E).

See Appendix E: New Zoning Ordinance Section, Section 11.070 (i)-Access Control Standards and Guidelines.

11.6 Recommendations - Land Use And Subdivision Regulations

Regulations

Issue: Bicycle Parking For Multifamily, Commercial And Instituional Development

Rule Requirements: OAR 660-12-045 (3)(a).

Background/options: Bicycle parking requirements can either be tied directly to the number of automobile parking spaces or to a separate list. It is generally simpler to tie the requirements to existing parking requirements. Key issues include:

1. **Applicability**

   The rule requires parking for buildings containing four units or more. Exemptions for temporary uses and land extensive uses should be provided.

2. **Number and Type**

   Some jurisdictions provide standards for both short and long term bicycle parking. This results in relatively complex standards. Standards may be applied as a percentage of auto parking. Typical ranges include 5% (Portland) to 20% (Ashland), with a minimum number.

3. **Location**

   The location of a bicycle parking facility influences how often it is used. Typical standards include:

   - within 50 feet of a main entrance
   - closer to the entrance than the nearest auto space
   - direct access to the right-of-way
   - dispersed parking for multiple entrances.

4. **Amenities**

   Amenities also influence how often a facility is used. Amenity standards should specify the type of rack to be provided and whether racks are lighted and openly visible. In addition standards should address covered parking typical standards including:

   - covered bicycle parking when auto parking is covered
   - covering 50%, if more than 10 spaces are required

Recommendation: Include the bicycle parking standards as part of Section 10.070-Parking and Loading Area Development Requirements of the Zoning Ordinance. Bicycle parking

standards also need to be included in the Woodburn Bicycle Plan. Apply the concepts listed above and tie to 10% of the auto parking standard.

See Appendix E: Amendments to the Parking and Loading Area Development Requirements Section of the Zoning Ordinance for Bicycle Parking, Section 10.071 - Bicycle Parking.

Issue: Sidewalks and Bikeways that Provide Safe and Convenient Access Within and From NewDevelopment to Nearby Residential Areas, Transit Stops, and Activities Centers

Rule Requirements: OAR 660-12-045 (3)(b)

Background/options: A primary purpose of the Transportation Planning Rule is to reduce reliance on automobiles and make other forms of transportation, such as walking and bicycling, more accessible. To this end, the rule requires sidewalks and bikeways on arterials and collectors and separate accessways, where appropriate.

1. **Sidewalks**

   Some streets in Woodburn do not have sidewalks. Although the Transportation Planning Rule requires sidewalks only on collectors and arterials (which is current policy for the City of Woodburn), provision of sidewalks on all city streets, including local streets, would further enhance access linkages for pedestrians. The Senior Estates area would be exempt from this requirement, and as such would constitute a special area in the pedestrian plan. With this requirement, it is assumed that neighborhoods of the city currently lacking sidewalks would participate in local improvement districts to provide the facilities.

   The standard width for all existing sidewalks (on local, collector, or arterial streets) is five feet. Standards recommended by the APA Transportation Rule Working Group range from a five-foot width for a setback residential sidewalk on a local street to a ten-foot width for a commercial curbed sidewalk on an arterial (an eight-foot width for sidewalks along major arterials has been proposed). It should be noted that for pedestrian safety and comfort sidewalks should be set back from the curb.

2. **Bikeways**

   The rule requires bikeways on arterials and collectors. Bikeways should meet minimum American Association of State Highway Officials (AASHTO) standards and the standards of the 1992 Oregon Bicycle Plan. To provide five-foot to six-foot-wide bikeways, right-of-way standards should be adjusted where on street parking is desired. It may be appropriate to identify bikeways on certain local streets. Appropriate right-of-way dedications will be needed on those streets.

3. Connections/Accessways

   Street connections and accessways between developments are important links that promote, rather than prevent, cycling and walking. One way to create these connections is to limit the use of cul-de-sacs and to require new streets to connect with the existing street network.

   Changes in the Woodburn Subdivision Standards are needed to include:

   - a requirement to submit a future street plan, which includes all land located within 400 feet of the subdivision;

- a limit or prevention for the use of cul-de-sacs and a restriction on cul-de-sac length;
- a provision for pedestrian accessways at a minimum of 600-foot intervals; and
- a requirement that pedestrian accessways to be a minimum of 15 feet wide with a 10 foot-wide paved surface.

4. **Block and Street Spacing**

Block length and spacing between streets influences access through a neighborhood. Generally, shorter block lengths provide easier access. Currently, Woodburn Subdivision Standard limit block length to 1,200 feet. The APA Working Group recommends that block perimeters not exceed 1,500 feet (i.e. 550 foot block lengths with 100 foot deep lots). As an alternative, a 1,600-foot perimeter would allow 600-foot block lengths with 100-foot-deep lots.

Recommendations: Provide sidewalks on all streets consistent with the APA Working Group recommendations. Amend city standards and the land division ordinance, as appropriate. Develop bikeways consistent with AASHTO standards.

Discourage the use of cul-de-sacs and limit their length to a maximum of 400 feet; cul-de-sacs shall serve no more than eighteen single-family dwellings. Each cul-de-sac shall have a circular end with a minimum diameter of right-of-way width.

Develop new standards for block length and accessways, as noted above. Block length shall not exceed 1,200 feet. In addition, when necessary for public convenience and safety, the Planning Commission may require a land divider to dedicate to public access ways to connect to cul-de-sacs, to pass through oddly shaped or unusually long blocks, to provide networks for public paths according to adopted plans, or to provide access to schools, parks, or other public areas.

Establish platting standards for alleys. The width of right-of-way and paving design for alleys should not be less than 20 feet, except in the case where an alley abuts land not located in the subdivision or partition. In this case, a lesser width may be allowed at the discretion of the Planning Commission, but the pavement width should not be less than 16 feet. Where two alleys intersect, 10 feet corner cutoffs are recommended. Unless otherwise approved by the Planning Commission, grades should not exceed 12 percent.

See Appendix E: New Plan Policies, Policy 4, Appendix E: New Zoning Ordinance Section, Section 8.011- Sidewalks, Section 8.012- Bikeways, and Section 8.013 - Street Standards Appendix E: Subdivision Standards, Section 12(J).

Issue: Carpool Matching Programs and Preferential Parking for Carpools and Vanpools

Rule Requirements: OAR 660-12-045 (4)(c)

Background/options: The Transportation Planning Rule (TPR) requires that demand management measures be included as a component for evaluation of transportation system alternatives. Transportation demand management measures help improve the performance of transportation facilities and reduces the need for additional roadway capacity. Methods include but are not limited to alternatives to single-occupancy vehicle travel, such as carpooling, vanpooling, cycling, walking, and other trip reduction measures.

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The APA Working Group recommends that 10 percent of required parking, but not less than one parking space, be reserved for carpool and vanpool parking. An alternative is to apply the requirement only to new developments with 50 or more employees.

1. **Carpool Matching Programs**

   Transportation demand management is primarily addressed through the provision of programs to encourage alternative modes for work related trips. In Woodburn, carpool programs are a possibility. The City should consider a program to encourage businesses with more than fifty employees to set up carpool matching programs, based on employees' residential location and work shift.

2. **Parking Reductions**

   Parking reductions need to be incorporated into approved transportation demand management (TDM) plans for new developments and redevelopment. Parking reductions of up to 10 percent would be appropriate in proposed high density areas to encourage alternatives to single-occupancy automobile travel, (i.e., carpools, vanpools, walking, and cycling).

   Parking should be made available on a preferential basis. Bicycle parking should be more accessible to buildings than parking for single-occupancy automobile travelers. Parking subsidies for carpool and vanpool users could also be implemented to discourage single-occupancy automobile travel. Alternatively, parking for single-occupancy vehicle travelers could be reduced in number or percentage or made to be more inaccessible to buildings.

Recommendations: Provide TDM measures to encourage carpooling, vanpooling, and reduce parking requirements.

See Appendix E: New Comprehensive Plan Policies and Appendix E: Section 10.100 of the Zoning Ordinance - Carpool and Vanpool Parking.

11.7 Recommendations—Other Modes

Issue: Improvements to Facilitate Bicycle and Pedestrian Travel

Rule Requirements: OAR 660-12-045 (6)

Background/Options: The Transportation Planning Rule requires identification of improvements to facilitate bicycle and pedestrian travel in undeveloped areas. Improvements should provide more direct, convenient, and safe bicycle and pedestrian travel within and between residential areas and activity centers.

Specific improvements should be part of the Transportation System Plan. The standards discussed above will help facilitate development of improvements. One method that has been used in other jurisdictions to create more pedestrian friendly streets is to narrow street width along local streets. Narrowing street widths has the effect of slowing traffic and creating a more compact and efficient development pattern. Currently, the required paved street width for local commercial and industrial streets is 36 feet. Typical widths for narrower pedestrian friendly streets range from 24 to 28 feet.

Recommendation: Include the improvements as part of the City's Transportation Systems Plan. Sidewalks shall be provided on both sides of local, collector, and arterial streets.

See Appendix E: New Plan Policies, Policy 1. Section 8.013 of the Zoning Ordinance Minimum Street Width.

Issue: Internal Pedestrian Connections - Walkway Connections Within Commercial and Office Park Development

Rule Requirements: Recent amendments to the Transportation Rule deleted this requirement, but it is recommended that it be included in the City of Woodburn's Zoning Ordinance.

Background/options: The TPR requires provision of internal pedestrian connections in new office parks and commercial developments. Methods for meeting this provision include:

- At least one sidewalk connection between abutting developments should be provided.
- Walkways should be provided to the street for every 300 feet of frontage.
- Connections should all be direct and driveway crossings minimized.
- Connections should be linked to the internal circulation of the building.
- Walkways should be at least five feet wide. Where possible, walkways should be raised, have curbing, or have different paving material when crossing driveways.

Recommendation: Amend the zoning ordinance by adopting the design standards noted above. Walkway connections should not be less than five feet in width.

See Appendix E: New Zoning Ordinance Section, Section 8.014 - Internal Connections.

Issue: Golf Carts

Background/Options: Approximately 25 percent of population in the City of Woodburn is over the age of sixty-five. This sector of the population is often mobility disadvantaged. Allowing residents to use golf carts in designated sections of the City or on designated streets would help alleviate the mobility challenges that these people encounter.

Woodburn Ordinance Number 18412 officially defines golf carts, and allows those vehicles fitting this description to use all streets in Senior Estates, and those streets providing access to Fairway Plaza. The Ordinance prohibits the use of golf carts on Highway 214. The Ordinance does not require that golf carts be registered with the State of Oregon. The City is interested in developing more off-street and on-street designated routes for golf cart travelers.

Recommendation: Amend the Zoning Ordinance to allow golf carts as an outright use in designated sections and on designated streets of the City, particularly along West Hayes Street from the area of Senior Estates (See Section 6.3-Golf Cart Facility Plan of the TSP) to downtown Woodburn, and Country Club Road for access to the Tukwila residential area and golf course. Golf carts could also use the off-street trail system developed along Mill Creek. With this expanded system, golf cart travelers would have access to downtown Woodburn, future new development in the vicinity of the I-5/Highway 214 interchange, and to the proposed off-street pathway system, which would circulate back to Senior Estates. Parking should be required along any expanded golf cart routes outside the Senior Estates area.

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Amend the Zoning Ordinance to modify road widths in areas where golf carts are permitted, to provide exclusive lanes for the use of such vehicles.

See Appendix E: New Zoning Ordinance Section 10.090 -Golf Carts. Modify Zoning Ordinance Section 8.013 - Street Widths. Appendix E: New Section 10.072 - Golf Cart Parking.

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Section 12

Compatibility with State Transportation Planning Rule & Other Policies

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12.0 Compatibility with State Transportation Planning Rule & Other Policies

12.1 State Transportation Planning Rule

In April 1991, the Land Conservation and Development Commission (LCDC), with the concurrence of the ODOT, adopted the Transportation Planning Rule (TPR), OAR 660 Division 12. The TPR requires local jurisdictions to prepare and adopt a Transportation System Plan (TSP) by May 1996. Table 22 is a list of requirements and recommendations (designated by italics) for a Transportation System Plan for an Urban Area with a population between 2,500 and 25,000, and how each of those were addressed in the Woodburn TSP. The comparison shows that the Woodburn TSP is in compliance with the provisions in the TPR.

12.2 ODOT Bypass and Major Improvement Planning Policy

In 1995, the Oregon Transportation Commission adopted a policy on the development of bypasses and other major improvements to state transportation facilities in local comprehensive plans. The intent was to identify a framework that would promote new facility development only as a last resort, after improvements to the existing transportation system, including TDM measures and operational improvements, were implemented.

Major improvements to a state transportation facility could only be identified as a short-range project (0-5 years) if the project was already identified in the construction section of ODOT's State Transportation Improvement Program (STIP). Such improvements could only be identified in a local comprehensive plan as a long-range project (5-20+) years only if:

- the improvement is needed to satisfy a state transportation objective or objectives;
- the scope of the project is reasonably justified, considering the long-range projection of need;
- the improvement was identified through a planning process that include public involvement, evaluation of reasonable transportation alternatives including measures to manage the existing transportation system, and sufficient environmental analysis to determine if there is a reasonable likelihood the improvement can be built;
- transportation management measures will not satisfy identified transportation needs during the planning period or there is a need to preserve a future transportation corridor for future needs beyond the planning period;
- the improvement would be a cost-effective means to achieve the objective(s);
- the proposed timing of the improvement is consistent with priorities established in corridor plans and regional transportation plans and if the financing program identified construction is dependent on the future availability of funds;
- funding for the project can be reasonably expected at the time the project is ready for development and construction; and
- the plan includes measures to effectively manage the existing transportation infrastructure and services in accordance with Policy G of the OTP;

Table 22

Evaluation of Woodburn TSP With State Transportation Planning Rule

TPR Recommendations/Requirements	Woodburn TSP Compliance
Public and Interagency Involvement	
Establish Advisory Committee	A Transportation Task Force (TTF) previously existed in Woodburn. This Task Force reviewed the development of the Transportation System Plan. Transportation Task Force members are listed in the acknowledgements at the beginning of the document.
Develop informational material	Materials (including technical memoranda, charts and maps) were prepared for public and agency review illustrating and defining critical components of the Woodburn TSP.
Schedule informational meetings, review meetings and public hearings throughout the planning process. Involve the community	Eight TTF meetings and four open houses were held in developing the Draft TSP. In addition, the TTF meetings were video recorded for airing on the local cable access.
Coordinate plan with other agencies	Representatives from Marion County, ODOT, FHWA and other agencies were apprised of the TSP development and participated when appropriate at the TTF.
Review Existing Plans, Policies, Standards, and Laws	
Review and evaluate existing comprehensive plan	The 1985 Woodburn Comprehensive Plan was reviewed and evaluated as part of the TSP development.
Land use analysis - existing land use/vacant lands inventory	The Woodburn Comprehensive Plan served as the basis for all population/employment forecasts, inventory of vacant lands, and initial location and type of collector/arterial streets serving the Woodburn Comprehensive Plan land uses.
Review existing ordinance - zoning, subdivision, engineering standards	Existing City ordinances and engineering standards were reviewed and incorporated where the appropriate development of the Woodburn TSP.
Forecast population and employment	The Woodburn Comprehensive Land Use Plan served as the basis for forecasting future year 2015 population and employment (see Section 5 of the Woodburn TSP).
Determination of transportation capacity needs (cumulative analysis, *transportation gravity model*)	Future p.m. peak hour traffic assignments were calculated using the travel demand model which was previously developed by Kittelson & Associates and updated for this project. The travel demand model includes the use of a gravity model.
Develop and evaluate alternatives (no-build system, all build alterantives, transportation system amangment, transit alternative/feasibility, improvements/additions to roadway system, land use alternatives, combination alternatives)	Section 5 identifies three roadway system alternatives to assess long-term transportation needs. These alternatives principally focused on identifying the impacts of differnt I-5 access scenarios and on South Arterial. Intra city and intercity transit system alternatives were also evaluated.

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Table 22

Evaluation of Woodburn TSP with State Transportation Planning Rule (continued)

TPR Recommendations/Requirements	Woodburn TSP Compliance
Determine Transportation Needs	
Select recommended alternative	The recommended roadway, transit, pedestrian, bicycle, and golf cart transportation facilities are summarized in Section 9 of the TSP.
Produce a Transportation System Plan	
Transportation goals, objectives, and policies	Specific recommendations regarding transportation goals and policies are outlined in Section 3 (Goals and Policies), Section 7 (Access Management), and Section 11 (Land Use Ordinances) of the documents.
Streets plan element (functional street classification and design standards, proposed facility improvements, access management plan, truck plan, safety improvements)	The streets plan element is outlined in Section 8 of the TSP.
Public transportation element (transit route service, transit facilities, special transit services, intercity bus and passenger rail)	The public transportation element is outlined in Section 9 of the TSP.
Bikeway system element	The bicycle plan is outlined in Section 9 of the TSP.
Pedestrian system element	The pedestrian plan is outlined in Section 9 of the TSP.
Airport element (land use compatibility, future improvements, accessibility/connections/conflicts with other modes)	An air transportation element is not relevant in Woodburn.
Freight rail element (terminals, safety)	The rail element is outlined in Section 9 of the TSP.
Water transportation element (terminals)	A water transportation element is not relevant in Woodburn.
Parking Plan	A parking plan was not identified as an issue in the Woodburn TSP.
Transportation System Management Element	TSM element not applicable per OAR 660-12-020(2)(f) and (g).
Transportation Demand Management Element	TDM element not applicable per OAR 660-12-020(2)(f) and (g)
Review existing significant transportation studies	Significant transportation studies were reviewed as part of the Woodburn TSP including the Interstate 5/Highway 214 Interchange Study, Woodburn Crossing Traffic Impact Analysis, Woodburn High School Pedestrian Study, and the West Hayes Street Closure traffic analysis.
Review existing capital improvements program/spublic facilities plans	Woodburn's most recent CIP was included as part of the TSP development.
Americans with Disabilities Act requirements	The ADA requirements were reviewed and incorporated where appropriate into the Woodburn TSP development.

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Table 22

Evaluation of Woodburn TSP with State Transportation Planning Rule (continued)

TPR Recommendations/Requirements	Woodburn TSP Compliance
Inventory Existing Transportation System	
Street system (number of lanes, lane widths, traffic volumes, level of service, traffic signal location and jurisdiction, pavement conditions, structure locations and conditions, functional classification and jurisdiction, *truck routes, number and location of accesses, safety, substandard geometry)*	An inventory of the existing street network, traffic volumes, traffic control devices and levels of service is provided in Section 4 of the TSP.
Bicycle ways (type, location, width, condition, *ownership/jurisdiction)*	A summary of the existing bicycle route system is given in Section 4 of this TSP.
Pedestrian ways (location, width, condition, *ownership/jurisdiction)*	An inventory of existing sidewalks in Woodburn is included in Section 4 of the TSP.
Public Transportation Services (transit ridership, volumes, route, frequency, stops, fleet, intercity bus, passenger rail, special transit services)	A summary of Woodburn public transit and paratransit is presented in Section 4 of this TSP.
Intermodal and private connections	No significant intermodal and private carrier transportation services and/or connections currently exist within Woodburn.
Air transportation	No air transportation facilities exist within Woodburn; as summarized in Section 4 of this document.
Freight rail transportation	Southern Pacific Railroad freight service is summarized in Section 4.
Water transportation	No significant water transport facilities exist within Woodburn; as summarized in Section 4 of this document.
Pipeline transportation	No significant pipeline transportation facilities exist within Woodburn; as sumamrized in Section 4 of this document.
Environmental constraints	With the development of the recommended off-street pathway system, special attention should be given to any environmental constraints that exist in the creek easements.
Existing population and employment	As outlined in Section 5 of the TSP and Technical Memorandum #3, the current population of Woodburn is approximately 15,000 people. 1991 employment was approxiamtely 5,045 jobs.
Plan Review and Coordination	
Consistent with ODOT and other applicable plans	forthcoming
Adoption	
Is it adopted?	forthcoming
Implementation	
Ordinances (facilities, services and improvements; land use or subdivision regulations)	See Section 11
Transportation financing/capital improvements program	See Section 10

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- the plan includes policies and implementing measures which protect the corridor and its intended function; and
- any maps showing a new alignment include a note stating "Incomplete funding plan, no construction date established".

Related to the Woodburn Transportation System Plan, this new policy relates to the development of I-5 interchange improvements and widening of Highway 219/214. It is important to note that the South Arterial is not intended to be a state facility. It would function as much of a local access road in the south Woodburn area as it would serve as a reliever facility to Highways 219, 214 and 99E.

Table 23 compares the policy criteria with respect to three different transportation improvements. The need for all three improvements over the 20+ year planning period is based on existing traffic operating conditions, projected traffic growth, and the extent to which a reasonable level of transit, TDM, and traffic operational improvements can be implemented to relieve the need for street capacity improvements. For the undeveloped southwest portion of Woodburn, some level of highway development to provide adequate access and circulation is needed. The City of Woodburn's ultimate goal is to implement a balanced, multi-modal set of transportation improvements to meet the needs of the community.

Table 23

Evaluation of Woodburn TSP With ODOT Bypass/Major Improvement Planning Policy

Policy	Evaluation
1. Proper Transportation Priorities	Project and program emphasis on improving existing transportation system. I-5 interchange improvement shown as longer-term (11-20 year) need. Widening of portion of existing Highway 214 before South Arterial identified. Balanced multi-modal TSP presented.
2. Short-Term Improvement to State Transportation Facility (0-5 years) Must be in STIP (Applicable to I-5 and Highway 219/214 improvements).	Improvements to I-5 interchange and Highways 219/214 programmed beyond five years. South Arterial not to be a designated state transportation facility, or planned to be a designated bypass facility.
3. Longer-Term Improvement to State Transportation Facility (5-20+ years) Must Meet Following Criteria (Applicable to I-5 and Highway 219/214 improvements).	I-5 Interchange & Highway 219/214 Improvements
- Satisfy Transportation Objectives	Consistent with Woodburn TSP goals and policies.
- Needed Based on Travel Demand/Congestion	Needed to serve projected traffic demand without Highways 219, 214 & 99E going substantially over capacity.
- Identified Through Planning Process	Developed as part of Woodburn TSP, which included public and agency involvement. No significant environmental impacts anticipated (will be assessed in follow-up refinement studies).
- TDM Will Not Satisfy Identified Transportation Needs, or Need to Preserve Corridor	TDM will not meet projected need, even with substantial transit and pedestrian/bicycle facility improvements.
- Cost-Effective Solution	Most cost-effective solution given road capacity improvement need.
- Timing Consistent with ODOT Corridor and Regional Transportation Plans	Marion County TSP is showing need for improved I-5 access in Woodburn area.
- Project Funding Expected at Time Project is Ready for Development and Construction	Project development (beyond initial I-5 interchange reconnaissance study) will not proceed until a framework for funding construction is identified (as part of reconnaissance study).
- Includes Measures to Manage Existing Transportation Infrastructure in Accordance with OTP Policy 4G	Access management strategies for Highways 219/214 a part of Woodburn TSP.
- Plan Includes Policies and Implementing Measures Which Protect Corridor and Its Intended Function	Access management strategies for Highways 219/214 a part of Woodburn TSP.
- Any Maps Showing a New Alignment Include a Note Stating "Incomplete Funding Plan, No Construction Date Established"	Included on all Woodburn TSP modal plan maps.

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Appendix A

Level of Service Analysis Concepts

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Appendix A

Level of Service Concept

Level of service (LOS) is a concept developed to quantify the degree of comfort (including such elements as travel time, number of stops, total amount of stopped delay, and impediments caused by other vehicles) afforded to drivers as they travel through an intersection or roadway segment. Six grades are used to denote the various LOS from A to F.[1]

Signalized Intersections

The six LOS grades are described qualitatively for signalized intersections in Table A1. Additionally, Table A2 identifies the relationship between level of service and average stopped delay per vehicle. Using this definition, LOS D is generally considered to represent the minimum acceptable design standard.

Table A1

Level of Service Definitions (Signalized Intersections)

Level of Service	Average Delay per Vehicle
A	Very low average stopped delay, less than five seconds per vehicle. This occurs when progression is extremely favorable, and most vehicles arrive during the green phase. Most vehicles do not stop at all. Short cycle lengths may also contribute to low delay.
B	Average stop delay is in the range of 5.1 to 15.0 seconds per vehicle. This generally occurs with good progression and/or short cycle lengths. More vehicles stop than for a LOS A, causing higher levels of average delay.
C	Average stopped delay is in the range of 15.1 to 25.0 seconds per vehicle. These higher delays may result from fair progression and/or longer cycle lengths. Individual cycle failures may begin to appear at this level. The number of vehicles stopping is significant at this level, although many still pass through the intersection without stopping.
D	Average stopped delays are in the range of 25.1 to 40.0 seconds per vehicle. The influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle length, or high volume/capacity ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.
E	Average stopped delays are in the range of 40.1 to 60.0 seconds per vehicle. This is considered to be the limit of acceptable delay.These high delay values generally indicate poor progression, long cycle lengths, and high volume/capacity ratios. Individual cycle failures are frequent occurrences.
F	Average stop delay is in excess of 60 seconds per vehicle. This is considered to be unacceptable to most drivers. This condition often occurs with oversaturation. It may also occur at high volume/capacity ratios below 1.00 with many individual cycle failures. Poor progression and long cycle lengths may also contribute to such high delay levels.

1 Most of the material in this appendix is adapted from the Transportation Research Board, *Highwav Capacity Manual*, Special Report 209 (1994).

Table A2

Level-of-Service Criteria for Signalized Intersections

Level of Service	Stopped Delay per Vehicle (Seconds)
A	≤ 5.0
B	5.1 to 15.0
C	15.1 to 25.0
D	25.1 to 40.0
E	40.1 to 60.0
F	> 60.0

Unsignalized Intersections

Unsignalized intersections include two-way stop-controlled (TWSC) and all-way stop-controlled (AWSC) intersections. The *1994 Highway Capacity Manual* provides new models for estimating total vehicle delay at both TWSC and AWSC intersections. Unlike signalized intersections, where LOS is based on stopped delay, unsignalized intersections base LOS on total vehicle delay. A qualitative description of the various service levels associated with an unsignalized intersection is presented in Table A3. A quantitative defination of LOS for unsignalized intersections is presented in Table A4. Using this definition, LOS E is generally considered to represent the minimum acceptable design standard.

Table A3

General Level-of-Service Descriptions for Unsignalized Intersections

Level of Service	Average Delay per Vehicle to Minor Street
A	• Nearly all drivers find freedom of operation. • Very seldom is there more than one vehicle in the queue.
B	• Some drivers begin to consider the delay an inconvenience. • Occasionally there is more than one vehicle in the queue.
C	• Many times there is more than one vehicle in the queue. • Most drivers feel restricted, but not objectionably so.
D	• Often there is more than one vehicle in the queue. • Drivers feel quite restricted.
E	• Represents a condition in which the demand is near or equal to the probable maximum number of vehicles that can be accomodated by the movement. • There is almost always more than one vehicle in the queue. • Drivers find the delays approaching intolerable levels.
F	• Forced flow. • Represents an intersection failure condition that is caused by geometric and/or operational constraints external to the intersection.

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Table A4

Level-of-Service Definitions (Unsignalized Intersections)

Level of Service	Average Total Delay per Vehicle
A	< 5 Seconds
B	5 to 10 Seconds
C	10 to 20 Seconds
D	20 to 30 Seconds
E	30 to 45 Seconds
F	> 45 Seconds

It should be noted that the LOS criteria for unsignalized intersections are somewhat different than the criteria used for signalized intersections. The primary reason for this difference is that drivers expect different levels of performance from different kinds of transportation facilities. The expectation is that a signalized intersection is designed to carry higher traffic volumes than an unsignalized intersection. Additionally, there are a number of driver behavior considerations that combine to make delays at signalized intersections less onerous than at unsignalized intersections. For example, drivers at signalized intersections are able to relax during the red interval, while drivers on the minor street approaches to TWSC intersections must remain attentive to the task of identifying acceptable gaps and vehicle conflicts. Also, there is often much more variability in the amount of delay experienced by individual drivers at unsignalized intersections than signalized intersections. For these reasons, it is considered that the total delay threshold for any given LOS is less for an unsignalized intersection than for a signalized intersection. **While overall intersection LOS is calculated for AWSC intersections, LOS is only calculated for the minor approaches and the major street left turn movements at TWSC intersections.** No delay is assumed to the major street through movements. For TWSC intersections, the overall intersection LOS is defined by the movement having the worst LOS (typically a minor street left turn).

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Appendix B

Travel Demand Model

Travel Demand Model Development

1.0 PREPARATION FOR THE MODEL

The Woodburn Travel Forecasting Model is designed to estimate and forecast major arterial and collector street travel flows; and to test future land use/transportation system alternatives in the Woodburn urban area. The EMME/2 transportation modeling software package was used for the purposes of estimating trip generation, trip distribution and trip assignment. This modeling software was developed by INRO Consultants, Inc. in Montreal, Canada and is available for use on PC-computers as well as mini-computers. Output from the model developed in EMME/2 includes both black and white and color plots as well as tabular print-outs from the various modeling steps (trip generation, distribution, and assignment). A QRS-II based model was originally created by the Oregon Department of Transportation (ODOT) for the Woodburn urban area. The basic simulation network (nodes and links) were converted to EMME/2 format by Kittelson and Associates, Inc.. Currently, ODOT is in the process of standardizing all of the modeling efforts throughout the state into EMME/2 format.

1.1 Creation of the Transportation Analysis Zone System

To facilitate development of travel forecasts, the household and employment data were assembled by the City of Woodburn and ODOT into 97 Transportation Analysis Zones (TAZ's # 1-20 are "external station" zones, TAZ's # 21-97 are zones internal to the urban area). Boundaries for these TAZ's were established in an attempt to meet the following criteria:

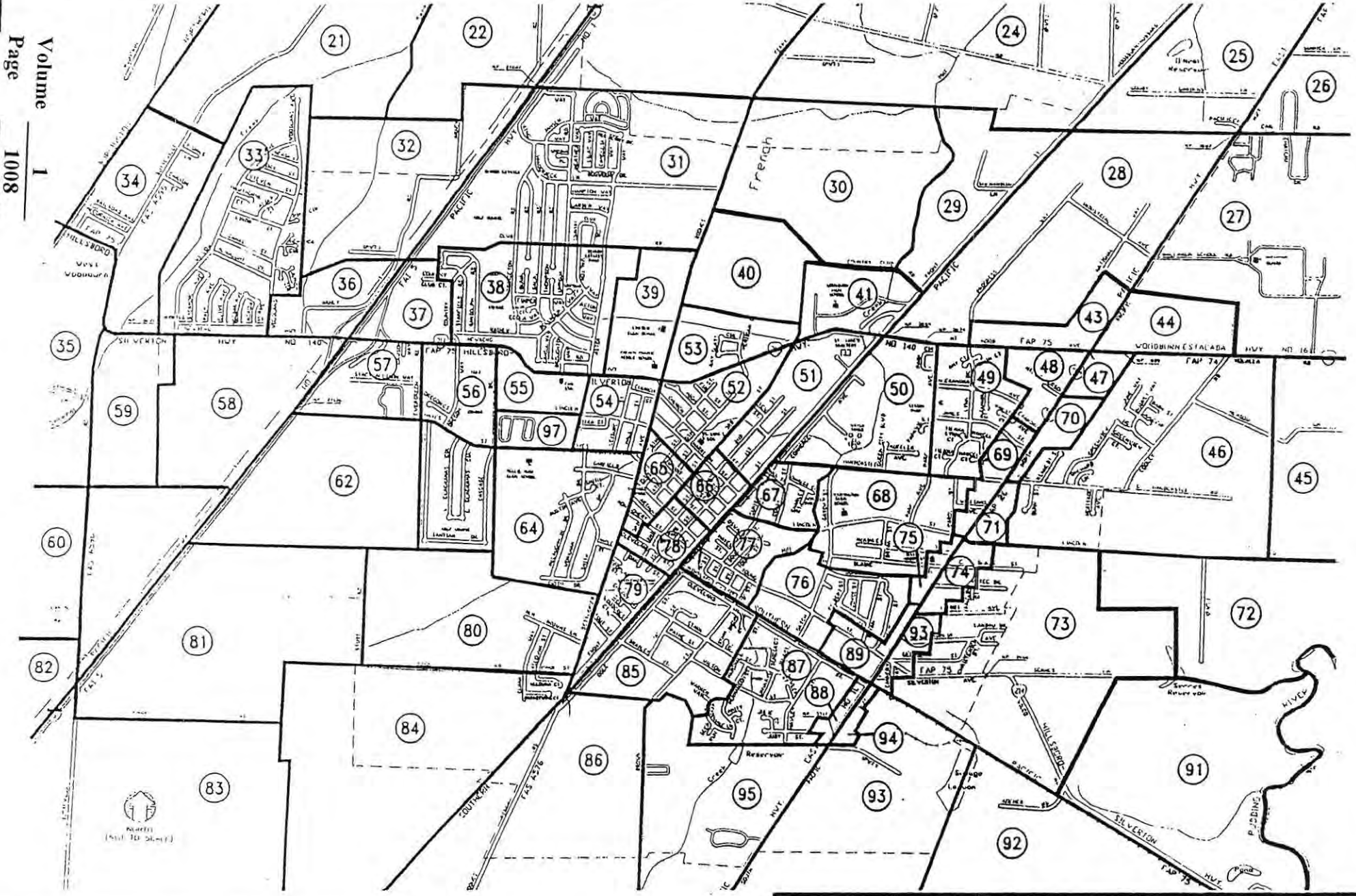
- homogenous land use;
- conformance with major boundaries
  - major transportation corridors
  - physical boundaries which prevent continuous development; and
- homogenous access of land use to transportation system (collector/arterial street system).

Figure 1 illustrates the Woodburn TAZ system.

1.2 Creation of the Roadway Network

All of the Woodburn urban areas' arterial and collector street intersection locations were converted from the QRS-II software in order to develop a computerized roadway network in the EMME/2 software. The EMME/2 database contains 97 centroids (TAZs and external stations), 218 regular nodes (intersections) and 732 links (roadway segments). All links in the study area were assigned the following characteristics based upon their existing function:

- **distance** (in hundredths of miles);
- **travel speed** (average free-flow, off-peak travel speed which includes potential delays at intersections);



LEGEND

TRANSPORTATION ANALYSIS ZONE BOUNDARY

TRANSPORTATION ANALYSIS ZONES

CITY OF WOODBURN
TRANSPORTATION SYSTEM PLAN

FEBRUARY 1995

FIGURE 1

- **link type** (all links were assigned a link type based on **functional classification** for arterials and collectors); and
- **link capacity** (peak hour roadway capacities were assigned based upon roadway functional classification).

Many of the travel speeds, link types, and link capacities were copied directly from the original QRS-II database.

A detailed explanation of the link classes is provided in Table 1.

Table 1

Existing Roadway Network
EMME/2 Link Class

Link Type	Definition	Speed (mph)	# of Lanes (one Direction)	Link Capacity (vph)[1]	# of One-Way Links
1	Centroid Connector	15 - 20	1	9,999	254
2	Interstate 5	45 - 65	2 - 3	1,800 - 3,600	18
3	Principle Arterials	25 - 55	1 - 2	1,100 - 2,200	112
4	Minor Arterials	25 - 55	1	900	52
5	Minor Arterials	20 - 55	1	900	48
6	Minor Arterials	20 - 45	1	900 - 1,100	56
7	Collectors	20 - 45	1	900	58
8	Collectors	20 - 35	1	900	26
9	Collectors	25 - 35	1	900	26
10	Local Roads	20 - 35	1	900	14
11	County Facilities	25 - 55	1	900	68

[1] As defined in original QRS-II network provided by ODOT.

Special note should be made in the handling of centroid connectors. The distance assigned to centroid connectors was computed by measuring the distance from the centroid to the nearest node in the collector/arterial network via the local street network. Centroid connectors are theoretically representative of the local access systems, and thus were considered to have adequate capacity to handle any volumes anticipated. Thus, centroid connectors were assigned a very high p.m. peak hour capacity of 9,999 vehicles per hour, per direction.

The travel model was designed to model *vehicle trips* only. Therefore, all trips made using other modes (i.e. bicycle, walk, bus) were not considered in this model. It is understood that, in the future, transit, bicycles, and pedestrian modes of travel will play a more significant role within the overall area transportation system, but it was deemed that the effort involved in developing a separate non-auto mode model would not yield sufficient results to warrant a full mode-split model development. It was assumed that, given the high proportion of elderly and minority (Hispanic) residents in the community today and expected to continue in the future (who traditionally have less auto ownership), that there is and will be an unmet travel demand by these residents. Added transit, carpooling, and bicycle/pedestrian facilities would serve to a large extent to meet this

latent demand, without having a major impact on vehicle trip generation. Hence, the current vehicle trip generation characteristics in the community were used for the year 2015 travel modeling effort on reducing vehicle trip demand.

2.0 CALIBRATION OF THE MODEL

The performance of a model to forecast future travel is measured by its ability to accurately estimate existing conditions. Thus, the first major step is developing a model that estimates existing travel demand based on land use inputs (i.e. existing households and employment) for trip generation, distribution, and the assignment of trips to the simulation network, then comparing volume estimates to measured traffic flows on the arterial/collector street system. The base year for calibration of the Woodburn model was 1991 as substantial traffic counts and population/employment estimates were available for that year.

2.1 Land-Use Assumptions

ODOT provided estimates of households and employees in each TAZ in the study area for 1991. A summary of the results is provided below:

Housing Type	1991 Housing Units
Single Family	4,463
Multi-Family	1,103
Mobile Home	495
TOTAL	6,061

Employment Type	1991 Employees
Retail	1,277
Industrial	1,909
Service	927
Education	396
Government	479
Other	57
TOTAL	5,045

In addition, there were 49 motel rooms and 148 recreation vehicle park spaces in the Woodburn urban area in 1991.

2.2 Trip Generation

The number of trips entering or leaving a transportation analysis zone is dependent on the trip-making characteristics of residents and land use in that zone. Therefore, trip generation is divided into two categories based on land use including trips *produced* by the home and trips *attracted* by employment.

Three basic trip types were developed for the Woodburn urban area to reflect basic travel patterns of existing residents and workers including: home-based-work (HBW), home-

based-other (HBO), and non-home-based (NHB), and were supplemented with special external travel behavior trip purposes. Basic trip generation rates and equations established by ODOT during the development of the Woodburn QRS-II model were used as the basis to calculate the HBW, HBO, and NHB trips.

The daily trip production equations for each trip purpose are shown below:

$$HBW_{PROD} = [0.16 \times (SF_{HH} \times 10 + MF_{HH} \times 6 + MH \times 6)]$$

$$HBO_{PROD} = [0.61 \times (SF_{HH} \times 10 + MF_{HH} \times 6 + MH \times 6)]$$

$$NHB_{PROD} = [0.23 \times (SF_{HH} \times 10 + MF_{HH} \times 6 + MH \times 6)]$$

Where:	HBW, HBO, NHB	=	Trip Purpose
	PROD	=	Daily Vehicle Trip Productions
	SF_{HH}	=	Number of Single-Family Households
	MF_{HH}	=	Number of Multi-family Households
	MH	=	Number of Mobile Homes

Trip attraction equations were calculated to ensure that total daily attractions within the study area matched total daily productions. The resultant daily vehicle trip attraction equations are shown below:

$$HBW_{ATT} = [0.16 \times (RETAIL_{EMP} \times 20 + INDUSTRIAL_{EMP} \times 2.5 + SERVICE_{EMP} \times 15 + EDUCATION_{EMP} \times 11 + GOVERNMENT_{EMP} \times 8 + OTHER_{EMP} \times 3.5 + MOTEL_{ROOM} \times 10.2 + RV\ PARK \times 3)]$$

$$HBO_{ATT} = [0.61 \times (RETAIL_{EMP} \times 20 + INDUSTRIAL_{EMP} \times 2.5 + SERVICE_{EMP} \times 15 + EDUCATION_{EMP} \times 11 + GOVERNMENT_{EMP} \times 8 + OTHER_{EMP} \times 3.5 + MOTEL_{ROOM} \times 10.2 + RV\ PARK \times 3)]$$

$$NHB_{ATT} = [0.23 \times (RETAIL_{EMP} \times 20 + INDUSTRIAL_{EMP} \times 2.5 + SERVICE_{EMP} \times 15 + EDUCATION_{EMP} \times 11 + GOVERNMENT_{EMP} \times 8 + OTHER_{EMP} \times 3.5 + MOTEL_{ROOM} \times 10.2 + RV\ PARK \times 3)]$$

Where:	HBW, HBO, NHB	=	Trip Purpose
	ATT	=	Daily Vehicle Trip Attractions
	EMP	=	Number of Employees by Type

During the development and calibration of the QRS-II model, ODOT made the following adjustments to the production and attraction equations to account for special generators in specific zones.

- The trip production equations were reduced in zones 31, 38, 55, 56, 63, and 97 to account for lower trip-making characteristics by the residents in the Senior Estates. Specifically,

the home-based work productions in those zones were set equal to zero, the home-based other productions were calculated at 72 percent of the total productions in the zone, and the non-home based productions were calculated at 28 percent of the total productions in the zone. In addition, the total number of trip productions by household type in these zones were reduced from 10 to 5.6 daily trips per single family unit and from 6 to 5.6 daily trips per mobile home.

- The trip production equations were increased in zones 68 and 76 to account for increased trip making in the densely populated residential areas (apartments). Specifically, the number of trips produced by a single family home were increased from 10 to 15 daily trips and the number of trips produced by a multi-family unit were increased from 6 to 10 daily trips.
- The trip attraction equations were increased in zones 43, 48, and 57 to account for the greater trip generation characteristics of large discount stores.

The trip production and attraction equations were then applied to 1991 Woodburn population and employment. Based upon the above trip generation equations, the Woodburn area currently produces an estimated 67,800 daily HBW, HBO and NHB vehicle trips.

2.3 Trip Distribution

Home-Based Work, Home-Based Other, and Non Home-Based Trip Purposes

This section describes the calculations and eventual validation process which was used in the development of the trip distribution model. The standard gravity model was employed to distribute trips between "producers" (households) and "attractors" (employment). The fundamental principle upon which the gravity model is based assumes that the volume of travel between two places is directly related to the size of these places, and inversely related to the distance between the places. The basic form of the gravity model used in the Woodburn model is:

$$T_{ij} = P_i \frac{A_j F_{ij} K_{ij}}{\sum A_j F_{ij} K_{ij}}$$

Where:

T_{ij}	=	trips produced in zone i and attracted to zone j
P_i	=	trips produced in zone i
A_j	=	trips attracted to zone j
F_{ij}	=	Friction factors derived from zone-to-zone travel times that are a function of the spatial separation between zones i and j and the area wide effect of this separation on the level of trip interchange.
K_{ij}	=	Specific zone-to-zone adjustment factor to account for the effect on travel patterns of defined social or economic linkages not otherwise incorporated in the gravity model formu-

lations (none were applied in the Woodburn model data set).

The calibration of a gravity model is the process of determining appropriate travel time factors which adequately reflect the effect of spatial separation between unique locations (zones). To calculate travel times factors by purpose for the Woodburn EMME/2 model, the exponential function outlined below was used.

$$F_{ij} = e^{(-\beta \times T_{ij})}$$

The beta values, calculated as the inverse of the average trip lengths, by purpose, were borrowed from the original QRS-II assignment, and are outlined below.

$\beta_{HBW} = 0.167504$

$\beta_{HBO} = 0.134048$

$\beta_{HBW} = 0.236968$

After calculating the appropriate travel time factors, an initial set of daily trip tables (HBW, HBO and NHB) were developed based on a set of zone-to zone travel costs (travel times).

The resulting daily trip tables were added to the "external" trips (copied from ODOT's QRS-II model) to determine total new travel generated in the study area. The number and distribution pattern of "external" trips were calculated based upon existing travel volumes.

2.4 Trip Assignment

The total existing daily trip table was assigned to the network using an equilibrium assignment algorithm. The calibration process of the daily volume trip assignment required relatively minor adjustments of travel speeds on a limited number of links to yield a proper balance of roadway volumes as compared to observed traffic counts. Tables 2 and 3 compare the resulting EMME/2 travel assignment volumes to existing traffic counts on each collector/arterial facility across east-west and north-south screenlines. As shown in the tables, the overall model screenline volumes are generally within 10 - 15 percent of the observed volumes, thereby indicating that calibration is achieved. A comparison of the modeled volumes vs. the observed volumes is also shown by the Regression Line in Figure 2. As shown in the Figure, the correlation coefficient (R^2) is equal to 0.87, also indicating calibration (A value of 1 indicates that the assigned volume on each road is exactly equal to the observed volume). The resulting 1991 daily travel volumes are shown in Figure 3.

Volume	**1**
Page	**1013**

Table 2

Observed vs. Modeled Volumes—East-West Screenlines

Roadway Segment	1991 2-Way Daily Traffic	1991 Model Assignment 2-Way Daily Volumes	Observed vs. Modeled (%)
East-West Screenline #1: North of Highway 214			
Woodland	4,085	4,400	
Arney	2,430	1,580	
Country Club Rd.	5,720	2,480	
Astor	1,255	3,345	
Boones	5,140	5,720	
Progress	3,600	1,770	
Highway 99E	13,700	16,150	
Total EW #1	35,930	35,445	98.7%
East-West Screenline #2: South of Highway 214			
Interstate 5	60,500	58,880	
Evergreen	2,565	2,495	
Oregon Way	1,245	990	
Cascade	1,170	710	
Boones	10,195	12,570	
Park	3,465	1,325	
Highway 99E	16,700	16,875	
Cooley	1,485	1,155	
Total EW #2	97,325	95,000	97.6%

Table 3

Observed vs. Modeled Volumes—North-South Screenlines

Roadway Segment	1991 2-Way Daily Traffic	1991 Model Assignment 2-Way Daily Volumes	Observed vs. Modeled (%)
North-South Screenline #1: West of Highway 99E			
Highway 214	11,900	10,610	
Hardcastle	3,920	1,590	
Lincoln	4,300	6,885	
Young	6,850	5,325	
Total NS #1	26,970	24,410	90.5%
North-South Screenline #2: East of Highway 99E			
Highway 214	5,900	6,725	
Hardcastle	3,210	1,090	
Lincoln	575	680	

Roadway Segment	1991 2-Way Daily Traffic	1991 Model Assignment 2-Way Daily Volumes	Observed vs. Modeled (%)
Young	6,700	6,430	
Total NS #2	16,385	14,925	91.1%

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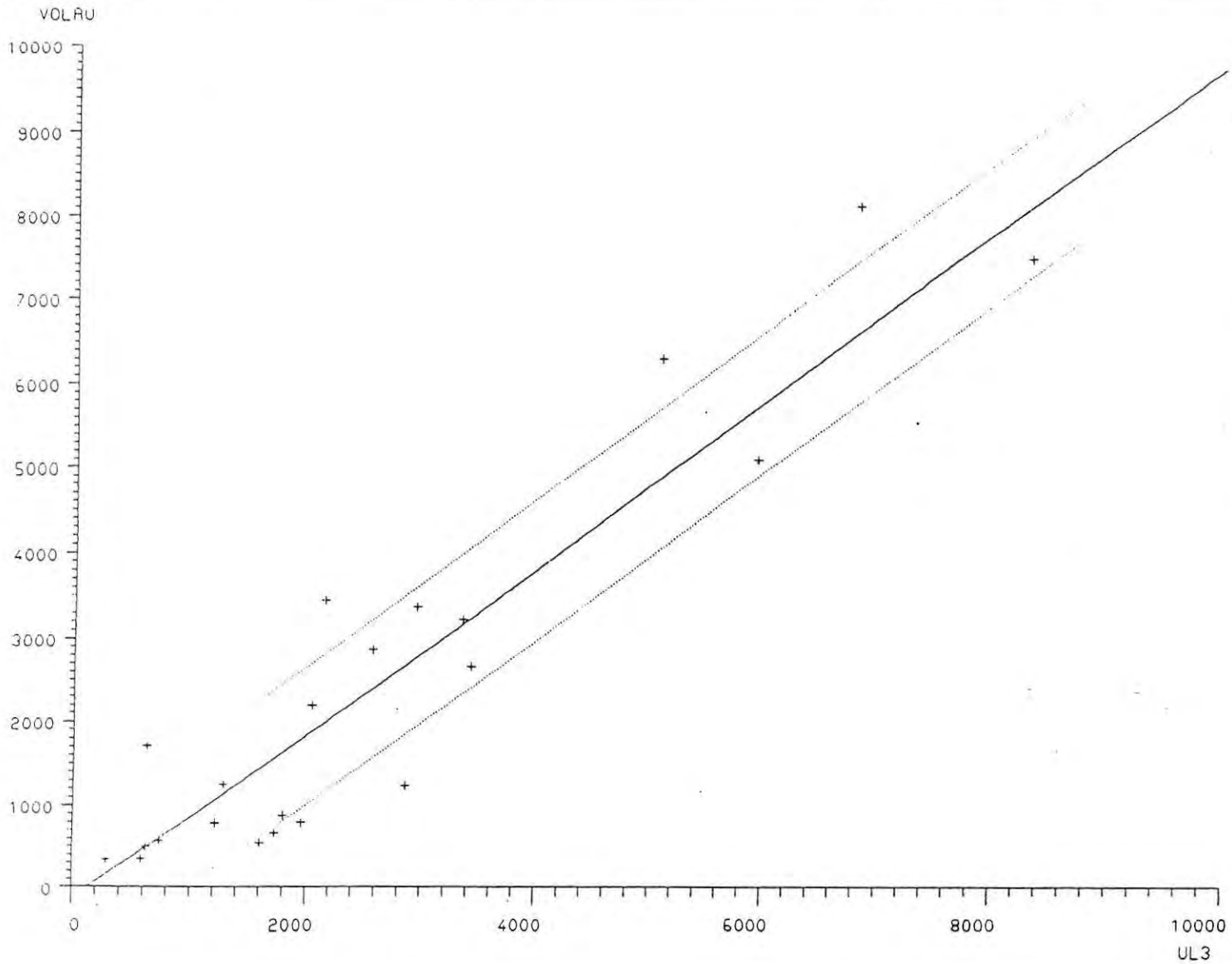
LINK SCATTERGRAM

emme/2



LINKS
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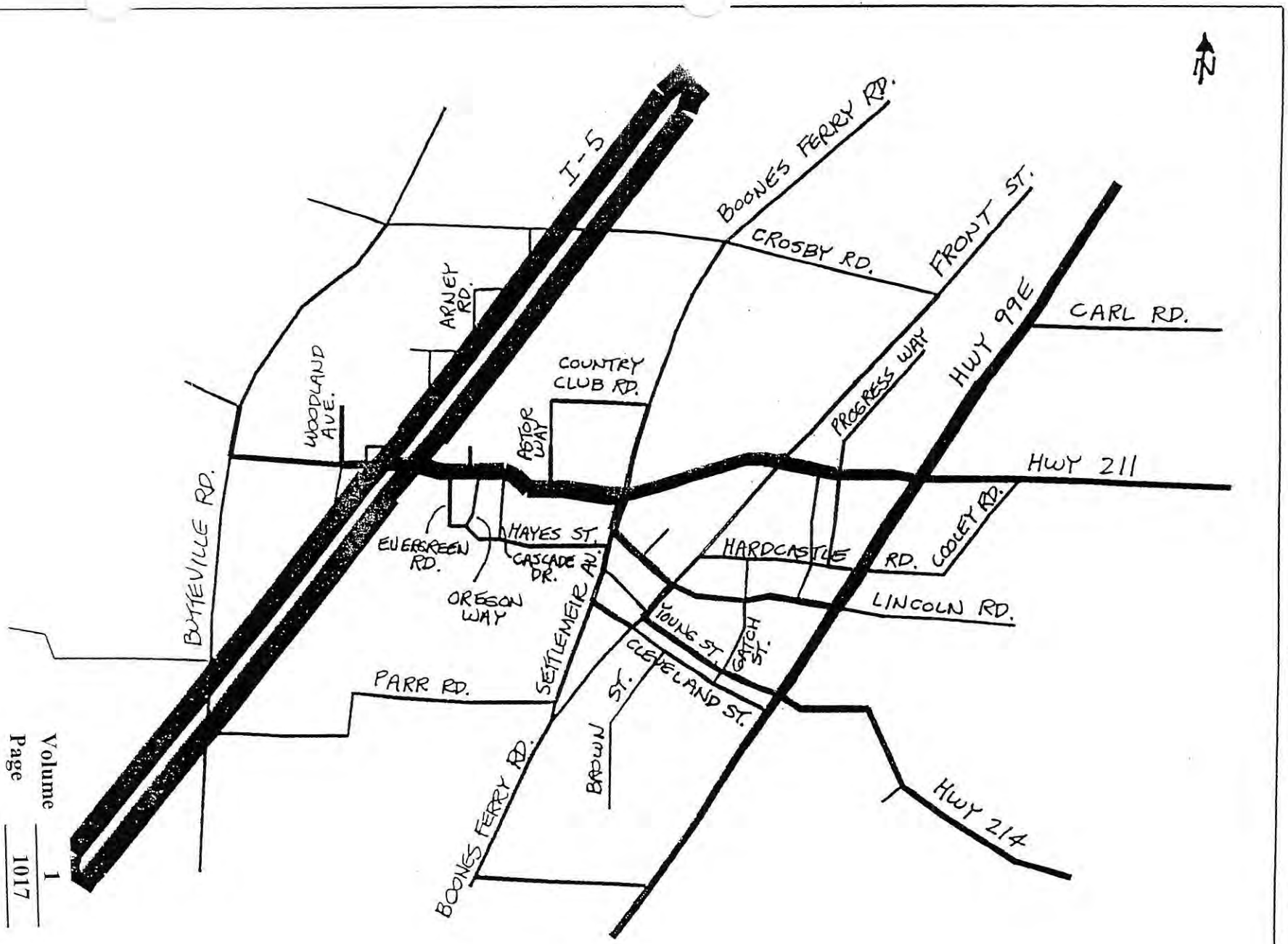
46 LINKS
REGR: Y=A+BX
A= -127.478
B= .98122
R2= .98145
STD= 827.1025
OUTSIDE: 2

EMME/2 PROJECT: CITY OF WOODBURN TSP
SCENARIO 4: 1991 Network Calibration

Figure 2: Observed Volumes vs. Assigned Volumes

95-02-09 13:45
MODULE: 2.43
KAINC.....jak



LINKS:
typ=2.100

SCALE: 2000
5000
10000
15000
20000
25000

WINDOW:
18.4/-457.2
601.6/ -19.8

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Page 1017

EMME/2 PROJECT: CITY OF WOODBURN TSP
SCENARIO 3: 1991 Network Calibration

Figure 3: 1991 Daily Volumes

95-02-21 10:18
MODULE: 6.12
KAINC.....jak

WOODBURN 1991 LAND USE DATA INPUT REQUIRMENTS

	EMPLOYEES								HOUSEHOLDS		
TAZ	RETAIL	INDUST	SERVICE	EDUC	GOV'T	OTHER	MOTEL	RV PARK	SF	MF	MH
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
21		75							12		
22									17		
23									12		
24									75		
25									15		
26									22		3
27					260				25		1
28		1137	59		10						
29		94							7		
30									0		
31	23		1						560		8
32		10							5		
33									393		7
34									35		
35									9		
36	36						49	148	1		
37	68		40		71					20	
38	6								614		
39		2	2	141					3		
40									11		
41				75							
42		0	0		0						
43	340		0								
44	10	52	26						9		
45									17		
46									208		
47									1		
48	128		80								
49					6	13			150	158	
50									90	26	
51	1	35							119	198	
52			2	22					123	16	
53			74	5	11						
54	6		11	13					100	111	

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Page 1018

WOODBURN 1991 LAND USE DATA INPUT REQUIRMENTS

	EMPLOYEES								HOUSEHOLDS		
TA	RETAIL	INDUST	SERVICE	EDUC	GOVT	OTHER	MOTEL	RV PARK	SF	MF	MH
5			98						4		
56	37		39						94	174	
57	0		83							70	
58		70									
59						2					
60									1		
61											
62											
63									254		
64			2	55					142		
65			54		16				85		
66	68		30	4	38				34	8	
67		35							58		
68				55		15			179	75	
69	25		23			15			2	8	
70	48		3							25	
71	184		4						3		
72									11		
73		143							103		
74	36	2	12						12		
75	16		12		12				6		
76						6			114	116	
77	33	53	33	24					64		
78	48	21	97	2	53				34	8	
79									65		
0						4			52		
1									15		
82									1		
83									3		
84									45		
85						2			185		
86									21		
87									166	53	
88			47						2		
89	58		47						9	37	
90	59		32		2				19		
91									4		
92									6		
93	14	150							6		
94	25	30	10						1		
95	8		2						15		9
96			4						10		
97									5		8
TOTAL	1277	1909	927	396	479	57	49	148	4463	1103	49

WOODBURN 2015 LAND USE DATA INPUT REQUIRMENTS

TAZ	EMPLOYEES								HOUSEHOLDS		
	RETAIL	INDUST	SERVICE	EDUC	GOV'T	OTHER	MOTEL	RV PARK	SF	MF	MH
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
21	0	75	0						115	278	
22	0		0						17	357	
23	0	0	0						204		
24	0	152	0						100		
25		256							15	0	
26									22	500	
27					260				25		1
28		1411	65		10				70		
29		293							7		
30						15			349	200	
31	23		1						991		
32	125	10	0						5	1490	
33									393		
34		20							127		
35									9	0	
36	76		45				49	148	1		
37	90		57		71					20	
38	6								614		
39		2	2	141					79		
40									0		
41				95					40		
42		595	0		0						
43	352		0								
44	60	52	57						9		
45	0		0						120		
46									457		
47	41		26						1		
48	148		93								
49					6	13			150	158	
50	27		13						118	26	
51	1	35							119	267	
52			2	22					123	70	
53	28		93	5	11						
54	6		11	13					105	111	
55			98						4	15	
56	37		39						94	174	
57	151		102							70	

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WOODBURN 2015 LAND USE DATA INPUT REQUIRMENTS

TAZ	EMPLOYEES								HOUSEHOLDS		
	RETAIL	INDUST	SERVICE	EDUC	GOVT	OTHER	MOTEL	RV PARK	SF	MF	MH
58		169									
59		210				2					
60	0		0						1	0	
61		220									
62	254		140						260	210	
63									254		
64			2	55					208		
65			54		16				85		
66	68		30	4	38				34	8	
67		35							58		
68				55		15			179	75	
69	25		23			15			2	8	
70	48		3						10	25	
71	184		4						3		
72	0		0						101	188	
73	0	403	0						232	290	
74	36	2	12						12		
75	16		12		12				31		
76						6			114	185	
77	33	53	33	24					71		
78	48	21	97	2	53				34	8	
79									65		
80						4			382		
81	140		60						250	60	
82	0		0						1		
83	0	0	0						3	0	
84									287		
85						2			248		
86		0							140	200	
87									171	53	
88			47						22		
89	58		47						9	37	
90	59		32		2				19		
91									3		
92	0	0	0						6	0	
93	14	351							6		
94	25	30	10						1		
95	8		2						320	440	92
96		100	4						10		
97									5		85
OTAL	2187	4586	1322	416	479	72	49	148	8120	5523	495

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Page 1022

Appendix C

Year 2015 Traffic Flow Maps—Roadway System Alternatives

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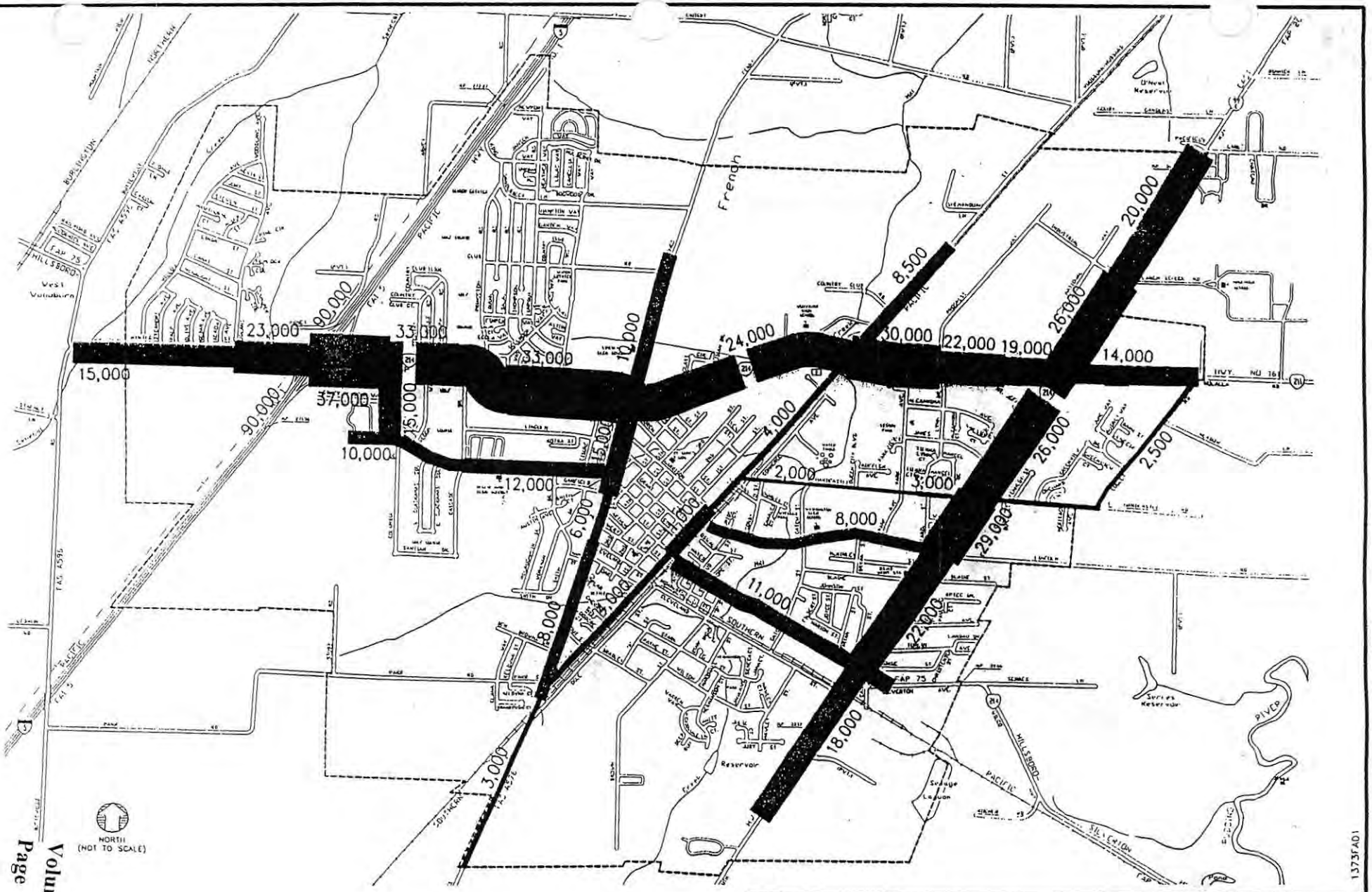
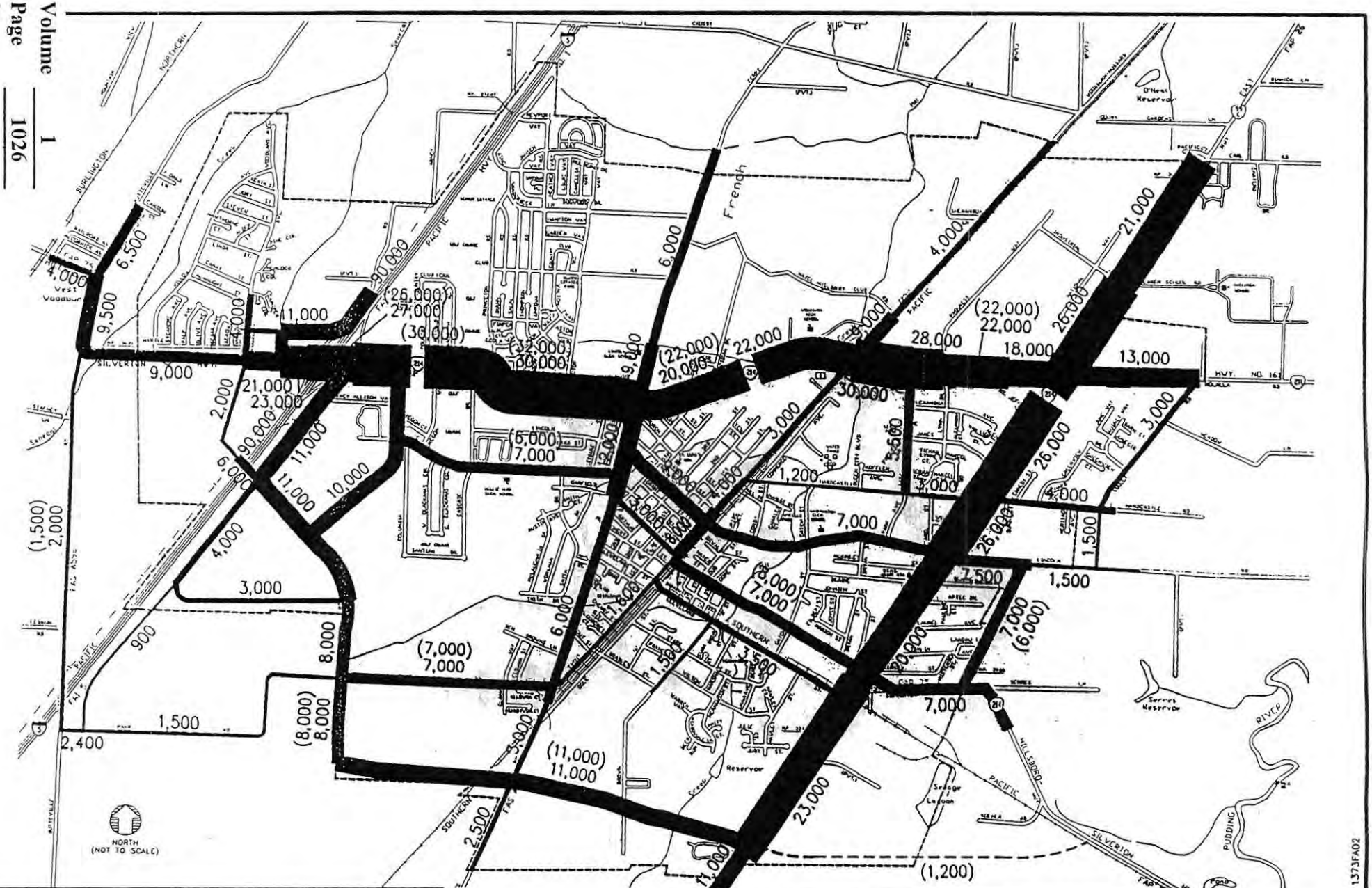


ROAD NO-BUILD ALTERNATIVE
2015 AVERAGE DAILY TRAFFIC

CITY OF WOODBURN
DRAFT TRANSPORTATION SYSTEM PLAN

JUNE 1996

FIGURE
C-1



LEGEND

XX,XXX – 2015 AVERAGE DAILY TRAFFIC WITH SOUTH ARTERIAL EXTENDED TO HWY 99E

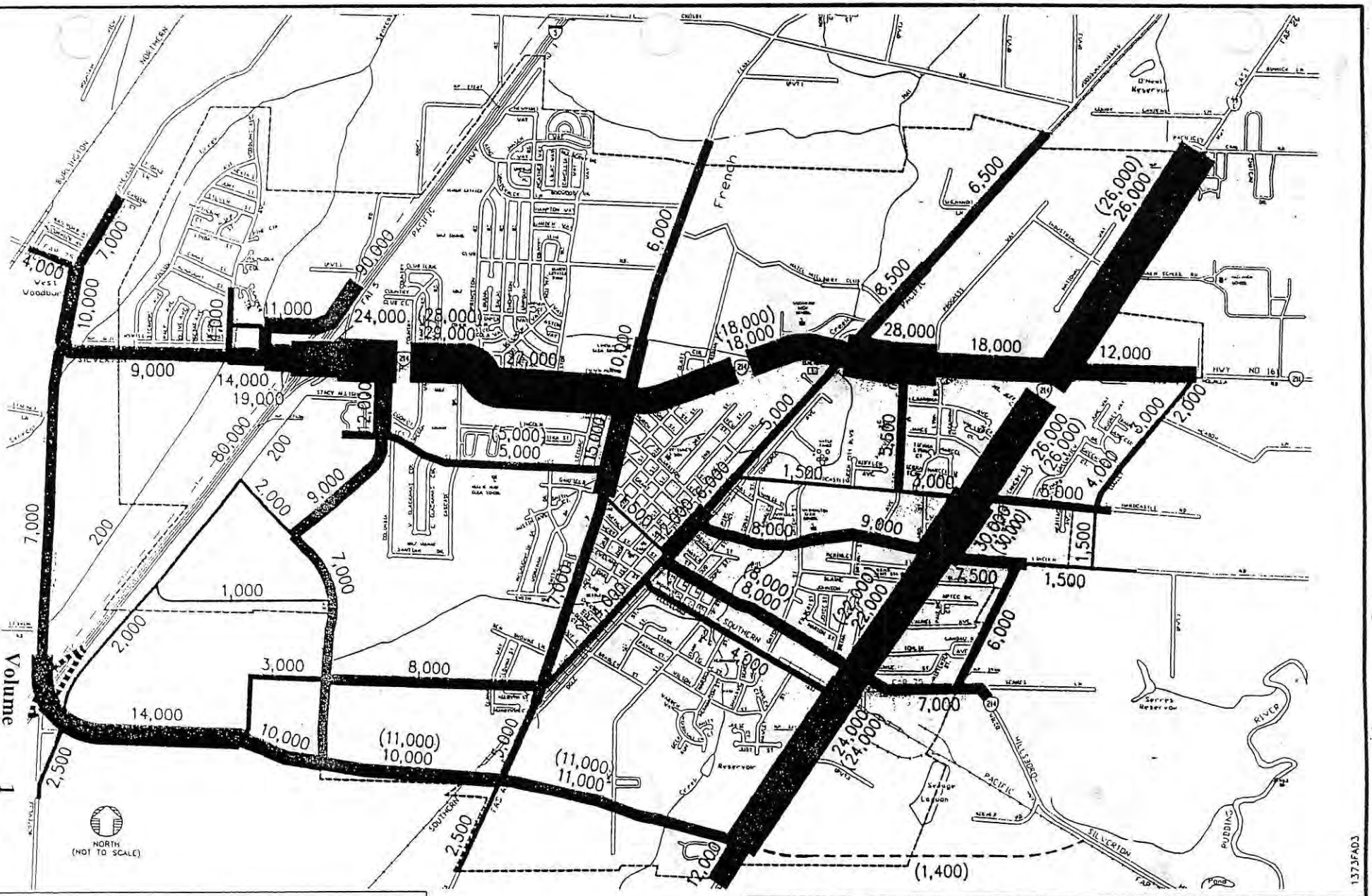
(XX,XXX) – 2015 AVERAGE DAILY TRAFFIC WITH SOUTH ARTERIAL EXTENDED TO HWY 214

REVISED 4/13/95

ROAD ALT. #1: I-5 SPLIT INTERCHANGE WITH SOUTH ARTERIAL
2015 AVERAGE DAILY TRAFFIC

CITY OF WOODBURN
TRANSPORTATION SYSTEM PLAN
JUNE 1996

FIGURE 6-2



LEGEND

XX,XXX – 2015 AVERAGE DAILY TRAFFIC WITH SOUTH ARTERIAL EXTENDED TO HWY 99E

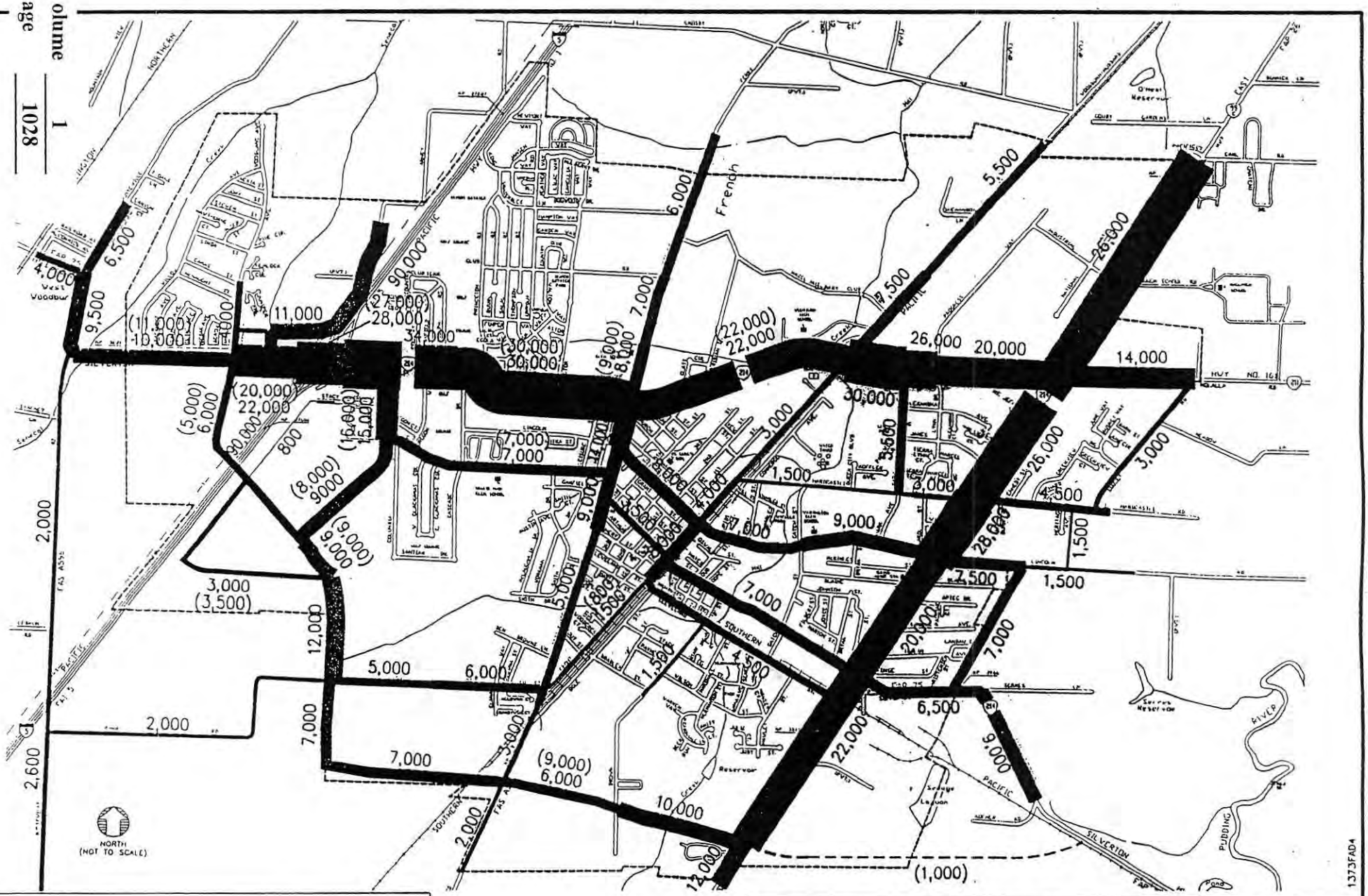
(XX,XXX) – 2015 AVERAGE DAILY TRAFFIC WITH SOUTH ARTERIAL EXTENDED TO HWY 214

REVISED 4/13/95

ROAD ALT. #2: SECOND I-5 INTERCHANGE/ SOUTH ARTERIAL
2015 AVERAGE DAILY TRAFFIC

CITY OF WOODBURN
TRANSPORTATION SYSTEM PLAN
JUNE 1996

FIGURE C-3



LEGEND

XX,XXX – 2015 AVERAGE DAILY TRAFFIC WITH SOUTH ARTERIAL EXTENDED TO HWY 99E

(XX,XXX) – 2015 AVERAGE DAILY TRAFFIC WITH SOUTH ARTERIAL EXTENDED TO HWY 214

REVISED 4/13/95

ROAD ALT. #3: IMPROVE EXISTING I-5 INTERCHANGE & HWY 214 SOUTH ARTERIAL WITH I-5 OVERPASS – 2015 AVERAGE DAILY TRAFFIC

CITY OF WOODBURN
TRANSPORTATION SYSTEM PLAN
JUNE 1996

FIGURE C-4

Appendix D

Year 2015 Ramp/Intersection Volumes—I-5 Interchange Alternatives

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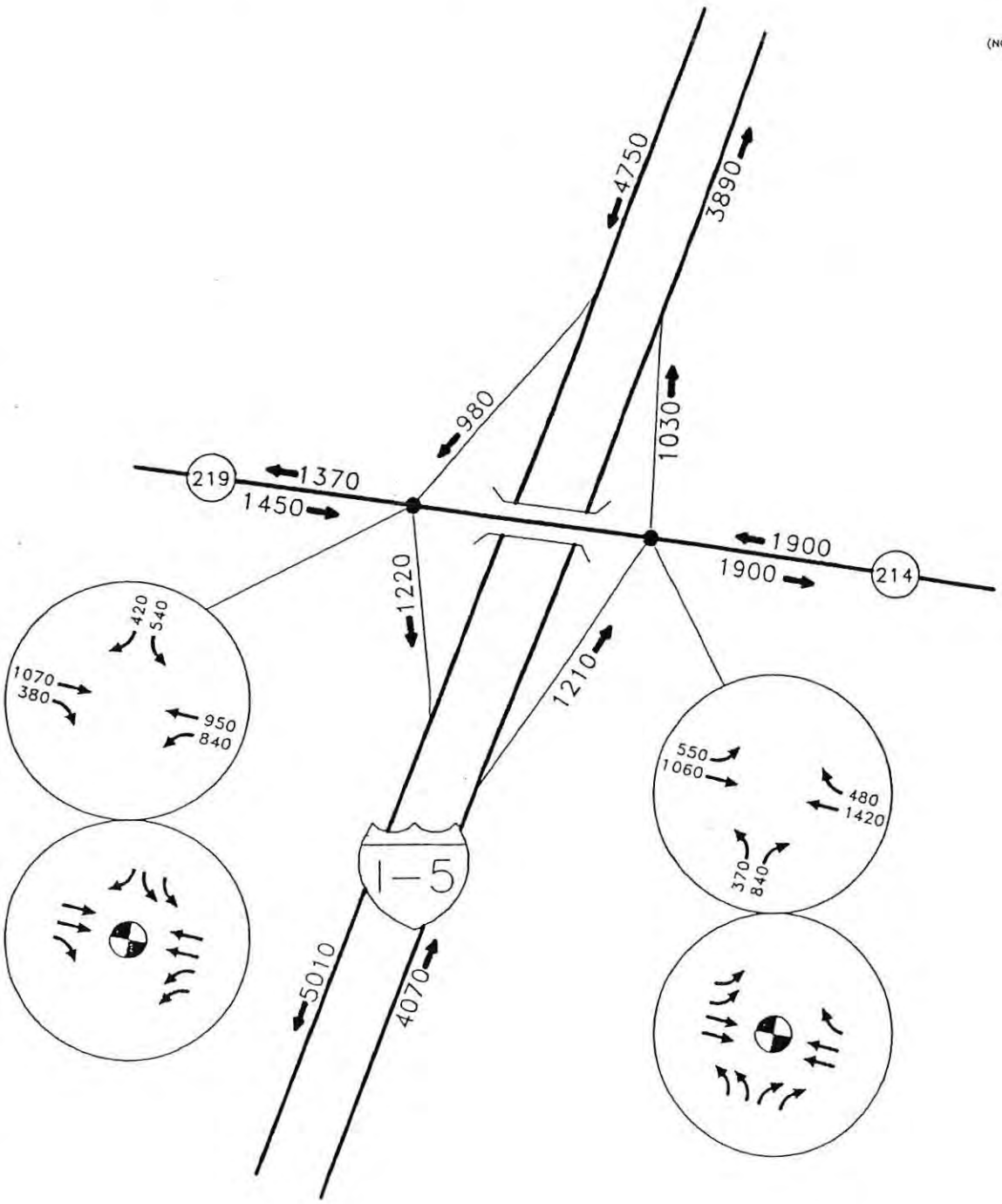

EXISTING DIAMOND INTERCHANGE

LEGEND

380 – YEAR 2015 PM PEAK HOUR TRAFFIC VOLUME ASSUMED

– LANE CONFIGURATION

– TRAFFIC SIGNAL

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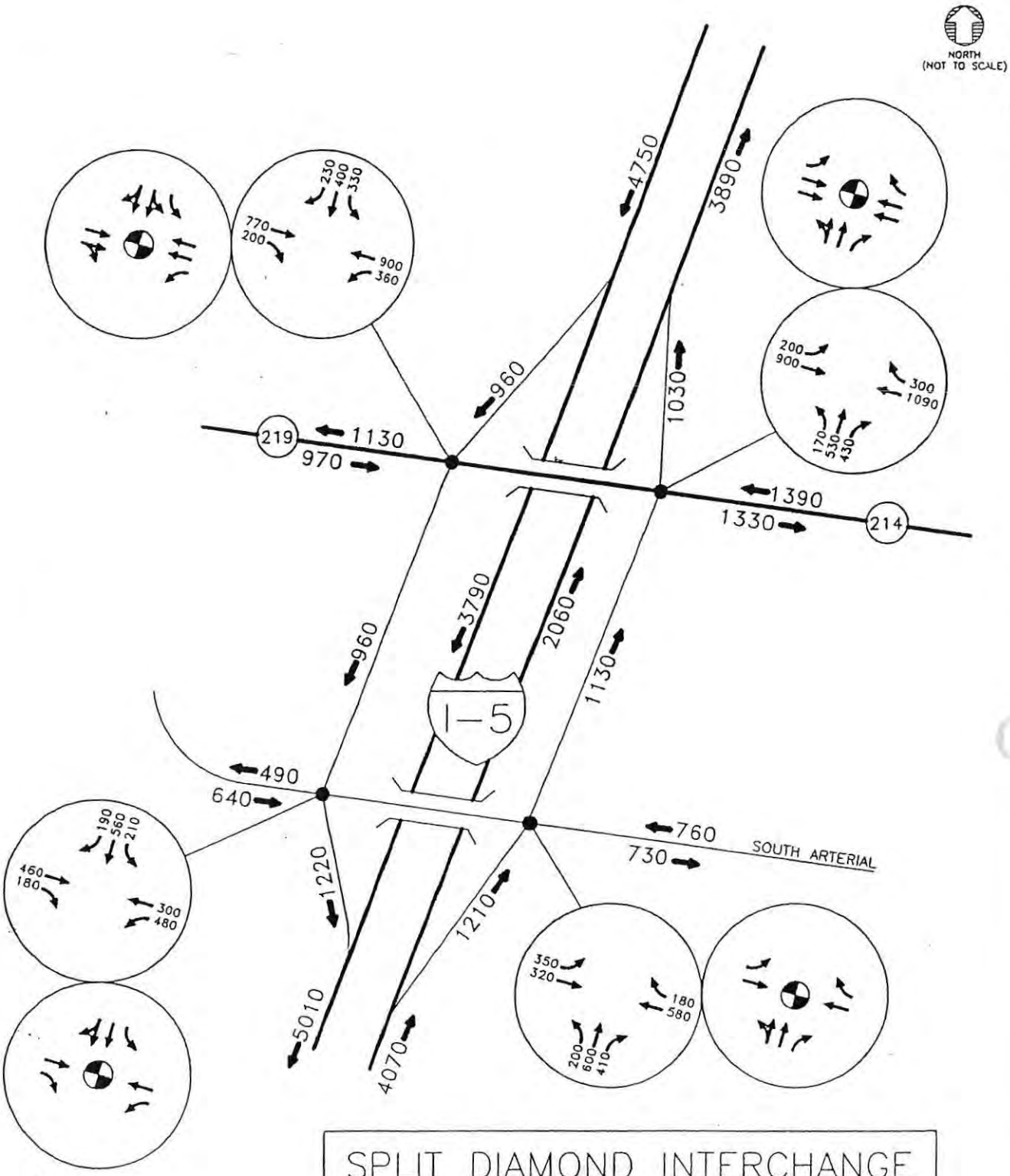
1373F0-1

2015 PM PEAK HOUR TRAFFIC AND LANE CONFIGURATIONS

CITY OF WOODBURN
TRANSPORTATION SYSTEM PLAN
JUNE 1996

FIGURE D-1



SPLIT DIAMOND INTERCHANGE

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LEGEND

85 – YEAR 2015 PM PEAK HOUR TRAFFIC VOLUME ASSUMED

– LANE CONFIGURATION

– TRAFFIC SIGNAL

1373FD-1

2015 PM PEAK HOUR TRAFFIC AND LANE CONFIGURATIONS

CITY OF WOODBURN
TRANSPORTATION SYSTEM PLAN
JUNE 1996

FIGURE D-2

Appendix E

Proposed Woodburn Plan/ Ordinance Text Modifications

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New Comprehensive Plan Policies

New Comprehensive Plan Policies

New Plan Policy 1 - Pedestrian Safety

The City shall encourage pedestrian safety and foster pedestrian activity, sidewalks shall be provided on all arterial, service collector, and access streets. Where possible, sidewalks should be detached from the curb, separated by a minimum 4-foot wide parkway strip.

New Plan Policy 2 - Carpool and Vanpool Programs

The City shall encourage large businesses in Woodburn to set up carpool and vanpool matching programs, based on employees' residential location and work shift.

New Plan Policy 3 - Parking Reductions

The City shall encourage a reduction in parking for single-occupancy vehicle travel. Where carpool/vanpool, or shared parking is provided, minimum parking requirements may be reduced by 10%.

New Plan Policy 4 - Access Control Policies and Guidelines

Access to a development site shall be consistent with an adopted access management plan for specific streets. Until such time that access management plans have been adopted by the City of Woodburn, access shall be consistent with applicable standards of the Oregon Highway Plan, the applicable standards of the zoning district or overlay zone, or the applicable standards or guidelines outlined in the Transportation System Plan.

Policy 4(a) - Road Classification

Highway 214 (between the west City limits and Settlemier Avenue/Boones Ferry Road) and Highway 99E between Lincoln Street and the South City limits. The 1991 Oregon Highway Plan classifies the following as Category 5 Highways:

- Public roads shall be spaced a minimum of one-quarter mile apart;
- Private driveways shall be full access spaced at least 300 feet apart (which equates to 18 driveways per mile on each side of the roadway); and
- Traffic signals shall be spaced at least one-quarter-mile apart.

Policy 4(b)- Driveway Access

Where possible, driveway access along Highway 214 and Highway 99E shall be consolidated to meet the driveway density guidelines outlined in the Access Management Classification System of the Oregon Highway Plan. Where possible, driveway access along the following sections of Highway 214 shall be consolidated:

- I-5 / Evergreen Road;
- Evergreen Road / Oregon Way;
- Oregon Way / Broughton Way; and
- Broughton Way / Settlemier Avenue.

Where possible, driveway access along the following sections of Highway 99E shall be consolidated:

- Lincoln Street / Aztec Drive;
- Aztec Drive / Laurel Avenue;
- Laurel Avenue / Highway 214; and
- Highway 214 / End of Curb.

Policy 4(c) - Compliance with Access Management Guidelines

In order to bring Highway 214 and Highway 99E into compliance with the Access Management Policy guidelines, the City of Woodburn shall coordinate with ODOT to:

- Develop a parallel road system to provide local access to businesses adjacent to Highways 214 and 99E and reduce the traffic volumes on Highway 99E; and
- Install two-way left turn lanes along the sections of Highways 214 and 99E outlined in Section 11.070(i)(2)- Driveway Access.

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Zoning Ordinance Amendments

New Zoning Ordinance Section

There are several general issues that need to be addressed as part of the amendments to the Zoning Ordinance.

SECTION 8 (Add)TRANSPORTATION PLANNING, DESIGN STANDARDS AND PROCEDURES

Section 8.011 Sidewalks

Sidewalks shall be provided along both sides of all arterial, service collector, and access streets and also on local streets if possible. Sidewalks shall meet the following minimum widths:

Curb sidewalks shall have a minimum unobstructed width two feet less than the required width above. A detached setback sidewalk shall be separated from the curb by a planting strip at least four feet in width.

Section 8.012 Bikeways

A comprehensive bicycle plan facility system shall be constructed providing access to major activity centers within the City. The bicycle facility system shall provide continuity and interconnectivity so that bicycle lanes do not terminate leaving a cyclist with no option but to ride on the shoulder of the road. The bicycle facility system shall provide continuous access to Downtown Woodburn, schools, recreational areas, and many of the residential areas in Woodburn. As new developments are constructed, the City shall provide safe, well lit, covered bicycle storage facilities. If the new development is an office building, the developer should be required to provide shower facilities as well.

Section 8.012(1) Bicycle Lane Width

Bicycle lanes and bikeways shall be provided in accordance with the Transportation System Plan. Bicycle lanes shall be six feet wide and shall be provided for each direction of travel. Except as amended or altered by the transportation plan, bicycle lanes shall be provided along collector and arterial streets. Bicycle lanes and bikeways shall be constructed consistent with ODOT Bicycle Plan standards.

Section 8.013 Street Standards

Streets shall meet the following standards:

Conform to the Streets Standard Ordinance.

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Section 8.014Internal Connections

Section 8.014(a)Connections To The Right-of-way

Every commercial, office, and institutional building shall include a pedestrian walkway connected to the public right-of-way. A walkway shall be provided for every 300 feet of street frontage.

Section 8.014(b) Connections Between Developments

Opportunities for at least one pedestrian walkway and one potential vehicular connection shall be provided between adjacent commercial, office, and institutional development. If connections are currently not available, then planned connections shall be designed to provide an opportunity to connect adjoining developments.

Section 8.014(c) General Walkway Standards

Walkways shall be designed to connect with internal circulation patterns within buildings. Walkways shall meet City standards for sidewalk construction and shall not be less than five feet in width. If adjacent to a parking area where vehicles will overhang the walkway, a seven-foot-wide walkway shall be provided. The walkways shall be separated from parking areas and internal driveways using curbing, landscaping, or distinctive paving material.

Section 10.090 Golf Carts

Section 10.091 Street Width Right-of-way

Streets that allow golf carts shall provide a minimum of an eight-foot wide exclusive lane for golf cart users on both sides of the street.

Section 10.092 On-site Right-of-way For Golf Carts

Land uses that allow the use of golf carts on site shall ensure that an eight-foot wide right-of-way access.

Amendments To The Parking Section Of The Zoning Ordinance For Bicycle And Carpool/vanpool Parking

Section 10.071 Bicycle Parking

Section 10.071(a) Applicability

Bicycle parking shall be provided for all new commercial, industrial, institutional, and multi-family development. In the downtown area, such uses that are be exempt from vehicle parking requirements shall provide bicycle parking.

Section 10.071(b) Number Of Spaces

The number of bicycle parking spaces shall be at least 10% of the required automobile parking for the use. In no case shall less than two spaces be provided.

Section 10.071(c) Space Standards And Racks

The dimension of each bicycle parking space shall be a minimum of two and one-half by six feet. A five-foot-wide access aisle must be provided. If spaces are covered, seven feet of overhead clearance must be provided. Bicycle racks must be securely anchored and designed to allow the frame and one wheel to be locked to a rack using a high security, u-shaped, shackle lock.

Section 10.071(d) Location

Bicycle parking facilities shall be:

- located within 50 feet of the main building entrance;
- closer to the entrance than the nearest automobile parking space;
- designed to provide direct access to a public right-of-way;
- dispersed for multiple entrances; and
- in a location that is visible to building occupants or from the main parking lot.

Section 10.071(e) Covered Parking

Covered bicycle parking shall be provided when 10% or more of automobile parking is covered. If more than 10 bicycle parking spaces are required, then a minimum of 50% of the spaces shall be covered.

Section 10.071(f) Lighting

Lighting shall be provided in bicycle parking areas to thoroughly illuminate facilities during working hours. Bicycle parking areas shall be at least as well lit as automobile parking areas.

Section 10.072 Carpool and Vanpool Parking

New industrial, institutional, and commercial development with 50 or more employees shall provide carpool/vanpool parking. Carpool/vanpool parking shall be provided for at least 10 percent of the required employee parking and shall be located no further from the primary employee entrance than any other employee parking spaces.

Section 11.020(g) Site Plan Review

Section 11.020(g)(1) Purpose

The purpose of this section is to provide standards and procedures to implement provisions of the State Transportation Planning Rule (OAR 660, Division 12) and local, regional, and state transportation plans.

Section 11.020(g)(2) Applicability

The standards and procedures of Section 8.011 shall apply to all commercial, industrial, institutional, and multifamily residential development. any construction, renovation, expansion or alteration of an existing use or portion of a use that is non-conforming and has a development permit value that exceeds 50% of the value of the land and structures, based on the county assessor's records, will be required to bring the property into conformance with the standards of this section. Permit value shall be determined by the building official.

If the development permit value is less than 50% of the land value, than an equal percentage of the site must comply with the standards as the percentage of building expansion or site alteration. For example, if building area is expanded by 25%, then a minimum of 25% of the site must be brought in to compliance with the standards in this section.

In all cases, regardless of permit value, new construction, renovation, expansion or alternation shall provide bicycle parking in accordance with this ordinance.

Section 11.020(g)(3) Coordinated Review

If a proposed development is within 200 feet of a state highway or an existing or planned transit route, notice of the proposal shall be provided to ODOT, participating transit operators, and Marion County. The notice shall be part of the administration review process.

Section 11.020(g)(4) Consolidated Review

Development review associated with proposed transportation facilities, services, and improvements shall be conducted in conjunction with other jurisdictions when appropriate.

Section 11.020(g)(5) Criteria

The criteria on which the Planning Director shall base development review decisions are as follows:

1. Compliance with standards and procedures of section 8.
2. Compliance with standards of the applicable zoning district.
3. Compliance with supplementary regulations and parking standards.

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Subdivision Standards Amendments

Section 12(J) New Development Standards

Section 12(j)(1) Sidewalk, Bikeway, And Street Standards

The sidewalk, bikeway, and street standards shall meet the standards outlined in the Street Standards Ordinance.

Section 12(J)(2) Cul-de-Sacs

Cul-de-sacs shall only be provided when no opportunity exists for creating a through street connection. A cul-de-sac shall have a maximum length of 250 feet.

Section 12(J)(3) Block Size

Except where required for access management, block length shall not exceed 600 feet. In addition, when necessary for public convenience and safety, the Planning Commission may require the land divider to dedicate to public access ways to connect to cul-de-sacs, to pass through oddly shaped or unusually long blocks, to provide networks for public paths according to adopted plans, or to provide access to schools, parks, or other public areas.

The perimeter of blocks formed by streets shall not exceed 1,600 feet, except where street location is restricted by natural topography, wetlands, or other bodies of water.

Section 12(J)(4) Pedestrian Ways

In any block over 600 feet in length between intersecting street lines, a pedestrian way with a minimum width of 15 feet shall be provided through the block near the middle.

Section 12(J)(5) Alleys

The width of right-of-way and paving design for alleys shall not be less than 20 feet, except that for an alley abutting land not in the subdivision or partition a lesser width may be allowed at the discretion of the Planning Commission. Where two alleys intersect, 10 feet corner cutoffs shall be provided. Unless otherwise approved by the Planning Commission, grades shall not exceed 12 percent.

New Definitions

Access ways: A walkway that provides pedestrian and or bicycle passage either between streets or from a street to a building or other destination such as a school, park, or transit stop. Access ways generally include a a walkway and additional land on either side of the walkway, often in the form of an easement or right-of-way to provide clearance and separation between the walkway and adjacent uses.

Bikeways: Any road, street, or path which in some manner is specifically designated for the use of bicycles or for shared use by bicycles and other transportation modes. The term "bikeway" includes bicycle lane, bicycle path, and bicycle route.

Bicycle Lane: A portion of a road, street, or shoulder which has been designated for use by bicyclists through the application of a paint stripe.

Bicycle Path: A separate trail or path on which motor vehicles are prohibited and which is for the exclusive use of bicycles or the shared use of bicycles and pedestrians.

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Item 3

ATTACHMENT A
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PARKS AND RECREATION COMPREHENSIVE PLAN UPDATE

Prepared by
David J. Reed, Ph.D.
and Don Ganer

October 1999

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Page 1047

Don Ganer & Associates

NW White Fox Dr. • Beaverton, Oregon 97006 • (503) 690-8981

COUNCIL BILL NO. 2005

ORDINANCE NO. 2247

AN ORDINANCE MAKING TEXTUAL AMENDMENTS TO THE WOODBURN COMPREHENSIVE PLAN; ADOPTING A PARKS AND RECREATION COMPREHENSIVE PLAN UPDATE; AND DECLARING AN EMERGENCY.

WHEREAS, the Woodburn Comprehensive Plan has been adopted by the City and acknowledged by the Land Conservation and Development Commission (LCDC); and

WHEREAS, the City is currently in the process of Periodic Review, and

WHEREAS, Task No. 5 of the City's Periodic Review Work Program states that the Recreation, Parks and Open Space Plan will be updated, and

WHEREAS, the passage of this ordinance represents completion of Task No. 5; and

WHEREAS, certain textual amendments to the Woodburn Comprehensive Plan regarding open space and parks have been proposed; and

WHEREAS, a Parks and Recreation Comprehensive Plan Update has been prepared; and

WHEREAS, the Planning Commission and City Council have conducted public hearings on the proposed textual amendments and Parks and Recreation Comprehensive Plan Update; and

WHEREAS, notice of the amendments has been forwarded by the City to the Department of Land Conservation and Development (DLCD) as provided by state law; **NOW, THEREFORE,**

THE CITY OF WOODBURN ORDAINS AS FOLLOWS:

Section 1. The City of Woodburn Comprehensive Plan, Land Use Element, IV Existing Land Uses, E. Open Space/Parks, is hereby amended to read as follows:

There are approximately 474 acres of Open Space and Parks within the city and UGB. A majority of the Open Space in the planning area is private land. Development of this private land is limited because it is in the floodplain area.

The Park Plan has inventoried existing park resources and has identified the need and vicinity for three additional neighborhood parks. The Plan also identifies

existing floodplain along Mill Creek, Senecal Creek and Goose Creek for greenways to be preserved as a natural greenway and transportation corridor as encouraged by Policy L-1, of Volume I of the Comprehensive Plan.

Systems Development Charges have assisted with funding for the first phase of development for Centennial Park located on Parr Road in South Woodburn. The first phase was completed in 1999 with two more phases planned for completion by 2006.

City Ordinance #1908 establishes a Tree Ordinance for inventory, preservation and replacement of public and private trees. This effort resulted in Woodburn gaining recognition as a "Tree City, USA", by the National Arbor Day Foundation in years, 1985, 1986, and 1987. In 1998, the City adopted a program to assist homeowners with repair, removal and replacement of trees within the public right-of-way.

Section 2. The City of Woodburn Comprehensive Plan, Land Use Element, X The Land Use Plan, F. Open Space/Parks, is hereby amended to read as follows:

Open space lands are indicated for three new 3-5 acre neighborhood parks. The vicinities for these parks include east of I-5, north of Parr Road and south of Hayes; another south of Cleveland, east of Union Pacific mainline/Boones Ferry, and west of Hwy. 99E; and another east of Hwy. 99E, south of Blaine and north of Hwy. 211. Additionally, the floodplain areas of the City are indicated for open space. This does not mean that the City will necessarily own these lands, however, any development scheme should leave these floodplain lands as open and undeveloped with structures.

In 1998, the City annexed the 25 acre Centennial Park site located south of Parr Road. In 1999, the City completed Phase 1 of the park's development including two soccer fields, a softball/baseball field and two playgrounds. Future phases, projected for completion in 2006, will construct three additional softball/baseball fields, picnic and concession facilities, athletic field lighting and hard court play surfaces.

The other open space uses such as floodplain areas could serve as transportation routes for pedestrian traffic, golf carts and bicycle paths. There would have to be a concerted effort by the city to acquire R.O.W. easements through private properties to establish these routes.

Section 3. The City of Woodburn Comprehensive Plan, Land Use element, IX Goals and Policies, is hereby amended to add a new subsection "R. Recreation and Parks Goals and

Policies" which shall read as follows:

R. Recreation and Parks Goals and Policies

Goal

R-1. It is the goal of the City to provide adequate parks, recreation facilities, and open space to maintain Woodburn's livability and managed growth, and to provide social, economic and environmental benefits to individuals, families and the community.

R-2. Downtown Woodburn should remain a centerpiece of activity, culture, and commerce within the City. Library Park, Woodburn Aquatic Center, Settlemier Park, the Woodburn World's Berry Center Museum, and Locomotive Park should be used as catalysts for downtown revitalization.

Policies

R-1-1. The City will insure that sufficient land is made available for parks and open spaces by adopting the system of facility types and standards in the 1999 Parks and Recreation Comprehensive Plan including: Mini-Parks; Neighborhood/School Parks; Community Parks; Municipal Parks; Greenways, Open Space, Trails and Pathways; and Cultural Resources and/or Special Use Parks/Facilities.

R-1-2. The City will insure the most efficient and effective means of providing sufficient land for neighborhood parks by adopting a neighborhood/school park concept including joint land acquisition and development, thereby strengthening the existing partnership between the City and the Woodburn School District.

R-1-3. Where neighborhood/school parks are not feasible, it is the policy of the City to acquire neighborhood parks, when practicable, through the development review process.

R-1-4. As a supplement to the City's neighborhood parks, it is the policy of the City to encourage new subdivisions to provide mini-parks, meeting City approved standards. The city shall insure that the excessive maintenance impacts of mini-parks are avoided by requiring ownership to be retained by the developer or a homeowner association, with maintenance provided by the developer, the homeowner association, or by the City through a maintenance LID. These facilities may not be used to reduce the

requirements for System Development Charge payments.

R-1-5. It is the policy of the City to manage Mill Creek, Goose Creek and Senecal Creek corridors as public greenways and pathways; multiple functions will include open space and habitat preservation, flood control, cycling and walking on all-weather pathways, nature recreation and education, and limited playground activities where there is a deficiency of neighborhood parks.

R-1-6. To provide for a continuous public greenway and pathway system, it is the policy of the City to acquire privately-owned segments along Mill Creek, Goose Creek, and Senecal Creek and other stream corridors including the west tributary from Settlemier Park to Parr Road. It is the policy of the City to seek dedication of floodplains and creek corridors for natural areas, neighborhood recreation areas, open space and transportation.

R-1-7. To insure adequate maintenance of the City's parks, recreation, and open space facilities, the City will prepare comprehensive management plans including maintenance management standards for each facility.

R-1-8. It is the policy of the City to require multi-family housing projects which exceed four (4) units to provide basic neighborhood park and playground facilities, based on development standards of the Recreation and Parks Department.

R-1-9. Because recreation participation preferences and interests vary among employment ethnic, social, and cultural groups, it is the policy of the City to exercise special sensitivity in selecting the types of recreation programs it offers, and in the design and management of parks, recreation and open space facilities.

Section 4. The Parks and Recreation Comprehensive Plan Update, affixed hereto as Attachment "A" and incorporated herein, is hereby adopted.

Section 5. The textual amendments to the Comprehensive Plan and the adoption of the Parks and Recreation Comprehensive Plan Update is justified by the legislative findings which are affixed as Attachment "B" and, by this reference, incorporated herein.

Section 6. This ordinance being necessary for the public peace, health and safety, an emergency is declared to exist and this ordinance shall take effect immediately upon passage by the Council and approval by the Mayor.

Approved as to form: _____ 11-18-99
City Attorney Date

Approved: _____
Richard Jennings, Mayor

Passed by the Council	November 22, 1999
Submitted to the Mayor	November 23, 1999
Approved by the Mayor	November 23, 1999
Filed in the Office of the Recorder	November 23, 1999

ATTEST: _____
Mary Tennant City Recorder
City of Woodburn, Oregon

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EXECUTIVE SUMMARY

In January 1997, the City of Woodburn hired Don Ganer & Associates, working in collaboration with David Reed, Ph.D., to update the City's Parks and Recreation Comprehensive Plan. The Woodburn Comprehensive Plan -- *Woodburn 2014,* along with the *Oregon Statewide Planning Goals and Guidelines (1995),* provide the primary framework for this Plan update. The planning service area includes both the current City limits and unincorporated lands within the Urban Growth Boundary. The planning time horizon is 1999 - 2020.

The City currently owns 87.02 acres of land designated as parks and recreation facilities, and the Woodburn School District has 114.8 acres of public school facilities. For the most part, all school campuses are large enough to provide community recreation facilities such as sports fields and playgrounds, and are either currently used for or have the potential for use as neighborhood/school park facilities.

This Plan is designed to meet population and employment needs based on the application of specific Level of Service (LOS) Standards, and to address other needs identified by the community. Facility types and minimum standards for park size, service area, and acreage per population/employment have been developed to insure that residents and employees are adequately served by parks and recreation facilities.

The LOS Standards were developed using recently updated guidelines of the National Recreation and Parks Association (NRPA) in it publication *Parks, Recreation, Open Space and Greenway Guidelines* (1996). Unlike previous NRPA publications which provided specific LOS Standards for facilities (i.e., a Neighborhood Parks LOS Standard of 5.0 acres per 1,000 persons, etc.), the current *NRPA Guidelines* suggest the development and adoption of local LOS Standards for the specific types of facilities important to the local community, and emphasize that Levels of Service should: 1) be practicable and achievable, 2) provide for an equitable allocation of park and recreation resources throughout the community, and 3) reflect the real time demand of citizens. The current *NRPA Guidelines* also introduced the classification "School-Park", recognizing that public school facilities are routinely used for for parks and recreation activities.

A Capital Improvements Plan which identifies $10,815,500 in projects designed to repair existing facilities and provide new facilities to meet LOS Standards for population and employment growth through the year 2020 is included as an appendix to the Plan.

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1. INTRODUCTION AND PLANNING FRAMEWORK

In January 1997, the City of Woodburn hired Don Ganer & Associates, working in collaboration with David Reed, Ph.D., to update the City's Parks and Recreation Comprehensive Plan. The Woodburn Comprehensive Plan --*Woodburn 2014*, was last amended in March 1996 and, along with the *Oregon Statewide Planning Goals and Guidelines (1995)*, provides the primary framework for this Plan update. The planning service area includes both the current City limits and unincorporated lands within the Urban Growth Boundary. The planning time horizon is 1999 - 2020.

1.1 Comprehensive Plan Goals and Policies

Woodburn 2014 includes many goals and policies related to parks, recreation and open space. They provide the framework for the development of this plan and include the following:

1.1.1 Residential Use

A-1. The neighborhood should provide a focus and identity within the community and should have a community facility, such as a school, park, or privately owned community facility to allow for interaction within the neighborhood.

A-3. Development should promote, through the use of moderate density standards and creative design, a feeling of openness and spaciousness with sufficient landscape area and open space to create a pleasant living environment.

1.1.2 Commercial Land Development

Policy B-5. Downtown redevelopment should be emphasized and the City should in its actions, encourage new commercial development to locate downtown when appropriate.

1.1.3 Annexation

Policy D-1. While it is important that enough land is available for the necessary development anticipated in the City of Woodburn, it is also essential to prevent too much land being included in the city limits as this leads to inefficient, sprawling development.

1.1.4 Public Services

Goal H-2. (Provide) detention systems for flood water and storm drain runoff so as not to overburden the drainage systems of the City.

Policy H-1. It is the policy of the City to provide facilities at the least long range cost to the City.

Policy H-6. To insure that the growth does not increase the cost to the present City residents, the City's policy should insure that new development pay for any additional services they demand.

Policy H-7. It shall be the policy of the City to maintain a working Capital Improvement Plan (CIP) which shall detail a set of public facility projects, their costs, and funding for a six year period, and for the logical extension of public facilities over a projected twenty year period.

1.1.5 Transportation

Policy I-1-2. Develop a transportation system that interconnects residential areas with employment centers, commercial areas, schools, parks, churches and regional transportation networks.

Policy I-2-2. Develop a bikeway and pedestrian system which will provide routes connecting residential areas to school, parks, places of employment and commercial areas

Goal I-4. To develop an area-wide bicycle and pedestrian plan.

Policy I-4-1. To make implementation of the area-wide bicycle and pedestrian plan a cooperative effort between the City of Woodburn and all other governmental jurisdictions within the area.

Policy I-4-2. To develop a comprehensive bicycle and pedestrian system including both on-street and off-street routes, which make pedestrian activity and bicycle riding feasible, safe and enjoyable as alternative modes of transportation in the area.

Policy I-4-5. To finance the bicycle and pedestrian system as much as possible with non-local funds.

Policy I-4-6. To insure that all new commercial, industrial, institutional, residential and recreation developments consider the elements contained with the bicycle and pedestrian plan.

Policy I-5-4. Establish a bicycle and pedestrian safety plan by implementing an area wide educational and recreational program oriented toward teaching bicycle and pedestrian safety.

Policy I-6-1. Provide bicycle and pedestrian routes within all state, regional and local parks and recreation areas by applying for grant assistance to support the development of bicycle and pedestrian systems in parks and open space areas.

Policy I-6-2. Plan off-street routes along creeks and establish routes which lead to local and regional open space areas. Establish local loop routes which take advantage of local amenities and historical areas.

1.1.6 Growth and Urbanization Policies

Policy K-3. The City's public facilities now being built are to be paid for by the system development charges from the anticipated growth.

Policy K-10. The City and County shall strive to enhance the livability of the urban growth area and to promote logical and orderly development therein in a cost effective manner.

1.1.7 Natural and Cultural Resources

Goal L-1. It is the City's goal to preserve the natural resources in the City including the unique stands of trees, the scenic areas within the City, and the floodway and floodplain.

Goal L-2. It is the City's goal to preserve its unique and historically significant cultural and historical resources.

Policy L-2. Floodplain should be set aside for city greenways and left in a natural state as much as possible. This would prevent building in the floodplain and provide a natural greenway throughout the City.

Policy L-3. Natural and scenic areas remaining in the City should be preserved.

1.1.8 Downtown Development

Policy N-2-1. The Central Business District (CBD) should continue to be the locale for City-wide activities (e.g., spring clean-up, crazy days, farm fest, fiesta days, etc.).

Goal N-3. Improve open space within the Central Business District (CBD).

Policy N-3-1. Improve Library Park for year-round use, by adding lighting, landscaping, wall graphics, information station, gazebo, etc. Library Park represents downtown's only area of usable open space. By improving it and making it more usable, more people will frequent the downtown area.

Policy N-3-4. Whenever possible, proposed improvements to buildings and/or open space should remain in general harmony with the concepts portrayed in the Chemeketa Community College drawings.

1.2 Transportation and Stormwater Plans

The Woodburn Transportation System Plan, which is an amendment to *Woodburn 2014*, also includes goals and policies related to parks, recreation and open space:

Goal 1, Policy 4. Develop a bikeway system which will provide routes and facilities to allow bicyclists to travel from residential areas to schools, parks, places of employment and commercial areas. Off-street facilities in City greenway/park areas will be identified. Insure all new collector and arterial streets are constructed with bike lanes.

Goal 1, Policy 5. Identify sidewalk and off-street pathway improvements to improve pedestrian mobility within neighborhoods and between residential areas and schools, parks, places of employment and commercial areas. Insure all new collector and arterial streets are constructed with sidewalks.

Goal 2. Develop a street system which will handle projected year 2015 traffic demands in the Woodburn area, and interconnects residential areas with employment centers, schools, parks, churches and regional transportation facilities.

Goal 3, Policy 2. Develop a plan for improving pedestrian and bicycle safety for travel to/from local schools.

The plan recommends a seven mile off-street pathway system along the Mill Creek and Goose Creek corridors to complement an expanded on-street system of sidewalks and bicycle lanes. The Plan notes that off-street pathways will not only enhance bicycle and pedestrian access to the greenway corridors, but will also provide more direct and safer access to schools, most of which are located next to or in close proximity to the creek corridors. The off-street system will also allow cyclists to travel off the main roadways to gain access to recreational, commercial and employment centers in Woodburn.

Options are outlined for separating bicycles and pedestrians, including either a single pathway to accommodate both cyclists and pedestrians, or separate trails "most likely on different sides of the creek corridors due to their limited width."

The City of Woodburn has also drafted new stormwater management policies, for the purpose of addressing new water quality standards in urban areas.

1.3 SCORP

The Oregon Parks and Recreation Department is responsible for preparing a Statewide Comprehensive Outdoor Recreation Plan (SCORP), updated every five years. In 1993, a statewide survey of recreation participation was conducted for the mid Willamette region, including Marion County and five other counties. These survey conclusions are relevant to the Woodburn Comprehensive Park and Recreation Plan:

- *sports and fitness programs* are the most popular activities in which children participate in (57%), followed by *swimming instruction* (39%), *summer day camps* (16%), and *arts and crafts programs* (10%).
- *adult arts and crafts programs* are not popular, but community *art/craft festivals and exhibits* have high community participation.

- communities have high participation in *park walking/running, picnicking, trail use including biking, and sports and games;* more opportunities are warranted for activities associated with *nature, wildlife, and botanical/historical exhibits; swimming, and cultural events.*
- overall, community *cultural events* appear important for many Oregonians in the mid-Willamette region,
- smaller communities have higher participation rates than larger communities.
- about 1/2 of the respondents reported it would be unfair to charge fees for recreation activities which are currently free; only 22% thought raising existing fees would be unfair.
- households with children are consistently more likely to encounter barriers to participation, including cost and lack of time.

1.4 Community Development and Image

Parks and Recreation facilities and programs play an important role in the community's image. Woodburn's centrally located parks, historic and cultural resources, and open space areas have potential for helping revitalize the downtown area. Downtown could be made more user friendly and economically viable by improving pedestrian connections to Settlemier Park and the Aquatics Center, Library Park, the Woodburn World's Berry Center Museum, and Locomotive Park, making them more integral features of the downtown, upgrading the quality where needed, providing more public information, and adding additional open space and amenities, especially along the railroad corridor.

2. COMMUNITY PROFILE

2.1 *Location and Physical Setting*

Woodburn is located in Marion County in the Willamette Valley, 17 miles north of Salem and 30 miles south of Portland. Woodburn is one of the earliest Oregon pioneering communities, strongly anchored in a very productive agricultural area. It has excellent transportation linkages, located on Interstate 5 and State Highway 99E, and on State Highway 214. Two railroads serve the community -- the Southern Pacific Railroad around which Woodburn was originally built, and the Burlington Northern Railroad which is west of the present City limits.

Woodburn is located in a flat area of the Willamette Valley known as the French Prairie. The topography varies approximately 40 feet from the highest point in West Woodburn, to the lowest point where Mill Creek leaves the northern City limits. Portions of Mill Creek provide major topographic relief. Mill Creek is the major drainage system for the City, and Senecal Creek extends through the western City limits. For the most part, unstable soils occur around Mill Creek and floodplain areas. On clear days, views of Mt. Hood and the Cascade Mountains are possible from some vantage points of the City.

2.2 *Population and Demographics*

Woodburn's population growth rate over the last ten years has averaged approximately 2.3% per year. The 1998 estimated population was 16,585 and the official estimate for resident population in the year 2020 is 26,290 persons. The estimated current (1999) population is 16,936, based on the average annual compound growth rate of 2.12% estimated by E.D. Hovee & Company (report dated June 28, 1999).

As with many growing communities, Woodburn's population profile and the needs of its residents are constantly in flux. Not only did the population increase by over 126% between 1970 and 1994, but the composition of the community also changed significantly. Some notable population characteristics that are important for parks and recreation are:

- While declining from 32.8% of total population in 1970 to 23.2% in 1994, Woodburn's percentage of persons over 65 years of age still continues to be well above that of Marion County (13.9%) and the State of Oregon (13.7%).
- Children and seniors, who characteristically participate in recreation activities at high rates, total 56% of the population.
- Young families (25 to 35 years old) with children constituted 23.2% of the City's total population in 1994.

- Family size has increased from an average of 2.7 persons per household in 1970 to 2.83 in 1994.
- Woodburn is ethnically diverse and includes large Latino (28% of population) and Russian origin (10% of population) communities.
- 5.7% of Woodburn's population is estimated to have mobility impairments, and require barrier free access to public parks, recreation facilities, and programs.
- Approximately 62% of Woodburn's population is considered low to moderate income (below approximately $16,000). 57% of school aged children are eligible for free or reduced-price meals.
- Over 25% of the housing stock in Woodburn is multi-family housing, and few of these developments have playgrounds or sufficient open space to meet the recreational needs of residents.
- Woodburn's 1991 crime index was the second highest for cities of its size in the region, supporting the need for recreational crime prevention programs.

2.3 *Existing Land Use and Growth*

According to a January 1996 Land Use Inventory, a total of 4,109 acres of land is included in the Urban Growth Boundary (UGB), with designated uses comprising these percentages:

Residential	50%
Industrial	14%
Commercial	12%
Roads/ROW	12%
Parks/Open Space	9%
Public	3%

A significant portion of open space land consists of private golf courses and private open space in the floodplains along Mill Creek and Senecal Creek. All existing floodplains have been designated as "City Greenway" in the Woodburn Comprehensive Land Use Plan.

Excluding parks and open space, approximately 49% of Woodburn is comprised of lands considered "developed." The periodic review process will determine if there is sufficient land for industrial, commercial and residential development; and for public use including parks and open space.

2.3.1 Residential Density

The amount of land needed for parks and open space may be influenced by decisions related to residential density. High density residential land is already the second largest land use in the UGB, with multi-family housing distributed throughout the community. Residential lands currently have densities of between 6 and 25 dwelling units per acre, but the Comprehensive Plan indicates continued growth in single family development, with a need for a decrease in minimum lot sizes to increase densities.

2.3.2 Historic District

Many of the City's most historic buildings are located in the downtown area, built around the turn of the century or shortly thereafter. This area has been designated as a local Historic District.

With development of competing commercial areas along Highway 99E and the I-5 Interchange, a lack of business activity has created a deterioration in condition and public image of downtown. An overall renovation and beautification of this commercial area is encouraged by the City, built around an historic theme. Parks and recreation programs may also aid in the revitalization process.

2.3.3 Growth

Woodburn 2014 describes the City's goal for growth and development to be one of "remaining as a redistribution center for outlying areas of the Valley," and "expansion of the City in an orderly and efficient manner to aid in giving the population the commerce and industry it has always historically desired." Results of a 1996 community survey also suggest that Woodburn residents have a concern for quality of life issues, balanced growth, transportation, and preservation of farm land near the City.

Since 1994, nine subdivisions have been approved and over 600 lots have been platted. The largest growth has occurred near the Woodburn High School and the new private Tukwila Golf Course built by the Oregon Golf Association. Some of the new housing developments have provided private or public recreation amenities such as fitness facilities, greenway areas, swimming pools, sports courts and playgrounds; but an absence of park requirements and standards has resulted in missed opportunities and acceptance of facilities in inappropriate locations.

Employment in the City has more than doubled during the 1990's, growing from an estimated 3,335 jobs in 1990 to 7,051 in 1999. By 2020, more than 2,000 additional jobs are expected to be added, for a total of 9,058. Employment impacts the need for municipal parks, community parks, greenways/open space, and other community facilities which are used by both residents and employees. An analysis of employment impacts was performed to consider factors related to employee use of facilities. Based on this analysis, it is estimated that the impact of each employee on the need for municipal parks, community parks, greenway/open space, and cultural resource/special use facilities is equivalent to 8.3% of the impact of each resident. This means that the roughly 2,007 new employees expected between 1999 and 2020 will have an impact equivalent to 167 new residents.

3. PARKS, OPEN SPACE, AND RECREATION RESOURCES

3.1 Greenways and Open Space

Woodburn and its urban growth boundary are located on a sensitive underground aquifer. The current periodic review process will update the Woodburn Comprehensive Plan to include a special study of wetlands and natural resources, which will provide more detailed information on the location and significance of wetlands and riparian areas in the City.

The floodplains of Mill Creek, Goose Creek and Senecal Creek represent the most significant open space resources in Woodburn. Mill Creek has been channeled, and in two locations constricted by urban development; but for the most part, broad floodplains and occasional high quality vegetation structure provide attractive and natural-like greenway areas.

The Mill Creek drainage system represents the major structure for public open space in the community, with potential for a connected system of greenways, linear parks and recreation opportunities; and off-street bikeways and pathways that, as recommended in the City's Transportation System Plan, could become an integral part of the City's transportation system.

The City has already designated 16.33 acres of City-owned greenway and open space along the Mill Creek corridor as identified park land (Hermanson I, II, III, and Wyffle parks). The locations of these facilities are identified on Map A - *Existing Parks and Recreation Facilities* (page 13). These facilities have had minimal development, consisting primarily of playground equipment and signage. A pond adjacent to the Meadow Park subdivision provides an amenity and a fish and wildlife habitat opportunity in the south Mill Creek corridor. Railroad tracks fragment the creek corridor in three locations: at Cleveland Street, east of Settlemier Park, and at Front Street. Highway 214 also disconnects the creek near the Woodburn High School.

An area north of Highway 214 along Mill Creek has been identified as jurisdictional wetland by the U.S. Army Corps of Engineers. This area extends to the northern Urban Growth Boundary. Recently, bones of an ancient land mammal were discovered along Mill Creek near Woodburn High School. Scientific studies indicate this may be one of the most significant paleoarchaeological finds in the Pacific Northwest. Scientists have dubbed the project "Mammoth Park."

The western part of Goose Creek has been ditched, has little riparian vegetation, and is impacted by adjacent urban development. The remaining corridor provides natural-like open space and supports a private fitness course and residential greenway as a part of the Tukwila subdivision.

Senecal Creek is largely undisturbed with an extensive riparian forest area, and ranks high as a significant wildlife habitat and wetland area.

The City is committed to preserving the creek corridors as greenways left in a natural state. Unlike urbanized creeks in larger cities, for the most part, Woodburn's creek corridors represent high quality greenways and have not been severely impacted by urban development. Therefore, the potential for public open space and off-street pathways is excellent.

3.2. *Public Parks and Recreation Facilities*

The City currently owns 87.02 acres of land designated as parks and recreation facilities. In addition to the 16.33 acres of greenway along Mill Creek, the City's inventory includes 40.64 acres of developed parks, cultural resource facilities, and special use facilities, and a 24.96 acre municipal park which is currently under development (Centennial Park).

The City also owns a 5.09 acre site north of Woodburn High School that is suitable for a neighborhood park (Glatt property).

Legion Park (Community Park) serves as the City's unofficial "fairgrounds", hosting a variety of community events including "Cinco de Mayo", "Fiesta", and "Fourth of July" celebrations. This facility also houses Legion Field and Stadium and serves as the Woodburn High School football stadium.

Developed Parks and Recreation Facilities include:

Neighborhood Parks	
Burlingham Park	6.5 acres
Senior Estates Park	4.0 acres
Nelson Park	3.0 acres
Community/Municipal Parks	
Legion Park	13.63 acres
Settlemier Park	9.5 acres
Centennial Park[1]	24.96 acres
Mini-Parks	
N. Front Street Park	1.25 acres
Heritage Mini-Park	0.5 acres
Cultural/Historic Resources	
Locomotive Park	0.05 acres
Woodburn World's Berry Center Museum	building
Special Use Facilities	
Aquatics Center	building
Community Center	0.06 acres
Community Garden	1.59 acres
Alvah Cowan Park	0.06 acres
Library Park	0.5 acres

[1] currently under development

A map showing the locations of existing parks and recreation facilities and schools appears on page 13.

3.3 *Public Schools*

The City has four public elementary schools, two middle schools and one high school; all schools have gymnasiums, and two of the schools (Heritage Elementary and Valor Middle School) are located adjacent to Centennial Park.

For the most part, all campuses are large enough to provide community recreation facilities such as sports fields and playgrounds and are either currently used for or have the potential for use as neighborhood/school park facilities. Public school facilities include:

Woodburn High	28.0 acres
French Prairie Middle/ Lincoln Elementary	21.3 acres
Valor Middle/Heritage Elementary	48.0 acres
Nellie Muir Elementary	7.6 acres
Washington Elementary	9.9 acres

3.4 *Sports and Recreation Programs*

The City offers a variety of sports and recreation programs for residents of all ages. Offerings expand or are reduced based on interest levels and the availability of funding. Current programs include:

- Youth and Adult Basketball
- Youth Soccer
- Adult Softball
- Youth After-School Drop-In Programs
- Middle School Co-Recreation Programs
- Youth Summer Day-Camp Programs
- Children's Dance Classes
- Youth, Adult, and Senior Swimming and Aquatics Programs
- Preschool Programs
- Special Events

In addition, the City works with the Woodburn School District, non-profit organizations, and other agencies to operate the community center and support other programs such as children's art classes, adult soccer, and youth baseball and softball.

3.5 *Privately-Owned Facilities*

3.5.1 Golf

Two privately-owned 18-hole golf courses provide substantial open space in the northern and western parts of the City.

Both golf facilities are parts of planned residential developments (Senior Estates, and Tukwila subdivisions), and both require membership.

3.5.2 Recreation/Fitness Centers

Three residential developments either have or plan to construct recreation facilities. Senior Estates' recreation facilities include a heated fitness center, pool room, shuffleboard room, and library; the Tukwila subdivision has a privately-owned fitness and jogging trail along the Mill Creek corridor, and has plans for a private community center; and the Woodburn Crest Mobile Home Park includes plans for a small recreation center.

Woodburn also has two other membership fitness centers: Nautilus of Woodburn, and I-5 Fitness Center.

3.5.3 Swimming Pools/Spas

Senior Estates includes a private spa and indoor swimming pool, and Tukwila subdivision has a private outdoor pool facility.

3.5.4 Tennis/Basketball Courts

The Meadow Park subdivision has a private outdoor basketball court and tennis court .

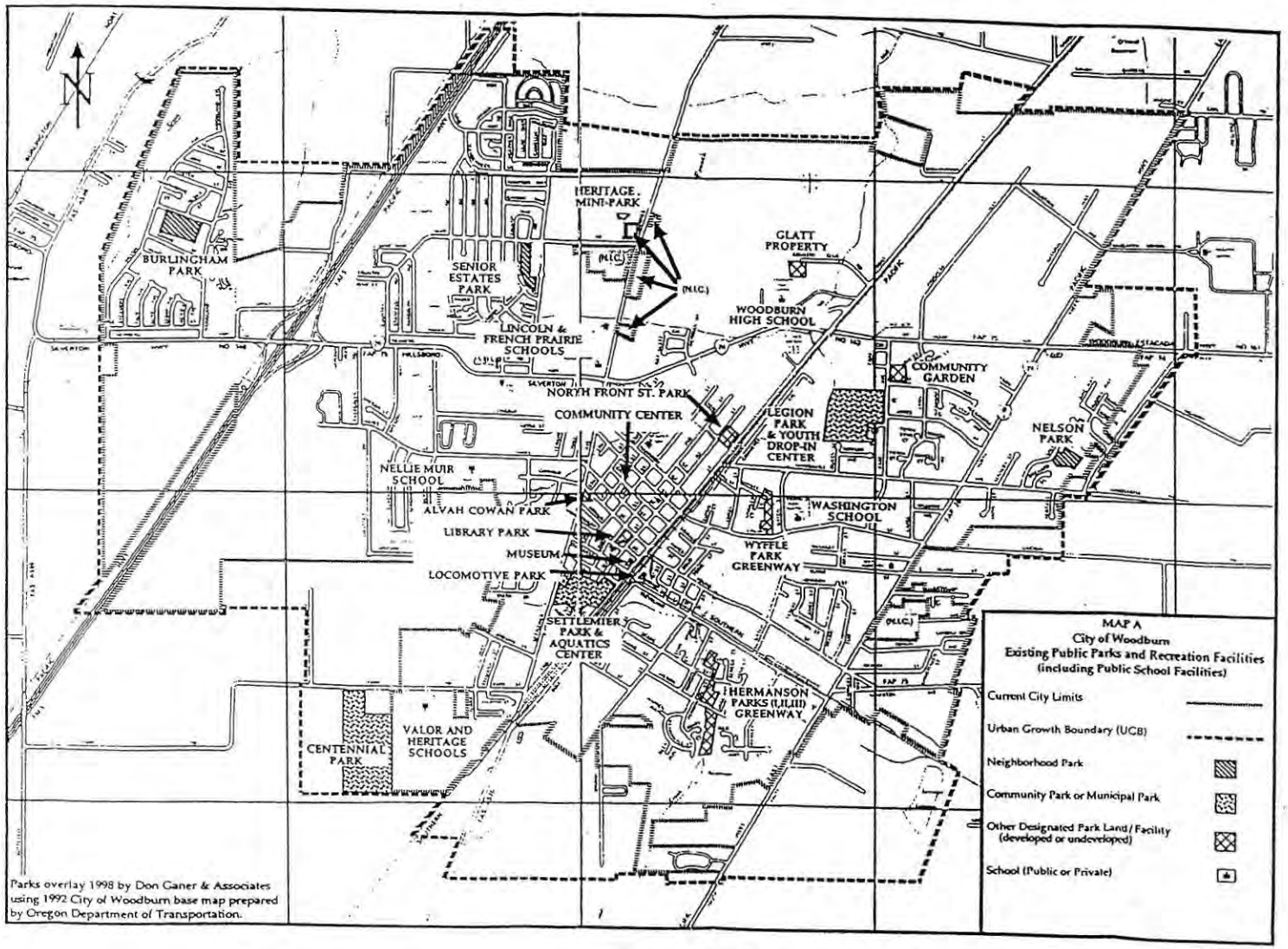
3.5.5 Bowling

Woodburn Lanes, a bowling center, is open to the public.

3.6 Other Cultural Resources

Woodburn is home to other cultural resources including historic buildings and an archaeological site. The City has four historic buildings, two of which are listed on the National Register of Historic Places:

Settlemier House (NRHP)
Old City Hall (NRHP)
Original City Library
Bank of Woodburn Building


HERITAGE MINI-PARK
GLATT PROPERTY
BURLINGHAM PARK
SENIOR ESTATES PARK
(N.I.C.)
WOODBURN HIGH SCHOOL
LINCOLN & FRENCH PRAIRIE SCHOOLS
COMMUNITY GARDEN
NORTH FRONT ST. PARK
COMMUNITY CENTER
LEGION PARK & YOUTH DROP-IN CENTER
NELSON PARK
NELLIE MUIR SCHOOL
ALVAH COWAN PARK
WASHINGTON SCHOOL
LIBRARY PARK
MUSEUM
WYFFLE PARK GREENWAY
LOCOMOTIVE PARK
SETTLEMIER PARK & AQUATICS CENTER
THERMANSON PARKS (I,II,III) GREENWAY
VALOR AND HERITAGE SCHOOLS
CENTENNIAL PARK
MAP A
City of Woodburn
Existing Public Parks and Recreation Facilities
(including Public School Facilities)
Current City Limits
Urban Growth Boundary (UGB)
Neighborhood Park
Community Park or Municipal Park
Other Designated Park Land/Facility (developed or undeveloped)
School (Public or Private)
Parks overlay 1998 by Don Ganer & Associates using 1992 City of Woodburn base map prepared by Oregon Department of Transportation.

4. NEEDS ASSESSMENT

The City's parks and recreation facility and program needs were identified using the planning framework guidelines, policies, and goals identified in Section 1; analysis of responses to a community needs assessment survey; Level of Service (LOS) analysis, and the results of a physical inspection of all existing facilities.

4.1 Facilities Level of Service

One method of assessing need is to review the community's Level of Service (LOS) for parks and recreation facilities, as measured by acres of public space used for parks and recreation activities. The LOS for Woodburn can be compared with adopted standards, if any, and/or with the LOS of other communities. The City has not previously adopted LOS standards for parks and recreation facilities, so a comparison with other communities provides an idea of how well the City is doing at providing parks and recreation facilities. Following are acreage and LOS comparisons for Woodburn and three other area communities including Newberg (Chehalem Parks and Recreation District), Oregon City, and Canby.

The City's municipal parks, community parks, greenway/open space, and cultural resource/special use facilities serve both population and employment needs, so employment impacts on these facilities must also be considered. A 1999 report by E.D. Hovee estimated 1997 employment within the Woodburn Zip Code (97071) at 7,834 jobs. The report also estimated that annual employment growth will increase by 2.9% per year between 1995 and 2000. Based on these estimates and the assumption that employment within the Woodburn City limits comprises 85% of total employment within the Woodburn Zip Code (97071), 1999 employment within Woodburn is estimated to total 7,051 jobs.

An analysis of employment impacts was performed to consider factors related to employee use of facilities. Based on this analysis, it is estimated that the impact of each employee on the need for municipal parks, community parks, greenway/open space, and cultural resource/special use facilities is equivalent to 8.3% of the impact of each resident. This means that the 7,051 estimated current employees have about the same impact as 585 residents.

PARKS AND OPEN SPACE ACREAGE

City (or PRD)	Parks	Schools	Total
Woodburn	87	114	201
Chehalem PRD (Newberg)	319	152	471
Oregon City	192	128	320
Canby	34	84	118

PARKS AND OPEN SPACE LEVEL OF SERVICE (LOS)
(acres per 1,000 persons)

City (or PRD)	Population	LOS
Woodburn	17,522*	11.8
Chehalem PRD (Newberg)	28,000	16.8
Oregon City	21,895	14.6
Canby	11,725	10.1

*includes estimated 1999 population of 16,937 plus the equivalent impact of 585 more residents created by employment.

4.2 Needs Assessment Survey

In March 1997, a bilingual (English and Spanish) public opinion survey instrument was mailed to 800 randomly selected residential addresses in the City of Woodburn. 68 of the survey instruments were returned by the U.S. Postal Service undelivered. From the 732 that were delivered, 187 completed surveys were returned, for a response rate of 25.5%. A copy of the survey instrument, and post-stratified results for each survey question are included in Appendix B.

A large proportion (47%) of survey respondent households were aged 65 and older with no children under 18; 25% of the respondent households included children under the age of 18.

16.6% of respondents were Latino, 78.1% were non-Latino white, and 5.3% were of another race or ethnic origin.

26.7% of respondents had total household incomes of more than $40,000 in 1996, 48.9% had incomes of between $20,000 and $40,000, and 24.6% had total incomes of less than $20,000.

Because of the large proportion of survey respondents aged 65 years and older, the survey results, while providing valuable information, may not be representative of or accurately reflect the opinions of the community as a whole.

4.2.1 Activities, Interests and Facility Use

- parks and playgrounds are the most frequently used facilities, with highest use by Latino households and households with children, and lowest use by retirees.
- picnicking is more popular for Latino households than for the general population, with 90.3% of Latino respondents indicating they "often" or "sometimes" go picnicking, versus 41.9% of all respondents with an opinion.
- the Aquatics Center is used "often" or "sometimes" by 71.7% of respondent households with children, but "never" by 74.1% of retirees; this suggests opportunities to market the aquatics center for water fitness and exercise programs aimed at retirees.
- Even though the City has two private golf course communities, 65.8% of retirees and 69.7% of all respondents indicated they "never" play golf.

4.2.2 Importance of Programs

- All demographic groups rank teen programs as their top priority, with the next five top priorities in the following group: children's swim lessons, youth soccer, youth basketball, youth after-school programs, and open swim.
- Retired respondents rank the need for children's, youth, and teen programs above adult programs.
- Latino respondents rank children's dance and art programs higher than does the general population, reflecting a cultural difference for this group for program preferences.

4.2.3 Facility Needs Preferences

- The need for more walking trails and bicycle paths ranked high for all respondents, which is consistent with the high demand for walking, and which supports greenway/pathway expansion and improvements.
- The need for more youth center facilities also ranked high for all respondents, which is consistent with the high level of support for youth and teen programs.
- There is high support by households with children and by Latinos for more playgrounds, parks, and picnic areas. These groups also support more soccer, basketball, and baseball/softball facilities.
- Most respondents want to keep aquatics the "same", indicating satisfaction with the new aquatics facility.

4.2.4 Facilities Maintenance and Repair

- The new aquatics center received very high ratings from all groups on the level of maintenance and repair it receives.
- While most facilities received a majority of "satisfactory" or "good" ratings, 25% or more of households with children and Latinos gave "poor" ratings for maintenance and repair of baseball/softball, soccer, basketball, and tennis facilities; and 25% or more of all respondents rated maintenance of parks, picnic areas, playgrounds, and the youth drop-in center as "poor". These ratings indicate a significant level of dissatisfaction with the current levels of maintenance and repair.

4.3 Physical Inspection of Facilities

In February 1997, a physical inspection of all existing City parks and recreation facilities was conducted to determine the physical condition and functionality of existing facilities. The inspection found that many of the City's existing facilities are below recommended standards and/or are in need of upgrade/repair or replacement. A summary of the physical condition of facilities is located in Table 1 (page 19).

4.3.1 Parks, Open Space, and Greenways

Woodburn parks are of marginal size and are generally in poor to good condition, primarily due to aging facilities and infrastructure, much of which has reached the end of its useful life. Open space and greenways are more abundant, but offer limited recreational opportunities because they lack all-weather pathways and have poor drainage. Other major deficiencies include:

- Old and outdated playgrounds, most of which are inaccessible to the disabled and include potentially unsafe surfaces within fall zones
- Lack of basic park furnishings, such as park benches, security lighting, and drinking fountains
- Lack of irrigation systems to maintain healthy, resilient turf
- Deteriorating roofs on structures

Due to the current physical conditions, few parks are able to function at full capacity. As a consequence, the larger parks (Settlemier, Legion) tend to be overused, while the small parks are generally underused. The greenways are especially underutilized because there are no pathways to accommodate recreation activities such as walking for pleasure.

Persons with disabilities cannot fully access most playgrounds and recreation facilities due to their age and outdated designs. Architectural barriers also hinder participation, notably steps to the tennis courts in Settlemier Park, and a lack of all-weather surface pathways throughout the system.

While basketball is a very popular activity, only three parks (Heritage, Burlingham, and Settlemier) have outdoor basketball courts. Settlemier Park's is in poor repair and Heritage Park's is in water during much of the year, leaving Burlingham's as the only functional outdoor court.

4.3.2 Recreation Facilities

With exception of the new Aquatics Center, the City's other major recreation facilities are in poor to good condition.

Community Center - The Community Center (9,600 s.f.) is a small facility operating above its functional capacities, and was not designed to accommodate present uses. Deficiencies include:

- No disabled access to the second floor
- Unfinished and inadequate storage
- Some portion of the floors is in need of replacement
- Exterior replacement/repair of south-facing roof and doors is needed
- Limited off-street parking

Legion Youth Center - Formerly a storage room for sports equipment, this (1,000 s.f.) facility was not designed to accommodate present uses. Given the crowded conditions at the Youth Center, it may be prudent to obtain the Fire Marshall's assessment of the building's functional capacity.

Legion Field and Stadium - Potentially hazardous steps and rotting at the base of support beams suggests the need for a structural and electrical survey to determine physical condition. In addition, drainage is poor and contributes to sparse and unhealthy turf conditions.

Woodburn Aquatics Center - Recently constructed, this facility is in good to excellent condition. Noted deficiencies are primarily outside the building and include:

- The Aquatics Center is oriented to Front Street, but is accessed by Oak Street
- The Aquatics Center is not well connected and integrated with the remainder of Settlemier Park
- Additional landscaping would make the fenced exterior area more attractive for group use, as would a landscape buffer of the adjacent parking lot
- The single family residence on Oak Street is impacted by the Aquatics Center and should be buffered
- Signage is needed along Settlemier Road to direct visitors to the Aquatics Center
- There is no turnaround for patrons to exit the parking lot and the service driveway should be upgraded

4.3.3 Cultural Resource Facilities

The Woodburn World's Berry Center Museum and Locomotive Park are two historical features of the park system, operated in partnership with community organizations.

Woodburn World's Berry Center Museum - The museum, located in historic Bungalow Theater and the adjacent building, are part of the historical fabric of downtown Woodburn. Improvements in accessibility, displays, interpretation and infrastructure could make this facility more inviting, educational, and enjoyable.

Locomotive Park - The historic 1875 locomotive is surrounded by a chain link fence for security, but the locked gates and barbed wire create a harsh and unattractive environment. The proximity of this facility to the greenspace area under the water tower, and location in the downtown area present an opportunity to not only preserve history, but to contribute to the attraction and viability of downtown. The setting could be made more user friendly if the parking lot and drainage were improved, and if park benches, picnic tables, and interpretive information related to the locomotive were made available.

TABLE 1

Cit, Woodburn

Existing Facilities Physical Condition Summary

Facility	Buildings/ Structures	Sport Fields & Facilities	Play Equipment	Safety Surfaces	Signage/ Furnishings	Lighting	Paving, Paths/Trails	Irrigation	Drainage	Landscape/ Vegetation	Turf	Parking
[redacted]												
Nelson Park	4	2	3	3	3	4	4	4	3	3	3	4
[redacted]												
Settlemier Park	3	3	3	3	3	1	2	4	2	1	1	1
[redacted]												
Aquatics Center	1	4	4	1	1	1	1	1	1	2	1	1
[redacted]												
Locomotive Park	1	4	4	4	2	4	4	4	4	1	1	2
[redacted]												
Library Park	4	4	4	4	1	1	1	1	1	1	2	4
[redacted]												
Heritage Mini-Park	4	2	4	4	2	4	4	4	2	2	2	4
[redacted]												
Centennial Park	4	4	4	4	4	4	4	4	4	4	4	4
[redacted]												
Wyffel Park	4	4	3	3	1	4	2	4	3	1	4	4

1 = meets standard

2 = below standard

3 = needs upgrade/repair or replacement

4 = not applicable

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5. PARKS AND RECREATION SYSTEM FRAMEWORK PLAN

The Parks and Recreation System Framework Plan provides the foundation for development of Woodburn's parks and recreation system. The components are designed to provide a level of service which will meet the needs of Woodburn residents during the planning period.

5.1 Findings, Issues, and Implications

FINDING 1. Woodburn is in a major growth cycle, and is expected to continue to increase in population and employment over the next several years. Policies of the Woodburn Comprehensive Plan call for orderly, efficient and managed growth, enhancement of community livability, and for new public facilities to be paid for by development fees.

ISSUES AND IMPLICATIONS:

- Adequate recreation, parks and open space are important for Woodburn's quality of life; meeting this goal will provide social, economic and environmental benefits to the community.
- Land for parks and open spaces in new subdivisions and employment centers will be critical to meet future growth needs; both developer participation and land acquisition in advance of development will become important methods for meeting future park and open space requirements.
- Traffic and transportation is now and will continue to be increasingly important community issues; safe off-street bicycle and pedestrian pathways will be needed for residents and employees.
- Public greenways and linear parks in the creek corridors will be important to meet needs of under-served neighborhoods, accommodate urban infilling, and provide safe and convenient alternatives to the automobile.
- The City should develop existing, available, and suitable City-owned land and acquire needed additional land to provide parks where deficiencies exist and where residential and employment growth is planned, and to develop a connected system of trails and pathways.
- Facilities maintenance and repair requires standards and adequate funding to promote community livability and prevent deterioration of facilities.

FINDING 2. Woodburn's population characteristics are unique: a substantial number of adults over 65 years of age and children below the age of 17; an increase in family size; a multi-ethnic community; a large number of families with low to moderate incomes; and a relatively large seasonal population.

ISSUES AND IMPLICATIONS:

- There will continue to be a high demand for recreation opportunities in the community because young children and older populations generally require more recreation opportunities than the population at large, and larger families generally participle in recreation activities at higher rates than smaller families.
- Since parks and playgrounds are the most frequently used parks and recreation facilities, the City should place a high priority on making repairs and improvements to existing parks, renovating playgrounds, and improving the levels of maintenance.
- Affordable recreation opportunities will continue to be important because of a large number of residents with low incomes; balancing tax subsidies with revenue enhancement strategies will become a major challenge to the City.
- Recreation participation, customs, and interests vary among ethnic groups, requiring cultural sensitivity in programming and parks facility planning and design. Latino survey respondents expressed preferences different from the larger community; in particular, this group makes high use of public parks and recreation facilities and programs, with a noted cultural preference for children's art and dance programs, and picnicking as the #1 activity.

FINDING 3. Multifamily housing makes up over 25% of the housing stock; many of these developments lack access to open space or playground facilities; there is a trend toward a decrease in minimum lot sizes and increased densities in new single family developments.

ISSUES AND IMPLICATIONS:

- Future single and multi-family housing developments should be required to provide and maintain mini-parks and playground facilities.
- Large single family subdivisions should be required to donate suitable land to the City for the development of neighborhood parks.

FINDING 4. Compared with other cities of comparable size, Woodburn's crime index is relatively high. There is a shortage of sports fields and sports courts, and the distribution of developed public parks and recreation facilities does not provide equitable access for many residents.

ISSUES AND IMPLICATIONS:

- Providing adequate facilities, constructive recreation alternatives for use of leisure time, community fitness and wellness, and programs for "at-risk" youth are emerging as an important "preventive recreation" agenda.

- There is high support among residents for children and youth programs and facilities, indicating an interest for keeping children and youth involved in constructive activities. Maintenance and expansion of programs for teens and youth, such as children's swim lessons, youth soccer facilities and programs, basketball courts and programs, baseball/softball facilities, youth after-school programs, open swim programs, and co-rec middle school programs should be pursued in cooperation with schools, other agencies, and non-profit organizations.
- The functional capacities of both the community center and the youth center are inadequate to meet youth recreation needs. The City should expand/replace or duplicate the drop-in youth center; or perhaps integrate a senior center, youth/teen center and multi-purpose gym in a new community center facility.
- The amounts and locations of developed parks acreage should be increased and distributed in a manner that provides a higher level of service and more equitable distribution of parks facilities for use by residents and employees.
- While desirable as open space resources, detention ponds and wetlands are inaccessible during periods of wet weather; therefore, active recreation facilities such as playgrounds, sports courts and playfields should not be located in detention ponds or wetlands.

FINDING 5. The City is concerned about deterioration of downtown and is working to revitalize the area; policies include improving open space in the Central Business District (CBD), and improving Library Park as a catalyst for rejuvenation.

ISSUES AND IMPLICATIONS:

- Library Park, Woodburn Aquatics Center, Settlemier Park, the Woodburn World's Berry Center Museum, and the historic locomotive site could make major contributions to downtown revitalization.
- The Aquatics Center does not have good visibility and exposure, with no access to Front Street even though it is oriented to the corridor.
- The Locomotive site lacks amenities and interpretive signage that could be improved.
- The Woodburn World's Berry Center Museum requires basic infrastructure improvements, especially restroom accessibility and alley enhancement.

FINDING 6. Woodburn's drainage system is extensive, but other than a few public greenways and playgrounds, little public use is made of the creek corridors. Much of the system is owned by the City, and by plan policy is recognized as a natural greenway system and transportation corridor. Although parts of the creek system have been channeled, there is excellent potential for accommodating non-vehicular transportation, and for natural greenways, linear parks, and playgrounds.

ISSUES AND IMPLICATIONS:

- A strategy is needed for making greater community use of the creek corridors for transportation, open space, education and recreation.
- Funding is needed for land acquisition, pathways, and appropriate park and playground improvements.
- Parts of the creek corridors function as wetlands, and therefore all-weather pathways and judicious selection and location of park improvements will be required to make these areas functional and accessible.
- Most schools are located on or near Woodburn creeks, with excellent potential for education and transportation.
- New development should be encouraged to dedicate floodplains and creek corridors for recreation, open space and transportation uses.

FINDING 7. While a blend of private and public recreation facilities can meet the needs of the community, there is some indication that the private recreation facilities and greenways (i.e.. Meadow Park, Tukwila, Senior Estates) may negatively impact the City's parks and recreation system as a whole.

ISSUES AND IMPLICATIONS:

- Extensive recreation facilities in Senior Estates, including the golf course and swimming pool, are available to members only, and do not meet needs of the total senior population in Woodburn.
- As privately-owned swimming pools continue to be built, it is likely that there is and will continue to be direct competition between these facilities and the Woodburn Aquatics Center.
- Private recreation facilities in new subdivisions may meet needs of the immediate neighborhoods, but exclusive greenway access and locked facilities (e.g. tennis and basketball courts) raise issues with respect to public access to facilities, the provision of facilities for the broader community, and maintaining safe and secure facilities.

FINDING 8. Woodburn school grounds and play facilities make a substantial contribution in providing neighborhood and community recreation and open space opportunities. A close working relationship exists between the School District and the City of Woodburn.

ISSUES AND IMPLICATIONS:

- The City of Woodburn and the School District may pursue joint acquisition, development, and use of future school sites and parks, which could strengthen the existing partnership.
- The extensive creek system provides an opportunity for instruction in environmental studies and nature education, and could serve a dual purpose with community recreation and open space.

5.2 *Goals and Policies*

The following parks and recreation goals and policies have been developed to address the findings identified in section 5.1.

Goal 1. It is the goal of the City to provide adequate parks, recreation facilities, and open space to maintain Woodburn's livability and managed growth, and to provide social, economic and environmental benefits to individuals, families and the community.

Goal 2. Downtown Woodburn should remain a centerpiece of activity, culture, and commerce within the City. Library Park, Woodburn Aquatic Center, Settlemier Park, the Woodburn World's Berry Center Museum, and Locomotive Park should be used as catalysts for downtown revitalization.

Policies

Policy 1. The City will insure that sufficient land is made available for parks and open spaces by adopting the system of facility types and standards in the 1999 Parks and Recreation Comprehensive Plan including: Mini-Parks; Neighborhood/School Parks; Community Parks; Municipal Parks; Greenways, Open Space, Trails and Pathways; and Cultural Resources and/or Special Use Parks/Facilities.

Policy 2. The City will insure the most efficient and effective means of providing sufficient land for neighborhood parks by adopting a neighborhood/school park concept including joint land acquisition and development, thereby strengthening the existing partnership between the City and the Woodburn School District.

Policy 3. Where neighborhood/school parks are not feasible, it is the policy of the City to acquire neighborhood parks, when practicable, through the development review process.

Policy 4. As a supplement to the City's neighborhood parks, it is the policy of the City to encourage new subdivisions to provide mini-parks, meeting City approved standards. The City shall insure that the excessive maintenance impacts of mini-parks are avoided by requiring ownership to be retained by the developer or a homeowner association, with maintenance provided by the developer, the homeowner association, or by the City through a maintenance LID. These facilities may not be used to reduce the requirement for System Development Charge payments.

Policy 5. It is the policy of the City to manage Mill Creek, Goose Creek, and Senecal Creek corridors as public greenways and pathways; multiple functions will include open space and habitat preservation, flood control, cycling and walking on all-weather pathways, nature recreation and education, and limited playground activities where there is a deficiency of neighborhood parks.

Policy 6. To provide for a continuous public greenway and pathway system, it is the policy of the City to acquire privately-owned segments along Mill Creek, Goose Creek, and Senecal Creek, and other stream corridors including the west tributary from Settlemier Park to Parr Road. It is the policy of the City to seek dedication of floodplains and creek corridors for natural areas, neighborhood recreation areas, open space and transportation.

Policy 7. To insure adequate maintenance of the City's parks, recreation, and open space facilities, the City will prepare comprehensive management plans including maintenance management standards for each facility.

Policy 8. It is the policy of the City to require multi-family housing projects which exceed four (4) units to provide basic neighborhood park and playground facilities, based on development standards of the Recreation and Parks Department.

Policy 9. Because recreation participation preferences and interests vary among employment, ethnic, social, and cultural groups, it is the policy of the City to exercise special sensitivity in selecting the types of recreation programs it offers, and in the design and management of parks, recreation and open space facilities.

5.3 Facility Types and Standards

The System Framework Plan is designed to provide facilities to achieve the City's parks and recreation goals and meet the needs of the City at the neighborhood, community, and City-wide levels. Facility types and minimum standards for park size, service area, and acreage per population have been developed to insure that residents and employees are adequately served by parks and recreation facilities.

Facility types include:

- mini-park
- neighborhood/school park
- community park
- municipal park
- special use/cultural resource facility
- greenways, open space, trails, and pathways
- core parks system

Acreage standards for mini-park, and neighborhood/school park apply only to residential development. Standards for all other facilities apply to both non-residential and residential development, as these facilities benefit both residents and employers/employees. Table 2 (pages 27 - 28) provides descriptions of each facility type, its standards, and existing sites.

5.4 *Facility Recommendations*

The System Framework Plan builds on the strengths of Woodburn's existing parks and recreation system, responds to the needs assessment of this planning effort, and helps implement adopted policies of the City's Comprehensive Land Use Plan. Map B (page 29) shows the locations of existing and needed parks and recreation facilities resulting from the application of the Level of Service standards outlined in Table 2 (pages 27 - 28).

In addition to Level of Service Standards which address access, acreage, and facility requirements, the City also needs to develop and adopt standards addressing items such as playground equipment design and functionality, security, turf and irrigation, park furnishings, and park amenities. A Capital Improvements Plan with suggested projects to repair existing facilities and provide new facilities to meet population growth needs is included as Appendix A.

5.4.1 Mini-Parks

The City has acquired a mini-park (Heritage Park) in one recently constructed subdivision. These small parks are desirable features to serve the needs of the immediate area (approximately 1/4 mile), but because of their small size, maintenance costs can be significantly higher than for larger facilities, and tight City budgets can lead to deferred maintenance and deterioration of facilities.

As an alternative to public ownership, the City should encourage new subdivisions to provide mini-parks, meeting City approved standards. Ownership should be retained by the developer or a homeowner association, with maintenance provided by the developer, the homeowner association, or by the City through a maintenance LID. A bond or other funding insurance mechanism should be required in case the developer or homeowner association fails to maintain the facility at City standards.

City of Woodburn Parks and Recreation Facility Types and Standards

Type of Facility	Use and Characteristics	Service Area	Desirable Size	Proposed Standard[1] / 1,000 persons	Current Units[2] / 1,000 persons	Existing Sites
Mini-Park	Small public or privately-owned and operated park facility which should include benches, play equipment, picnic tables, and/or other similar amenities; usually easily accessible only to adjacent/nearby residents.	1/4 mile radius, no access barriers	no standard	no standard	n/a	N. Front St. Park Heritage Park
Neighborhood Park/School Park	Park facility designed to serve the daily active and passive recreation needs of a neighborhood; may be co-located with or on a school site. Generally should include playground equipment, a hard surface sports court, and a playfield; may also include picnic areas, vegetation, and other amenities Within safe and easy walking distance for area residents; does not require the crossing of multi-lane streets or other barriers. Usually does not include restrooms or on site parking.	1/2 mile radius, no access barriers	3 to 5 acres (3 acres min.)	5.5 acres (combined with Mini-Parks)	7.69 acres (includes Mini Parks)	Burlingham Park Nelson Park[3] Senior Estates Park[4] Public Schools[5] (130.05 total acres[6])
Community Park	Park facility designed to serve broader recreation needs than a neighborhood park. Should include passive recreation areas for picnicking, walking, etc., as well as facilities for active recreation such as lighted sports fields, a recreation center and/or a swimming pool. Generally includes restrooms and on-site parking. May be co-located with a school site and, if standards are met, may also serve as a neighborhood park for residents within 1/2 mile.	City	5 to 20 acres	2.0 acres (combined with Municipal Parks)	2.74 acres (includes Municipal Parks)	Legion Park Settlemier Park (23.13 total acres)
Municipal Park	Large park facility designed to serve broader recreation needs than a community park. Should include a multi-facility/multi-field sports complex and other similar facilities designed to serve the needs of the entire City. Includes restrooms and on-site parking. May be co-located with a school site and, if standards are met, may also serve as a neighborhood park for residents within 1/2 mile.	City	20+ acres	2.0 acres (combined with Community Parks)	2.74 acres (includes Community Parks)	Centennial Park (24.96 total acres)

[1]except for mini-parks, neighborhood park, and school parks; standards include facilities for employees, with each equal to 8.3% of a resident.

[2]except for mini-parks, neighborhood parks and school parks; units include facilities for employees, with each equal to 8.3% of a resident.

[3]does not currently meet use and characteristics standard for a neighborhood park.
[4]ibid.
[5]access during non-school hours is required to serve as a neighborhood or school park.
[6]includes mini-parks, neighborhood parks, and public school facilities.

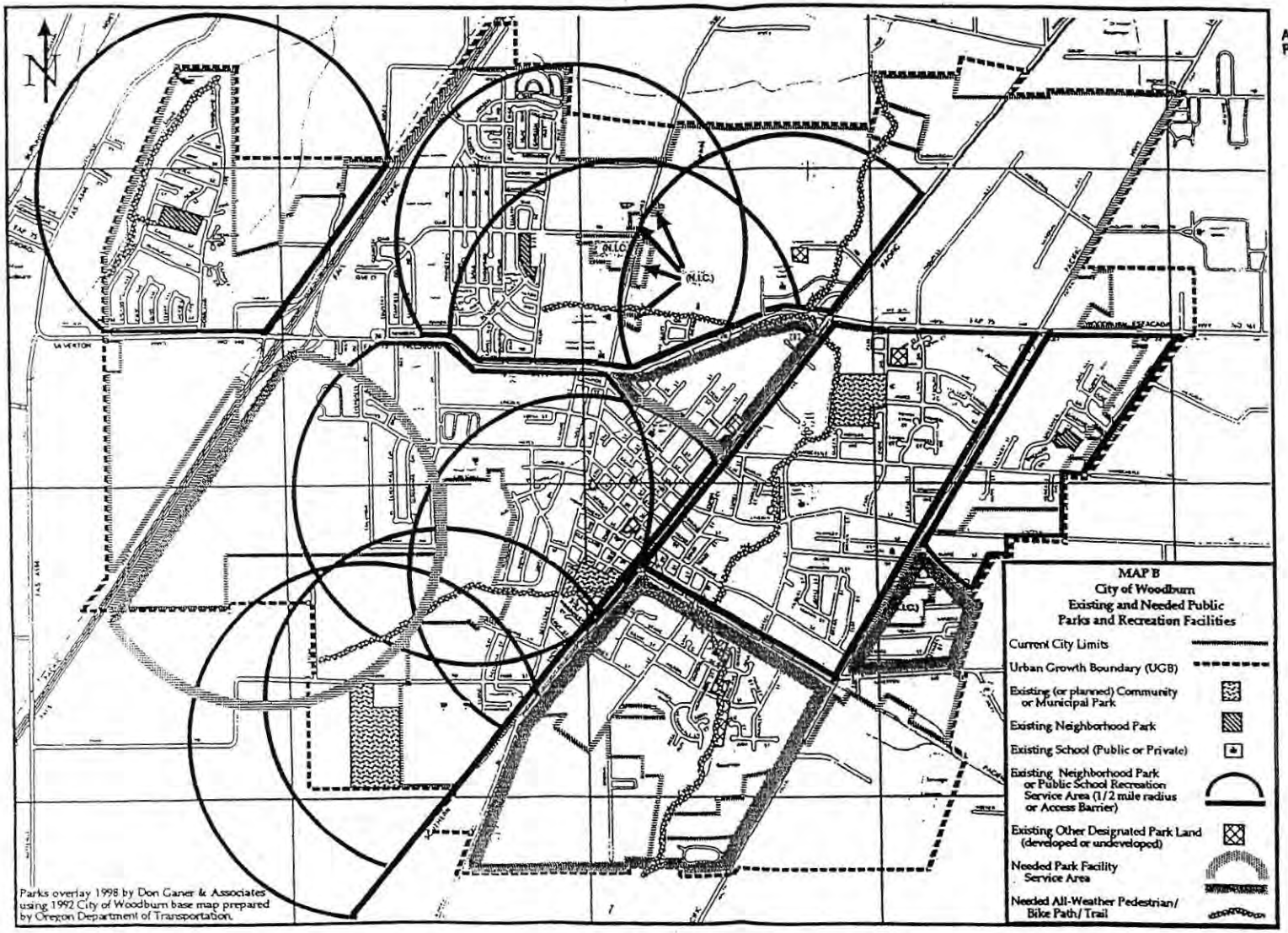
City of Woodburn Parks and Recreation
Facility Types and Standards

pe of Facility	Use and Characteristics	Service Area	Desirable Size	Proposed Standard[7] / 1,000 persons	Current Units[8] / 1,000 persons	Existing Sites
ural Resource pecial Use k/Facility	Area or facility of cultural or historic significance, such as a museum or artifact; or designed for specialized or single purpose recreational activities, such as a community center, community garden, aquatics center, etc.	no standard	no standard	no standard	n/a	Community Center Community Garden Aquatics Center Library Park Alvah Cowan Park Locomotive Park Berry Museum
enways/ en Space, ils/Pathways	Linear park or natural open space areas which may include limited recreation facilities such as trails, all weather pathways or boardwalks, small playgrounds, etc.; may use streams, floodplains, or other natural features to connect parks and open space areas to form a contiguous system. May also include undeveloped park properties planned for future development as neighborhood parks, municipal parks, or other parks and recreation facilities	no standard	no standard	no standard	1.22 acres	Wyffle Park Hermanson Parks (I, II, and III) Glatt Property (21.42 total acres)
e Parks tem	Includes all City-owned developed and undeveloped parks and recreation facilities, and public schools.	n/a	n/a	8.25 acres	11.78 acres[9]	All City-owned parks and recreation, and public school facilities (201.82 total acres)

[7]except for mini-parks, and neighborhood parks, and school parks; standards include facilities for employees, with each equal to 8.3% of a resident.

[8]except for mini-parks, neighborhood parks, and school parks; units include facilities for employees, with each equal to 8.3% of a resident.

[9]considers employees for all except mini-parks, neighborhood parks, and school parks.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MAP B
City of Woodburn
Existing and Needed Public
Parks and Recreation Facilities
Current City Limits
Urban Growth Boundary (UGB)
Existing (or planned) Community or Municipal Park
Existing Neighborhood Park
Existing School (Public or Private)
Existing Neighborhood Park or Public School Recreation Service Area (1/2 mile radius or Access Barrier)
Existing Other Designated Park Land (developed or undeveloped)
Needed Park Facility Service Area
Needed All-Weather Pedestrian/ Bike Path/ Trail
Parks overlay 1998 by Don Ganer & Associates using 1992 City of Woodburn base map prepared by Oregon Department of Transportation.

5.4.2 Neighborhood/School Parks

The most efficient and effective means of providing for some of the needed future neighborhood parks is to adopt a neighborhood/school park concept, strengthening the existing partnership between the City of Woodburn and the Woodburn School District. Implementation of this concept will allow expansion and upgrading facilities at area schools to provide accessibility, security, and adequate facilities. An agreement should also be explored to designate St. Luke's School as a neighborhood park facility for the central portion of Woodburn, which is currently under served.

The City will need to acquire/develop or provide alternatives for three new neighborhood parks in order to meet expected needs during the next twenty years. Joint location of neighborhood parks with schools should be explored in areas where new schools will be needed. In other locations, stand-alone neighborhood parks may be necessary and, in some cases, smaller mini-parks may substitute for neighborhood parks.

Specific needed improvements to existing neighborhood parks and mini-parks include:

Burlingham Neighborhood Park

- Construct Neighborhood Activity Center (3,000 s.f.)
- Update/replace playground equipment
- Install park furniture, especially park benches, and additional signage
- Install security lighting
- Make drainage improvements
- Develop an all weather pathway to Senecal Creek
- Install automatic irrigation system

Senior Estates Park

- Explore feasibility of connecting the park with Goose Creek
- Work with neighborhood to consider need for adding playground facilities
- install furnishings and other amenities such as tables, benches, and a gazebo
- Improve drainage; develop an all-weather pathway system
- Install security lighting

Nelson Park

- Explore feasibility of expanding park
- Replace playground
- Develop all weather pathway system
- Make drainage improvements in playground and playfield areas
- Add sports court
- Restore turf
- Install a landscape buffer to screen at south end of property
- Install security lighting

Heritage Park (mini-park)

- Install access path and retaining wall
- Install security lighting
- Install monument sign

North Front Street Park (mini-park)

- Replace playground and install park furniture, additional signs, and sports court
- Develop all weather pathway system
- Restore turf, install irrigation system
- Install security lighting

5.4.2 Community Parks

New Community Parks are not recommended for acquisition or construction during the planning period. Specific needed improvements to existing community parks facilities include:

Legion Park

- Make entry improvements including signage upgrades for more user friendly statement
- pave/upgrade access road and path surfaces
- install security lighting
- Relocate and replace playground
- Define park boundaries
- Conduct a hazardous tree survey
- Make drainage and turf improvements throughout the facility, including sports fields and recreation areas
- Consider an additional group picnic shelter
- Explore feasibility of integrating Mill Creek amenities into park design/use
- Explore opportunities for acquiring additional land along Mill Creek northward
- Install automatic irrigation system

Settlemier Park

- Replace playground; install park benches
- Replace picnic shelter; restore picnic tables
- replace roof on restroom and upgrade;
- Correct drainage problems; install retaining walls; restore turf
- Make a pathway connection to the Aquatics Center
- Make tennis courts accessible (provide a ramp); repair fencing & sign
- Buffer adjacent residences from the park/shelter activity with landscaping
- Cover base of light standards with veneer
- Remove and relocate basketball court to open area east of parking lot
- Develop new driveway to access the park and Aquatics Center from Front Street, as well from Settlemier Road
- Designate parking spaces for the disabled
- Relocate memorial to a more prominent location
- Remove all hazards
- Relocate park regulations sign closer to the parking lot/park entry

- Install park signs on Settlemier Road and Front Street (acknowledge both aquatics center and park)
- Define boundaries of the park
- Conduct a hazardous tree survey
- Install automatic irrigation system

5.4.3 Municipal Parks

Once developed, Centennial Park should meet city-wide needs for a municipal park for the time frame of this plan. Specific recommendations for Centennial Park include:

- Obtain the services of an experienced, professional parks planner/landscape architect to design a site master plan
- Begin tree planting as soon as a site plan is completed; complete planned initial development
- Explore connection with Mill Creek tributary to develop pathway connection to Settlemier Park
- Explore partnership opportunities with adjacent schools, especially sharing infrastructure, such as parking
- Consider acquiring adjacent land to meet need for future sports fields

5.4.4 Greenways, Open Space, Trails and Pathways

Mill Creek and Goose Creek are recommended as a system of public greenways and pathways. The recreational functions of the creek corridors should be limited primarily to open space and habitat preservation, flood control, cycling and walking on all-weather surface paths, nature recreation, and limited playground activities. A comprehensive management plan for these resources should be developed.

New subdivisions should be encouraged to dedicate floodways and creek corridors to the City, and a high priority should be placed on:

- working with the Tukwila subdivision and other property owners to extend the existing pathway easements near Hazelnut Drive
- acquiring the corridor areas between Lincoln and Cleveland Streets, in the Meadow Park subdivision beyond the existing pond south to the UGB, and along the west tributary from Cleveland Street to Settlemier Park
- extending the greenway/pathway north above Legion Park up to the UGB

More long term acquisition should include a pathway easement along the west tributary from Settlemier Park to Parr Road, which would provide a direct and safe route to the Aquatics Center and downtown, as well as connect Centennial Park, the two adjacent schools, and Settlemier Park. Acquisition or access easements should also be pursued for Senecal Creek, and a pathway should be constructed connecting the Creek with Burlingham Park.

Because the City owns substantial portions of Mill Creek, a phased plan is recommended for developing an all-weather pathway, beginning with areas already in public ownership. Small creative play facilities should be installed in the greenways to address current neighborhood park deficiencies in Wyffle Park and the Hermanson Parks (I, II, and III), but the facilities should be located away from adjacent homes and be accessible and visible from cross streets. Existing play equipment should be relocated to better strategic sites in the corridor.

The City should also study the feasibility of overcoming physical barriers to continuous pathway development caused by the railroad tracks at Cleveland Street and Ogle Street. The archeological discovery and excavation in the corridor near the high school provides an outstanding opportunity for an educational feature and pathway exhibit.

Efforts should also be made to work with the Woodburn School District to secure pathway easements on the south bank of Goose Creek, and to connect Lincoln and French Prairie Schools with Senior Estates Park to the west, and along Woodburn High School to connect with Mill Creek.

The City of Woodburn owns a high quality fir grove east of Senecal Creek, but the creek corridor itself is owned by the developer. Since much of the corridor appears to be wetland, the greenway in this location may function more suitably as habitat and open space protection, and with limited recreation. However, the fir grove has excellent potential for a nature preserve and nature trail, from which strategic penetrations could be made to access the creek.

Specific recommendations for improvements to existing greenways and open space areas include:

Wyffle Park

- Replace playground with a small children's' play facility; relocate closer to Lincoln St.; provide adequate drainage and surface material to be functional during wet weather
- Develop an all weather pathway from Lincoln St. to Hardcastle Ave.
- Elevate grade around exposed sewer manholes or cover with veneer

Hermanson Park I

- Replace existing playground near Stark St. with a fully accessible, all weather small children's" playground, preferably relocated closer to Marshall St.
- Develop an all weather pathway extending from Cleveland St. southward to Stark St.

Hermanson Park II

- Develop an all weather pathway extending from Stark St. to Wilson St.

Hermanson Park III

- Develop an all weather pathway extending from Wilson St. southward to the small greenway pond
- Provide amenities around the pond including benches, picnic tables and signage
- Extend public greenway southward to city limits

5.4.5 Sports and Recreation Facilities

Both staff interviews and survey responses indicate the need for additional community recreation and meeting space, sports fields and sports courts for soccer, basketball, baseball/softball and other activities. Survey responses and physical inspection also indicate a need for drainage and maintenance improvements at sports facilities.

Centennial Park will include sports fields, but these fields will not be designed or located conveniently for neighborhood recreational play. Additional sports fields and sports courts will be needed at existing and future neighborhood/school and community park facilities.

Additional indoor community recreation facilities and meeting space are also needed. A new Community Center building designed for recreational use, including a gym to support recreational sports programs, and with adequate off-street parking.

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Because of the physical separation of West Woodburn from the main part of the City, a "neighborhood activity center" (approximately 3,000 s.f) should also be considered for Burlingham Park.

Legion Field and Stadium

Consideration should be given to converting Legion Field to a soccer field.

Specific recommended improvements at Legion Field include:

- Make drainage and turf improvements throughout the facility, including sports fields and recreation areas
- Conduct a structural and electrical survey of the stadium to determine physical condition
- Correct potentially hazardous steps and rotting of the base of support beams

Woodburn Aquatics Center

Because it serves the entire City, the Woodburn Aquatics Center and its Settlemier Park location should become a major anchor for the parks and recreation system. Direct access from Front Street would acknowledge orientation of the building to the east, which in turn would reinforce it's proximity to the lower downtown area.

The Aquatics Center should also function as a more integral part of Settlemier Park. This can be accomplished by adding pathway linkages and connecting the two existing parking lots.

Specific recommended improvements at the Aquatics Center include:

- Integrate and promote the Aquatics Center as a part of Settlemier Park, including a pathway connection
- Explore feasibility of accessing the facility from Front Street as the main entry, and connecting the two existing parking lots
- Buffer the parking lot and rental area with additional landscaping
- Buffer the adjacent residence on Oak Street
- Upgrade the service driveway
- Replace lighting

Woodburn Community Center

The current building does not meet accessibility requirements to the second floor, is marginal in size to meet the indoor recreation needs of the community (less than 10,000 s.f.), was not designed for recreational use, does not include a gym to support recreational sports programs, and has inadequate off-street parking. Specific recommended improvements include:

- Study the feasibility of a new community center, possibly including other needed facilities such as a youth/teen center

Woodburn Drop-In Youth Center

The Youth Center is marginal in size and operating beyond its functional capacity. Because the need for indoor youth recreation is expected to increase, this facility should be included as a part of the feasibility study for a new community center. Specific recommendations include:

- Study the feasibility of a new youth/teen center, possibly including other needed facilities, such as a community center
- Review functional capacity
- If the facility cannot be replaced with a new community center, upgrade to include new paint, floor coverings, etc.

5.4.6 Cultural and Historic Resources

Several parks and cultural/historic resources have potential for contributing to a more user friendly and attractive downtown area -- the Aquatics Center; Woodburn World's Berry Center Museum; and Locomotive, Settlemier, and Library parks.

Improved connections between Settlemier Park and downtown from Front Street are recommended, as well as upgrading the Woodburn World's Berry Center Museum by beautifying the alley and making improvements to the displays, interpretation, and infrastructure.

Upgrades at Locomotive Park could be a catalyst for enhancing the south side of Front Street along the railroad tracks. Specific recommendations include:

Locomotive Park

- Provide interpretive information on the history and background of the locomotive
- Install park benches and picnic tables.
- Upgrade the parking lot, including drainage improvements
- Evaluate alternatives to use of locked gates and barbed wire for security
- Work with the railroad company to upgrade adjacent properties to improve the appearance of the railroad corridor, to include screening of the storage yard

Library Park

- Extend mural to full length of the south building wall behind small outdoor stage
- Upgrade barren area next to the old library, restore areas where large trees were removed
- Install park furniture and benches
- Restore turf
- Consider additions of lighting, landscaping, wall graphics, information station, gazebo, etc. as recommended in the City's comprehensive plan

Woodburn World's Berry Center Museum

- Upgrade the alley, combining of adjacent property owners to beautify downtown
- Make restrooms fully accessible
- Contact other museums for strategies to upgrade exhibits and interpretive programs

5.5 *Maintenance Recommendations*

Maintenance Standards

The City should develop a maintenance management plan using guidelines such as those included in Park Maintenance Standards, published by the National Recreation and Park Association (1986). This publication includes a Maintenance Standard Classification System with six maintenance "modes":

Mode I - State of the Art Level
Mode II - High Level
Mode III - Moderate Level
Mode IV - Moderately Low Level
Mode V - High Visitation Natural Areas
Mode VI - Minimum Level

Each "mode" includes specific maintenance requirements for turf care, fertilizer, irrigation, litter control, pruning, disease and insect control, snow removal, lighting, surfaces, repairs, inspection, floral plantings, restrooms, and special features. Park Maintenance Standards also includes productivity standards for most common maintenance tasks.

Maintenance Facilities

The storage facilities currently used for parks and recreation equipment are inadequate, requiring that much of the equipment be stored in uncovered, open areas.

Specific recommendations for maintenance facilities include:

- Install additional covered storage facilities (approximately 7,000 s.f.)

6. FUNDING

This section provides a description of a variety of sources which may be used to fund parks and recreation facilities and improvements. This is an overview of commonly used funding sources; additional funding sources not included in this list may also be available.

6.1 System Development Charges (SDC's)

System Development Charges (SDC's) are fees paid by new development to help pay a portion of the costs of capital facilities needed to serve new development. SDC's were implemented by the City for parks and recreation facilities in 1991. The methodology and rates established in 1991 need to be updated to reflect changes in costs since that time, and to address facility needs identified in this comprehensive plan update.

SDC revenues may not be used for the construction of administrative facilities or to fund operations, maintenance, or repairs.

6.2 General Obligation Bonds (G.O. Bonds)

G.O. Bonds are debt instruments which may be sold by the City to fund new parks and recreation facilities, or make improvements to existing facilities. These are repaid with property tax revenue generated by a special levy that is outside the limits imposed by ballot measure #5 (1990), and #50 (1997). Voters must approve G.O. Bond sales either in a General Election in an even numbered year, or in another election in which a minimum of 50% of registered voters participate. G.O. Bond revenues may not be used for operations, maintenance, or repairs; but they may be used for major renovations to existing facilities.

6.3 Revenue Bonds/Certificates of Participation

Revenue bonds and certificates of participation are debt instruments which commit specific revenue sources, such as service or user fees, or special tax revenues for repayment of principal and interest on borrowed funds. Revenue bonds are widely used by utility and enterprise operations to fund large scale improvements, and they do not require voter approval. A reliable long-term source of revenue is not currently available to commit for large scale parks and recreation projects.

6.4 Special Assessment/Local Improvement Districts

Residents may choose to form a local improvement district (LID) to pay for capital improvements or maintenance of facilities through special assessments on their property. This method requires the approval of at least 60% of the owners of land within the proposed district, and must represent at least 60% of the land abutting the proposed improvement. The use of LID's may be appropriate for new mini-parks in locations where homeowner associations do not exist or are not formed.

6.5 General Fund Revenues

General fund revenues consist chiefly of property taxes derived from the permanent tax rate, and are subject to the $10 combined limit on local government taxing agencies imposed by Measure #5 (1990). General fund revenues offer a source of funds for facility operations and maintenance, and may be available on a limited basis for "pay-as-you-go" capital improvements. The limited availability of unrestricted general fund revenues makes them a very unlikely source of funds for parks and recreation capital improvements.

6.6 Local Option Levies for Capital Improvements

A local option levy for capital improvements provides for a separate property tax levy outside the City's permanent rate limit, subject to the $10 combined rate limit imposed under Measure #5. This levy may be used to fund a capital project or group of projects over a specified period of time, up to 10 years. Revenues from these levies may be used to secure bonds for projects, or to complete one or more projects on a "pay as you go" basis. Local option levies require voter approval and are subject to the double majority requirement of Measure #50.

6.7 Local Option Levies for Operations

A local option levy for operations provides for a separate property tax levy outside the City's permanent rate limit, subject to the $10 combined rate limit imposed under Measure #5. This levy may be used to fund a operations and maintenance activities over a specified period of time, up to 5 years. These local option levies require voter approval and are subject to the double majority requirement of Measure #50.

6.8 User Fees and Rents

User fees and rents are direct charges to individuals and groups who use specific programs, facilities and services. These fees and rents usually help pay only a portion of the costs of providing programs and services. User fees generally are set at levels sufficient to cover only a portion of program and maintenance costs, and are rarely used to fund capital projects.

6.9 Federal/State/Other Grants

Federal, state, and other government agencies and foundations often make funds available to serve specific purposes related to parks and recreation; such as land and water conservation, open space preservation, bicycle path construction, or blighted area improvements. Grants often have conditions and limitations, such as providing for project planning but not construction, and they may require a local match, either in dollars, in-kind services, or both. The availability of many grants has decreased in recent years due to federal and state cutbacks in funding, but new grants have recently become available for trails. The City should explore the availability of grants to provide for needs identified in the master plan and for other worthwhile projects.

6.10 Sponsorships/Partnerships/Donations

Public, private, and/or not-for-profit organizations may be willing to fund outright or join together with the City to provide additional parks and recreation facilities and/or services. The City has a history of partnership with other agencies and should explore the use of new and expanded partnerships, sponsorships. and donations as a method of providing additional parks and recreation facilities and/or services for the community.

APPENDIX A

Woodburn Parks and Recreation Capital Improvements Plan

Priority	Facility	Total Estimated Cost	1999 - 2005	2006 - 2010	2011 - 2020
NEIGHBORHOOD PARKS/SCHOOLS					
	Acquire/develop a neighborhood park in the southern portion of the City (approx. 5 acres).	$775,000			
	Acquire/develop a neighborhood park in the eastern portion of the City (approx. 5 acres).	$775,000			
	Acquire/develop a neighborhood park in the southwestern portion of the City (approx. 5 acres).	$775,000			
	Make improvements to Burlingham Park including restrooms, playground equipment replacement, park furniture, security lighting, drainage improvements, and automatic irrigation.	$170,000			
	Construct Activity Center and pathway to Senecal Creek at Burlingham Park.	$215,000			
	Renovate Senior Estates Park including park furniture, security lighting, and drainage improvements.	$70,000			
	Make improvements to Nelson Park including playground equipment replacement, drainage improvements, turf replacement, and landscape buffer.	$120,000			
	Expand Nelson Park (approx. 1 acre); add Sport Court and all weather pathway.	$240,000			
	Make Improvements to Heritage Park including access path, retaining wall, security lighting, and signage.	$12,500			
	Make improvements to North Front Street Park including playground equipment replacement, park furniture, sports court, and signage.	$67,500			
	Make improvements to public schools including picnic tables, playground enhancements, and other amenities.	$67,500			
	SUBTOTAL	$3,287,500			
DISTRICT AND COMMUNITY PARKS					
	Complete Phase II & III development of Centennial Park, including ballfields, soccer fields, lighting and amenities.	$950,000			
	Redesign and renovate Legion Park to include stadium improvements, signage/access improvements, playground relocation and replacement, security lighting, drainage and turf improvements, additional group picnic shelters, and automatic irrigation.	$800,000			
	Redesign and renovate Settlemier Park to include signage/access improvements, playground, basketball court relocation and replacement, picnic shelter replacement, restroom renovation, drainage improvements, and other improvements.	$770,000			
	SUBTOTAL	$2,520,000			

APPENDIX A

/oodburn Parks and Recreation
apital Improvements Plan

riority	Facility	Total Estimated Cost	1999 - 2005	2006 - 2010	2011 - 2020
	CULTURAL AND HISTORIC RESOURCES				
	Improve Locomotive Park to include interpretive information, park furniture, and parking lot improvements; evaluate security and screening alternatives.	$12,000			
	Improve Library Park to include furniture, lighting, graphics, gazebo/kiosk; restore turf and landscaping.	$13,500			
	Upgrade alley and make restrooms fully accessible at the Woodburn World's Berry Center Museum.	$12,500			
	SUBTOTAL	$38,000			
	GREENWAYS, OPEN SPACE, TRAILS, AND PATHWAYS				
	Acquire Mill Creek corridor areas between Lincoln and Cleveland Streets, in Meadow Park Subdivision, and from Cleveland Street to Settlemier Park.	$100,000			
	Acquire Mill Creek corridor areas north from Legion Park to the UGB.	$60,000			
	Acquire access easements to extend pathways near Hazelnut drive; from Settlemier Park to Parr Road, along Senecal Creek, and on the south bank of Goose Creek.	$235,000			
	Upgrade Wyffle Park Greenway to include all-weather pathway from Lincoln St. to Hardcastle Ave.	$30,000			
	Replace and relocate playground equipment at Wyffle Park.	$30,000			
	Upgrade Hermanson Parks I, II, and III to include all-weather pathway from Cleveland St. south to the City limits.	$100,000			
	Replace and relocate playground equipment at Hermanson Park I; install park furniture/amenities at pond at Hermanson Park III..	$35,000			
	SUBTOTAL	$590,000			
	SPORTS AND RECREATION FACILITIES				
	Construct new Community Center (approximately 25,000 s.f.).	$4,345,000			
	SUBTOTAL	$4,345,000			
	MAINTENANCE FACILITIES				
	Install additional covered storage facilities at maintenance yard (7,000 s.f.).	$35,000			
	COMBINED RECREATION AND PARKS FACILITIES NEEDS				
	TOTAL	$10,815,500			

APPENDIX B

City of Woodburn

PARKS AND RECREATION FACILITY AND PROGRAM NEEDS QUESTIONNAIRE

1. ACTIVITIES AND INTERESTS

How often did members of your household participate in these recreation activities during the past year?

	Often	Sometimes	Seldom	Never
A. Golfing	☐	☐	☐	☐
B. Swimming or aquatics	☐	☐	☐	☐
C. Visiting a park	☐	☐	☐	☐
D. Jogging or running	☐	☐	☐	☐
E. Walking for recreation or exercise	☐	☐	☐	☐
F. Picnicking	☐	☐	☐	☐
G. Fishing	☐	☐	☐	☐
H. Nature enjoyment (bird watching, etc.)	☐	☐	☐	☐
I. Bicycling	☐	☐	☐	☐
J. Unstructured sports (frisbee, kites, etc.)	☐	☐	☐	☐
K. Youth After School Drop-In Program	☐	☐	☐	☐
L. Taking a recreation class	☐	☐	☐	☐
M. Visiting the Woodburn Community Center	☐	☐	☐	☐
N. Participating in a Senior Excursion	☐	☐	☐	☐
O. Baseball	☐	☐	☐	☐
P. Softball	☐	☐	☐	☐
Q. Basketball	☐	☐	☐	☐
R. Soccer	☐	☐	☐	☐
S. Tennis	☐	☐	☐	☐
T. Supervised fitness activities (water fitness, etc.)	☐	☐	☐	☐
U. Dancing	☐	☐	☐	☐
V. Teen Programs	☐	☐	☐	☐
W. Arts and crafts	☐	☐	☐	☐
X. Other (specify) _____	☐	☐	☐	☐

2. PROGRAM NEEDS
How important is it for Woodburn to offer the following programs?

	Very Important	Somewhat Important	Not Important	No Opinion
A. Youth Basketball	☐	☐	☐	☐
B. Youth Soccer	☐	☐	☐	☐
C. Children's Dance Classes	☐	☐	☐	☐
D. Children's Swim Lessons	☐	☐	☐	☐
E. Open Swim	☐	☐	☐	☐
F. Adult Aquatics	☐	☐	☐	☐
G. Senior Aquatics	☐	☐	☐	☐
H. Senior Excursion	☐	☐	☐	☐
I. Teen Programs	☐	☐	☐	☐
J. Adult Basketball	☐	☐	☐	☐
K. Adult Softball	☐	☐	☐	☐
L. Youth After School Drop-In Program	☐	☐	☐	☐
M. Middle School Co-Rec Program	☐	☐	☐	☐
N. Children's Art Classes	☐	☐	☐	☐
O. Other (specify) _____	☐	☐	☐	☐

3. FACILITY USE
Please check the appropriate box to indicate how frequently members of your household visit or use each of the following types of facilities in Woodburn.

	Often	Sometimes	Seldom	Never
A. Aquatics Center (Swimming Pool)	☐	☐	☐	☐
B. Baseball/softball facilities	☐	☐	☐	☐
C. Soccer facilities	☐	☐	☐	☐
D. Basketball facilities	☐	☐	☐	☐
E. Tennis facilities	☐	☐	☐	☐
F. Children's playground facilities	☐	☐	☐	☐
G. Community Center	☐	☐	☐	☐
H. Youth Drop-In Center	☐	☐	☐	☐
I. Parks	☐	☐	☐	☐
J. Greenways	☐	☐	☐	☐

4. FACILITY NEEDS

Do current parks and recreation facilities meet the needs of Woodburn?

	Need More	Need Less	Keep Same	No Opinion
A. Swimming/aquatics facilities	☐	☐	☐	☐
B. Baseball/Softball facilities	☐	☐	☐	☐
C. Soccer facilities	☐	☐	☐	☐
D. Basketball facilities	☐	☐	☐	☐
E. Tennis facilities	☐	☐	☐	☐
F. Parks and picnic areas	☐	☐	☐	☐
G. Children's playgrounds	☐	☐	☐	☐
H. Community centers	☐	☐	☐	☐
I. Youth centers	☐	☐	☐	☐
J. Walking trails/bicycle paths	☐	☐	☐	☐
K. Greenways and natural areas	☐	☐	☐	☐
L. Other (specify)_____	☐	☐	☐	☐

5. MAINTENANCE AND REPAIR

In general, how well do you think the current Woodburn parks and recreation facilities are maintained?

	Good	Satisfactory	Poor	No Opinion
A. Aquatics Center (swimming pool)	☐	☐	☐	☐
B. Baseball/Softball facilities	☐	☐	☐	☐
C. Soccer facilities	☐	☐	☐	☐
D. Basketball facilities	☐	☐	☐	☐
E. Tennis facilities	☐	☐	☐	☐
F. Parks and picnic areas	☐	☐	☐	☐
G. Children's playgrounds	☐	☐	☐	☐
H. Community Center	☐	☐	☐	☐
I. Youth Drop-In Center	☐	☐	☐	☐
J. Other (specify)_____	☐	☐	☐	☐

6. Please let us know your ideas. Attach additional pages, if needed.

_____

_____

_____

_____

7. PAYING FOR FACILITIES
Which of the following should be used for new parks and recreation facilities?

	Should Use	Shouldn't Use	No Opinion
A. Voter approved bond-issue (special property tax)	☐	☐	☐
B. Neighborhood property fees for park improvements	☐	☐	☐
D. Special fees on new development for growth costs	☐	☐	☐
E. Business partnerships/sponsorships	☐	☐	☐
F. Other (specify) _____	☐	☐	☐

8. PAYING FOR PROGRAMS AND SERVICES
Which of the following should be used for programs and maintenance?

	Should Use	Shouldn't Use	No Opinion
A. Property tax base and levy revenues	☐	☐	☐
B. User fees	☐	☐	☐
C. Business partnerships/sponsorships	☐	☐	☐
D. Jointly sponsored city/school facilities and programs	☐	☐	☐
E. Other (specify) _____	☐	☐	☐

The following information will help insure that this questionnaire is completed by a representative sample of all Woodburn residents. The information is anonymous and confidential, and will be used for statistical validation purposes only.

9. How long have you lived in Woodburn?
0 to 2 years ☐ 3 to 5 years ☐ 6 to 10 years ☐ 11 to 20 years ☐ 21 + years ☐

10. Please list the number of people in each age group within your household.
Under 5 years ☐ 5 to 17 years ☐ 18 to 39 years ☐ 40 to 64 years ☐ 65 + years ☐

11. Please list the number of adults within your household in each category.
Full Time ☐ Work Part Time ☐ Work Student ☐ Retired ☐ Other ☐

12. Please list the number of people of each race/origin within your household.
Black ☐ Hispanic Origin ☐ Non-Hispanic White ☐ Asian ☐ Other ☐

13. What was your 1996 household income?
Less than $10,000 ☐ $10,000 - 19,999 ☐ $20,000-29,999 ☐ $30,000-39,999 ☐ $40,000 or More ☐

14. Do you live to the North or to the South of Lincoln Street?
North ☐ South ☐

15. Do you live to the East or to the West of Settlemier Street?
East ☐ West ☐

Thank you for answering this questionnaire. Please fold and place it in the enclosed stamped, addressed envelope and mail before April 10, 1997.

	A	B	C	D	E	F
1	City of Woodburn					
2	Parks and Recreation Planning Survey			TOTAL	% of Total	% W/OPINION
3	1. ACTIVITIES AND	A. GOLF	OFTEN	19	10.16%	10.86%
4	INTERESTS		SOMETIMES	23	12.30%	13.14%
5			SELDOM	11	5.88%	6.29%
6			NEVER	122	65.24%	69.71%
7			NO ANSWER	12	6.42%	n/a
8		B. SWIMMING	OFTEN	44	23.53%	23.53%
9			SOMETIMES	42	22.46%	22.46%
10			SELDOM	19	10.16%	10.16%
11			NEVER	82	43.85%	43.85%
12			NO ANSWER	10	5.35%	n/a
13		C. VISITING A PARK	OFTEN	23	12.30%	12.64%
14			SOMETIMES	64	34.22%	35.16%
15			SELDOM	40	21.39%	21.98%
16			NEVER	55	29.41%	30.22%
17			NO ANSWER	6	3.21%	n/a
18		D. JOGGING	OFTEN	16	8.56%	9.20%
19			SOMETIMES	19	10.16%	10.92%
20			SELDOM	28	14.97%	16.09%
21			NEVER	111	59.36%	63.79%
22			NO ANSWER	14	7.49%	n/a
23		E. WALKING	OFTEN	68	36.36%	37.99%
24			SOMETIMES	60	32.09%	33.52%
25			SELDOM	14	7.49%	7.82%
26			NEVER	37	19.79%	20.67%
27			NO ANSWER	8	4.28%	n/a
28		F.PICNICKING	OFTEN	20	10.70%	11.17%
29			SOMETIMES	55	29.41%	30.73%
30			SELDOM	39	20.86%	21.79%
31			NEVER	65	34.76%	36.31%
32			NO ANSWER	9	4.81%	n/a
33		G. FISHING	OFTEN	13	6.95%	7.47%
34			SOMETIMES	28	14.97%	16.09%
35			SELDOM	27	14.44%	15.52%
36			NEVER	106	56.68%	60.92%
37			NO ANSWER	13	6.95%	n/a
38		H. NATURE	OFTEN	29	15.51%	16.67%
39			SOMETIMES	45	24.06%	25.86%
40			SELDOM	28	14.97%	16.09%
41			NEVER	72	38.50%	41.38%
42			NO ANSWER	13	6.95%	n/a
43		I. BICYCLING	OFTEN	25	13.37%	14.29%
44			SOMETIMES	39	20.86%	22.29%
45			SELDOM	27	14.44%	15.43%
46			NEVER	84	44.92%	48.00%
47			NO ANSWER	12	6.42%	n/a

	A	B	C	D	E	F
48		J. UNSTRUCUTED	OFTEN	5	2.67%	2.91%
49		SPORTS	SOMETIMES	24	12.83%	13.95%
50			SELDOM	36	19.25%	20.93%
51			NEVER	107	57.22%	62.21%
52			NO ANSWER	14	7.49%	n/a
53		K. YOUTH	OFTEN	4	2.14%	2.31%
54		AFTER SCHOOL	SOMETIMES	8	4.28%	4.62%
55			SELDOM	8	4.28%	4.62%
56			NEVER	153	81.82%	88.44%
57			NO ANSWER	13	6.95%	n/a
58		L. RECREATION CLASS	OFTEN	1	0.53%	0.57%
59			SOMETIMES	17	9.09%	9.77%
60			SELDOM	21	11.23%	12.07%
61			NEVER	135	72.19%	77.59%
62			NO ANSWER	13	6.95%	n/a
63		M. COMMUNITY	OFTEN	14	7.49%	7.91%
64		CENTER	SOMETIMES	22	11.76%	12.43%
65			SELDOM	39	20.86%	22.03%
66			NEVER	102	54.55%	57.63%
67			NO ANSWER	9	4.81%	n/a
68		N. SENIOR EXCURSION	OFTEN	6	3.21%	3.33%
69			SOMETIMES	16	8.56%	8.89%
70			SELDOM	21	11.23%	11.67%
71			NEVER	137	73.26%	76.11%
72			NO ANSWER	7	3.74%	n/a
73		O. BASEBALL	OFTEN	8	4.28%	4.57%
74			SOMETIMES	12	6.42%	6.86%
75			SELDOM	15	8.02%	8.57%
76			NEVER	140	74.87%	80.00%
77			NO ANSWER	12	6.42%	n/a
78		P. SOFTBALL	OFTEN	9	4.81%	5.11%
79			SOMETIMES	11	5.88%	6.25%
80			SELDOM	16	8.56%	9.09%
81			NEVER	140	74.87%	79.55%
82			NO ANSWER	11	5.88%	n/a
83		Q. BASKETBALL	OFTEN	17	9.09%	9.60%
84			SOMETIMES	12	6.42%	6.78%
85			SELDOM	17	9.09%	9.60%
86			NEVER	131	70.05%	74.01%
87			NO ANSWER	11	5.88%	n/a
88		R. SOCCER	OFTEN	16	8.56%	9.09%
89			SOMETIMES	7	3.74%	3.98%
90			SELDOM	10	5.35%	5.68%
91			NEVER	143	76.47%	81.25%
92			NO ANSWER	11	5.88%	n/a
93		S. TENNIS	OFTEN	3	1.60%	1.72%
94			SOMETIMES	9	4.81%	5.17%
95	Volume 1		SELDOM	14	7.49%	8.05%
96	Page 1102		NEVER	148	79.14%	85.06%
97			NO ANSWER	12	6.42%	n/a

	A	B	C	D	E	F
98		T. FITNESS	OFTEN	13	6.95%	7.47%
99			SOMETIMES	21	11.23%	12.07%
100			SELDOM	17	9.09%	9.77%
101			NEVER	123	65.78%	70.69%
102			NO ANSWER	13	6.95%	n/a
103		U. DANCING	OFTEN	14	7.49%	8.00%
104			SOMETIMES	20	10.70%	11.43%
105			SELDOM	21	11.23%	12.00%
106			NEVER	120	64.17%	68.57%
107			NO ANSWER	12	6.42%	n/a
108		V. TEEN PROGRAM	OFTEN	6	3.21%	3.45%
109			SOMETIMES	15	8.02%	8.62%
110			SELDOM	8	4.28%	4.60%
111			NEVER	145	77.54%	83.33%
112			NO ANSWER	12	6.42%	n/a
113		W. ARTS/CRAFTS	OFTEN	12	6.42%	6.94%
114			SOMETIMES	24	12.83%	13.87%
115			SELDOM	19	10.16%	10.98%
116			NEVER	118	63.10%	68.21%
117			NO ANSWER	13	6.95%	n/a
118		X. OTHER	OFTEN	13	6.95%	72.22%
119			SOMETIMES	1	0.53%	5.56%
120			SELDOM	1	0.53%	5.56%
121			NEVER	3	1.60%	16.67%
122			NO ANSWER	2	1.07%	n/a
123	2. PROGRAM NEEDS	2A. YOUTH	VERY	92	49.20%	64.79%
124		BASKETBALL	SOMWHAT	44	23.53%	30.99%
125			NOT	6	3.21%	4.23%
126			NO OPINION	26	13.90%	n/a
127			NO ANSWER	19	10.16%	n/a
128		2B. YOUTH SOCCER	VERY	96	51.34%	67.61%
129			SOMWHAT	41	21.93%	28.87%
130			NOT	5	2.67%	3.52%
131			NO OPINION	27	14.44%	n/a
132			NO ANSWER	19	10.16%	n/a
133		2C. CHILDREN'S DANCE	VERY	40	21.39%	30.08%
134			SOMWHAT	62	33.16%	46.62%
135			NOT	31	16.58%	23.31%
136			NO OPINION	30	16.04%	n/a
137			NO ANSWER	24	12.83%	n/a
138		2D. CHILDREN'S SWIM	VERY	105	56.15%	69.08%
139			SOMWHAT	41	21.93%	26.97%
140			NOT	6	3.21%	3.95%
141			NO OPINION	20	10.70%	n/a
142			NO ANSWER	15	8.02%	n/a
143		2E. OPEN SWIM	VERY	90	48.13%	62.94%
144			SOMWHAT	47	25.13%	32.87%
145			NOT	6	3.21%	4.20%
146			NO OPINION	26	13.90%	n/a
147			NO ANSWER	18	9.63%	n/a

	A	B	C	D	E	F
148		2F. ADULT AQUATICS	VERY	67	35.83%	48.20%
149			SOMWHAT	56	29.95%	40.29%
150			NOT	16	8.56%	11.51%
151			NO OPINION	29	15.51%	n/a
152			NO ANSWER	20	10.70%	n/a
153		2G. SENIOR AQUATICS	VERY	67	35.83%	50.00%
154			SOMWHAT	48	25.67%	35.82%
155			NOT	19	10.16%	14.18%
156			NO OPINION	32	17.11%	n/a
157			NO ANSWER	21	11.23%	n/a
158		2H. SENIOR EXCURSION	VERY	50	26.74%	35.71%
159			SOMWHAT	67	35.83%	47.86%
160			NOT	23	12.30%	16.43%
161			NO OPINION	26	13.90%	n/a
162			NO ANSWER	20	10.70%	n/a
163		2I. TEEN PROGRAMS	VERY	107	57.22%	72.79%
164			SOMWHAT	33	17.65%	22.45%
165			NOT	7	3.74%	4.76%
166			NO OPINION	25	13.37%	n/a
167			NO ANSWER	15	8.02%	n/a
168		2J. ADULT	VERY	26	13.90%	20.63%
169		BASKETBALL	SOMWHAT	65	34.76%	51.59%
170			NOT	35	18.72%	27.78%
171			NO OPINION	41	21.93%	n/a
172			NO ANSWER	22	11.76%	n/a
173		2K ADULT SOFTBALL	VERY	25	13.37%	20.00%
174			SOMWHAT	70	37.43%	56.00%
175			NOT	30	16.04%	24.00%
176			NO OPINION	39	20.86%	n/a
177			NO ANSWER	22	11.76%	n/a
178		2L. YOUTH	VERY	87	46.52%	60.00%
179		AFTER SCHOOL	SOMWHAT	48	25.67%	33.10%
180			NOT	10	5.35%	6.90%
181			NO OPINION	28	14.97%	n/a
182			NO ANSWER	14	7.49%	n/a
183		2M. MIDDLE SCHOOL	VERY	68	36.36%	50.00%
184		CO-REC	SOMWHAT	59	31.55%	43.38%
185			NOT	9	4.81%	6.62%
186			NO OPINION	30	16.04%	n/a
187			NO ANSWER	21	11.23%	n/a
188		2N. CHILDREN'S ART	VERY	53	28.34%	37.59%
189			SOMWHAT	68	36.36%	48.23%
190			NOT	20	10.70%	14.18%
191			NO OPINION	29	15.51%	n/a
192			NO ANSWER	17	9.09%	n/a
193		2O. OTHER	VERY	8	4.28%	
194			SOMWHAT	4	2.14%	
195			NOT	2	1.07%	
196			NO OPINION	30	16.04%	
197			NO ANSWER	9	4.81%	

	A	B	C	D	E	F
198	3. FACILITY USE	3A. AQUATICS	OFTEN	41	21.93%	23.16%
199			SOMETIMES	22	11.76%	12.43%
200			SELDOM	18	9.63%	10.17%
201			NEVER	96	51.34%	54.24%
202			NO ANSWER	13	6.95%	n/a
203		3B. BASEBALL/ SOFTBALL	OFTEN	5	2.67%	2.96%
204			SOMETIMES	21	11.23%	12.43%
205			SELDOM	25	13.37%	14.79%
206			NEVER	118	63.10%	69.82%
207			NO ANSWER	18	9.63%	n/a
208		3C. SOCCER	OFTEN	14	7.49%	8.19%
209			SOMETIMES	14	7.49%	8.19%
210			SELDOM	14	7.49%	8.19%
211			NEVER	129	68.98%	75.44%
212			NO ANSWER	16	8.56%	n/a
213		3D. BASKETBALL	OFTEN	14	7.49%	8.28%
214			SOMETIMES	17	9.09%	10.06%
215			SELDOM	16	8.56%	9.47%
216			NEVER	122	65.24%	72.19%
217			NO ANSWER	18	9.63%	n/a
218		3E. TENNIS	OFTEN	3	1.60%	1.78%
219			SOMETIMES	14	7.49%	8.28%
220			SELDOM	18	9.63%	10.65%
221			NEVER	134	71.66%	79.29%
222			NO ANSWER	18	9.63%	n/a
223		3F. PLAYGROUND	OFTEN	18	9.63%	10.59%
224			SOMETIMES	32	17.11%	18.82%
225			SELDOM	18	9.63%	10.59%
226			NEVER	102	54.55%	60.00%
227			NO ANSWER	16	8.56%	n/a
228		3G. COMMUNITY CENTER	OFTEN	15	8.02%	8.72%
229			SOMETIMES	26	13.90%	15.12%
230			SELDOM	36	19.25%	20.93%
231			NEVER	95	50.80%	55.23%
232			NO ANSWER	15	8.02%	n/a
233		3H. YOUTH DROP-IN	OFTEN	6	3.21%	3.53%
234			SOMETIMES	5	2.67%	2.94%
235			SELDOM	16	8.56%	9.41%
236			NEVER	143	76.47%	84.12%
237			NO ANSWER	17	9.09%	n/a
238		3I. PARKS	OFTEN	28	14.97%	16.18%
239			SOMETIMES	44	23.53%	25.43%
240			SELDOM	40	21.39%	23.12%
241			NEVER	61	32.62%	35.26%
242			NO ANSWER	15	8.02%	n/a
243		3J. GREENWAYS	OFTEN	12	6.42%	7.27%
244			SOMETIMES	25	13.37%	15.15%
245			SELDOM	27	14.44%	16.36%
246			NEVER	101	54.01%	61.21%
247			NO ANSWER	21	11.23%	n/a

	A	B	C	D	E	F
248	4. FACILITY NEEDS	4A. SWIMMING	MORE	16	8.56%	12.60%
249			LESS	7	3.74%	5.51%
250			SAME	104	55.61%	81.89%
251			NO OPINION	41	21.93%	n/a
252			NO ANSWER	19	10.16%	n/a
253		4B. BASEBALL/	MORE	29	15.51%	32.58%
254		SOFTBALL	LESS	4	2.14%	4.49%
255			SAME	56	29.95%	62.92%
256			NO OPINION	77	41.18%	n/a
257			NO ANSWER	22	11.76%	n/a
258		4C. SOCCER	MORE	30	16.04%	33.71%
259			LESS	4	2.14%	4.49%
260			SAME	55	29.41%	61.80%
261			NO OPINION	77	41.18%	n/a
262			NO ANSWER	21	11.23%	n/a
263		4D. BASKETBALL	MORE	32	17.11%	37.21%
264			LESS	3	1.60%	3.49%
265			SAME	51	27.27%	59.30%
266			NO OPINION	79	42.25%	n/a
267			NO ANSWER	22	11.76%	n/a
268		4E. TENNIS	MORE	19	10.16%	23.17%
269			LESS	5	2.67%	6.10%
270			SAME	58	31.02%	70.73%
271			NO OPINION	84	44.92%	n/a
272			NO ANSWER	21	11.23%	n/a
273		4F. PARKS AND PICNIC	MORE	59	31.55%	48.76%
274			LESS	8	4.28%	6.61%
275			SAME	54	28.88%	44.63%
276			NO OPINION	48	25.67%	n/a
277			NO ANSWER	18	9.63%	n/a
278		4G. PLAYGROUNDS	MORE	63	33.69%	56.76%
279			LESS	7	3.74%	6.31%
280			SAME	41	21.93%	36.94%
281			NO OPINION	59	31.55%	n/a
282			NO ANSWER	17	9.09%	n/a
283		4H. COMMUNITY	MORE	35	18.72%	33.02%
284		CENTERS	LESS	7	3.74%	6.60%
285			SAME	64	34.22%	60.38%
286			NO OPINION	62	33.16%	n/a
287			NO ANSWER	19	10.16%	n/a
288		4I. YOUTH CENTER	MORE	71	37.97%	62.28%
289			LESS	6	3.21%	5.26%
290			SAME	37	19.79%	32.46%
291			NO OPINION	63	33.69%	n/a
292			NO ANSWER	20	10.70%	n/a
293		4J. TRAILS/PATHS	MORE	72	38.50%	62.61%
294			LESS	9	4.81%	7.83%
			SAME	34	18.18%	29.57%
			NO OPINION	53	28.34%	n/a
297			NO ANSWER	19	10.16%	n/a

	A	B	C	D	E	F
298		4K. GREENWAYS/	MORE	47	25.13%	41.96%
299		NATURAL AREAS	LESS	16	8.56%	14.29%
300			SAME	49	26.20%	43.75%
301			NO OPINION	55	29.41%	n/a
302			NO ANSWER	20	10.70%	n/a
303		4L. OTHER	MORE	5	2.67%	
304			LESS	1	0.53%	
305			SAME	1	0.53%	
306			NO OPINION	48	25.67%	
307			NO ANSWER	14	7.49%	
308	5. MAINTENANCE/	5A. AQUATICS	GOOD	61	32.62%	61.00%
309	REPAIR		SATISF	36	19.25%	36.00%
310			POOR	3	1.60%	3.00%
311			NO OPINION	72	38.50%	n/a
312			NO ANSWER	15	8.02%	n/a
313		5B. BASEBALL/	GOOD	17	9.09%	23.61%
314		SOFTBALL	SATISF	43	22.99%	59.72%
315			POOR	12	6.42%	16.67%
316			NO OPINION	92	49.20%	n/a
317			NO ANSWER	23	12.30%	n/a
318		5C. SOCCER	GOOD	18	9.63%	27.69%
319			SATISF	35	18.72%	53.85%
320			POOR	12	6.42%	18.46%
321			NO OPINION	99	52.94%	n/a
322			NO ANSWER	23	12.30%	n/a
323		5D. BASKETBALL	GOOD	10	5.35%	16.39%
324			SATISF	38	20.32%	62.30%
325			POOR	13	6.95%	21.31%
326			NO OPINION	103	55.08%	n/a
327			NO ANSWER	23	12.30%	n/a
328		5E. TENNIS	GOOD	7	3.74%	11.48%
329			SATISF	42	22.46%	68.85%
330			POOR	12	6.42%	19.67%
331			NO OPINION	104	55.61%	n/a
332			NO ANSWER	23	12.30%	n/a
333		5F. PARKS/PICNIC	GOOD	21	11.23%	19.81%
334			SATISF	49	26.20%	46.23%
335			POOR	36	19.25%	33.96%
336			NO OPINION	59	31.55%	n/a
337			NO ANSWER	22	11.76%	n/a
338		5G. PLAYGROUNDS	GOOD	15	8.02%	17.86%
339			SATISF	44	23.53%	52.38%
340			POOR	25	13.37%	29.76%
341			NO OPINION	81	43.32%	n/a
342			NO ANSWER	22	11.76%	n/a
343		5H. COMMUNITY	GOOD	22	11.76%	26.83%
344		CENTER	SATISF	46	24.60%	56.10%
345			POOR	14	7.49%	17.07%
346			NO OPINION	83	44.39%	n/a
347			NO ANSWER	22	11.76%	n/a

	A	B	C	D	E	F
348		5I. YOUTH DROP-IN	GOOD	6	3.21%	12.77%
349			SATISF	23	12.30%	48.94%
350			POOR	18	9.63%	38.30%
351			NO OPINION	114	60.96%	n/a
352			NO ANSWER	26	13.90%	n/a
353		5J. OTHER	GOOD	0	0.00%	
354			SATISF	3	1.60%	
355			POOR	2	1.07%	
356			NO OPINION	59	31.55%	
357			NO ANSWER	13	6.95%	
358		6.IDEAS	YES	43	22.99%	
359			NO	142	75.94%	
360	7. PAYING FOR	7A. BONDS	SHOULD	56	29.95%	44.44%
361	FACILITIES		NOT	70	37.43%	55.56%
362			NO OPINION	29	15.51%	n/a
363			NO ANSWER	30	16.04%	n/a
364		7B. FEES	SHOULD	32	17.11%	29.36%
365			NOT	77	41.18%	70.64%
366			NO OPINION	37	19.79%	n/a
367			NO ANSWER	39	20.86%	n/a
368		7D. SDC'S	SHOULD	88	47.06%	72.13%
369			NOT	34	18.18%	27.87%
370			NO OPINION	32	17.11%	n/a
371			NO ANSWER	32	17.11%	n/a
372		7E. PARTNER/	SHOULD	105	56.15%	86.78%
373		SPONSORSHIPS	NOT	16	8.56%	13.22%
374			NO OPINION	36	19.25%	n/a
375			NO ANSWER	29	15.51%	n/a
376		7F. OTHER	SHOULD	14	7.49%	
377			NOT	6	3.21%	
378			NO OPINION	28	14.97%	
379			NO ANSWER	18	9.63%	
380	8.PAYING FOR	8A. PROPERTY TAX	SHOULD	56	29.95%	43.75%
381	PROGRAMS		NOT	72	38.50%	56.25%
382			NO OPINION	25	13.37%	n/a
383			NO ANSWER	34	18.18%	n/a
384		8B. USER FEES	SHOULD	118	63.10%	83.10%
385			NOT	24	12.83%	16.90%
386			NO OPINION	19	10.16%	n/a
387			NO ANSWER	26	13.90%	n/a
388		8C. PARTNER/	SHOULD	106	56.68%	88.33%
389		SPONSORSHIPS	NOT	14	7.49%	11.67%
390			NO OPINION	42	22.46%	n/a
391			NO ANSWER	30	16.04%	n/a
392		8D. CITY/SCHOOL	SHOULD	114	60.96%	88.37%
393		JOINT PROGRAMS	NOT	15	8.02%	11.63%
394			NO OPINION	31	16.58%	n/a
395			NO ANSWER	26	13.90%	n/a

	A	B	C	D	E	F
396		8E. OTHER	SHOULD	5	2.67%	
397			NOT	1	0.53%	
398			NO OPINION	25	13.37%	
399			NO ANSWER	8	4.28%	
400	9 TENURE		0-2	22	11.76%	
401			3-5	41	21.93%	
402			6-10	42	22.46%	
403			11-20	32	17.11%	
404			21+	47	25.13%	
405			NO ANSWER	3	1.60%	
406	10.AGES		<5	39		
407			5-17	78		
408			18-39	91		
409			40-64	126		
410			65+	133		
411			NO ANSWER	8		
412	65+NOCHILD			85	45.45%	
413	65+CHILD<5			0	0.00%	
414	65+CHILD<5+5-17			1	0.53%	
415	65+CHILD5-17			0	0.00%	
416	18-39NOCHILD			3	1.60%	
417	18-39CHILD<5			9	4.81%	
418	18-39CHILD<5+5-17			7	3.74%	
419	18-39CHILD5-17			6	3.21%	
420	40-64NOCHILD			30	16.04%	
421	40-64CHILD<5			3	1.60%	
422	40-64CHILD<5+5-17			6	3.21%	
423	40-64CHILD5-17			15	8.02%	
424	40-64CHILD18-39			8	4.28%	
425	NO ANSWER			8	4.28%	
426	11. WORK		FULL	143		
427			PART	34		
428			STUDENT	31		
429			RETIRED	151		
430			OTHER	15		
431			NO ANSWER	4		
432	11A. WORK (HOUSEHOLDER)		FULL	86	45.99%	
433			PART	6	3.21%	
434			STUDENT	1	0.53%	
435			RETIRED	89	47.59%	
436			OTHER	5	2.67%	
437			NO ANSWER	4	2.14%	
438	12. RACE/ORIGIN		BLACK	1		
439			HISPANIC	129		
440			WHITE	321		
441			ASIAN	4		
442			OTHER	8		
443			NO ANSWER	7		

	A	B	C	D	E	F
444	12A. RACE/ORIGIN		BLACK	1	0.53%	
445	(MAJORITY OF HOUSEHOLD)		HISPANIC	31	16.58%	
446			WHITE	146	78.07%	
447			ASIAN	3	1.60%	
448			OTHER	4	2.14%	
449			NO ANSWER	7	3.74%	
450	13. INCOME		<10K	10	5.35%	
451			10-19.9K	36	19.25%	
452			20-29.9K	40	21.39%	
453			30-39.9K	30	16.04%	
454			40K+	50	26.74%	
455			NO ANSWER	22	11.76%	
456	14. NORTH/SOUTH		NORTH	111	59.36%	
457			SOUTH	60	32.09%	
458			NO ANSWER	15	8.02%	
459	15. EAST/WEST		EAST	69	36.90%	
460			WEST	106	56.68%	
461			NO ANSWER	11	5.88%	
462			NW	68	36.36%	
463			NE	39	20.86%	
464			SW	31	16.58%	
465			SE	29	15.51%	

ATTACHMENT "B"

FINDINGS AND CONCLUSIONS

RELEVANT FACTS

1. The City of Woodburn is currently conducting Periodic Review for the City's Comprehensive Plan. As a part of this review the City is updating the Parks and Recreation Comprehensive Plan.

2. The City of Woodburn recognizes that quality recreation and park facilities and programs are vital components of a healthy and safe community.

3. Woodburn is expected to grow within the next 20 years. The City's Parks and Recreation Comprehensive Plan Update addresses projected development patterns, community demographic composition and facility and program needs.

FINDINGS

1. Woodburn is in a major growth cycle, and is expected to continue to increase in population and employment over the next several years. Policies of the Woodburn Comprehensive Plan call for orderly, efficient and managed growth, enhancement of community livability, and for new public facilities to be paid for by development fees.

2. Woodburn's population characteristics are unique: a substantial number of adults over 65 years of age and children below the age of 17; an increase in family size; a multi-ethnic community; a large number of families with low to moderate incomes; and a relatively large seasonal populations.

3. Multifamily housing makes up over 25 percent of the housing stock; many of these developments lack access to open space or playground facilities; there is a trend toward a decrease in minimum lot sizes and increased densities in new single family developments.

4. Compared with other cities of comparable size, Woodburn's crime index is relatively high. There is a shortage of sports fields and sports courts, and the distribution of developed public parks and recreation facilities does not provide equitable access for many residents.

5. The City is concerned about deterioration of the downtown and is working to revitalize the area; policies include improving open space in the Central Business District (CBD), and improving Library Park as a catalyst for rejuvenation.

6. Woodburn's drainage system is extensive, but other than a few public greenways and playgrounds, little public use is made of the creek corridors. Much of the system is owned by the City, and by plan policy is recognized as a natural greenway system and transportation corridor. Although parts of the creek system have been channeled, there is excellent potential for accommodating non-vehicular transportation, and for natural greenways, linear parks, and playgrounds.

7. While a blend of private and public recreation facilities can meet the needs of the community, there is some indication that the private recreation facilities and greenways (i.e. Meadow Park, Tukwila, Senior Estates) may negatively impact the City's parks and recreation system as a whole.

8. Woodburn school grounds and play facilities make a substantial contribution in providing neighborhood and community recreation and open space opportunities. A close working relationship exists between the School District and the City of Woodburn.

9. The Parks and Recreation Comprehensive Plan Update complies with applicable requirements included in *Oregon's Statewide Planning Goals and Guidelines(1995)* including Goal 1: Citizen Involvement, Goal 5: Open spaces, scenic and historic areas, and natural resources, Goal 8: Recreational needs, and Goal 11: Public facilities and services.

10. The Parks and Recreation Comprehensive Plan Update complies with applicable Goals and Policies related to parks, recreation, and open space included in *Woodburn 2014*, as amended, including Residential Land Development Policies A-1 and A-3; Commercial land Development Policy B-5; Annexation Policy D-1; Public Services Goal H-2, and Policies H-1, H-6, and H-7; Transportation Goal I-4, and Policies K-1-2, I-2-2, I-4-1, I-4-2, I-4-5, I-4-6, I-5-4, I-6-1 and I-6-2; Growth and Urbanization Policies K-3 and K-10; Natural and Cultural Resources Goals L-1 and L-2, and Policies L-2, and L-3; Downtown Development Policies N-2-1, N-3-1, and N-3-4; and Woodburn Transportation System Plan Goal 1 Policies 4 and 5, Goal 2, and Goal 3 Policy 2.

11. *Woodburn 2014* does not currently include a Parks and Recreation Element. Opens Space/Parks are addressed only briefly in the Land use Plan (Chapter X, Section F). Because parks and recreation facilities and programs may have a significant role in the development patterns and livability of the City, a comprehensive plan element devoted to these facilities and programs is warranted.

12. The Parks and Recreation Comprehensive Plan Update was developed with public involvement, and is based on a thorough review of community needs and interests. This plan addresses expected parks and recreation facility needs through the year 2020 and best satisfies the public need for parks and recreation facilities and programs.

CONCLUSION

The Parks and Recreation Comprehensive Plan Update will serve as a practical guide for the development of recreation and park facilities and programs in Woodburn through 2020.

Oversized Map Exhibit

Figure 4
Trunk and Interceptor System
SAM Identification Numbers
City of Woodburn Facilities Plan

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DRAFT

CITY OF WOODBURN OREGON

WATER MASTER PLAN

DECEMBER 1996

DRAFT

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Water Master Plan
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CHAPTER 1
EXECUTIVE SUMMARY

1.1 PURPOSE AND OBJECTIVES

The City of Woodburn has decided to prepare a Water Master Plan to address the following main points:

- **To Satisfy Public Requirements:** Currently Woodburn's well water contains elevated levels of iron and manganese. These two metals produce staining on plumbing fixtures and laundry, can cause turbidity and color in the water, and taste and odor problems. While iron and manganese do not endanger the public health, consumers have demanded a better quality water in the Woodburn system.
- **To Comply with Changing Regulations:** The Safe Drinking Water Act is implementing many new and challenging regulations. Regulations for disinfection of groundwater's may be coming and the City of Woodburn needs to be prepared for this requirement. Arsenic limits may be lowered and radon may become an issue. Planning for these new regulations will allow the City to efficiently meet the regulations if they come into being.
- **To Provide Reliable Fire Protection:** A water supply and distribution system must be capable of providing water where it is needed in the quantities needed to provide reliable fire protection to Woodburn residents. Adequate quantities of water must be stored in the system, pipelines in the distribution system must be properly sized and looped, and sufficient fire hydrants must exist in the system. Design standards and planning will help to ensure that the highest level of fire protection is available in Woodburn.
- **And to Economically meet future needs:** Woodburn is a rapidly growing and expanding City. It is projected that the population of the City will more than double in the next 25 years. Providing safe, plentiful drinking water at a reasonable price to Woodburn residents requires good sound planning. Woodburn must look for sources of water, decide on treatment and water quality goals, and establish standards for system expansion that will most efficiently meet the City's needs. Developing a Master Plan that is regularly updated will guide the City efficiently through this anticipated growth.

The objectives of the plan will be:

- Project the water needs of the system over a 25-year planning period and evaluate the water resources and infrastructure to meet the future projected demands.
- Conduct an assessment of the water quality with regard to the Safe Drinking Water Act (SDWA)
- Establish treatment goals which address the upcoming regulations of the SDWA and other water quality issues facing Woodburn, in particular, the reduction of iron and manganese concentrations.
- Develop water treatment alternatives to meet the treatment goals.
- Develop a Capital Improvements Plan to meet the water distribution system goals, water storage capacities, and future water supply needs.

- Outline the current financial condition of the Water Division and assess the ability of the City to complete the needed improvements.
- Meet the requirements of OAR 333-061-0060.

1.2 AUTHORIZATION

On March 26, 1996, the City of Woodburn entered into a contract with HDR Engineering, Inc. to complete a Water Master Plan to bring the City into compliance with the requirements stipulated in the OAR 333-061-0060. The Water Master Plan will take a holistic look at the water supply system to develop criteria and tools that the City can use over the next 25 years to ensure that as the City grows, residents will have plenty of safe high quality drinking water. This planning document will be a guide outlining needed improvements to meet growth needs, regulations, and treatment objectives.

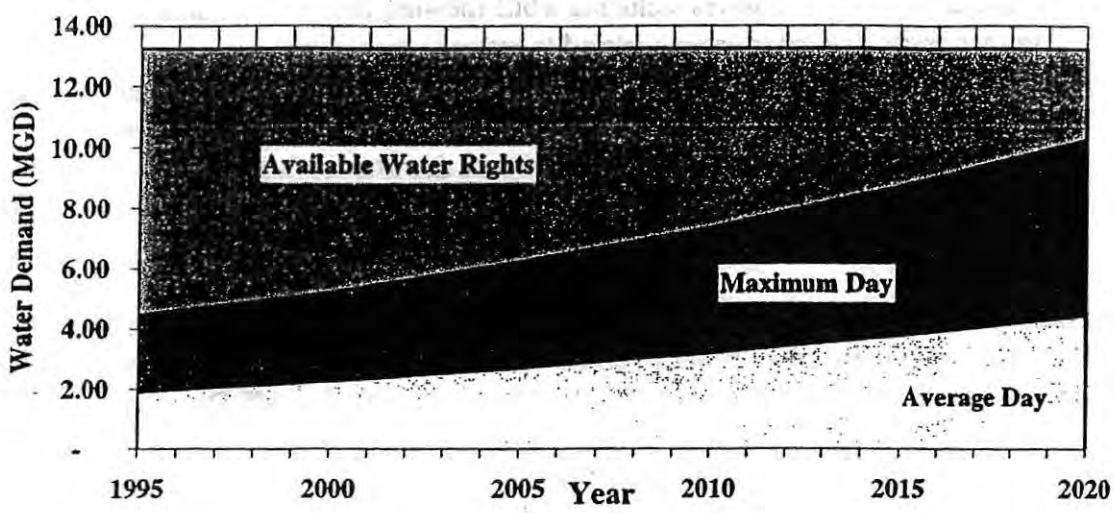
1.3 SERVICE AREA AND PROJECTED WATER DEMANDS

The City of Woodburn is located in Marion County approximately 17 miles north of Salem and 30 miles south of Portland. It is situated within the Pudding River basin in the Willamette Valley. The City's sole water source is groundwater from the Troutdale aquifer, a large semi-confined aquifer. Woodburn has 12 wells in the Troutdale, 6 of these wells are active. The water system has approximately 4,800 connections which include single family, multi-residential, commercial, industrial, city owned and fire service connections. The service area covers approximately 3,285 acres. The current Woodburn service area population is approximately 16,727 permanent residents with an estimated 1,777 seasonal residents bringing the total to 18,504. By the year 2020 it is projected that the permanent population of Woodburn will reach 38,586 with a seasonal population of 4,099 bringing the total to 42,685.

Woodburn has sufficient water rights to meet the projected water demands through the year 2020. It is anticipated that Woodburn will continue to utilize the Troutdale aquifer as their sole source of water. In the long term, if the area continues to grow, Woodburn will have to look to other sources of water to meet their demands. Current planning by the City of Portland indicates that they do not plan to provide water as far south as the Woodburn area. Developing a new regional source of water has been discussed with neighboring communities however no definite plan has been developed and no agreements have been reached. For the long term, it is recommended that Woodburn continue to investigate the possibility of regional water supply with neighboring communities.

Since the Troutdale aquifer will remain the main source of water for the City of Woodburn for the next twenty five years, it is in the City's best interest to protect the source. It is recommended that the City develop a wellhead protection plan. A wellhead protection plan will identify potential sources of contamination, it will establish best management practices for industries within the influence zone of the City's wells, it will allow the City to develop ordinances that will provide protection for the aquifer, and it will map the flow patterns of the aquifer. All of these actions will serve to protect the aquifer.

Figure 1-1
Woodburn Water Master Plan
Water Demands and Water Rights



By the year 2020 it is estimated that average day demands (ADD) will increase to 4.47 million gallons per day. Maximum day demand (MDD) in the year 2020 will be 10.28 million gallons per day. These projected demands and the current water rights are illustrated in Figure 1-1. It is recommended that the City construct a minimum of 4 each 1,000 gpm wells over the next 25 years to meet the projected demands. The estimated cost and year of construction for the proposed 4 wells is listed in Table 1-1.

TABLE 1-1
WOODBURN WATER MASTER PLAN
ESTIMATED BUDGETARY COSTS - PROPOSED WELLS

Project No.	Description	Project Year	Const. Cost (1996 Dollars)
W-NH	New Well at Church on Newberg Highway	2000	$250,000
W-CP	New Well at Centennial Park	2005	$250,000
W-ST	New Well at Settlemier/Tout St.	2010	$250,000
W-CR	New Well at County Rd. 517	2015	$250,000

Water conservation measures can have a significant impact on the water demand in a water system. Water conservation is a function of education, availability of water resources, water rates, and public participation. Woodburn's current water conservation program includes:

- Leak detection and water line repair and upgrading.
- Annual water audit to calculate the amount of unaccounted-for water.
- Metering of all service connections.

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The following additional water conservation measures are recommended for the Woodburn system:

- A public education program using bill inserts to publicize the need for water conservation.
- Technical assistance measures including a bill showing the consumption history and customer assistance for questions related to water conservation.
- Incentives such as the distribution of water-saving devices including shower flow restrictors, toilet tank water displacement bags, and leak detection dye tablets.
- Promotion of conservation for nurseries and park department facilities and low water demand landscaping in all retail customer classes.
- Increasing Block Structure and/or Seasonal Pricing for water rates.

It is expected that a moderate conservation program could reduce demands between 5 and 8 percent. An approximate 8% reduction in water demand as the result of conservation efforts, would reduce 2020 demands to approximately 4.13 mgd for ADD and 9.50 mgd for MDD.

1.4 STORAGE AND FIRE FLOW REQUIREMENTS

The City currently has one 750,000 gallon elevated storage tank that maintains system pressures and provides equalizing and fire flow reserve storage. For a system the size of Woodburn, this tank does not provide adequate storage capacity in the Woodburn system. It is recommended that the City construct an additional 4.4 million gallons of water storage over the next 25 years. The storage reservoirs will be ground level reservoirs located at the proposed water treatment plants. Pumps will be used to move the water into the distribution system and maintain pressure. Diesel powered generators or diesel powered pumps will provide emergency pumping capabilities. The first tank will be constructed in 2002 and will make up a significant portion of the storage deficiency.

Water storage in a distribution system consists of 3 parts: 1- equalizing storage, 2- fire flow reserves, and 3- emergency standby storage. Equalizing storage provides water supply when the demand exceeds the production capacity of the system. Fire flow reserve is the volume of water required to provide the fire flow demand for the duration of the fire. Emergency standby storage is water used to supply the city when a portion of the production system is out of commission. This is usually due to either natural disasters such as earthquakes or floods, or subsequent power outages associated with natural disasters. Fire flow reserve will be considered to be a part of the emergency standby storage for the Woodburn system. The recommended storage volumes required for the Woodburn system by the year 2020 are illustrated in Figure 1-2. Estimated costs for the proposed water storage reservoirs are listed in Table 1-2.

Figure 1-2
Woodburn Water Master Plan
Storage Volume Breakdown - Year 2020

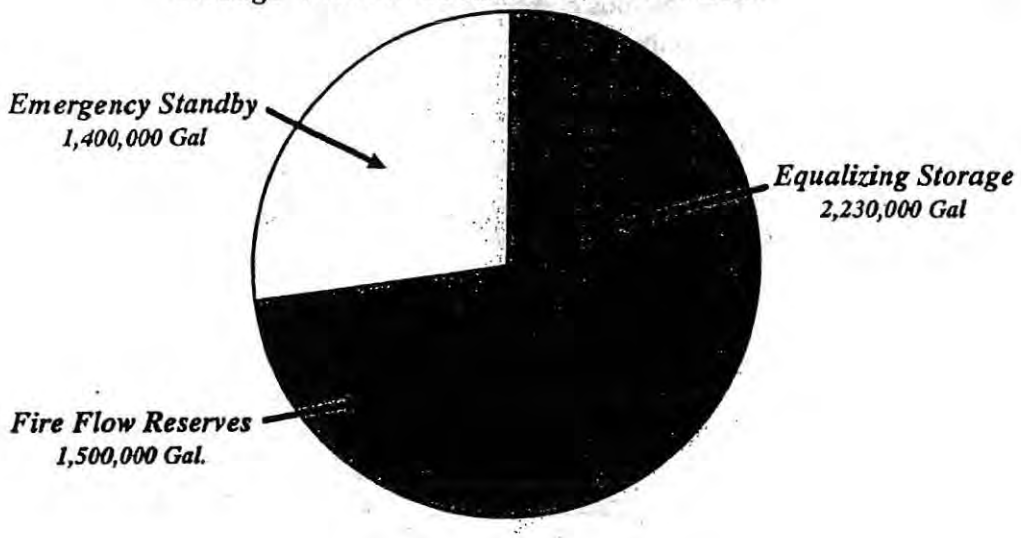


TABLE 1-2 WOODBURN WATER MASTER PLAN WATER RESERVOIR ESTIMATED BUDGETARY COSTS			
Project No.	**Description**	**Project Year**	**Const. Cost (1996 Dollars)**
WT-1	2.2 MG Reservoir at Well 10 Treatment Plant with attached booster pump station	2002	$1,900,000
WT-2	2.2 MG Reservoir at Centennial Park Treatment Plant with attached booster pump station	2010	$1,900,000

1.5 WATER QUALITY AND TREATMENT ISSUES

The key water quality issues facing the City of Woodburn that may drive the system to treatment include:

- Iron and Manganese which exceed the Secondary Maximum Contaminant Levels (SMCL).
- The possibility of the Groundwater Disinfection Rule requiring disinfection.
- Arsenic levels that may be above the proposed new regulations.

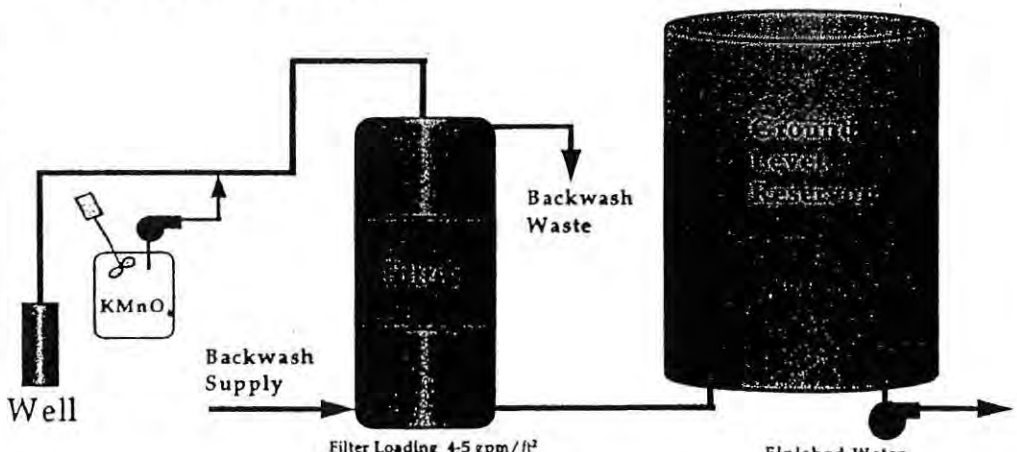
Currently the City of Woodburn provides no water treatment of any kind or disinfection for their system. Generally speaking, Woodburn's water is excellent quality. It is characterized as being moderately hard and well buffered. The water has very low organic content that will not be a problem if the City is required to disinfect the water at some point. The pH of the water is above 7.5 and the City is in compliance with the Lead and Copper Rule. Woodburn is in compliance with the parts of the Safe Drinking Act that are currently in force and apply to the City.

Iron and Manganese: Iron at levels from 0.4 to 2.1 mg/l and manganese at levels of 0.3 to 0.6 mg/l both exceed the SMCL. Secondary contaminants are not a threat to the public health but are a nuisance due to aesthetics. Woodburn receives numerous complaints about the water quality due to the elevated levels of iron and manganese found in the water. Iron and manganese will stain plumbing fixtures and laundry, they will cause turbidity in the water after exposure to the atmosphere, and are linked to taste and odor problems. Oxidized iron and manganese will accumulate in the distribution system piping and will be mobilized during hydrant flushing, fire flow events, or other high flow velocity episodes. Once mobilized, the metal oxides will show up at customer taps as rusty or black water that is not aesthetically pleasing yet it does not pose a health threat.

To eliminate the iron and manganese problem, the City will have to construct treatment plants that will oxidize and then remove the metal on a mixed media filter. After evaluating all of the available technologies for the removal of iron and manganese, four processes were selected for cost estimation and detailed evaluation. These alternatives included: 1- potassium permanganate ($KMnO_4$) oxidation and pressure filtration; 2- Prechlorination, $KMnO_4$ oxidation and pressure filtration; 3- ozone oxidation and pressure filtration; and 4- biological filtration. The recommended treatment process is $KMnO_4$ oxidation followed by pressure filtration. This process was selected for its economic advantages, it proven technology for the removal of iron and manganese, its ease of operation, and its flexibility. This process is illustrated in Figure 1-3.

Since no treatment plants exist in the Woodburn system, determining how many plants to construct and where these plants should be located was a significant part of the evaluation process. Three alternatives were considered: 1- one centralized treatment plant located in the northeast part of the

Figure 1-3
Woodburn Water Master Plan
$KMnO_4$ with Filtration



City; 2- two neighborhood treatment plants, one in the northeast corner of the City and one in the southwest corner of the City; and 3- five wellhead treatment plants located at Wells 7, 8, 9, 10, and in the southwest corner of the system. Well 11 will be treated at the Well 9 treatment plant, the Well 7 plant will provide treatment for a new 1,000 gpm well located on the west side of I-5, and the plant in the southwest corner of the City will provide treatment for 3 new each 1,000 gpm wells. Evaluating each alternative with respect to construction cost, phasing capability, operation and maintenance cost, raw water transmission main costs, and impacts to the distribution system, it is recommended that two treatment plants be constructed in the Woodburn system.

The first treatment plant will be constructed in the year 2002 and will be located at Well 10. This plant will have a design capacity of 4.8 MGD and will treat water from wells 8, 9, 10, and 11. These wells are good producing wells with poor water quality. A 2.2 million gallon ground level reservoir will be a part of the treatment facilities. It is noted that when the plant is constructed, the average day demand will be 2.45 MGD and the maximum day demand in the system will be 5.62 million gallons per day which exceeds the plant capacity. Untreated water will have to be pumped into the system straight from the wells to meet peak demands until the second treatment plant is constructed in 2010. Plant No. 2 will have a capacity of 5.6 MGD and will provide treatment for Well No. 7 and the four new 1,000 gpm wells. A second 2.2 million gallon ground level reservoir will be constructed as a part of the treatment facilities.

Budgetary level cost estimates for the treatment facilities are listed in Table 1-3:

Table 1-3
Woodburn Water Master Plan
Treatment System Summary of Budgetary Cost Estimates

Treatment Component	Year of Improvement	Estimated Costs (1996 Dollars)
Raw Water Transmission Pipelines	2002	$2,270,000
Upgrade and Restoration of Existing Wells	2002	$294,000
4.8 MGD Plant at Well 10	2002	$4,920,000
Raw Water Transmission Pipelines	2010	$1,598,000
Upgrade and Restoration of Existing Wells	2010	$74,000
5.6 MGD Plant at Centennial Park	2010	$5,750,000

Currently the City is not required to disinfect the groundwater source. Parts of the Safe Drinking Water Act (SDWA), namely, the Total Coliform Rule (TCR) and the proposed Groundwater Disinfection Rule (GDR), may change this requirement at some point and the City should consider this in any proposed treatment scheme. If the Groundwater Disinfection Rule is enacted, the City would be required to provide primary and secondary disinfection. Primary disinfection is the elimination of any pathogenic organisms from the water. Secondary disinfection is providing a long term disinfectant residual in the system to kill any problem organisms that may enter the distribution system.

The City can not implement disinfection without implementing treatment for the removal of iron and manganese. Chlorine or ozone, both strong oxidants, will oxidize the iron and manganese in

the water and exacerbate the color and aesthetics problems the City is already experiencing due to the iron and manganese. Conversely, if Woodburn utilizes a primary disinfectant in the treatment process, i.e. chlorine or ozone, they will be obligated to provide a secondary disinfectant in the distribution system. The selected treatment process, $KMnO_4$ oxidation followed by filtration does not use a primary disinfectant and therefore secondary disinfection is not provided in the process.

Disinfection processes considered included chlorine, ozone, chloramines, chlorine dioxide, and UV light. After evaluating all of the operational and cost components of the various systems, chlorine is recommended for its ease of use and low cost. Chlorine is widely used for disinfection due to the fact that it is inexpensive, it can be used as a primary disinfectant, and it will maintain a residual in the distribution system. Chlorine can combine with organic matter in the water to produce disinfectant byproducts that are regulated by the Safe Drinking Water Act. Due to the low organic matter found in the Woodburn water, disinfectant byproducts are not anticipated to be a problem. It is estimated that providing disinfection to the treatment plants would cost $100,000.

During 1993 and 1994, Woodburn had non-acute violations of the Total Coliform Rule (TCR). Woodburn conducted an investigation of the source of the contamination problem, flushed and superchlorinated waterlines in the problem areas, and switched coliform testing methods from the MMO-MUG test to the multiple tube fermentation (MTF) test method. No contamination was found in the wells, so the source is out in the distribution system. After completing this work and switching methods for coliform testing in 1994, only two samples have tested positive for total coliform; one repeat sample in November 1994, and one sample in October 1995. No definite source of the contamination problem has ever been identified in the Woodburn System. It is recommended that Woodburn continue their diligent efforts to control the non-acute violations with the TCR through operational changes and cross connection control.

Arsenic has been detected in one of the abandoned wells in the Woodburn water system at concentrations up to 31 µg/L. This is below the current MCL of 50 µg/L, but above the anticipated future MCL of between 2 to 15 µg/L. Arsenic is lower in the operating wells, however the City must be diligent in monitoring the levels of arsenic in the water to ensure that they meet the regulations. Arsenic would be removed gratuitously with treatment for the removal of iron. During pilot testing of the proposed iron removal process, the arsenic levels will be monitored to determine if they will be a problem that must be addressed.

1.6 DISTRIBUTION SYSTEM

To evaluate the distribution system, a computer model was developed as a part of this Water Master Plan. The software package Cybernet, produced by Haestad Methods was used in conjunction with the City's water system map in AutoCAD to develop a model data base. The model was calibrated using field tests and pressure readings. Once the model was calibrated, average and maximum day demands for both 1996 and the year 2020 conditions were modeled. Results from the computer analysis indicate that during both the average day and the maximum day demand, typical service pressures range from approximately 50 psi to 60 psi and the system does not have significant deficiencies.

Available fire flows were calculated at five locations throughout the system using the model. Based on the recommended minimum requirements for fire flow, current water demands, and projected future demands, in the current distributed well configuration, the distribution system can generally provide the required fire flow throughout the system. It is recommended that the City use the computer model in evaluating system expansions, development proposals, and other work in the system to ensure that adequate fire flow is provided to all areas of the system. Fire flow capabilities also need to be recognized and considered when approving building type and occupancy in all areas of Woodburn.

Construction of water treatment facilities and the centralizing of the water supply to the distribution system will alter the hydraulics of the distribution system. Rather than the distributed supply system that exists now with the wells pumping directly into the system, supply to the system will be centered around the treatment plants. In evaluating the treatment plant locations, the impact on the distribution system was studied using the computer model to determine what and if any improvements would be required in the system due to particular treatment plant locations. The required piping system improvements, for each treatment plant location is illustrated on the system maps included in this Water Master Plan. The recommended improvements to the distribution system are listed in Table 1-4.

TABLE 1-4
WOODBURN WATER MASTER PLAN
DISTRIBUTION SYSTEM IMPROVEMENTS AND ESTIMATED COSTS

Project No.	Description	Project Year	Const. Cost (1996 Dollars)
FF-1	Install 60 feet of 10-inch pipe to cross Boones Ferry Road to tie system together	1998	$9,000
FF-2	Install 810 feet of parallel 8-inch pipe to increase capacity on State Highway 214	1998	$93,000
FF-3	Install 850 feet of parallel 10-inch pipe to increase capacity	2005	$122,000
FF-4	Install 200 feet of parallel 10-inch pipe to increase capacity	2005	$29,000
WS-1	Install 990 feet of 16-inch pipe to improve the flow from the treatment plant area to west of I-5	2000	$227,000

The existing telemetry and control system is over 30 years old and it is recommended that it be upgraded to conform to current industry standards. Modern computerized control, monitoring, and data storage and reporting systems will allow the operators to optimize the system and provide the City with high quality of water service. Woodburn is in the process of upgrading their wastewater treatment plant and a new SCADA system will be developed for this new facility. The proposed treatment plants will use this system and will expand its function and abilities. Remote monitoring and control, modem connections to wells, treatment plants, reservoirs, and pump stations will allow the operators the freedom to operate the system from home via laptop computer hookup. This will reduce operator hours and improve system performance while ensuring a high quality water is delivered to the public.

1.7 CAPITAL IMPROVEMENT PLAN

All of the projects identified during the preparation of this Water Master Plan and listed in the tables in this Chapter, were entered into the Capital Improvement Plan (CIP). The CIP schedules and prioritizes the projects and improvements over the next 24 years. Tables 12-1, 12-2 and 12-3 list all of the recommended projects listed by type, year of construction, and classification respectively. The total present worth of the CIP is over $15,560,000 and includes transmission piping, distributions system improvements, treatment plants, reservoirs, and new wells. To ensure that Woodburn residents continue to receive a high level of water service, it is recommended that the City adopt this CIP and work toward completing the recommended projects as scheduled.

To adjust and conform to changing conditions, it is recommended that the City regularly evaluate the system performance and the CIP projects at a minimum of once every five years. This will allow projects to be modified, projects to be added, and projects to be deleted as the City grows and develops into the 21st century.

1.8 FINANCIAL PLAN

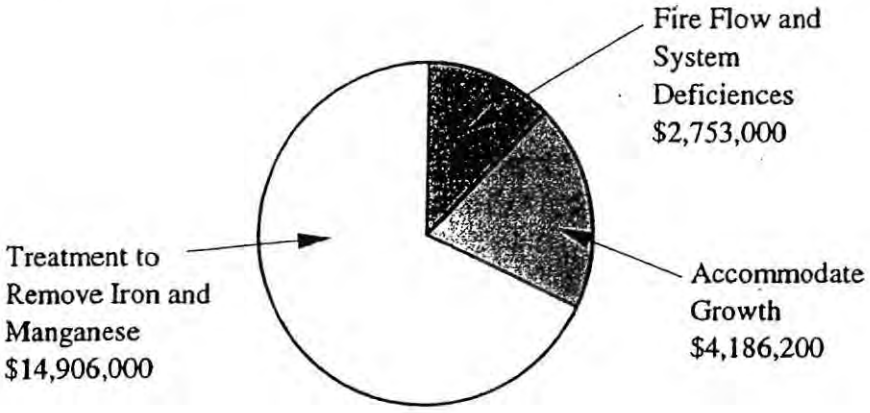
The City's financial audits indicate that during the last five years, the following ranges of revenues and expenditures were experienced:

- Revenues (excluding interest): $863,000 to $1,190,000
- Total expenditures: $598,000 to $1,000,400
- Net income (excluding interest): $185,000 to $382,000
- Net income (excluding interest) and eliminating capital expenditures: $265,000 to $450,000, with an average of approximately $372,000

The last rate increase, which was approximately 15%, occurred in 1992. Based on a review of Woodburn's financial status over the last five years, it is recommended that Woodburn consider a full water rate study. An evaluation of the estimated costs of the recommended improvements and the capital currently viable for financing those improvements, the City will have to develop sources of funding for the projects to allow them to be constructed as scheduled.

Since Woodburn will be experiencing significant growth over the next twenty years, it is recommended that the City establish the necessary fee structure to allow them to adequately charge for improvements to their system that result from development and growth. Such fees as developers extension fees, connection fees, or general facilities fees should be evaluated to spread the costs of improvements to the right sources. Figure 1-4 illustrates the breakdown of the proposed improvements by 1- Improve fire flow and correct deficiencies; 2- Accommodate growth; and 3- provide treatment to remove iron and manganese.

Figure 1-4
Woodburn Water Master Plan
Breakdown of Costs for CIP
(1996 Dollars)



1.9 PLAN IMPLEMENTATION

Implementation of this Water Master Plan should proceed through the following steps:

1. Adopt this Water Master Plan by City Council Resolution.
2. Submit the plan to the Oregon Health Department for review and approval.
3. Proceed with the development of a Wellhead Protection Plan.
4. Start the process of pilot testing and evaluating the proposed treatment process.
5. Start the implementation of the Capital Improvement Plan as outlined herein.
6. Authorize a full water rate structure study to develop sources of project funding.
7. Update and review the recommendations of this plan at least every 5 to 7 years.

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CHAPTER 2
INTRODUCTION

2.1 BACKGROUND

The City of Woodburn has been supplying city residents for decades with water with no treatment and no disinfection. Changes in the water regulations over the last 10 to 15 years, continued customer complaints about water quality, anticipated regulations that will impact the Woodburn system, and anticipated significant growth have all pointed toward the need for a Water Master Plan. A plan is needed to allow the City to:

- ensure that the water supply system will satisfy all public requirements,
- water quality will comply with the changing regulations,
- the distribution and storage system will provide reliable fire protection in the system,
- and the water system can be expanded to economically meet future needs.

This master plan will be the first Water Master Plan developed by the City of Woodburn. The Woodburn Water Division, operating under the direction of the Public Works Department, currently supplies water to approximately 18,500 part time and full time residents. It is estimated that the City will more than double in size over the course of the next 25 years.

2.2 AUTHORITY, MANAGEMENT AND BUSINESS LOCATION

The City of Woodburn has the responsibility and authority to plan for and to provide water services to its customers within its boundaries. The Water Division operates under the jurisdiction of the City Council of the City of Woodburn. The City Council has final say in setting policy and making planning decisions for the Woodburn water system.

The day to day operation of the Water Division is headed up by the Director of Public Works, with direct supervision by the Public Works Program Manager. The Engineering Department provides technical expertise and guidance and day to day operations are handled by the field operations staff. The water engineering and operations staff respond to complaints, make system repairs, and monitor construction projects for the City.

The Water Division offices are located at:

City of Woodburn
City Hall
270 Montgomery Street
Woodburn, Oregon 97071
(503) 982-5245

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2.2 PURPOSE

This Water Master Plan will look at the whole system to determine how to best meet the water needs of City residents as the City grows and develops. The plan will incorporate current growth projections to estimate the quantity of water required over the next 25 years. This plan will evaluate the impact of current and projected Federal drinking water regulations on the City of Woodburn. Water quality characteristics will be assessed and treatment objectives will be developed to meet the regulations and public demand for a high quality drinking water. Using the treatment goals, processes will be studied and developed that will meet these treatment goals. Budgetary cost estimates will be prepared, phasing of projects will be considered, and operations and maintenance characteristics will be evaluated in the recommendation of a treatment system.

A computer system model will be developed to study the distribution system and determine what if any deficiencies exist in the system. The model will identify pipes that are causing restrictions in the system, it will provide sizing information for proposed pipe extensions, and it will pin point any areas where pressures may be a problem. Once developed, the City engineering staff will use the computer model on a regular basis to evaluate the impact of proposed water system improvement projects.

This Water Master Plan will look at the water storage in the system and its ability to provide fire protection and emergency supply. Protection of the public is a vital part of a water system and recommendations will be made on the Woodburn storage systems ability to meet the required demand.

The Water Master Plan will report on the financial status of the water system and the operations and maintenance of the system. The Water Divisions' ability to finance the recommended projects will be critical to the implementation of the Plan. Operations and maintenance procedures will be itemized and outlined to establish the current system status and methods.

The overall purpose of this Water Master Plan will be to develop a guide that can be used by the City to efficiently and effectively plan for and meet growth needs, regulations, and treatment objectives within the water system for the next 25 years.

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CHAPTER 3
PLANNING DATA INFORMATION

3.1 EXISTING/FUTURE SERVICE AREA

The Woodburn service area is defined as the area within the city limits. With the exception of approximately 10 units, residents outside the city limits but within the urban growth boundary (UGB) are not serviced by city water.[1] The current service area includes approximately 3285 acres within the Woodburn city limits. The UGB includes 4110 acres. The city of Woodburn services approximately 18,504 full- and part-time residents.

It was assumed for this report that the UGB will remain constant during the planning period and that all growth will occur within the UGB. Expansion of the city limits and service area to the UGB will be expected as areas are developed according to their zoned uses. Industrial expansion will occur in the northeast, southeast and southwest. Commercial development will occur along major thoroughfares and residential expansion is expected in the north and south areas of the city. Buildout of underdeveloped areas in the city is also expected.

3.2 SERVICE AREA CHARACTERISTICS

Woodburn is located in Oregon's Willamette Valley approximately 17 miles north of Salem and 30 miles south of Portland in the Pudding River basin. The topography of the service area is relatively flat, sloping slightly to the northeast with an elevation range of 150 to 200 feet above sea level. The service area drains through Mill Creek and the Pudding River. Senecal Creek drains a small portion of the service area west of I-5. There are no other physical formations of significance in the city. The climate is mild with wet winters and dry summers.

The soils in the area are of two associations, Amity silt loam and Woodburn silt loam. Both of these formations are found throughout the city in all areas except drainage channels. The Amity series consists of poorly drained soils formed in mixed alluvial silts. The layer is generally 17 inches thick overlaying a 7-inch silt loam subsurface layer and a 13-inch silty clay loam subsoil. The Woodburn series consists of moderately well-drained soils formed in silty alluvium and loess. The 17-inch surface layer overlays 37 inches of subsoil and a silt loam substratum to a depth of 68 inches. The course of Mill Creek is etched in Bashaw clay and Dayton soils and terrace escarpment are also found in the service area.

The geology of the study area consists of Troutdale formation materials and Willamette silts overlying Columbia River basalt. Depth to basalt is unknown but thought to be approximately 600 feet. The Troutdale formation consists of alternate layers of clay, silt, sand and gravel. The Willamette silt formation consists of stratified silt, sandy silt, clayey silt and silty clay and has poor drainage characteristics. (Wastewater Facilities Plan, 1995) The city is located in a

[1] From discussions with city staff.

Seismic Zone 3. All structures associated with the water system will be considered essential facilities according to the Uniform Building Code.

Currently the city's source of water supply is the Troutdale aquifer. City wells extend to depths of 186 to 333 feet. Well yields range from 400 to 1200 gpm.

3.3 SERVICE AREA AGREEMENTS

The following summarizes the agreements that have been initiated that are related to the City of Woodburn Water System:

Agreement Between Birdseye Division, General Foods Corporation (Agripac) and the City of Woodburn

This agreement, dated April, 1971, is for the City to provide the facility with unmetered water to their fire sprinkler system in exchange for the facility supplying the City with water from its well should it be needed during a fire emergency. The agreement, originally with Birdseye was transferred to Agripac when they purchased the facility.

3.4 SERVICE AREA POLICIES

The following summarizes the policies/ordinancesthat have been adopted relating to the Woodburn water system:

Woodburn Resolution 1097

This resolution establishes the current water rates for the City.

Woodburn Ordinance 1515

This ordinance provides for the payment of costs of extending water or sewer service lines by the property owner who benefit from the extensions.

Woodburn Ordinance 1866

This ordinance establishes regulations and rates for the city water system. It defines the service provided, discusses meter policy, sets fees, charges and rates and discusses discontinuance of service. It establishes general policy items such as damage to City property, source development, cross connections, access and water conservation.

Woodburn Ordinance 2070

This ordinance, dated September, 1991, establishes the current System Development Charges for the City of Woodburn as authorized by ORS 223.297-223.314.

3.5 STATE LEGISLATION/REGULATIONS/GUIDELINES

The following describes legislation that has been enacted by the State of Oregon, regulations and guidelines that are applicable to water supply planning.

ORS 448.115 - 448.285 Oregon Drinking Water Quality Act

This legislation, enacted in 1981, sets forth the mechanism for the state of Oregon to administer the federal Safe Drinking Water Act. It authorizes the Health Division to administer the legislation. The stated purpose of the legislation is to:

- Assure all Oregonians safe drinking water
- Provide a simple and effective regulatory program for drinking water systems
- Provide a means to improve inadequate drinking water systems.

It establishes the jurisdiction of municipalities, defines penalties and operator certification requirements.

ORS 197 Comprehensive Land Use and Planning Coordination

This legislation requires comprehensive land use planning within the state and gives authority to local governments to conduct the planning. It also requires coordination of planning efforts.

ORS 215 and 227 County and City Planning Authority

This legislation establishes and defines the authority of counties and cities to conduct local planning.

ORS 536.220-536.360

This statute establishes the need for a statewide integrated, coordinated water resources policy and authorizes the Water Resources Department to administer it.

Oregon Administrative Rules - Chapter 333, Division 61

This document, dated January, 1996, provides the basis for implementing the Oregon Drinking Water Quality Act of 1981 as required in ORS 448.131.. The Chapter sets forth responsibilities of water suppliers, establishes maximum contaminant levels and treatment and performance standards for water supplies. It also establishes sampling and analytical, reporting and record keeping and public notice requirements. It outlines permit requirements, construction standards and land use coordination requirements. Operation and maintenance and product standards are also addressed.

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Oregon Administrative Rules - Chapter 660, Division 11

The purpose of this rule is to implement ORS 197.712(2)(e) which requires that a city or county shall develop and adopt a public facility plan for areas within a urban growth boundary. The purpose of the plan is to ensure that urban development is guided and supported by appropriate types and levels of facilities and services and that the facilities are developed in a timely manner. The division contains definitions relating to a public facility plan, procedures and standards for developing, adopting and amending such a plan, the date for submittal of the plan and standards for review.

Oregon Administrative Rules - Chapter 660, Division 31

The purpose of this rule, entitled "State Permit Compliance and Compatibility," is to specify state agency responsibilities for goal compliance and comprehensive plan compatibility for agency land use programs which involve the issuance of state permits.

3.6 ZONING/LAND USE

Figure 3-1 shows land uses within the UGB. The land uses shown on Figure 3-1 are based on current zoning designations and indicate types of activities that are currently authorized on the property. Approximately 17 percent of the city is zoned for multi-family development and 33 percent is zoned for low density, single family development. A total of 50% of the city's area is zoned for residential development. Approximately 12 percent of the land use is designated as commercial and 14 percent as industrial. The industrial area includes the Woodburn Industrial Park located north of Highway 214 and four other areas in the City. Parks and open areas make up approximately 9 percent of the service area. Publicly owned lands comprise 15 percent of the area.

3.7 POPULATION

The population projection for the City of Woodburn is shown in Table 3-1. The population projection shown in Table 3-1 were derived from the Wastewater Facilities Plan (1995). Four forecasts were shown in the Wastewater Plan. They were based on the following:

- Woodburn's highest historical growth rate held constant at 4.2 percent
- Facilities plan growth rate (3.4 percent)
- Woodburn's average historical growth rate
- Portland State University (PSU) Population Research and Census Center projection

The 3.4 percent population growth rate was approved by the Wastewater Advisory Committee and City Council because it was considered to represent a conservative and reasonable projection that is greater than the average historical growth rate but less than the maximum historical growth rate and reflects the high population growth rate projections for the Portland metropolitan area. At the City's direction, the same population projection was used in this plan.

Table 3-1
City of Woodburn Population Forecast

Year	Permanent	Summer Only	Total
1996	16,727	1,777	18,504
2000	19,771	2,100	21,871
2005	23,368	2,482	25,850
2010	27,620	2,934	30,554
2015	32,646	3,468	36,114
2020	38,586	4,099	42,685

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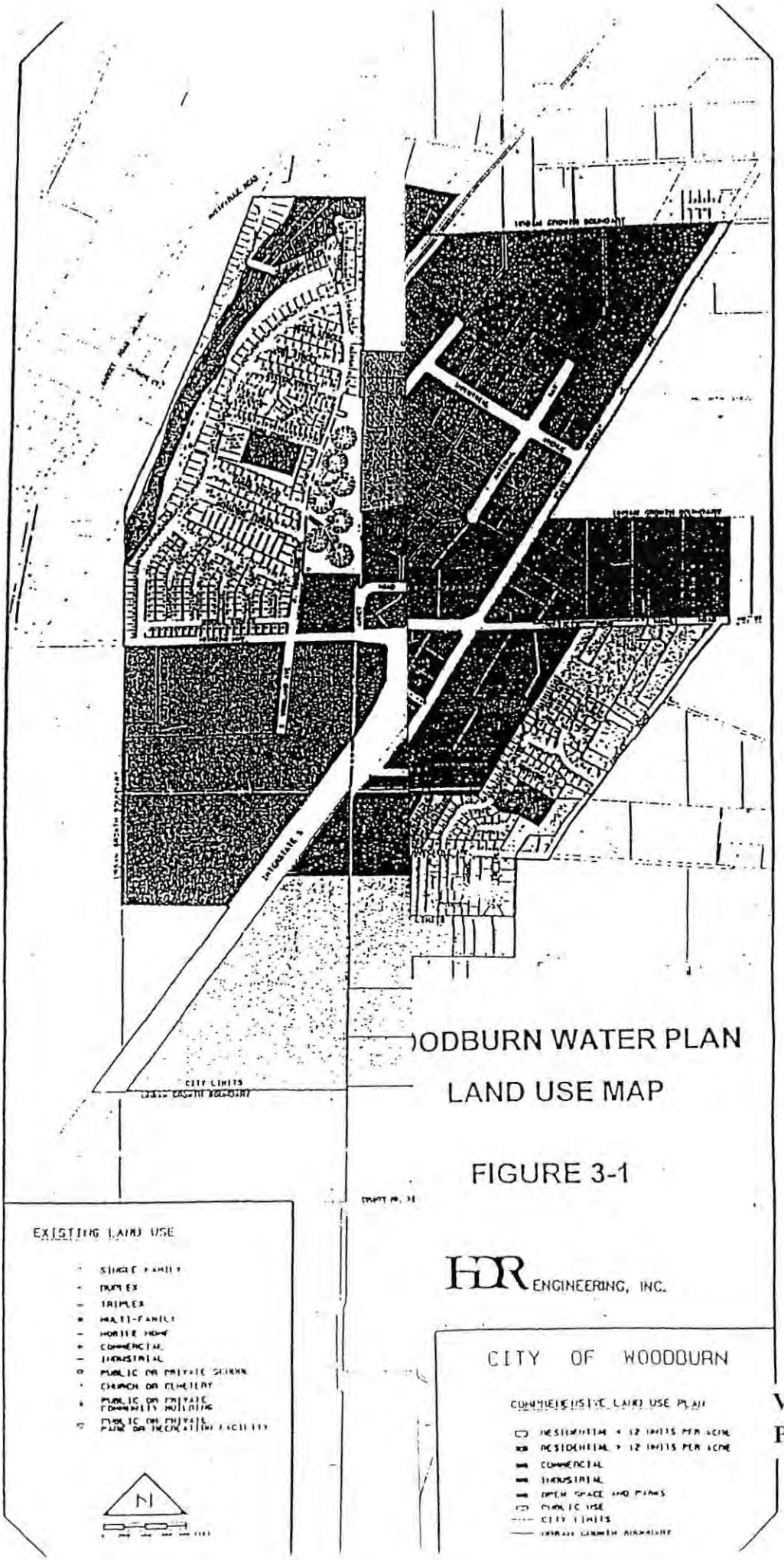

ODBURN WATER PLAN

LAND USE MAP

FIGURE 3-1

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CHAPTER 4
WATER SYSTEM DEMANDS

4.1 INTRODUCTION

This chapter looks at existing and projected water demands for the City of Woodburn. In addition, water conservation measures to reduce future water demands are presented. The water demands are projected for a 25-year planning horizon. The projections are based on the assumption that all growth will be contained within the existing Urban Growth Boundary (UGB) and the current zoning will remain.

4.2 EXISTING SYSTEM DEMANDS

Based on metering records from 1992 to 1995, the average daily water demand (ADD) for the City of Woodburn ranged from 1.6 to 1.8 million gallons per day (mgd). The maximum daily water demand (MDD), which occurred during the summer months, ranged from 3.5 to 4.3 mgd. The values are summarized in Table 4-1. The average ratio of MDD/ADD from pumping records is 2.3. It is reasonable to assume the ratio of MDD/ADD for pumping and demand are the same.

Seasonal variation of water demand is illustrated in Figure 4-1, which shows the average daily demand by month during the period of July 1994 through June 1995. The demand follows the typical pattern of summer highs and winter lows. Superimposed on Figure 4-1, are the ADD and the MDD during the same time period.

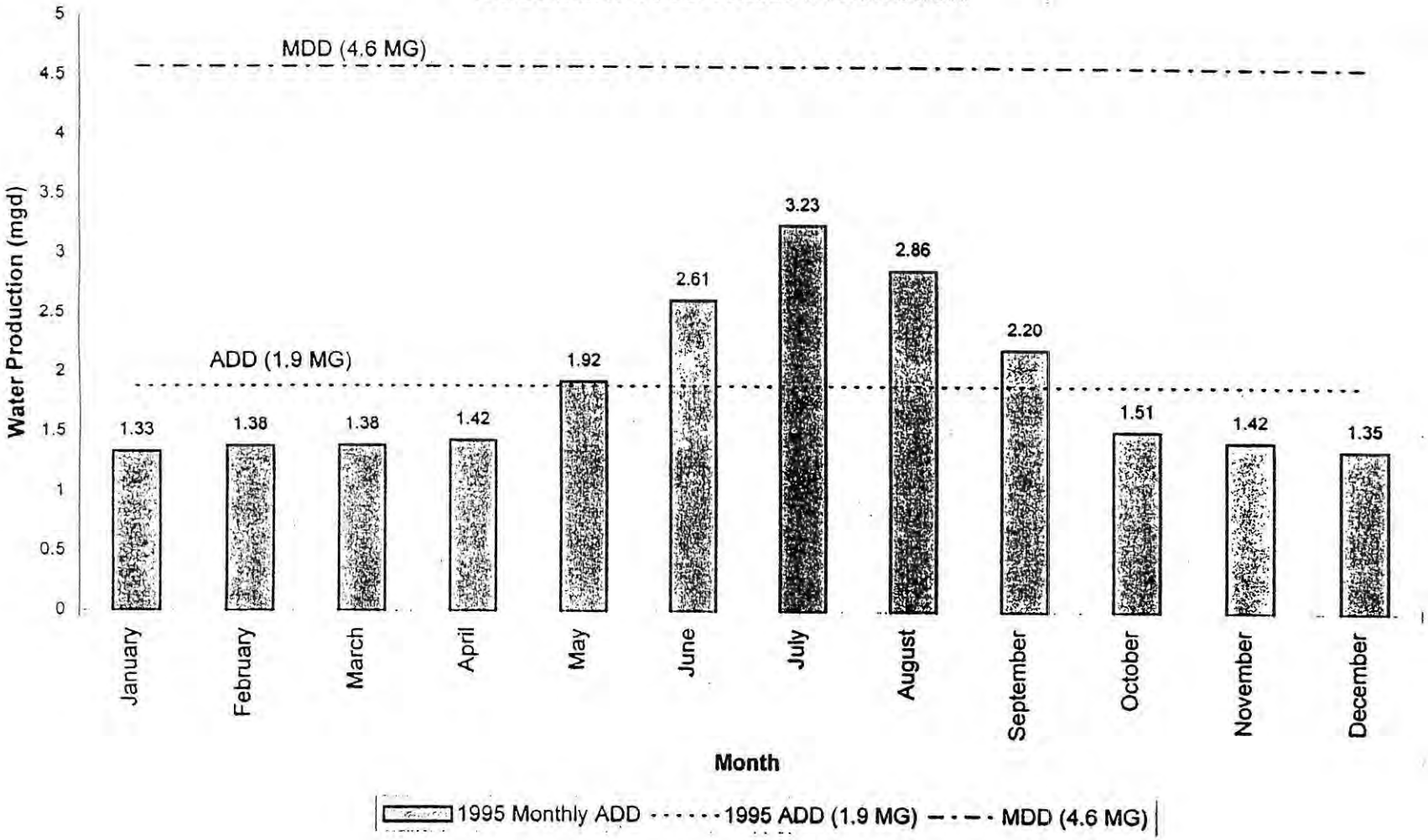
Table 4-1
Woodburn Yearly Water Demand[1]

	Average Daily Demand	Maximum Daily Demand[2]	
Year	MGD	MGD	Month in which MDD Occurred
1992/1993	1.57	3.53	August
1993/1994	1.65	3.83	July
1994/1995	1.78	4.34	July

[1] Based on metering records.
[2] Based on ratio of MDD/ADD from pumping records.

There are no specific historical data available to determine the ratio of the maximum instantaneous system demand (MID) to the ADD. The maximum peak hour demand generally occurs during the evening dinner hours at typically 170 percent of the average demand for that day. During a maximum day, this demand would, therefore, be approximately 2.3 times 1.7 or 3.9 times the ADD. For this master plan analysis, a MID/ADD factor of 3.9 was used.

Figure 4 - 1
Woodburn 1995 Water Production



4.3 DEMAND CATEGORIES

System demands were categorized by single-family, multi-family, commercial and industrial. The utility bill data base provided information regarding the number of connections in each category. All of Woodburn's service connections are currently metered. Included in Table 4-2 are the total demand by category, the total number of connections (in 1996) per demand category, unit demands for each category, and the percent of the total demand per category.

Table 4-2
Woodburn Existing Water Demand Per Demand Category

Demand Category	Total Demand (gpd)	No. of Connections[1]	Unit Demand[2,3] (gpd/connection)	Percent of Total Demand (%)
Single Family Residential	1,098,000	4,176	266	62
Multi-residential	310,400	127	2,440	17
Commercial	315,800	386	820	18
Industrial	520	3	173	0.03
City Owned	38,300	56	697	2
Fire Service	1,300	53	26	0.07
Other (Flushing)	13,800			0.08
Total	1,778,000	4801	--	100

(1) As of April 1996.
(2) Based on number of connections in June 1995 and demand from June 1994 through June 1995.
(3) gpd = gallon per day.

The unit demand per single family residence was approximately 266 gpd/connection. The unit demand per multi-family connection was calculated as 2,440 gpd/connection. The number of multi-family dwelling units per unit connection varies significantly, from 2 to 192, with an average of 23.4 units per connection (excluding duplexes) and a median of 12. The estimated per capita water demand based on a 1995 full-time residential population of 16,727 and a part-time residential population of 1777 and the 1995 ADD of 1.8 mgd is 97 gallons per capita per day (gpcd).

As indicated on Table 4-2, residential water demand accounts for about 80 percent of the total water demand. Commercial water demand accounts for 18 percent. City connections account for the remaining 2 percent of the water demand. Less than one percent of the water demand comes from the industrial and fire service categories.

Fire flow places a high demand on the system for a relatively short period of time. Fire flow requirements must be added to the calculated service demands presented in this chapter. Fire flow demands are discussed in Chapter 6.

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4.4 UNACCOUNTED-FOR WATER

Unaccounted-for water results from unmetered demands, meter inaccuracies, leakage, hydrant and line flushing and testing, and authorized or unauthorized hydrant use. Typical water systems can average from 5 to 10 percent unaccounted-for water.

Woodburn conducts annual audits of pumping and water consumption records to measure its unaccounted-for water. A comparison of the past 10 years data, summarized in Table 4-3, shows the unaccounted-for water in Woodburn to range from 5 to 11 percent of production with a median and average of 8 percent. To minimize unaccounted-for water, leaking pipelines have priority replacement in Woodburn's distribution system maintenance budget. Unaccounted-for water in the City of Woodburn appears to be reasonable, and no special corrective action is recommended.

Table 4-3
Woodburn Unaccounted For Water

Year	Unaccounted for Water	
	MG	Percent
1994 - 95	56.6	9
1993 - 94	55.3	8
1992 - 93	64.4	10
1991 - 92	86.3	11
1990 - 91	50.4	8
1989 - 90	67.0	11
1988 - 89	50.1	8
1987 - 88	30.9	5
1986 - 87	31.0	5
Average	**54.7**	**8**

4.5 WATER CONSERVATION PROGRAM

Water conservation requirements for cities pursuing additional water rights have been established by the Oregon Department of Water Resources (ODWR). The basic philosophy of the requirements is that in looking at a range of water supply options, a utility must include water conservation measures as a water supply option. Water conservation measures can be used to reduce both overall demand and peak demand. Conservation measures include both demand side strategies, which lessen the demand, and supply side strategies, which supply the demand through an alternative source or through a more efficient system. Water conservation measures are grouped into four categories:

- Public Education
- Technical Assistance
- System Measures
- Incentive/Other Measures

Woodburn's current water conservation program includes:

- Leak detection and water line repair and upgrading
- Annual water audit to calculate the amount of unaccounted-for water
- Metering of all service connections

The following water conservation measures are recommended for consideration:

Public Education

The ODWR requires some type of public information program to publicize the need for water conservation. Options may include television and radio public service announcements, news articles, and public water system bill inserts. It is recommended that Woodburn implement this measure through bill inserts. The AWWA has pre-printed brochures with which can be used as bill inserts.

Technical Assistance

Bill Showing Consumption History
In this conservation measure, the customer's water bill lists the percentage of increase/decrease of water use for a time period compared with the same period in the previous year. This technique has been used successfully by electric utilities.

Customer Assistance
This includes responding to customers questions related to water conservation. Woodburn could implement this measure through appointing a current staff member to become a specialist in water conservation, who could address customer concerns or questions which may develop.

System Measures

Limit Unaccounted Water/Leak Detection
This measure involves a regular and systematic program of finding and repairing leaks in system mains and laterals. A water audit is a mandatory conservation measure of the ODWR. Woodburn's current water conservation program includes both a leak detection and water line repair and upgrading program and an annual water audit.

Require Meters
This measure involves the installation of meters for all service connections. The ODWR requires that all connections be metered. Woodburn has metered all service connections. The City should maintain their periodic meter testing and repair program.

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Incentives/Other Measures

Single-Family/Multi-Family Kits

Kits are distributed which contain easily installed, water-saving devices to single-family residential homes and the owners and managers of apartment buildings and condominiums. Devices in the kits include shower flow restrictors, toilet tank water displacement bags, leak detection dye tablets, and an informational brochure.

The toilet tank displacement bag lessens the amount of water used to flush by holding a small amount of water out of use. Non-conserving toilets equipped with tank displacement bags use 4.8 gallons per flush versus 5.5 gallons per flush for a non-conserving toilet without a tank displacement bag.

Part of the National Energy Policy Act of 1992 governs water fixtures and requires water saving plumbing fixtures for new construction. Existing fixtures do not have to be removed, but new construction must include water fixtures which meet the requirements. This regulation requires a maximum flow 2.5 gpm from a shower head (a "low flow" shower head).

Nurseries/Agriculture

This technique includes the application of current technology to water use practices of large agriculture/irrigationoperations, such as nurseries and park department facilities. The practices include moisture sensors, flow timers, low volume sprinklers, drip irrigation, and other practices to increase irrigation efficiency.

Landscape Management/Playfields

In this technique, low water demand landscaping in all retail customer classes (private, public, commercial, industrial, etc.) is promoted. Local nurseries are encouraged to ensure the availability of plants that achieve this objective.

Increasing Block Structure and/or Seasonal Pricing

Water conservation can be encouraged by increasing the unit price of water as consumption increases (an increasing block rate or inverted block rate) and seasonal pricing, in which the unit price of water is increased during the high seasonal use period (the summer months for Woodburn). With this structure, the customer is more conscious of the quantity of water consumed which may encourage water conservation.

Woodburn currently charges a flat unit rate up to a basic quantity, then a lower unit rate for quantities above the basic quantity. The ODWR requires that systems evaluate the feasibility of an increasing block and/or seasonal rate structure, although implementation of this rate structure is not required.

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Program Effects on Demand

It is expected that a water conservation program for Woodburn would have some measurable effects on system demand. A 15 percent reduction in residential water use over a 10 year period has been indicated as a goal for a utility conservation program which involves plumbing code changes for new construction, an aggressive fixture retrofit program and a landscape water conservation program. It is expected that a moderate conservation program would reduce demands between 5 and 8 percent over the ensuing 10 year period.

4.6 PROJECTION METHODOLOGY

The population forecast for Woodburn is shown in Table 3-1. Projected water demands were based on the population projection and per capita demands. This approach assumes commercial and industrial demand growth rates of 3.4%, the same as the population growth rate. The Woodburn Wastewater Master Plan (1995) projects a commercial flow growth rate of 3.4% and an industrial flow growth rate of 0.5%. Since the industrial component of the water demand is very small, the difference made by this simplifying assumption will be negligible.

4.7 FUTURE DEMAND PROJECTIONS

Projected water demands at five year increments through 2020 are summarized in Table 4-4. Water projections were made assuming two water conservation impact scenarios. They include a "no impact" scenario, in which water conservation measures fail to reduce the per capita water demand, and a "moderate impact" scenario in which the reduction achieved from conservation measures is 8 percent. It is assumed that the 8 percent reduction is accomplished linearly over a 10 year period beginning with program implementation in 1997 and resulting in an ultimate reduction of per capita water demand to 90 gpcd in 2007. Unit demands are then expected to remain constant through the year 2020.

The MDD was calculated based on the ratio of MDD/ADD of 2.3. The MDD projections for both scenarios are summarized in Table 4-4.

Table 4-4
Water Demand Projections

Year	No Conservation Impact		Moderate Conservation Impact	
	ADD (mgd)	MDD (mgd)	ADD (mgd)	MDD (mgd)
1995	1.78	4.34[1]	1.78	4.34[1]
2000	2.10	4.83	2.05	4.72
2005	2.51	5.77	2.36	5.43
2010	2.96	6.81	2.73	6.28
2015	3.51	8.07	3.23	7.43
2020	4.14	9.52	3.82	8.79

[1] Actual demand

Production requirements are the sum of the demand requirements plus unaccounted-for water. It is assumed that Woodburn will continue their maintenance program and that unaccounted-for water will remain unchanged at 8% of production. Table 4-5 summarizes projected water production requirements. Figure 4-2 illustrates production projections for both conservation scenarios.

Table 4-5
Water Production Projections

Year	No Conservation Impact		Moderate Conservation Impact	
	ADD (mgd)	MDD (mgd)	ADD (mgd)	MDD (mgd)
1995	1.92	4.46 [1]	1.92	4.46 [1]
2000	2.27	5.22	2.21	5.10
2005	2.71	6.23	2.55	5.86
2010	3.20	7.35	2.95	6.78
2015	3.79	8.72	3.49	8.03
2020	4.47	10.28	4.13	9.50

[1] Actual production.

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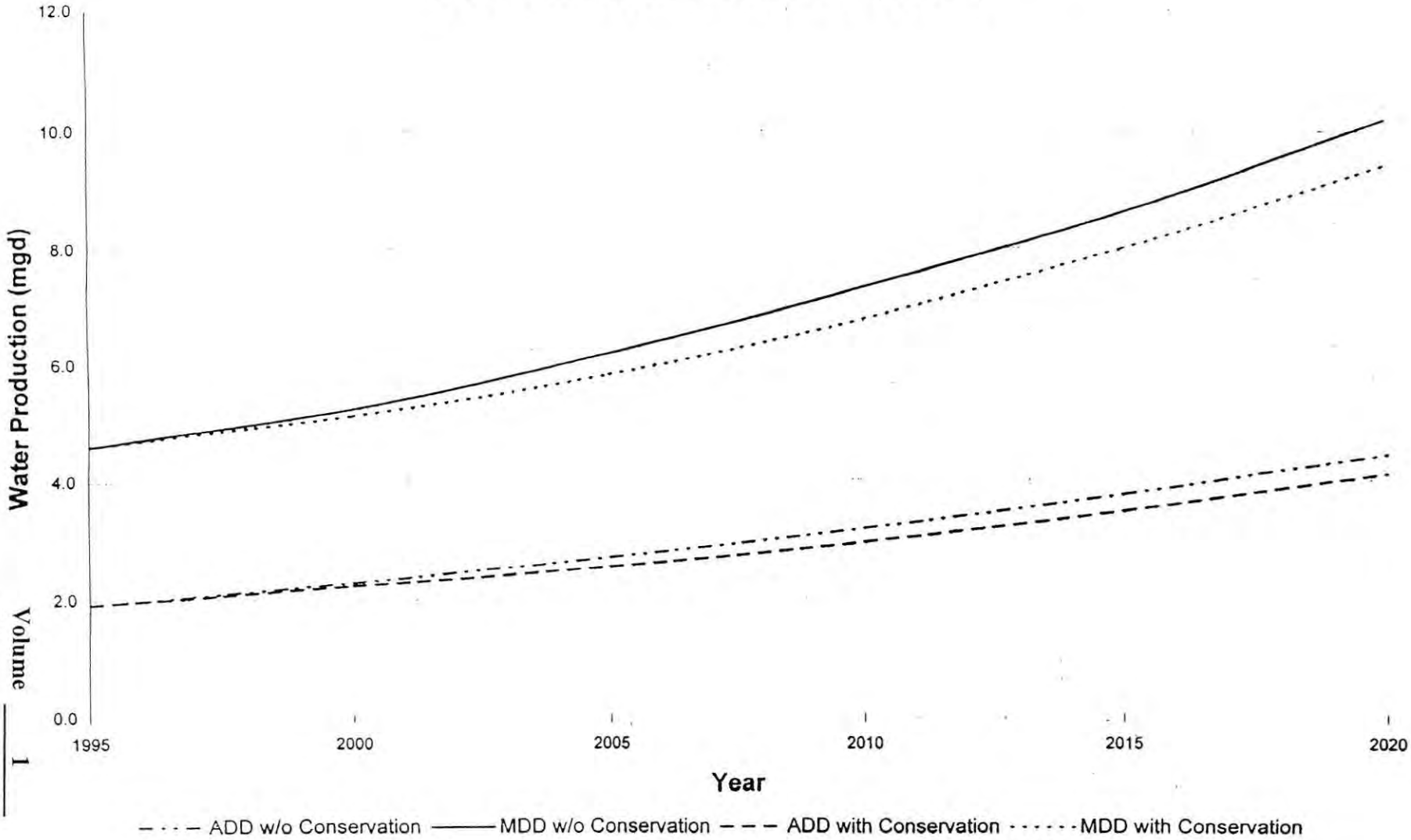
Figure 4 - 2
Woodburn Water Production Projections



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CHAPTER 5
EXISTING SYSTEM INVENTORY/REVIEW

5.1 SUMMARY OF AVAILABLE INFORMATION

Information on the existing system was primarily provided by City of Woodburn staff, and a site visit. The general characteristics of the City's water system are illustrated on the water system map found in the back of this Master Plan.

The City of Woodburn currently draws water from the Troutdale Aquifer from six wells. Water is distributed to customers through approximately 66 miles of water pipe varying in size from 4 inches to 24 inches in diameter. The system also includes substandard piping of 1 and 2 inch size. One operating water storage reservoir serves as a system pressure regulator and provides some emergency reserves. A second elevated water reservoir is currently out of service. The system consists of a single pressure zone. Detailed descriptions and inventories are summarized in this chapter.

5.2 FACILITIES DESCRIPTION/CONDITION

Source of Supply

The City of Woodburn has 6 active production wells supplying groundwater to the system. The City has six other wells that are note in production at this time. The wells are described in detail in Table 5-1. In 1995, average day production from the wells was 1.78 mgd (1236 gpm), with a maximum day production in July of 4.58 mgd (3180 gpm). The location of the wells within the system are shown on the Water System Map which is inserted in the back of this Water Master Plan.

The well pumps feed directly into the system during operation The pumps are controlled through an Autocon control system based on the level in the water reservoir. The system rides on the level of the tank and system pressures are generally 45 psi to 60 psi.

Storage Facilities

The City of Woodburn currently has one operating reservoir in the system. This reservoir is an elevated steel tank and has a capacity of 750,000 million gallons. There is also one reservoir which is out of service. The reservoirs are described in Table 5-2. The operating reservoir provides peak demand storage, emergency reserve, and hydraulic gradient control for the system.

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Table 5-1
City of Woodburn
Existing Wells

No.	Description	Capacity	Function	Comments
1	Shop No. 1		Not in Service	
2	Shop No. 2		Not in Service	
3	Library		Not in Service	
4	Settlemeir Well located at the intersection of West Hayes St. and Settlemeir Avenue. Drilled in 1952.	600 gpm Depth = 183'	Provides water to the central part of Woodburn.	Well is manually controlled through Autocon panel.
5	Old SPRR		Not in Service	
6	Abandoned			
7	Nazarene Well located on Woodland Avenue. Drilled in 1967	1,000 gpm Depth = 333'	Provides water to the northwest part of Woodburn.	Well is manually controlled through Autocon panel.
8	Legion Park Well located on Alexandra Avenue. Drilled 1974.	868 gpm Depth = 194'	Provides water to the southern area of Woodburn.	Well is manually controlled through Autocon panel.
9	Warren Donner Well located on Country Club Road.	1,000 gpm Depth = 280'	Provides water to the north central area of Woodburn.	Well is manually controlled through Autocon panel.
10	Centennial Well located 2205 National Way. Drilled in 1988.	1,000 gpm Depth = 273'	Provides water to the northeast area of Woodburn.	Well is manually controlled through Autocon panel.
11	Astor Way Well located at 1108 Astor Way. Drilled in 1989.	1,000 gpm Depth = 279'	Provides water to the north central area of Woodburn.	Well is manually controlled through Autocon panel.
A	King Way		Not in Service	
-	Senior Estate		Not in Service	

Table 5-2 City of Woodburn Existing Water Storage Reservoirs			
Description	**Capacity (gallons)**	**Overflow Elevation**	**Comments**
Elevated Steel Tank. Located near Broadway and Front Street.	750,000	140 feet	
Elevated Steel Tank. Located near Broadway and Front Street.	60,000	140 feet	Currently not in use due to leakage problems.

Transmission and Distribution Piping

The City of Woodburn has a network of transmission and distribution piping ranging in size from 4 inches to 24 inches in diameter. Substandard pipe of 1 and 2 inch diameter that exists is being routinely replaced. Transmission lines connect major service areas of the city. A pipe inventory lists approximately 66 miles of pipe with the majority being 6-inch or 8-inch diameter service piping. A summary of the quantity of pipe by diameter is illustrated in Figure 5-1. The pipe materials include PVC, cast iron, ductile iron, steel, galvanized steel and asbestos cement. Ductile iron and cast iron pipe make up the majority of the system. The City has an ongoing program of repair of their system, which is done by the City staff. The system has fire hydrants and valves throughout the system to provide customers with fire protection.

Telemetry and Controls

The City of Woodburn uses an Autocon telemetry system to monitor and control the water supply and distribution system. The heart of the system is a central control panel located near the elevated storage tank. The central panel contains the following information:

- indication lights for current status information
- elevated tank level indicator and recorder
- system pressure indicator and recorder
- HAND/OFF/AUTO switches for well pump control
- elapsed pump operating time
- High and low elevated tank level alarms

Field data are telemetered to the central panel using leased telephone lines. The high and low tank level alarm signals are also sent to a monitoring service which relays the alarm to the Woodburn police station. The telemetry system has no battery backup and is approximately 30 years old.

There are no operating or intrusion alarms at the wells. Flow metering is by turbine-type flow meters.

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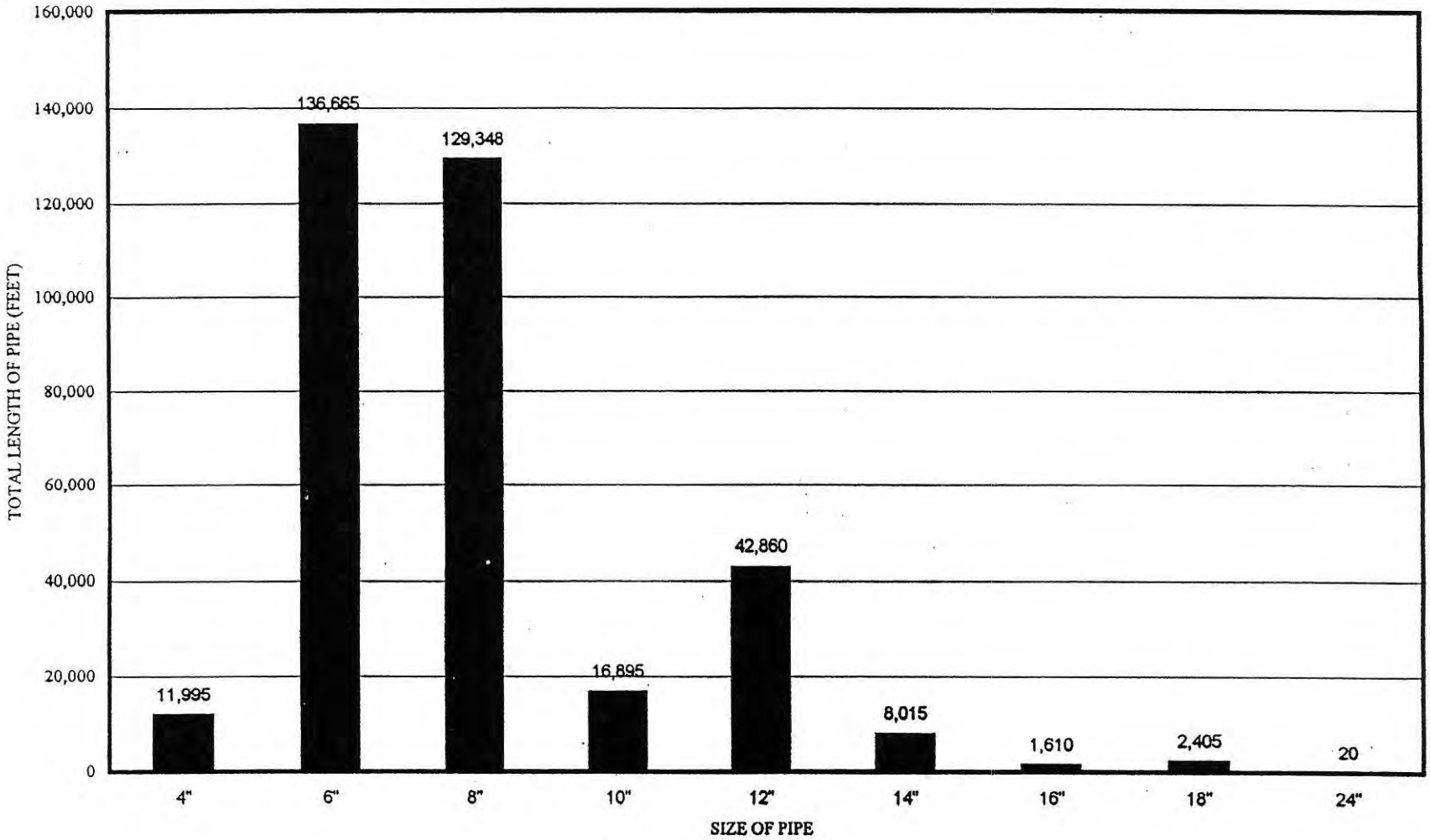
FIGURE 5-1
WOODBURN 1995 WATER SYSTEM PIPE INVENTORY



CHAPTER 6
STORAGE AND FIRE FLOW REQUIREMENTS

6.1 FIRE FLOW STANDARDS

Fire flow demand refers to the required water flow rate that is available for fighting fires. The high fire flow rates place a high stress on the distribution and supply system for relatively short periods. A fire flow demand usually occurs at one location, but can affect a large part of the water distribution system. To ensure that the system is capable of providing the minimum required flows under most conditions, fire flows are calculated while imposing maximum day demands on the system with the largest source of supply out of service. If the water system is not designed properly for fire flow demands, high water main velocities will cause excessive head loss in the system and water pressures will drop to unacceptable levels. Systems without adequate storage facilities or production capabilities, will have difficulty meeting the required fire flow demands.

Woodburn's minimum fire flow requirements are based on fire flow demands specified in the 1994 Standard Uniform Fire Code and set forth by the Insurance Service Office (ISO) in the *Guide for Determination of Required Fire Flow* (December 1974).

6.2 FIRE FLOW REQUIREMENTS

In the City of Woodburn, fire flow requirements for large facilities are determined on a case-by-case basis. The fire flow requirements are established by Woodburn's Fire Marshall, based on recommendations of the underwriting insurance company for the facility. Woodburn's minimum fire demands by land use classification are summarized in Table 6-1. Also presented in Table 6-1 are ISO requirements for each zoning classification. Duration's of ISO fire flows are based on Table 4 of ISO's Grading Schedule for Municipal Fire Protection.

To comply with OAR 333-61-025, during a maximum day demand fire flow event, the pressure at any point in the system should not drop below 20 pounds per square inch (psi). The distribution system, storage reservoirs, and sources of supply all work together to provide the required flow at the site of the fire while maintaining the system pressure above 20 psi.

The fire flow requirements shown are used as a guideline. The actual fire flow required for a specific structure is dependent upon the following items:

- Size of the Structure(s)
- Location of the Structure/Project
- Type of Construction Materials (Wood vs. Concrete/Brick, etc.)
- Number of Stories
- Building Fire Protection Systems (Sprinklers, Automatic Fire Doors, etc.)
- Proximity of Adjacent Structures
- Type of Occupancy/Building Use (Any flammable chemicals being stored, etc.)

Table 6-1 Required Fire Flows on the Peak Day				
	Insurance Services Office		Woodburn Fire District - Minimum Requirement	
Class	Fire flow (gpm)	Duration (Hours)	Fire Flow (gpm)	Duration (Hours)
Residential/ Single Family	1,000[1]	2	1,000[2]	2
Residential Multiple Family	3,000[3]	3	1,500 - 2,000[4]	2
Commercial	3,000[5]	4	1,500	2
Schools	4,000[6]	4	-	-
Industrial	5,000[7]	5	1,500	2

[1] Based on Wood-frame house with approximately 2,600 square feet or smaller houses grouped closer than 40 feet apart. Add 500 gpm for shingle roofs.

[2] Based on Rural, Semi-Rural, Semi-Urban, Urban, and Planned Unit Developments with 10 or more Residential Units.

[3] Based on Wood-frame construction of an apartment complex with approximately 23,000 square feet.

[4] For Multi-Family structures having over 4,000 gross square feet.

[5] Based on Ordinary construction materials, and an approximate gross area of 50,000 square feet.

[6] Based on Non-combustible materials with a gross area of approximately 125,000 square feet.

[7] Based on Ordinary construction materials with a gross area of approximately 81,000 square feet.

[8] No consideration is given towards sprinkler systems in any of the above calculations. Sprinkler systems can reduce the required fire flow by 50 percent or more in some cases.

6.3 FIRE FLOW REQUIREMENTS BY ZONING CLASSIFICATION

Table 6-2 summarizes the recommended fire flow demand for Woodburn by zoning classification. Zoning information was obtained from the City of Woodburn's Comprehensive Plan (1978, amended 1996). The fire flow recommendations were developed based on the ISO requirements listed in Table 6-1.

Future project development will be required to be designed and constructed using fireproof materials, partitions, and fire sprinklers to keep fire protection demands less than those shown on Table 6-2. When a new development is proposed, the City will analyze the development's impact on the water system. Using the distribution system computer model, the City will calculate the available maximum day demand fire flow at the site of the proposed development. Calculated available fire flow will be compared to the values listed in Table 6-2. If the available fire flow is less than the required value, the developer may be required to either modify the proposed method of construction to reduce the required fire flow or make system improvements to increase the available fire flow in the water system within the development. Proposed improvements to the Woodburn water system should be consistent with the latest version of the Woodburn Water Master Plan.

Table 6-2 Fire Flow Demands by Zoning Classification (All flows are calculated on the Maximum Day)		
Zoning Classification	**Minimum Required Fire Flow (gpm)**	**Duration (Hours)**
Residential (<12 units/acre)	1,000	2
Residential (>12 units/acre)	3,000	3
Commercial	3,000	4
Public Use	4,000	4
Industrial	5,000	5

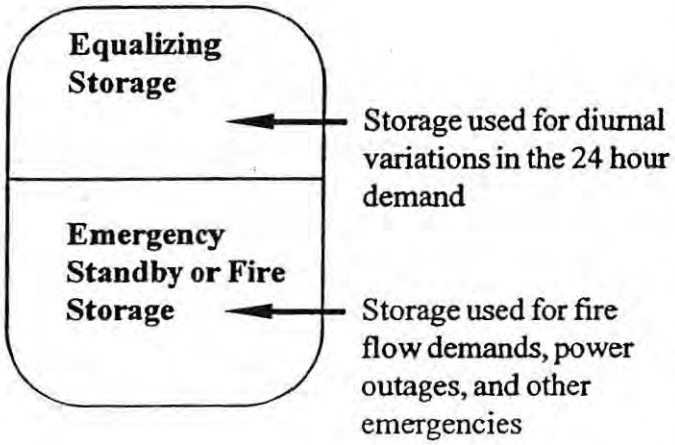


Figure 6-1
Typical Storage Reservoir Breakdown

6.4 STORAGE REQUIREMENT STANDARDS

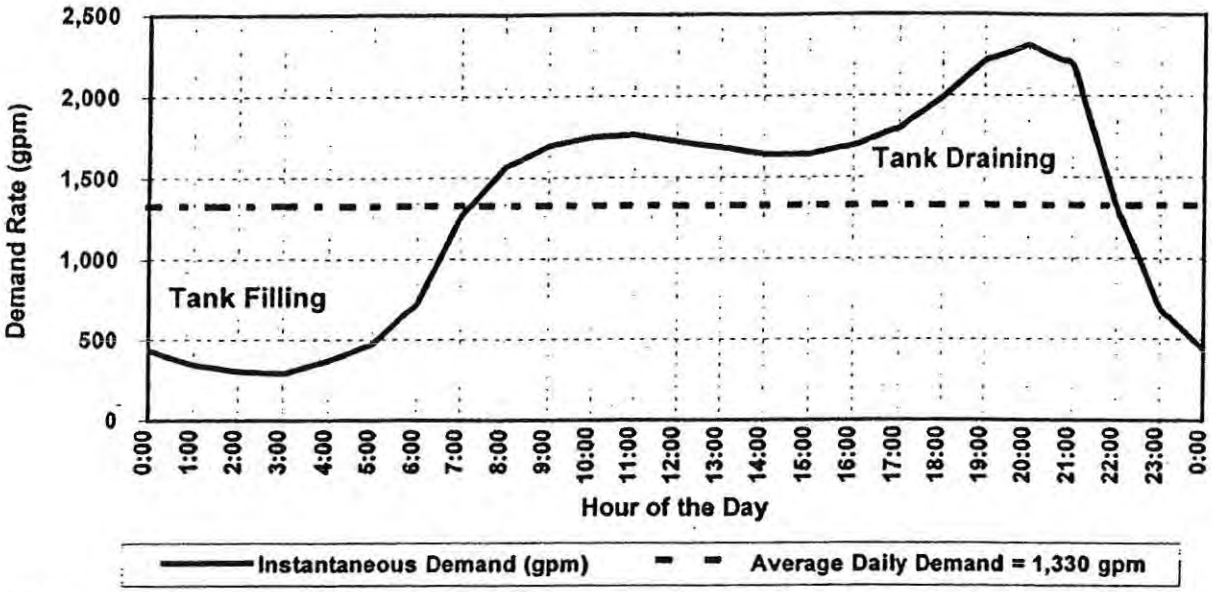
Water storage in a system is composed of two parts: 1) equalizing storage and 2) emergency standby or fire reserve storage. This is illustrated graphically in Figure 6-1. Each of these storage components is described as follows:

Equalizing Storage

Equalizing storage within a water system allows the components of a water supply and transmission grid to be sized for the average rate of demand on the maximum day. Over the course of a 24 hour day, there are significant variations in the water demand. The maximum instantaneous demand (MID) can be as much as 75 percent to 80 percent higher than the 24-hour average flow. Adding wells to the system and constructing the treatment plant and pumping system to provide the MID flow is not economical. Therefore, stored water is utilized to make up the deficit between the average daily and the maximum instantaneous demands. The quantity of equalizing storage required is dependent on the capacity of the production system with the largest source out of service. In the case of Woodburn this would be with one of the large wells out of service.

The City of Woodburn has not recorded its specific daily or diurnal demand curve. For the purposes of this Water Master Plan analysis, a typical water system diurnal curve was used to determine the quantity of equalizing storage required for the Woodburn system. This typical system diurnal curve is shown in Figure 6-2.

Figure 6-2
City of Woodburn, Oregon
Textbook Diurnal Demand Curve



If the production capacity significantly exceeds the average daily demand, the volume of equalizing storage can be minimal. If the production capacity of the water sources is limited to the maximum day demand, more equalizing storage is required to meet peak demands. For Woodburn, it will be less costly to add storage capacity (on the order of 50 cents per gallon) than to construct and operate treatment plants (on the order of one dollar per gallon). Therefore, this plan recommends installing wells and building treatment to meet maximum day demands and using less costly storage facilities to meet peak demands. Using the diurnal curve illustrated in Figure 6-2, the projected demands for Woodburn, and the projected well capacities, the required equalizing storage was calculated and is presented in Table 6-3.

Table 6-3
Required Equalizing Storage

Year	Maximum Day Demand (MGD)	Treatment Plant Production Capacity[1] (MGD)	Minimum Equalizing Storage Required[2] (Gal)	Maximum Equalizing Storage Required[2] (Gal)
1995	4.46	5.47	480,000	480,000
2000	5.22	6.12 to 10.44	190,000	730,000
2005	6.23	7.56 to 10.44	290,000	720,000
2010	7.35	7.56 to 10.44	360,000	1,520,000
2015	8.72	9.00 to 10.44	1,010,000	1,800,000
2020	10.28	10.44	2,230,000	2,230,000

1. Largest well source out of service.
2. Depends on the production capacity available.

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Emergency Standby Storage

Emergency standby storage provides water supply during fires, equipment failures, power failures, or during natural disasters such as earthquakes or floods. Although, unlike equalizing storage, emergency standby storage is seldom used, it is important part of the safety and reliability of the water system. The volume required for emergency standby storage is determined based on the amount of water needed for both fire-fighting reserves and/or emergency conditions.

Fire flow storage is described earlier in this chapter. Fire fighting storage is the product of the required fire flow multiplied by the duration of the fire. Fire flow storage is one component of emergency standby storage. Depending upon the methods used fire flow storage can either be considered to be included in or be in addition to emergency standby storage.

Emergency standby storage is based on the projected emergency duration and consequence in conjunction with the rate of supply available. It is difficult to quantify emergency standby storage and the quantity provided in a system should be based on an analysis of the vulnerability of the system and its ability to provide drinking water to the public. With only one source of supply the minimum recommended emergency standby storage is on the order of 800 gallons of storage for each equivalent residential connection. Based on an estimated average day demand of 266 gallons per connection, 800 gallons is approximately equal to three days of standby storage per connection.

However, each water system is unique and in systems like Woodburn's with multiple sources of supply, the 800 gallons per connection standard can be reduced because it is not likely that all of the well sources will be out of service at the same time. The Woodburn emergency standby storage volume required is reduced significantly if it is assumed that the "source of supply" are the wells rather than planned treatment plants. This is because taking one large well out of service reduces source production by only 1.4 mgd while the reduction in source production of taking a treatment plant out of service varies depending upon the number of treatment plants. Even if it were assumed that the wells were "sources of supply" in the emergency-standby storage calculation and that it would be acceptable to supply untreated water into the system under emergency conditions, it is recommended that a minimum of 200 gallons per connection be set aside for emergency-standby storage.

If it is assumed that only treated water should be introduced into the system, one centralized plant would required more storage than two or more treatment plants. Based upon 13,300 year 2020 ERU's, the following calculations show the range of emergency standby storage:

Minimum

Minimum storage = 200 gpc x 13,300 ERU's **2.7 million gallons**

One Centralized Treatment Plant

Maximum emergency standby storage required - one treatment plant

(800 x 13,300) = **10.6 million gallons**

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Two Neighborhood Treatment Plants

Total water production capacity	12.0 mgd
Largest water source out of service	7.2 mgd
Remaining capacity (firm production capacity)	4.8 mgd
Emergency Standby Storage Required - Two Treatment Plants (10.6 mg - 4.8 mg) =	**5.8 million gallons**

Five Wellhead Treatment Plants

Total water production capacity	12.0 mgd
Largest water source out of service	4.3 mgd
Remaining capacity (firm production capacity)	7.7 mgd
Emergency Standby Storage Required - Five Treatment Plants (10.6 mg - 7.7 mg) =	**2.9 million gallons**

Considering the unique nature of the Woodburn system, multiple well sources with two neighborhood treatment plants it is recommended that an equivalent emergency standby storage of 2.9 million gallons be provided. With this storage volume it will be important that the City have established procedures to promptly notify all customers of emergency conditions to request that they conserve water. A summary of the storage requirements are listed in Table 6-4.

Table 6-4
Summary of Year 2020 Storage Components

Storage Component	Recommended Volume (Gallons)
Equalizing Storage	2,230,000
Maximum Fire Flow Reserves (5,000 gpm for 5 hours)	1,500,000
Emergency Standby	2,900,000

Since emergency standby storage volumes exceed fire flow reserve storage the minimum total recommended storage volume is approximately 5,150,000 gallons. Allowing credit for the existing 750,000 gallons of elevated storage leaves a remaining required storage volume of 4,400,000 gallons. Therefore, it is recommended that a 2.2 million gallon storage reservoir be constructed at each of the two treatment plant sites.

Construction of this storage can be phased so that the first 2.2 million gallons is constructed with the first treatment plant by year 2000 and the second 2.2 million gallons is constructed along with the second treatment plant by 2010. The need for storage beyond that recommended for 2020 should be reevaluated within the next five to ten years based upon actual population growth rates and corresponding increases in demand. However, it is likely that it will be beneficial in the distant future to site additional storage in the northwest and/or southeast parts of the system.

CHAPTER 7
PERFORMANCE AND DESIGN CRITERIA

7.1 WATER QUALITY PARAMETERS

Water quality must conform with the Federal Safe Drinking Water Act (SDWA) as amended and Oregon Department of Health criteria as specified in ORS 448.115 to 448.285. The State of Oregon under OAR Chapter 333 has established rules for the regulation and operation of water systems. Section 333-61-030 of these rules identifies water quality requirements that must be met. These regulations define monitoring requirements, maximum primary and secondary contaminant levels (MCL's), follow-up action that must be taken, and define when public notification is required. Water quality requirements are presented in detail in Chapter 9.

7.2 TREATMENT ISSUES (SDWA)

The water source for the Woodburn water system is groundwater from the Troutdale Aquifer. This source is untreated and has been exempt from disinfection under OAR 333-61-032(6). Treatment and water quality issues are discussed in detail in other sections of this Master Plan.

7.3 SYSTEM DEMANDS

The average daily demand (ADD) for 1995 was approximately 1.8 mgd for the City's system. Based on a full-time service area population of 16,727 and a part-time population of 1,777 within the City's service area, the average per capita domestic demand is 97 gpcd.

The maximum day demand (MDD) in 1995 was approximately 4.3 mgd. The ratio of this demand to the average daily demand is 2.39, slightly higher than the average of 2.3 for 1992-1995. For purposes of analyzing the water system, the ADD will be multiplied by 2.3 to determine MDD. The 1995 maximum Instantaneous Demand (MID) has been estimated to be approximately 3.9 times ADD or 4,820 gpm.

Recommended fire flows are summarized in Table 6-2. Fire flows will be combined with MDD for system hydraulic analysis.

Refer to Chapter 4 for additional information regarding current and future water system demands.

7.4 BACKUP SUPPLY/SYSTEMS

It is highly desirable to have as much redundancy as economically feasible within the water system. This is particularly true with respect to meeting fire flow requirements. Frequently fires occur when natural disasters such as earthquakes strike, or major fires often can cause power outages which can severely impact fire fighting efforts if the water is supplied from a nearby well. For these reasons, the Insurance Services Office (ISO) looks very closely at all aspects of a water system when evaluating and grading the system for fire protection effectiveness.

Backup or redundant considerations and criteria for water systems include:

- Back-up emergency power, or dual power sources for well stations (depending on available storage).
- Multiple storage tanks.
- Looped or dual transmission mains.
- Telemetry systems with alarms for critical components in the system.
- A broad, looped distribution system.
- Redundant components in the supply works.
- Isolation valves at critical connections, and frequently spaced along major transmission mains so that damaged portions of main can be easily isolated and repaired.
- Adequate number and location of fire hydrants.
- Adequate storage of water in reservoirs to supply fire flows with the largest source component of the system, such as a well pump or transmission line out of service.

7.5 FIRE FLOW STORAGE

Using the fire flows and fire duration's listed in Table 6-2, the fire flow storage required for the largest fire flow demand in the Woodburn system is 5000 gpm for 5 hours or 1.5 million gallons. Using the current city minimum fire flow guidelines, the maximum fire flow is 2000 gpm with a duration of 2 hours for residential multi-family structures or 240,000 gallons. Even the largest fire flow volume is less than the recommended emergency standby storage volume. Therefore, the more stringent ISO criteria can be met by considering that the fire flow reserve storage is contained within the emergency standby storage volume.

7.6 EQUALIZING STORAGE

Equalizing storage requirements are defined in Chapter 6. It is recommended that the treatment system be designed to meet the demand of the maximum day and that sufficient equalizing storage be constructed to meet the maximum instantaneous demands during the maximum day.

7.7 EMERGENCY STANDBY STORAGE

Emergency standby storage requirements are defined in Chapter 6. The City has the advantage of having multiple sources of supply, therefore the volume of recommended emergency standby storage is reduced significantly from that which would be required with a single source of supply.

7.8 SYSTEM DESIGN STANDARDS

This section presents the general design criteria for the distribution system. These criteria along with the fire flow standards listed in Table 6-1 are considered to be the minimum standards for all facilities within the Woodburn water system.

The standards presented in this section will be used to analyze the existing system to identify deficiencies that may exist and will serve as a basis of design of the proposed system. The analysis of the system will be discussed in more detail in later chapters.

General

- All new developments connecting to the system shall be designed by a Professional Engineer registered with the State of Oregon.
- City of Woodburn retains the right to inspect all new facilities during construction, and prior to being placed in service.
- Connections to the existing water system must be in accordance with City standards.
- Service lines shall be installed so that each residential, commercial, and industrial structure will have a separate meter. If approved by the designated utility, domestic water consumption may be measured by a master meter for service to a complex, under single ownership, and where water line subdivision is impractical. Service lines providing fire flow may be required to be equipped with a fire detection check valve and/or appropriate cross-connection control devices as required by OAR 333-61-070.

Pipelines

- Water lines should be constructed within City or County right-of-ways or within private easements. Easements should be at least 16-feet wide. Pipelines should be located at least 5 feet inside all easements and right-of-ways.
- Minimum pipe sizes:
  - 6 inch for looped distribution pipes
  - 8 inch for dead-end pipes
  - 12 inch for transmission pipes
  - Actual pipe size may be larger in some areas due to system requirements
- Pipelines should be looped where possible.
- Maximum pipeline flow velocities
  - Maximum Day Demand - 5 feet per second
  - Fire Flow Condition under maximum day demand conditions - 10 feet per second
- System pressure
  - Maximum Day Demand - 40 psi minimum at any point
  - Fire Flow Condition - MDD - 20 psi minimum at any point
  - Maximum allowable pressure - 100 psi
- As a minimum, pipe materials should meet AWWA Standard C100 for ductile iron pipe and fittings unless approved by the City.
- All water mains should have a minimum cover of 30 inches over the top of the pipe.

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- Minimum separation distances between water mains and sanitary sewer mains should conform to OAR 333-61-050 (Figure 1) when the mains are parallel, and the water main shall be a minimum of 1.5 feet above the sanitary sewer when crossing. Adjustments to these requirements may be allowed if the proposed adjustments are within the latest guidelines published by the Health Division of the Oregon Department of Human Resources.
- A minimum separation distance of 5 feet horizontally be maintained between water mains and storm sewer systems. Lesser separations will be allowed if it is shown that it is not feasible to locate the water main further away.
- All new piping should be pressure tested to a minimum of 150 psi over normal working pressures for 15 minutes.

Valves

- A sufficient number of valves should be installed in the system to allow isolation of the system for maintenance and repair. As a guideline, valves should be located at all tees and crosses, at all intersections, and have a maximum spacing of 800 feet.
- Two-inch minimum air and vacuum release valves should be installed at all high points in the piping system.

Fire Hydrants

- Fire hydrants should be 5-1/4 inch or larger. Hydrants should be spaced a maximum of 700 feet apart in residential areas and a maximum of 300 feet apart in multi-family residential areas, commercial areas, and industrial areas. Actual hydrant spacing and location will be determined on a project by project basis in consultation with the Fire Marshall.
- Maximum length of six-inch fire hydrant leads shall be 50 feet of equivalent length pipe including fittings.
- Dry-barrel type of construction conforming to AWWA C502 and equipped with National Standard Threads, or devices.
- Fire hydrant type, features, and spacing must be approved by the City and the Fire Marshall.

Disinfection and Testing

- All new pipe, reservoirs, and appurtenances must be flushed, disinfected, and tested in accordance with the standards of OAR 333-61-050, AWWA C600 and D105.

Cross Connection Control

- Where there exists a possibility of contamination of the potable water system, appropriate cross connection control measures must be taken to protect the water system. Refer to OAR 333-61-070, Cross Connection Control.

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CHAPTER 8
WATER SUPPLY RESOURCES

8.1 INTRODUCTION

This chapter presents an evaluation of Woodburn's water supply resources. Included is:

- A summary of the projected water needs of the City through 2020
- A look at the supply and capacity requirements to meet the water needs
- An identification and assessment of the potential sources to meet the supply requirements including the long-term reliable/sustainable yield of the source
- The City's legal ability to acquire the source (i.e. the water rights), and:
- The quality of the source

8.2 FUTURE SUPPLY NEEDS

Water supply projections for Woodburn as described in Chapter 4 indicate that by 2020 an average daily demand (ADD) of 4.47 and a maximum daily demand (MDD) of 10.28 will be required. The water production requirements for Woodburn expressed in 5-year increments through 2020 are summarized in Table 4-5. The ADD and MDD projections as developed in Chapter 4 represent the demand requirements plus provisions for unaccounted-for water, which is assumed to be 8% of the demand. To be conservative, projections for the supply needs assume that conservation efforts have no impact on future water demand or production.

8.3 EXISTING SUPPLY

The City's existing source of water is the Troutdale aquifer. The City has existing water rights of 20.45 cfs (13.25) mgd in the Troutdale aquifer, which are sufficient to meet the projected year 2020 ADD supply needs of 4.47 mgd and MDD needs of 10.28 mgd. The Troutdale aquifer and the City's water rights are described below.

8.4 CAPACITY REQUIREMENTS

The City has six active wells, designated Wells Nos. 4, 7, 8, 9, 10, 11. Existing information on the individual wells is summarized in Chapter 5, Table 5-1. The total capacity of these six wells is approximately 6.77 mgd. Because of Well No. 4's low capacity and poor water quality, the City intends to abandon Well No. 4. Eliminating the capacity of Well No. 4, the remaining wells have a total capacity of 6.12 mgd. With Well No. 4 in service and assuming that the largest source is out of service, the City of Woodburn currently has a firm supply capacity of 5.47 million gallons per day.

Table 8-1 summarizes the minimum required system production capacity to meet the MDD through the year 2020. The water production capacity to meet the MDD must be provided by the firm capacity of the system (i.e. with the largest production well out of service). Consequently, 1,000 gpm (the highest production capacity of a well in the Woodburn system) was subtracted from the total available well capacity to determine the additional capacity required to meet the projected MDD for the year noted in Table 8-1.

Table 8-1
Additional Production Capacity Requirements to Meet the MDD[1]
City of Woodburn

Year	MDD	Additional Supply Required	
		(mgd)[2]	(gpm)
2000	5.22	0.54	380
2005	6.23	1.55	1,085
2010	7.35	2.67	1,870
2015	8.72	4.05	2,835
2020	10.28	5.60	3,920

(1) Existing Total Well Capacity (Wells 7, 8, 9, 10, and 11) is 6.12 mgd. (Well 4 abandoned)
(2) Assume largest well (1,000 gpm) out of service, therefore current available firm capacity 4.68 mgd.

Experience with wells drilled in the Troutdale aquifer indicates that the City can reasonably expect to be able to develop new wells with a production capacity of 1,000 gpm. Based on the information presented in Table 8-1, the City will have to develop a new 1,000 gpm well approximately every 5 years to the year 2020.

8.5 POTENTIAL SOURCES

The City's long term water source should provide a reliable/sustainable yield. The City must have the legal ability to acquire the source through the water rights, and the source should be high quality. Woodburn's 20-year water needs may be met with the continued reliance on the Troutdale aquifer. Another potential water supply source for the City of Woodburn could be the Pudding River.

Troutdale Aquifer

Description

The regional Troutdale aquifer is characterized as an unconsolidated to semi-consolidated sedimentary aquifer overlying a deeper basalt aquifer. In the vicinity of Woodburn, the Troutdale aquifer has been characterized as a semi-confined aquifer. The aquifer is confined underneath by the sandy river mudstones formation and is confined somewhat above by Willamette silts. The Troutdale aquifer is comprised of fine to coarse sand and gravel with interspersed layers of clay and silt occurring with increasing depth. Wells in the Troutdale aquifer extend to depths of approximately 120 to 300 feet. Well depths for Woodburn range from 186 to 333 feet.

Above the Troutdale aquifer is a shallow unconfined aquifer in the Willamette silts. Wells within this shallow aquifer extend to depths of 40 feet. Groundwater in the shallow Willamette aquifer flow northwestward toward Senecal Creek at a rate of about 25 feet per year. Regionally, the aquifer is unconfined and is recharged from local sources and infiltration from direct precipitation. The Willamette silts near Woodburn have been characterized as tight, so downward migration of groundwater from the lower Willamette silt may provide only slight recharge to the underlying Troutdale aquifer. The downward movement of groundwater in the Willamette silt has been estimated to be in the range of one to four feet per year.

Locally, the groundwater in the Troutdale aquifer has been observed to flow north/northwest. Regionally, the ground water table has the shape of a broad mound, and follows the shape of the land surface. The overall shape is modified in local areas by cones of depression produced by the seasonal pumping of wells. The groundwater flows radially outwards towards the Willamette River to the west and the Pudding River to the east.

Water Rights

The City has existing water rights of 13.25 mgd (20.45 cfs) for the Troutdale aquifer, which are sufficient to meet the projected water demand. The City has 12 separate water right permits, registration statements and certificates which summarized in Table 8-2. These water rights have priority dates ranging from 1913 to 1993. The total existing capacity of the City's six wells is 6.76 mgd. It is assumed that the City will be permitted to drill the needed additional wells under their currently water rights permits.

Table 8-2
City of Woodburn
Water Rights Summary

Certificates of Water Rights (Supply)				
WRD Designation	**Amount (gpm)**	**Well Name**	**Well No.**	**Status**
Permit No. G-10931	1000	Centennial	Well 10	Active
Permit No. G-11921	1400	Donner	Well 9	Active
Permit No. G-11922	2100	Nazerene	Well 7	Active
Permit No. G-12029	600	Astor Way	Well 11	Active
Cert. No. 36537	500	Senior Estate		Not in Service
Cert. No. 36538	750	King Way	Well A	Not in Service
Cert. No. 56379	750	Legion Park	Well 8	Active
Regis. GR 2267	300	Shop No. 1	Well 1	Not in Service
Regis. GR 2268	500	Shop No. 2	Well 2	Not in Service
Regis. GR 2269	500	Library	Well 3	Not in Service
Regis. GR 2270	500	Settlemeir	Well 4	Active
Regis. GR 3815	300	Old SPRR	Well 5	Not in Service
TOTAL	9,200 gpm (13.25 mgd)			

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The City's water rights permits, registration statements and certificates, authorize the appropriation of groundwater for municipal use within the city limits. They require the City to pump and use water from each well in accordance with the terms and conditions of the particular registration, permit or certificate covering that well. With this arrangement, the delivery of the water is inflexible. Additional flexibility could be gained by filing applications with the WRD to operate the system as an integrated wellfield, pumping from each well as needed, without the constraints of water right permit or certificate of the individual wells. The place of use should be modified to refer generically to all areas within the city's urban growth boundary.

Water Availability

The future availability of groundwater in the Troutdale aquifer depends on the recharge via infiltration. Because of declining water levels and well production rates, there are two areas within the southern end of the Pudding River drainage area which have been designated as "groundwater limited". Wells in the Woodburn area have not shown declining levels in production. An on-going water level monitoring program is important for long term water management planning.

One of the current issues regarding the water supply for the Willamette Valley as a whole, is the interaction of the groundwater and surface water and how the appropriation of groundwater affects the surface water supplies. The majority of the surface waters in the basin are closed to further appropriation.

Contamination Potential

For any unconfined aquifer in a developed area there are many potential sources of groundwater contamination. A site of recent investigations is the North Marion County Disposal Facility (NMCDF). The NMCDF is the only active landfill in the area, it is located approximately two miles north of Woodburn.

The NMCDF has been in operation since September 1974. Groundwater sampling at the NMCDF found concentrations of VOCs and nickel above the MCLs in the Willamette silt aquifer (Dames & Moore, 1996). The Remedial Investigation Report (RI) reported that long-term aquifer pumping tests conducted to assess the hydraulic connection between the Troutdale aquifer and the shallow Willamette aquifer indicated some leakage between the confining layer separating the two aquifers. The vertical hydraulic conductivity of the aquitard at the NMCDF was measured to be 2.8×10^{-7} cm/sec and 6.8×10^{-7} cm/s. These values are below the DEQ threshold level of 10^{-6} cm/sec, which is considered sufficiently tight to protect the Troutdale aquifer from compounds of concern observed in the shallow Willamette aquifer. Based on the investigation results, the RI recommended continued monitoring with no further action at this time. It should be emphasized that Woodburn is upgradient of the landfill, and does not obtain its water from the shallow Willamette aquifer.

In 1993, the DEQ conducted groundwater sampling in the Woodburn area as part of the statewide ground water monitoring program. The results of the monitoring program, as well as discussions with DEQ personnel, indicated that there are no trends of groundwater quality degradation of wells.

To further evaluate the potential for groundwater contamination and protect the groundwater resource, it is recommended that the City prepare a Wellhead Protection Plan. Further recommendations for Woodburn regarding a Wellhead Protection Plan are presented in Chapter 9.

Other Sources

Under current water rights, the City has the ability to meet the 20-year demand relying on the Troutdale Aquifer. The City should begin to develop strategies to meet demand beyond the 20-year planning period when the water rights are exceeded. Strategies that the City may consider include purchasing water rights currently used by agriculture or acquiring water rights for properties that develop within the urban growth boundary.

Currently, Woodburn has no surface water rights. Nearby surface water bodies include Mill Creek and Senecal Creek which flow through Woodburn and the Pudding River, which runs east of Woodburn. Mill Creek and Senecal Creek are small with seasonal flow, they are not considered potential sources. Both creeks drain to the Pudding River, which is a tributary to the Molalla River. Under consideration for the City is the purchase of water rights for the Pudding River, currently used by agriculture. The Pudding River is classified as a "Water Quality Limited Stream" because of unacceptable temperature, nutrient and turbidity levels. This indicates that the out-of-stream or instream use of the Pudding River has been reached or exceeded. Developing a local surface source for the City may not be a feasible alternative due to water availability and water quality issues.

8.6 POTENTIAL REGIONAL WATER USERS

Nearby municipalities providing water include Hubbard and Gervais. These utilities all rely solely on groundwater for their water supply needs. Both communities treat their water to remove the iron and manganese. Because Woodburn and the adjacent cities rely on groundwater, a regional supply system has not been pursued. These communities share similar interests with Woodburn in the maintenance of the local ground water and surface water resources.

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CHAPTER 9
WATER QUALITY ASSESSMENT

9.1 INTRODUCTION

This chapter presents an evaluation of Woodburn's water quality with regard to the Safe Drinking Water Act (SDWA). The key water quality issues facing Woodburn include:

- Iron and manganese levels which exceed Secondary Maximum Contaminant Levels (MCLs) and cause consumer complaints due to taste and odor problems and staining on plumbing fixtures and laundry.
- Disinfection to meet the anticipated Groundwater Disinfection Rule.
- Eliminating non-acute violations of the Total Coliform Rule (TCR).
- Arsenic levels which exceed the anticipated, future, more stringent MCL for arsenic.

9.2 WOODBURN WATER QUALITY

Woodburn's water quality is summarized in Table 9-1. The groundwater may be characterized as moderately hard and well buffered. The water exceeds the SMCLs for iron and manganese and will require treatment. Organics are very low and will not be a problem.

Table 9-1
City of Woodburn
Summary of Water Quality

	Active Wells Only			All Wells
Parameter (in mg/L unless noted)	**Range**	**Average**	**Median**	**Range**
pH (std. pH units)	7.3 - 7.9	-	7.6	7.1 - 7.9
Alkalinity (as $CaCO_3$)	80 - 155	115	114	80 - 155
Calcium	12 - 35	18	18	12 - 35
Conductivity (µmhos/cm)	185	185	185	185
Hardness (as $CaCO_3$)	67 - 104	88	87	67 - 120
Total Dissolved Solids (TDS)	125 - 175	142	138	116 - 175
Chloride	0.75 - 5.5	2.7	2.5	0.75 - 6.5
Sulfate	2.2 - 16.4	6.3	2.4	1.5 - 16.4
Sodium	7 - 29	13.7	11.8	5.3 - 29
Nitrate	0.1 - 1	0.5	0.4	0.1 - 1
Total Organic Carbon (TOC)	< 1	< 1	< 1	< 1
Iron	0.15 - 2	0.5	0.4	0.1 - 2.1
Manganese	0.2 - 0.4	0.3	0.3	0.2 - 0.6
Magnesium	1.8 - 22	12.2	10.8	1.8 - 26
Arsenic	0.003 - 0.013	0.008	0.008	0.003 - 0.031
Radon (pCi/L)	108 - 532	358	361	108 - 532
Volatile Organic Compounds (VOCs)	nd	nd	nd	nd
Synthetic Organic Compounds (SOCs)	nd	nd	nd	nd

9.3 WATER QUALITY AESTHETICS - IRON AND MANGANESE

Requirements

Iron and manganese are groundwater contaminates that produce objectionable precipitates in drinking water. When the soluble metals are oxidized, the precipitates of iron and manganese turn the water rusty colored or black and cause stains on plumbing and laundered clothing and disagreeable tastes in water and beverages. The secondary standards for iron and manganese are 0.3 mg/l for iron and 0.05 mg/l for manganese. Iron and manganese are not health concerns. Secondary standards are established for guidance, based on aesthetic issues, not health issues.

Status of Woodburn System

Iron and manganese concentrations for Woodburn exceed the SMCLs, as summarized in Table 9-2. Over time with the exposure to oxygen these metals will oxidize insoluble forms, which can accumulate in the distribution system piping and cause problems at the consumer tap. Treatment to reduce the iron and manganese concentrations are recommended.

Table 9-2
City of Woodburn
Summary of Iron and Manganese Concentrations of Wells In Service

Detected Concentrations	Iron	Manganese
Maximum	2.0	0.4
Median	0.4	0.3
Average	0.5	0.3
Secondary MCLs	0.3	0.05

Recommendations for Iron and Manganese

1. Continue to monitor the iron and manganese levels.
2. Treatment will be required to reduce the iron and manganese in the system to reduce the number of customer complaints.

9.4 HEALTH PROTECTION - SDWA COMPLIANCE

This section presents results of the evaluation of the status of the Woodburn system with existing and proposed regulations including the TCR, the Lead and Copper Rule (LCR), the Standardized Monitoring Framework (SMF) (Phases I, II, and V), the anticipated Disinfectants/Disinfection By-Products (D/DBPs) Rule, the Groundwater Disinfection Rule (GWDR), radionuclides, arsenic, sulfates, and the Wellhead Protection Plan.

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The Oregon Health Division (OHD) is responsible for the administration of both the federal and state drinking water laws, under ORS Chapter 448, the Oregon Drinking Water Quality Act. The basic regulatory requirements for drinking water quality in the State of Oregon are published in the Oregon Administrative Rules (OAR) 333-061 Public Water Systems. In most cases, the regulations adopted by OHD are the minimum requirements from the federal SDWA. However, OHD has the option to adopt and enforce standards that are more stringent than the federal regulations.

The application of the drinking water regulations is guided by the source water type and the treatment technology employed. Woodburn relies on unchlorinated groundwater. Key health related water quality issues for Woodburn are summarized in Table 9-3.

Table 9-3
City of Woodburn
Summary of SDWA Compliance Concerns[1]

Regulation	Status	Area of Concern
TCR	In effect	Episodes of non-acute violations.
GWDR	Future	Disinfection most likely required. Possible requirement of contact basins for CT compliance at wells.
Arsenic	In effect, Future	Treatment would be required to meet anticipated lower MCL.
Wellhead Protection	Voluntary Program	It is recommended that the City develop a Wellhead Protection Plan.

[1] Woodburn's status with secondary standards established for iron and manganese is discussed in Section 9.3.

A review of the relevant requirements of each existing or proposed regulation affecting Woodburn is presented, followed by the specific monitoring and reporting requirements. This includes the requirements under the federal regulation as well as those listed under the OAR. The status of Woodburn's system with each regulation is discussed and recommendations are made.

SDWA Reauthorization

The SDWA Reauthorization was signed into law on August 6, 1996. Components specific to a rule that affect the City of Woodburn are included in the discussion of the particular rule.

Monitoring Flexibility

The SDWA requires the EPA to review the monitoring requirements for not less that 12 contaminants and promulgate any necessary modifications within two years. The EPA is required to promulgate regulations for the monitoring of unregulated contaminants and promulgate a list of not more than 40 contaminants to be subject to monitoring.

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Process for Setting New Contaminants
The reauthorization of the SDWA gives the EPA the authority to decide which contaminants to regulate based on several criteria, including: i) whether the contaminant is known to occur or there is substantial likelihood that the contaminant will occur in public water systems with a frequency and level of public health concern; and ii) regulation of the contaminant presents a meaningful opportunity for public health risk reduction.

Standard-Setting
The SDWA sets maximum contaminant level goals (MCLGs) "at the level at which no known or anticipated adverse effects on the health of persons occur". The SDWA requires that the EPA make such determinations on the bases of the best-available information and that the level be as close to the MCLG "as is feasible". At the time MCLs are proposed, EPA is required to publish an analysis of quantifiable and non-quantifiable health risk reduction benefits and costs associated with the MCL and the effects of the contaminant on the general population and identified sub-populations.

Under the SDWA, the EPA is not required to set an MCL at a level where the benefits outweigh the costs, but must set the MCL at a level that maximizes health risk reduction benefits at a cost that is justifiable by the benefits. The EPA is granted discretionary flexibility to establish an MCL at a level other than the "feasible" level if the feasible level would result in an increase in the concentration of other contaminants in drinking water. In other words, if a certain MCL or treatment technique would result in increasing risks from other contaminants, the EPA is authorized to "balance" the risks involved and minimize the overall risks. Interim regulations are authorized without risk, cost and benefit determinations where there is an "urgent "threat to public health, subject to after the fact determinations and repromulgation.

Public Notification
The SDWA specifies that the EPA promulgate regulations to prescribe the form and content of giving public notification, and to distinguish between violations that are serious and frequent or continuing and violations that do not present a significant risk to public health.

The SDWA requires an annual report to consumers which must be published in local newspapers and mailed to each customer. Some of the information which must be included in the report is information on the source water, the level of regulated contaminants in the water, and brief statements on health concerns.

State Revolving Loan Fund (SRF)
The SRF for drinking water systems was created to address economic needs and secure the ability of systems to come into compliance with standards under the SDWA. States will receive federal capitalization grants. SRF funds are to be used for providing loans, loan guarantees, or as security leveraged loans for expenditures that will facilitate compliance with MCLs or "otherwise significantly further the health protection objectives" of the SDWA.

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Operator Certification
The SDWA requires EPA to promulgate regulations to specify minimum standards for operator certification, but directs such regulations take into account existing state programs, reasonable costs and system size. The SDWA allows states to use preexisting programs for operator certification.

Time Frames Allowed to Comply With Regulations
The SDWA provides that MCLs take effect three years after promulgation unless the EPA determines an earlier date is practicable. The EPA or state may allow an additional two years for compliance where additional time is necessary for capital improvements.

Total Coliform Rule

Requirements
The Total Coliform Rule (TCR), which became effective on December 31, 1990, prescribes monitoring and compliance protocols for assuring the bacteriological quality of water in distribution systems. It applies to all types of systems, and establishes a maximum contaminant level goal of zero for total coliform, fecal coliform, and *E. coli*. The key monitoring elements of the rule are summarized below. Requirements of the TCR have been adopted by the OHD in Chapter 333-061 OAR.

The TCR requires that the system have a written coliform monitoring plan which must include the following:

- System Map or diagram showing:
  - Water sources
  - Storage, treatment, and pressure regulation facilities
  - Distribution systems
  - Pressure zones
  - Interconnections
  - Coliform sample collection sites
- Narrative which includes:
  - Public water system identification number
  - Population served and services
  - Water sources
  - System facilities and processes for storage, treatment, and pressure regulation
  - Coliform sample collection sites
  - Sampling schedule

Woodburn's coliform monitoring plan was reviewed and appears to meet the intent of the requirements.

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Monitoring

The water system is responsible for collection and submittal of coliform samples from representative points throughout the distribution system. Monitoring frequency is a function of the population served. Based on a population of 19,100 the City of Woodburn is required to take a minimum of 20 samples per month.

When total coliform bacteria are present in any sample and the sample is validated, the following must take place:

- Analyze the sample for fecal coliform or E. coli.
  Collect repeat samples as follows:
  1) A set of three repeat samples shall be collected and submitted for every sample in which the presence of coliform is detected. The samples shall be collected on the same day and submitted for analysis within 24 hours after notification by the laboratory of a coliform presence except when waived by the OHD on a case-by-case basis.
  2) At least one repeat sample must be taken from the site of the original positive coliform sample. Two repeat samples must be within 5 active services of the site of the sample with coliform presence, one upstream and one downstream.
  3) When repeat samples have coliform presence, the system must collect one additional set of repeat samples for each sample where coliform presence was detected.
- Notify the OHD (OHD notification is presented below under Reporting).
- Determine and correct the cause of the coliform presence.

There are both acute MCLs and non-acute MCLs for coliform bacteria. An acute MCL occurs when there is: 1) Fecal coliform or *E. coli* presence in a repeat sample; or 2) Coliform presence in a set of repeat samples collected as a follow-up to a sample with fecal coliform or *E. coli* presence. For systems collecting fewer than 40 routine coliform samples per month, no more than one positive coliform test per month is allowed.

Reporting

A written coliform sampling plan as delineated above must be on file, ready for inspection by the OHD.

Reporting requirements associated with the TCR are as follows:

1) Within ten days of notification by the laboratory of a positive sample, the system must notify the OHD of the results of the fecal coliform and/or total coliform bacteria test on the raw (untreated) source water.
2) Within 24 hours or by the end of the business day on which the system is notified by the laboratory, the system must notify the OHD of analyses indicating any positive coliform bacteria.

Status of Woodburn System

Woodburn collects 20 samples per month from 25 permanent sampling sites located throughout the system. The sample locations are arranged in five groups, each week one group is sampled. The samples are submitted to a certified independent laboratory.

Table 9-4 summarizes results of TCR monitoring for Woodburn since 1993. The table lists the number of episodes in which total coliform was detected in the Woodburn distribution system. No fecal coliform nor *E. coli* has been detected during the TCR monitoring.

Table 9-4
Summary of Coliform Testing Results (1993 - 1995)
Woodburn Water System

Month	No. of Positive Total Coliform Results	
	Routine Testing	Repeat
February 1993	1	1
June 1993	1	15
July 1993	0	12
August 1993	2	0
June 1994	1	0
July 1994	1	0
August 1994	1	0
September 1994	1	5
October 1994	0	7
November 1994	2	6
October 1995	1	0

Beginning in June 1993, Woodburn experienced several non-acute violations, testing positive for total coliform in both routine and repeat samples. The violations in 1993 were limited to a specific area, within a neighborhood known as Senior Estates. However, subsequent violations were spread throughout the system. In 1993, an investigation was undertaken to identify the potential cause(s) for the waterborne contamination as well as recommend strategies to remedy the situation (*Water System Analysis Report*, OTAK, Inc., October, 1993). In the OTAK report, cross-contamination with a non-potable water source was identified as the potential cause of contamination However, the specific source of the contamination was not identified.

The OTAK Report recommended the following strategies to control and eliminate the contamination problems and improve management of the water system:

- Begin testing of all failed water samples from the affected area sampling station using a laboratory procedure to identify and speciate bacteria that could be the cause for the problem.
- In the absence of any definitive bacteria speciation, begin a program of flushing and chlorination throughout the affected area.

- Install pressure monitors with recording capabilities throughout the system. Use the information to understand how the system responded (i.e. pressure, flow, etc.) during normal operation and fire flow scenarios for varying groundwater pumping configurations. Use the information to calibrate the hydraulic system computer model to identify any low pressure or other problem areas.
- Conduct a door to door survey within the affected area to inform residents of the problems and causes and dispense information about cross connection control and also perform an informal survey of residences to identify any potential problems.
- Continue to test groundwater from wells for the absence of bacteria.

Woodburn has responded to contamination problems by:

- Flushing and superchlorinating waterlines in the problem areas.
- Conducting an investigation of the source of the contamination problem.
- In November 1994, Woodburn switched coliform testing methods from the MMO-MUG test to the multiple tube fermentation (MTF) test method.

Since switching methods coliform testing methods in 1994, only two samples have tested positive for total coliform; one repeat sample in November 1994, and one sample in October 1995. No definite source to the contamination problem has ever been identified in the Woodburn System.

Due to these non-acute violations of the TCR, the OHD has discussed primary and secondary disinfection with the City of Woodburn. The City is currently investigating its disinfection options. The selected method of disinfection must be compatible with other water quality characteristics.

Recommendations for Woodburn TCR Compliance

1. Continue monitoring for coliform bacteria.
2. Institute primary disinfection and maintain a chlorine residual throughout the system.
3. Identify sources of potential contamination and take action to eliminate the source.
4. Develop a regularly scheduled main flushing program.
5. Identify low pressure areas and develop corrective measures.
6. Promote a cross connection control program with inspection and the training of cross connection control specialists.
7. Implement a public education program through bill stuffers and a newsletter.
8. Develop a wellhead protection plan.

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Lead And Copper Rule

Requirements

The Lead and Copper Rule (LCR), published June 1991, sets treatment technique requirements for lead and copper. The LCR calls for monitoring to establish compliance with action levels for lead and copper of 0.015 mg/L and 1.3 mg/L, respectively. Should either action level be exceeded, the utility is required to conduct an assessment of corrosion control alternatives and implement an "Optimal" corrosion control program and/or treat the source water. Systems that remain in non-compliance after implementing "optimal" corrosion-control strategies are required to locate and replace lead service lines, according to a prescribed schedule.

The specific provisions of the rule vary depending on the size of the system. The following provides a summary of the rule provisions that apply to medium-sized systems (3,301 to 50,000 people), such as the Woodburn system.

A system is deemed to have optimized corrosion control and is not required to complete the applicable corrosion control treatment steps if it meets the lead and copper action levels during each of two consecutive six-month monitoring periods. The requirement for any medium-sized system to implement corrosion control treatment steps deemed to have optimized corrosion control is triggered when the system exceeds the lead or copper action level.

Monitoring

Medium-sized systems were to have begun the first round of compliance monitoring in July 1992, during which the water system analyzed a minimum of 60 samples from customer taps for lead and copper concentrations.

If a system meets the lead and copper action levels during each of two consecutive monitoring periods, the system may request from the OHD to reduce the required frequency of monitoring to once per year. A medium-sized water system that meets the lead and copper action levels during three consecutive years of monitoring may reduce the frequency of monitoring from annually to once every three years.

Status of Woodburn System

Woodburn has completed four monitoring rounds for lead and copper. The 90th percentile levels are summarized in Table 9-5. The results indicate the 90th percentile levels to be below the action levels for both lead and copper during all sampling rounds. Because of its compliance during the first two 6-month monitoring rounds, Woodburn was allowed a reduced sampling frequency of once per year and a reduced number of required samples for the subsequent rounds from 60 to 30.

Table 9-5 City of Woodburn LCR Compliance Monitoring					
	90th Percentile Action Levels				
	Round 1 1992	Round 2 1993	Round 3 1994	Round 4 1995	Action Level
Lead	0.004	0.009	0.0077	0.0015	0.015
Copper	<0.05	<0.05	0.014	0.007	1.3

Recommendations for Woodburn LCR Compliance

1. If 1996 LCR monitoring results meet the lead and copper action levels, request a further reduction in sampling frequency to once every 3-years.
2. No treatment or operational changes are required for compliance with the LCR. It is not anticipated that treatment for the removal of iron and manganese and providing primary disinfection will result in a violation of the LCR.

Standardized Monitoring Framework

Requirements

The Standardized Monitoring Framework (SMF) is the EPA's attempt to streamline the drinking water monitoring requirements. To date, the rules included under the SMF are divided into three phases: Phase I, Phase II, and Phase V. The contaminant groups included are inorganic chemicals (IOCs), volatile organic compounds (VOCs), and synthetic organic compounds (SOCs), plus three individual contaminants: asbestos, nitrate, and nitrite.

Appendix A contains two tables which describe the various contaminant groups and the phases under which they are regulated. Table 1 of Appendix A lists the contaminants regulated under Phases I, II, and V. Table 2 lists the contaminants along with the MCLs and the best available technology (BAT) for removing the contaminant.

Monitoring

Table 9-6 presents the monitoring requirements under the SMF groundwater systems serving a population greater than 3,300. The SMF was implemented on a 9-year compliance cycle, consisting of three consecutive 3-year sampling periods. When a regulation is promulgated during the 9-year cycle, the initial round of monitoring is scheduled to begin during the next full 3-year compliance period. The initial period ran from January 1, 1993 through December 31, 1995. The OHD requires that sampling for a system with a population of 300 or greater must have completed initial monitoring by December 31, 1993.

Repeat monitoring is based on initial results and vulnerability. As shown in Table 9-6, if a contaminant is not detected (or is detected at relatively low levels), then the frequency of monitoring is considerably reduced. However, if a contaminant is found above the "trigger," then the City would have to sample for that contaminant on a quarterly basis.

The degree of vulnerability of groundwater systems to contamination from chemicals and/or pathogens is important in many of the regulations. Vulnerability of the source water helps determine the degree to which monitoring is required. Sampling frequencies for Phase I, II, and V chemicals may be reduced or eliminated if the system obtains a waiver based on initial or previous monitoring or the results of a vulnerability assessment.

The vulnerability assessment must prove that the water system is not vulnerable to a particular contaminant, either through showing that the contaminant was never used in the source area, or that the susceptibility to the contaminant does not exist (due to source water production programs, prior test results, wellhead protection programs, etc.). Further, the OHD requires a state approved wellhead protection plan for reduced SOC and VOC monitoring. It may be less costly for a water purveyor to perform the required testing under the SMF than to perform the vulnerability assessment.

Reporting

Results of the analyses must be reported to the OHD within 10 days after the end of the required monitoring period, unless the results exceed the MCL. In that case, the results must be reported to the OHD within 24 hours, or by the next business day after the results are reported to Woodburn.

Status of Woodburn System

The discussion below focuses on the SMF's impact on the City by examining available water quality test results for the various contaminants included in the SMF.

Asbestos. The City tested for asbestos in 1993. No asbestos was detected.

Nitrate. The City has performed annual nitrate analyses. A review of data since 1991, indicates maximum nitrate levels of 1.0 mg/L, which do not exceed the "trigger" value of 5 mg/L (50 percent of 10 mg/L).

Nitrite. The City has performed nitrite tests on their water supplies as part of their inorganic chemical analysis. The results have always been below the detection limit.

Inorganic Chemicals. The City been in compliance with all currently regulated IOCs. Woodburn should continue to monitor as required for IOCs.

Volatile Organic Compounds. Quarterly testing of each source for VOCs is required during the initial monitoring year. Repeat sampling is based on initial results and vulnerability.

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Table 9-6
Woodburn Compliance Monitoring Requirements
Under the Standardized Monitoring Framework (Groundwater Source; > 3,300 Population)

Contaminant	Initial Monitoring Requirements	Trigger that Increases Sampling	Requirements for Waivers	Monitoring Frequency With Waiver and All Concentration < MCL
Asbestos	1 Sample every 9 years	> MCL	Based on vulnerability assessment of asbestos contamination due to source water or corrosion of asbestos-cement pipe.	Waiver may be granted.
Nitrate	Annual	³ 50% MCL	No waivers allowed	No waiver allowed. Annual
Nitrite	1 Sample during compliance period.	³ 50% MCL	No waivers allowed	No waiver allowed. If first sample is 50% of MCL, then once each subsequent compliance period
Inorganic Chemicals (IOCs)	1 Sample every 3 years	> MCL	Analytical results of 3 rounds are less than MCL.	A minimum of one sample not to exceed one 9-year compliance period following 3 rounds of monitoring.
Volatile Organic Compounds (VOCs)	4 Quarterly samples at every sampling point during first 3 year monitoring period.	Detection (0.5 µg/L)	Based on initial results, state certified wellhead protection plan, and vulnerability assessment.	. One sample every 6 years with state certified Wellhead Protection Plan. . One sample every 9 years if portion of aquifer is of "low susceptibility" according to Use and Susceptibility Waiver Document.
Synthetic Organic Compounds (SOCs)	4 Quarterly samples at every sampling point during first 3 year monitoring period.	Detection	Based on initial results, state certified wellhead protection plan, and vulnerability assessment.	. One sample every 6 years with state certified Wellhead Protection Plan. . One sample every 9 years for SOCs i) "not used" in delineated wellhead protection area or ii) "used" in portion of aquifer in delineated wellhead protection area with "low susceptibility" according to Use and Susceptibility Waiver Document.
Unregulated . IOCs . SOCs . VOCs	. 1 Sample in the first 3 year cycle. . 4 Quarterly samples at every sampling point during first 3 year monitoring period.	Not applicable	Based on initial results, state certified wellhead protection plan, and vulnerability assessment.	IOCs - same as regulated IOCs SOCs - same as regulated SOCs VOCs - same as regulated VOCs

Source: U.S. Environmental Protection Agency, OAR 333-061

The City performed quarterly VOC analyses of both regulated and unregulated compounds in Wells 4, 7, 8, 9, and 10 in 1993. The results demonstrated that all the VOCs were below the detection limit of 0.0005 mg/L.

Synthetic Organic Compounds. SOCs include certain man-made volatile organic compounds, as well as pesticides, herbicides, and polychlorinated biphenyl compounds (PCBs) (see Table 2, Appendix A). The monitoring requirements are similar to those of VOCs. Quarterly sampling of SOCs was required during the first round of monitoring, which Woodburn conducted in 1993.

Results showed PCBs concentrations which ranged from 0.00023 to 0.00051 mg/L. A follow-up investigation dismissed the PCB levels, attributing the concentrations to laboratory interference. All other SOC were undetected.

Unregulated IOCs and SOCs. IOCs and SOCs that have not yet been assigned MCLs are referred to as unregulated. These are included in Table 1 of Appendix A. These compounds must be include in the testing for regulated IOCs and SOCs.

Recommendations for Woodburn SMF Compliance

1. Sample the water quality at each entrance to the distribution system after treatment.
2. Continue to monitor as required.
3. Develop a Wellhead Protection Plan.
4. Following state certification of the Wellhead Protection Plan, request reduced monitoring frequency.
5. No treatment or operation changes are required for Woodburn as a result of this monitoring.

Disinfectants/DisinfectionByproducts Rule (Proposed)

Requirements

The D/DBPs rule will apply to all water systems that add a disinfectant during any part of the treatment process including addition of a residual disinfectant. The D/DBPs rule was proposed in July 1994. The SDWA reauthorization bill requires that the EPA promulgate the Information Collection Rule (ICR) by December 31, 1996, to facilitate revisions to the D/DBP rule. (The ICR requirements only apply to large systems and does not affect Woodburn). A 180 day extension is allowable based on progress toward Cryptosporidium regulation.

A two-step negotiated rule making process has been underway to arrive at a consensus proposal for DBPs, consisting of Stage I and Stage II. Stage I, has been completed. The bill allows for "risk-risk" analysis of Stage II. The 1994 proposed requirements are shown in Table 9-7.

Table 9-7 City of Woodburn Disinfectants/Disinfection Byproducts Rule Proposed Limits/Monitoring Requirements			
Disinfectant/ Disinfection Byproducts[1]	**Stage I**	**Stage II[2]**	**Monitoring Requirements**
Disinfectant By-Products (MCL):			
Total trihalomethanes (TTHMs)	80 mg/L	40 mg/L	Quarterly
Total haloacetic acids (THAAs)	60 mg/L	30 mg/L	Quarterly
Bromate (systems using ozone)[3]	10 mg/L	10 mg/L	1 sample/month
Chlorite (systems using chlorine dioxide)[3]	1 mg/L	1 mg/L	3 Samples/month
Disinfectants (MRDL):			
Chlorine	4 mg/L	4 mg/L	With Coliform Sampling
Chloramines	4 mg/L	4 mg/L	With Coliform Sampling
Chlorine dioxide	0.8 mg/L	0.8 mg/L	Daily

Notes:
1. MCL=Maximum Contaminant Level; MRDL = Maximum residual disinfectant level.
2. Stage I rules are tentative and subject to renegotiation following the results of the ICR
3. Values for bromate and chlorite may be reduced in Stage II.

Additional future modifications to the anticipated D/DBP Rule include: 1) the limits on bromate and chlorite may be lowered, 2) a MCL may be promulgated for chlorate, 3) the level of TOC (total organic carbon) may be regulated at the point of disinfection, 4) additional individual DBPs may be regulated, and 5) biological filtration may be required following ozonation. The flexibility to comply with these potential modifications should be incorporated into any future treatment system.

Monitoring

Proposed monitoring requirements are listed in Table 9-7.

Status of Woodburn System

When D/DBP Rule is finalized it will apply to Woodburn once the City begins disinfection.

Recommendations for Woodburn Proposed D/DBP Compliance

1. Conduct simulated distribution system THMFP tests.
2. Conduct simulated distribution system THAAFP tests.
3. Based on the results of the THMFP and THAAFP tests, develop a primary disinfection scheme to comply with the D/DBP Rule.
4. Following installation of primary disinfection, monitor the levels of DBPs in the system.

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Groundwater Disinfection Rule (GWDR) (Proposed)

Requirements

The amended SDWA requires the EPA to establish disinfection requirements for all public water supply systems. To date, only disinfection of surface waters and groundwater's under the direct influence of surface water have been regulated under the Surface Water Treatment Rule (SWTR). Under development is the Groundwater Disinfection Rule (GWDR), which covers the disinfection of groundwater's. In July 1992, the EPA published a draft GWDR in the Federal Register for public comment. The following is a summary of the major provisions of that draft rule.

The draft GWDR includes an MCL goal (MCLG) of zero viruses. The EPA also is considering establishing an MCLG of zero for *Legionella*. Disinfection (including natural disinfection) would be established as the treatment technique for viruses, HPC bacteria, and *Legionella*, if included. The rule would require all groundwater sources to disinfect the water from each well or wellfield, unless the wells meet natural disinfection criteria (defined below), or the system qualifies for a variance.

The rule is designed to provide protection from viruses. Pathogenic protozoa, such as *Giardia*, are not considered to be a threat in groundwater sources. The rule will be based on achieving a minimum level of inactivation of viruses, which has not been determined. The EPA will base that percent inactivation on the results of a virus survey (now underway), provide guidance to the states for specifying design and operating conditions for wells, and will apply CT concepts, such as are used in the SWTR. Systems using a chemical disinfectant would have to maintain a minimum detectable residual in the water throughout the distribution system.

Natural disinfection status would be applied to systems that satisfy the definition of "source water treatment via virus attenuation by natural subsurface processes such as virus inactivation, dispersion (dilution), and irreversible sorption to aquifer framework solid surfaces." Wells that are not vulnerable to viral contamination would be considered to meet the criteria of natural disinfection.

The draft rule includes preliminary criteria by which the risk of viral contamination and the conditions for natural removal in the ground before the potential sources reach the well may be judged. A detailed model and risk assessment methodology will be developed.

Systems wishing to avoid disinfection will, in addition to meeting one of the natural disinfection criteria, have to meet all of the following conditions:

- The well must not have been identified as a source of a waterborne disease outbreak, or if it has, it must have been modified since.
- The well must meet state-approved construction codes.
- The system must be in compliance with the TCR.

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The GWDR will require that a disinfectant residual be maintained throughout the system, based on a detectable residual or an HPC concentration of less than 500/ml, unless the state determines that the distribution system is not vulnerable to external contamination or significant bacterial regrowth. In addition, the rule would require that all systems using groundwater and a disinfectant other than sodium hypochlorite must be run by a qualified operator.

There would be provisions for variances for systems that can demonstrate, through a rigorous analysis and sanitary survey, that the system meets the established vulnerability standards. The procedure would include the need for notice and opportunity for a public hearing for each proposed variance.

Exemptions would be permitted if the utility can show that they can not comply due to compelling factors (including economic), that the system is either in operation or that no alternative source of drinking water is available, and that the exemption will not result in an unreasonable risk to health.

Monitoring
Monitoring requirements would be for chlorine entering the distribution system, residual within the distribution system, and for CT compliance.

Reporting
Monthly reports to the OHD would be required. These reports would detail disinfection treatment including quantities of chemicals used and would include CT compliance calculations.

Status of Woodburn System
The GWDR will apply to Woodburn. Most likely, the minimum requirements for the GWDR would be to provide a level of viral inactivation through contact time and the provision for disinfection facilities to provide a detectable disinfectant residual throughout the distribution system.

Because of the likelihood of the future requirements for disinfection, disinfection options are investigated as part of this Plan. The primary disinfection chemical must be compatible with the water quality in the system and the selected iron/manganese treatment technique. In fact, several of the iron/manganese treatment options employ a primary disinfectant as part of the treatment process. The introduction of chlorine into the system would initially produce noticeable taste and odors in the water. This impact would lessen as consumers adjust to the chlorine residual in the water. In many cases, the addition of chlorine may actually be a benefit to the water quality by removing musty tastes and eliminating other objectionable tastes and odors. Because of the taste and odor associated with chlorine, the City favors primary disinfection options which do not rely on chlorine.

The City intends to implement treatment for iron/manganese removal prior to the requirement of disinfection under the GWDR. The introduction of the majority of the disinfectants (chlorine, ozone, hypochlorite) will oxidize any iron and manganese that exist in the well water, increasing staining problems. Removal of the iron and manganese is essential prior to adding disinfection to the system to prevent operation and maintenance problems.

Recommendations For Woodburn GWDR Compliance
If the GWDR is implemented, the City should:

1. Install primary disinfection facilities.
2. Maintain a measurable residual in the distribution system.
3. Calculate and report daily CT values for the system.
4. Monitor disinfectant levels.

Radionuclides (Proposed)

Requirements
In July 1991, EPA published a proposed rule for radionuclides (Phase III). It included the following proposed MCLs:

Radium-226	20 pCi/l
Radium-228	20 pCi/l
Radon	300 pCi/l
Uranium	20 mg/l
Beta/photon emitters	4 mrem/yr
Adjusted gross alpha	15 pCi/l

The reauthorized SDWA bill sets a 3,000 pCi/L standard for radon. The rule was originally scheduled to be proposed in April 1993. Within 3 years of SDWA reauthorization, the EPA must propose and promulgate a regulation for radon. The SDWA bill sets the effective date for regulations to be enforced at three years after the date on which they are promulgated unless the EPA determines that an earlier date is practicable. EPA or the state may allow up to two additional years to comply if capital improvements are needed.

Monitoring
Currently, the OHD requires monitoring for gross alpha activity every four years. Compliance is based on analysis of an annual composite of four quarterly samples, or the average of the analyses on four quarterly samples. If the gross alpha activity exceeds 5 pCi/L, the same or an equivalent sample must be analyzed for Radium-226. If the Radium-225 activity exceeds 3 pCi/l, the same or an equivalent sample shall be analyzed for Radium-228.

Reporting
Results of the analyses will be required to be reported to the OHD following the monitoring period.

Status of Woodburn
The Radionuclides Rule will apply to Woodburn. Woodburn has monitored for gross alpha activity with detected concentrations ranging from 0 to 0.6 pCi/l. Recent testing for radon showed concentrations ranging from 108 to 532 pCi/L.

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Recommendations for Woodburn Radionuclide Compliance

1. Continue to monitor for radon.
2. Removal requirements for radon will be dependent on the MCL set by the future Radionclides Rule.

Arsenic

Requirements

Arsenic is currently regulated at 50 mg/L. Under the SDWA reauthorization bill, the EPA is required to promulgate a new MCL for arsenic by January 1, 2000. An MCL between 2 to 15 μg/L is under discussion. There is considerable evidence that suggests that arsenic is hazardous at extremely low levels, including evidence that suggest that ingested arsenic causes cancer. Skin cancer data suggests that a 1 in 10,000 risk level for arsenic is 2 mg/L. Internal cancer studies could lower this figure even further. The EPA has estimated that nationwide capital costs for compliance with a 2 mg/L limit for arsenic would be over $6 billion.

Monitoring

Currently, systems are required to monitor each groundwater source for arsenic every three years.

Reporting

Results of the analyses must be reported to the OHD within 10 days after the end of the required monitoring period, unless the results exceed the MCL. In that case, the results must be reported to the OHD within 24 hours, or by the next business day after the results are reported to Woodburn.

Status of Woodburn

Arsenic has been detected in active wells in Woodburn at concentrations up to 13 μg/L. This is below the current MCL of 50 μg/L. It exceeds the majority of the anticipated future MCL range of 2 to 15 μg/L.

Recommendations for Woodburn Arsenic Compliance

1. Monitor for arsenic levels.
2. Future removal requirements for arsenic will be dependent on the future MCL selected.
3. Arsenic will be removed along with proposed treatment processes to remove iron. During the evaluation of a water treatment process for the removal of iron and manganese, Woodburn should monitor their arsenic levels to determine if additional treatment for arsenic removal will be necessary.

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Sulfate

Requirements

The original proposed rule for Phase V contaminants included an MCL for sulfates of 500 mg/L. Sulfate was removed from the final Phase V rule due to controversy over the cost versus benefits of meeting the MCL. The SDWA reauthorization bill requires additional study to determine a reliable dose-response level for sulfate. The bill also allows EPA to promulgate another national standard for sulfate which includes options for the provision of alternative water supplies and public notification.

Monitoring

Monitoring for sulfate was required during the initial three-year compliance period.

Status of Woodburn

The maximum detected sulfate concentration at Woodburn is 16.4 mg/L, well below 500 mg/L.

Recommendations for Woodburn Sulfate Compliance

No actions are required by the City of Woodburn.

Wellhead Protection Plan

Oregon has a voluntary Wellhead Protection Program. A public water system that wishes to have a state certified wellhead protection program must comply with the requirements specified in 333-061-057, 0060, 0065, as well as OAR 340-040-0140 through 0200. A certified Wellhead Protection Plan is required in applying for reduced monitoring of SOCs and VOCs. In addition, the OHD identifies compliance with wellhead protection program as one of the means available for achieving compliance with the MCL for total coliform.

Status of Woodburn System

Woodburn does not have a state certified wellhead protection plan.

Recommendations regarding a Wellhead Protection Plan

1. Woodburn should prepare a wellhead protection plan for state certification during the next five years.
2. With the certification of the wellhead protection plan, request reduced monitoring frequency as applicable for VOCs and SOCs.

9.5 SUMMARY OF DRINKING WATER REGULATIONS IMPACTS

A summary of the drinking water regulations is presented in Table 9-8.

Woodburn is complying with this complex and changing set of regulations. As summarized in this chapter, the water quality issues of concern facing Woodburn, include:

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- Iron and manganese levels which exceed the secondary Maximum Contaminant Levels (MCLs) This situation results in frequent consumer complaints due to taste and odors and stains on plumbing and laundry.
- Providing disinfection to meet the anticipated GWDR.
- Elimination of the non-acute violations noted under the TCR.
- Arsenic levels which potentially exceed the anticipated, future, more stringent MCL for arsenic

Treatment options for iron/manganese removal and potential disinfection are discussed in succeeding chapters.

Table 9-8
City of Woodburn
Summary of Drinking Water Regulations

Analyte	Federal Regulation	EPA/Oregon Status	Monitoring Location	Sampling Frequency	Comments
Coliform	TCR	In effect	Representative points throughout distribution system	Based on population in system (20/month for Woodburn)	Repeat sampling required if coliform is detected
Lead and Copper	LCR	In effect	Source, Distribution System, Tap	Initially 6-month monitoring periods. Two consecutive 6-month rounds of LCR compliance can reduce to once every 3 year period. Three consecutive years of LCR compliance may reduce the frequency to once every 3 years.	Requirements vary depending on 90th percentile level of lead and copper
Chlorine Residual	GWDR	Anticipated Regulation	Compliance Point	Daily during peak hourly flow	For CT compliance, to determine level of inactivation
Chlorine Residual	GWDR	Anticipated Regulation	Entrance to distribution system	Continuous	Must maintain above 0.2 mg/L. Report lowest value each day
Chlorine Residual	GWDR	Anticipated Regulation	Same points as for coliform samples	Daily, and at a minimum, at the same times as coliform samples	
IOCs	Phase II and V	Phase II and V IOCs in effect.	In distribution system representative of each source after treatment	Monitoring is required as per SMF - See Table 9-5.	
TTHMs, THAA	D/DBPs	Anticipated Regulation	Point reflecting maximum residence time in distribution system.	Proposed Rule: Quarterly Currently in accordance with OAR: system with only groundwater: one annual sample per source if THMFP is <0.1 mg/L with written request to OHD	

Table 9-8
City of Woodburn
Summary of Drinking Water Regulations

Analyte	Federal Regulation	EPA/Oregon Status	Monitoring Location	Sampling Frequency	Comments
VOCs	Phase I, Phase II, Phase V	In effect	Entrance to Distribution System	In accordance with SMF - see Table 9-5.	
SOCs: Pesticides, Herbicides, PCBs, Organics	Phase II, Phase V	Phase II and V in effect.	In distribution system representative of each source after treatment.	In accordance with SMF - see Table 9-5.	
Radionuclides: Radium-226 Radium-228 Radon Uranium Beta/photon emitters Adjusted gross alpha	Rad	Proposed Regulation. Currently, under OAR 333-061-0036, monitoring is required for gross alpha activity.	Source	Current OHD: Requires once every four years. Compliance based on analysis of annual composite	Current OHD: If the gross alpha activity exceeds 5 pCi/L, the same or an equivalent sample must be analyzed for Radium-226. If the Radium-225 activity exceeds 3 pCi/l, the same or an equivalent sample must be analyzed for Radium-228
Sulfate	Sulfate	Anticipated OAR 333-061-0036 requires monitoring for sulfate	Source	Not Set	
Arsenic	Arsenic	OAR 333-061-0036 requires monitoring for arsenic	Source	Not Set	

CHAPTER 10
TREATMENT PROCESSES FOR WOODBURN

10.1 INTRODUCTION

The City of Woodburn is faced with the need to provide treatment for their well water. The City has three treatment objectives:

- The reduction of the elevated iron and manganese levels.
- The potential need for disinfection
- The potential need for arsenic removal

Driving Forces

Iron and Manganese Reduction
The existing concentrations of iron and manganese in the active wells exceed the EPA guidance standards and have led to frequent complaints from customers concerning taste, odor, and staining, particularly of yellow rusty laundry stains.

Disinfection
Two types of disinfection are employed in water treatment: primary and secondary. Primary disinfection achieves the desired level of microorganism kill or inactivation. Secondary disinfection ensures a stable residual concentration of disinfectant in the finished water to prevent microbial growth in the distribution system. Some disinfectants can serve either as primary or secondary disinfectants, while some can be used for both processes.

The key factors driving the potential requirement for disinfection for Woodburn include:

- Past non-acute violations with the Total Coliform Rule (TCR) (secondary disinfection only)
- The proposed Ground Water Disinfection Rule (GWDR) (both primary and secondary disinfection)
- The introduction of a disinfectant with treatment for the removal of iron and manganese (secondary disinfection only)

Woodburn implemented measures to address the problem and has been in compliance with the TCR since 1994. The OHD recognizes that these measures appear to be working and presently is not requiring the implementation of disinfection for TCR compliance. Several of the treatment methodologies for iron and manganese removal utilize traditional disinfectants. The OHD has stated that the use of a disinfectant for iron and manganese removal would trigger the requirement of a disinfectant residual in the distribution system. The last driver for disinfection is the GWDR which is described in Chapter 9, "Water Quality Assessment." Disinfection would be required with the implementation of the GWDR.

Arsenic Removal
As described in Chapter 9, depending on the future MCL for arsenic, the reduction of arsenic levels may be required.

Key Decisions To Be Made

Key treatment decisions facing the City are:

- The type of treatment to be provided: Several options exist from chemical/physical to biological methods to sequestering which does not remove the iron and manganese.
- Phasing of treatment: The City may wish to phase construction of the plant for budgetary concerns.
- The location and number of treatment facilities. Since the City does not currently treat its well water, the question of centralized treatment, neighborhood plants, or wellhead treatment must be addressed.

Organization of Chapter

The chapter is organized by:

- A general discussion of the treatment options for iron and manganese reduction, disinfection, and arsenic removal.
- An evaluation of the treatment methodologies. A "fatal flaw" screening is performed to narrow the treatment methodologies to four viable options for the City.
- An description of three treatment location scenarios.
- Budgetary cost estimates are provided for the four viable options for each of the treatment location scenarios.
- A treatment recommendation is made based on the budgetary estimates, the treatment objectives, storage requirements, and operational characteristics.

Evaluation Methodology

With several treatment methodologies and treatment location scenarios to consider, evaluation criteria was developed to rank the alternatives. The criteria was grouped into three main issues: cost, treatment plant performance, and siting/implementation. The following criteria will be considered:

Cost:
1) Capital Cost
2) Operating Cost

Treatment Plant Performance:
1) Reliability
2) Water quality

3) Siting/Implementation:
4) Availability of Property
5) Ease of Operation
6) Safety
7) Impacts on the distribution system
8) Phasing of construction
9) Public Acceptance
10) Neighborhood Impacts (traffic, aesthetics, chemical transport)
11) Implementability

10.2 TREATMENT METHODOLOGIES - IRON AND MANGANESE

Processes typically used for the removal or stabilization of iron and manganese include:

- Chemical Oxidation followed by Filtration
- Biological filtration
- Sequestering

Table 10-1 summarizes the iron and manganese treatment options. The advantages and disadvantages of the iron and manganese removal options are summarized in Table 10-2.

One factor to consider for each of the iron and manganese removal options is whether the option triggers the requirement of a secondary disinfectant. The OHD has stated that if the selected method of iron and manganese removal introduces a disinfectant, as part of the treatment process, then the City must maintain a disinfectant residual in the distribution system. Disinfectants which are part of the iron and manganese treatment options include chlorination, ozone, and UV (a potential process of biological treatment).

Chemical Oxidation Followed by Filtration

Iron and manganese removal can be accomplished by chemically oxidizing the metals to their insoluble forms followed by the removal of the precipitates through either pressure or gravity filtration. Chemical oxidants that have successfully been used for the removal of iron and manganese include: air, chlorine, potassium permanganate, and ozone. Iron oxidizes relatively easily at a neutral pH and short contact time. Manganese oxidizes at a much slower rate and is more dependent upon pH, and is therefore more difficult to remove. Oxidation processes as they apply to Woodburn are discussed below.

Table 10-1
Woodburn Water Master Plan
Iron and Manganese Treatment Options

	Aeration - Filtration	Ozonation and Filtration	Chlorine, $KMnO_4$ and Filtration	Biological Filtration	Proprietary Process Filtration (Filtronics)	Sequestering
Raw Water Metal Concs. Applicable for Treatment (mg/L)	Fe: 1.0 - 10.0 Mn: Not effective at a pH <9.5	Fe: Unlimited Mn: Unlimited	Fe: Unlimited (Most effective at conc. < 2.0 mg/l Mn: Unlimited	Fe: Unlimited Mn: Unlimited	Fe: Unlimited Mn: Unlimited	Total Fe and Mn conc must be less than 1.0 mg/l
Would Trigger Requirement for Disinfectant Residual	No	Yes	Yes (Because of chlorine)	No (Unless Chlorine were used)	No	Yes (If Chlorine used)
Filtration Type	Pressure or gravity filters with dual media of anthracite and silica sand	Pressure filters with dual media of anthracite and silica sand	Pressure or gravity filters with: 1. Dual media of anthracite and sand 2. Dual media of anthracite and green sand	Pressure or gravity filters with: 1. Silica sand to support bacteria 2. Silica sand to support bacteria	Pressure filters with proprietary media supplied by a single manufacturer	None required
Hydraulic Loading Rate	2 to 5 gpm/ft^2	4 to 5 gpm/ft^2	With silica sand: Gravity 2 to 5 gpm/ft^2 Pressure 4 to 5 gpm/ft^2 With green sand: ~ 4 gpm/ft^2	10 - 15 gpm/ft^2	5 - 10 gpm/ft^2 depending on approvals	Added directly into the pipe from the well
Detention Time	Fe: minimum of 20 minutes Mn: > 1 hour (at pH of 9.5)	Generally provide a Ozone contract tank with 3 to 5 minutes of contact time	Nothing additional required - sufficient time available in water above the media	None	2 contact tanks provided with a contact time of 1 minute each	Sequestering chemicals should be injected before the chlorine

Table 10-1
Woodburn Water Master Plan
Iron and Manganese Treatment Options

	Aeration - Filtration	Ozonation and Filtration	Chlorine, $KMnO_4$ and Filtration	Biological Filtration	Proprietary Process Filtration (Filtronics)	Sequestering
Factors Affecting Removal	Rate of removal and treatment performance is improved with: • Increasing temperature • Increasing pH • Decreasing organic content • Increased detention time	Rate of removal and treatment performance is improved with: • Increasing temperature • Decreasing organic content	Rate of removal and treatment performance is improved with: • Increasing temperature • Decreasing organic content	Optimum conditions for: Fe removal: • Zinc <0.45 mg/L • H_2S <0.1 mg/L • pH: 6.0-7.8 • Temp. >10°C • Redox: 0 - 500 mV Mn removal: • Zinc <0.45 mg/L • H_2S <0.1 mg/L • pH >7.4 • NH_4 < 0.1 mg/L • Fe <0.1 mg/L • DO >4.0 mg/L • Temp. >10°C • Redox > 200 mV	Rate of removal and treatment performance is improved with • Increasing temperature • Decreasing organic content	Role of pH uncertain
Theoretical Oxidant Dosage	Saturated dissolved oxygen conditions	Fe: 1 mg/L of ozone per 2.3 mg/L of Fe Mn: 1 mg/L of ozone per 1.5 mg/L of Mn	Fe: 1 mg/L of Cl per 1.6 mg/L of Fe Mn: 1 mg/L of $KMnO_4$ per 0.52 mg/L of Mn (generally lower dosage required in practice)		Fe: 1 mg/L of Cl_2 per 1.6 mg/L of Fe Mn: 1 mg/L of Cl_2 per 0.52 mg/L of Mn SO_2 used as a catalyst at a rate of approx 10% of Cl_2 dose	Varies depending on the chemical selected
Notes	Often used in systems where Fe is found alone, Recommended for high Fe conc. to save chemical costs	Potential to over-oxidize the Mn to $KMnO_4$, which can result in "pink" water complaints	Potential to over dose the $KMnO_4$ which will result in "pink" water complaints	Only one known permitted biological Fe removal plant in the USA that has not been constructed, no permitted biological Mn removal plants in the USA	Proprietary process from California that has shown good results at reduced operating costs, City is tied to one supplier and competition is limited for this process	General only effective for 48 to 72 hours, can cause problems in long dead-end lines or in storage reservoirs

Table 10-1
Woodburn Water Master Plan
Iron and Manganese Treatment Options

	Aeration - Filtration	Ozonation and Filtration	Chlorine, $KMnO_4$ and Filtration	Biological Filtration	Proprietary Process Filtration (Filtronics)	Sequestering
Operational Consideration	Repumping usually required, pH adjustment up and then down would be required for Mn removal	Equipment is operationally complex and expensive to buy, requires significant electrical power, no chemicals to handle, easy to control with a stable groundwater chemistry, requires secondary disinfection	Requires the addition and handling of two chemicals, $KMnO_4$ is corrosive and requires special handling	Need to operate the plant continuously for best operational results, may require variable speed drives on the well pumps,	Process only uses Cl_2 to oxidize both the iron and the manganese, the process is sensitive to organic content in the water, operator friendly	Only requirements are chemical feed pumps and chemical storage, the use of phosphates may result in regrowth in the distribution system, does not remove the Fe and Mn from the water
Backwashing Requirements	Anticipated filter run times of 24 to 48 hours, backwash rates of 15 gpm/ft2 are typical with volumes of 2% to 5% of the water produced	Anticipated filter run times of 24 to 48 hours, backwash rates of 15 gpm/ft2 are typical with volumes of 2% to 5% of the water produced	Anticipated filter run times of 24 to 48 hours, backwash rates of 15 gpm/ft2 are typical with volumes of 2% to 5% of the water produced	Anticipated filter run times of 48 hours, backwash rates of 10 gpm/ft2 are typical with volumes of 0.5% to 2% of the water produced	Short backwashes at rates of 15 gpm/ft^2 are completed every 8 hours to flush the system and release contaminates	No backwashing facility required
Permitting	Widely accepted treatment technology and would be readily permitted OHD	Relatively new technology for Fe and Mn removal but should be readily permitted by OHD with secondary disinfection facilities	"Classical" method for the removal of Fe and Mn, widely used in the USA, it will be readily accepted by the regulatory agencies	Widely used in Europe but new to the USA, permitting would require extensive piloting to demonstrate to OHD that it is a viable and safe treatment technology	Would require pilot testing but do not anticipate any problems gaining approval of the system	Generally accepted by the regulatory agencies for low concentrations of Fe and Mn, may be viewed as a temporary measure

Table 10-2
Woo[illegible]n Water Master Plan
Advantages and Disadva[illegible]ges of Iron/Manganese Removal Options

Disinfection Option	Advantages	Disadvantages
Aeration - Filtration	• Can reduce high concentrations of iron • Would not trigger a requirement for secondary disinfection	• Unsuccessful for manganese removal
Ozonation and Filtration	• Effective for both Fe and Mn removal • Should be readily permitted by OHD • Can serve as primary disinfectant • Provides taste and odor benefits	• Potential to over-oxidize Mn to $KMnO_4$, causing "pink" water • High capital and energy costs • Low filter loading rates • Operationally complex • Would trigger a requirement for secondary disinfection
$KMnO_4$ and Filtration	• Effective for both Fe and Mn removal • Relatively Rapid Reaction • Widely used method to remove Fe and Mn • Operationally simple • Would be readily accepted by OHD • Would not trigger a requirement for secondary disinfection	• Potential to overdose Mn to $KMnO_4$, causing "pink" water • High chemical costs • Low filter loading rates • $KMnO_4$ is corrosive, special handling required.
$KMnO_4/Cl_2$ and Filtration	• Effective for both Fe and Mn removal • Lower chemical costs compared with $KMnO_4$ only • Relatively Rapid Reaction • Operationally simple • Should be readily accepted by OHD	• Potential to overdose Mn to $KMnO_4$, causing "pink" water • Two chemicals required • Low filter loading rates • Would trigger a requirement for secondary disinfection • $KMnO_4$ is corrosive, special handling required.
Biological Filtration	• Capable of producing lowest concentrations of Fe and Mn • Simple operation • Reduced backwash requirements compared with conventional filtration • Small space requirement compared with conventional filtration • Higher hydraulic loading rates compared with conventional filtration • Less sludge production	• Would require pilot testing for acceptance by OHD • Two stage filtration required • Limited application in U.S. • Long initial start-up for manganese removal
Proprietary Process Filtration (Filtronics)	• Simple operation	• Process tied to single supplier • High capital cost due to proprietary nature of process • Would require pilot testing for acceptance by OHD
Sequestering	• Simple operation	• Would not remove iron and manganese, only hold in solution • Effectiveness exhausted after 48 to 72 hours, which could lead to staining problems with large storage volumes and long dead end pipelines • Possible enhancement of biological growth

Aeration and Filtration

Simple aeration can be accomplished with multiple tray aerators, pressure air saturation tank, forced draft aeration and induced draft aeration. Since the reaction time with air is slow, a detention tank is usually provided prior to filtration. The rate of oxidation for aeration is a function of pH, with oxidation increasing with increasing pH.

Aeration alone can usually remove up to 5 to 10 mg/l of iron. A minimum detention time of 20 minutes is required. Complete manganese removal with aeration is difficult, and requires the raising of the pH to 9.5 or above. Even at a pH of 9.5, a detention time of more than one hour would be required. To successfully remove manganese with aeration may require the use of a catalyst or adsorption type media.

Following the aeration process the oxidized metals are removed by filtration. The filters can be either pressure or gravity design and generally operate in the 2 to 5 gpm/ft^2 range. Media's used for iron and manganese removal include silica sands, anthracite coal, and greensand. Filter runs are expected to be 24 to 48 hours with backwash rates of 12 to 15 gpm/ft^2. The manganese concentration in the Woodburn water do not lend itself to the use of simple aeration for removal. The requirement for pH adjustment and long detention times make this process impractical. Aeration will not be considered further for Woodburn.

Ozonation and Filtration

Theoretically, 1 mg/L of ozone will oxidize 2.3 mg/L of iron and 1.5 mg/L of manganese. The required dosages increase with increasing organic content. Given Woodburn's low TOC level (< 2 mg/L), the lower ozone dosages would be anticipated. Ozone is such a powerful oxidant when it is used for the removal of manganese, an overdose will tend to over-oxidize the manganese to permanganate. Permanganate is soluble and can pass through the filter, causing "pink" water and allowing manganese to enter the distribution system. This is usually only a problem if the water quality changes and the dosage remains the same.

Ozone is a very volatile gas that can not be stored but has to be generated on site. Ozone generators require electricity and either an air prep unit or a pure oxygen feed. The pure oxygen feed produces a higher concentration of ozone and is thereby more efficient. Pure oxygen can either be generated on site, which is usually only used for large systems, or purchased as a liquid and stored in pressure vessels on site. The ozone is injected into the water flow as it is produced and usually enters a reaction vessel that provides 3 to 5 minutes of detention time. All of the ozone gas does not go into solution and the excess gas must be handled through an ozone destruct unit.

Following the ozone contractor, the oxidized metals are removed by filtration. The filters are generally pressure filters and operate in the 4 to 5 gpm/ft^2 range. Media's used for iron and manganese removal include silica sands, anthracite coal, and greensand. Filter runs are expected to be 24 to 48 hours with backwash rates of 12 to 15 gpm/ft^2. Because this treatment method uses ozone, a primary disinfectant, the process would trigger the requirement of a residual secondary disinfectant in the distribution system.

$KMnO_4$ or Cl_2 Oxidation and Pressure Filtration

Chlorine and potassium permanganate have been used in the removal of iron and manganese throughout North America. Chlorine, a relatively inexpensive chemical can be used alone or in conjunction with $KMnO_4$ to oxidize the metals prior to filtration. Chlorine rapidly oxidizes iron at neutral pH and can be readily used alone if only iron is found in the water. Chlorine reacts slower with manganese at neutral pH and requires either pH adjustment, a long contact time, or a specially coated media to be effective alone. It has been reported that at pH 8.0, approximately 2 to 3 hours would be required for chlorine oxidation of the manganese. At pH 6.0, 12 hours would be required for the reaction.

$KMnO_4$ is a much stronger oxidant than chlorine and can be readily used alone for the oxidation of both iron and manganese prior to filtration. $KMnO_4$ is not as pH dependent and complete oxidation of the metals generally occurs within a few seconds. For this reason, no additional contact time is provided in the system. $KMnO_4$ is pink in color and an overdose will produce pink water in the distribution system. $KMnO_4$ is highly corrosive and operators must take care in handling the chemical. It is generally delivered in crystal form and is mixed in a day tank for feeding with a chemical dosing pump. The chemical is relatively expensive when compared to chlorine.

It is common to use chlorine and $KMnO_4$ together in an iron and manganese removal plant to accomplish the treatment goals while reducing chemical costs. The chlorine is added first to oxidize the iron and reduce the $KMnO_4$ dose, $KMnO_4$ is then added to oxidize the manganese. Once oxidized, the iron and manganese are removed by a pressure filter. The chlorine in this system can also serve as a primary disinfectant and the utility can take the credit for the contact time in the filters.

The oxidation of iron by either chlorine or $KMnO_4$ is influenced by pH, organic content and temperature. It requires approximately 0.62 mg/l of Cl_2 for every mg/l of Fe and approximately 0.95 mg/l of $KMnO_4$ for every mg/l of Fe to fully oxidize the metal. The oxidation of manganese by potassium permanganate may be influenced by pH, organic content and temperature. Theoretically a dosage of 1 mg/L of potassium permanganate oxidizes 0.52 mg/L of manganese. Less is generally required, unless the manganese is organically bound, which should not be the case given Woodburn's low TOC levels. The oxidation of manganese is pH dependent within the low pH range. However, within the pH range of Woodburn water quality (7.15 to 7.94), the reaction is rapid. At a pH of 7.0, a reaction time of 1 minute has been reported. Above a pH of 7.5 the reaction is essentially instantaneous. Low temperatures have been reported to decrease the oxidation efficiency.

During the process of oxidizing the manganese with $KMnO_4$, manganese dioxides are formed that will coat the filter media. This coating will act as a catalyst and will aide in the oxidation and removal of the manganese from the water. This manganese dioxide coating has an attraction for manganese and has the ability to remove the manganese by adsorption. This allows the $KMnO_4$ dosage to be reduced thereby reducing chemical, operations, and maintenance costs. The manganese dioxide coating on the media must be periodically regenerated with $KMnO_4$.

Following the addition of Cl_2 and $KMnO_4$, the oxidized metals are removed by filtration. The filters are generally pressure filters and typically operate in the 4 to 5 gpm/ft^2 range. Media's used for iron and manganese removal include silica sands, anthracite coal, and greensand. Filter runs are expected to be 24 to 48 hours with backwash rates of 12 to 15 gpm/ft^2. Chlorination to produce a residual in the distribution system would be added after filtration.

Greensand media is a specially coated media that acts as a catalyst in the oxidation of manganese. Greensand has traditionally been used in small installations due to its high cost and the small size of the media. Manganese impregnated greensand (zeolite) is a purple-black material processed using a natural mineral called glauconite. The product is manufactured with manganous sulfate and potassium permanganate to provide an active supply of iron and manganese oxides on the sand grains. A typical greensand filter bed is composed of a top layer of anthracite and a lower layer of manganese greensand. Due to the small size of the media, it has a tendency to plug off quicker than conventional media and thereby reduce the length of the filter run. The anthracite layer reduces plugging of the finer greensand by removing most of the insolubles in the upper layer of the filter. The manganese greens and acts as a "catalyst" removing iron and manganese chemically as well as physically. The greensand will adsorb some of the unoxidized iron and manganese thereby providing a second means of removal in the filter. The greensand also reduces the required dosage of $KMnO_4$ compared with the dual media anthracite/silica sand layer. The greensand is exhausted over time and must be regenerated. Regeneration of the greensand is accomplished in two ways, an intermittent batch process using $KMnO_4$ or continuously by feeding $KMnO_4$ into the raw water. Greensand media is fouled and exhausted by high loading of Fe and Mn, organic material, nitrogenous material, or H_2S. Greensand media has been known to be permanently fouled when used with waters having high organic loading. Filtration rates are generally lower than for conventional filter media and can be expected to be approximately 3 to 4 gpm/ft^2. Filter runs should be approximately 24 hours in length.

Biological Filtration

Biological water treatment is widely used in Europe but has received little recognition in the USA. The US practice has been to minimize biological (pathogen) activity throughout the treatment process while the Europeans have tried to promote controlled biological activity for specific treatment processes. Biological process have been successfully used for 1) Iron removal, 2) Manganese removal, 3)Ammonium nitrification, 4) Nitrate removal, and 5) AOC removal.

In the biological filtration process, bacterial action would be used to oxidize the iron and manganese. For removal of both iron and manganese, two stages (reactors) are generally required. This is necessary because the optimal conditions for biological iron removal and biological manganese removal are significantly different. Typical loading rates for the biological reactors are quite high being 10 to 14 gpm/ft^2. Iron and manganese can be removed in a single reactor in some waters, however the filter loading rates must be very low typically 2 gpm/ft^2. The biological reactors are set up with the proper conditions for the bacteria to grow and thrive and remove the contaminate from the water. This is generally accomplished by the addition of air and pH adjustment to the influent water stream.

Startup times of 2 to 5 days for biological iron removal and 2 to 3 months for biological manganese removal would be expected. Once seeded the reactors will consistently remove the iron and manganese to well below the SMCL. Studies have shown that the biomass is relatively stable and easy to control once established. Although the bacteria recover rapidly from periods of shutdown, it is recommended that the plant be operated continuously. This could be accomplished with the use of variable speed motors on the well and treatment plant pumps.

The filter run lengths in the biological processes are longer than conventional filters due to the compact nature of oxidized metals. The metals become a part of the bacteria and are flushed out during the backwashing process. It has been reported that as much as 5 times as much iron and manganese can be removed per filter volume when compared to conventional filters. The sludge has good settling characteristics and is easily handled.

Backwashing of the filter is accomplished using unchlorinated water to protect the bacteria. The objective of the backwashing is more of a flushing than a cleaning. Rinsing away the dead and old bacteria to maintain hydraulic capacity and sustain bacteria growth are the main functions of the backwash process. Due to these facts, the rate and length of backwashing is significantly lower than in conventional filtration. Anticipated filter runs are from 48 to 72 hours.

Due to the lack of use in North America, extensive pilot testing and consultation with the Department of Health will be necessary to gain approval of the process. It is anticipated that once the process is demonstrated to the regulatory agencies, they will accept it as a viable option.

Advantages of biological treatment over conventional treatment include:

- cost savings due to smaller facilities
- space savings
- higher capacities
- better water quality
- simpler operation
- reduced backwash requirements

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Disadvantages include slow startup times for manganese and ammonium removal and a sensitivity to zinc levels (>0.45 mg/L), H_2S levels (>0.1 mg/L) and ammonia levels. Woodburn's water quality data indicates low concentrations for these constituents. One water sample from Woodburn showed zinc concentrations of 0.87 mg/L, all other concentrations have historically been below 0.21 mg/L. Sulfide concentrations tested in the Woodburn source water in 1989 showed one detected concentration of 0.008 mg/L, well below 0.1 mg/L. Ammonia concentrations are low (~ 0.075 mg/L).

The pH of the process stream is critical. For optimal removal of iron, a pH of around 7.0 is ideal. Higher pH have been used if the dissolved oxygen in the water is low. For optimal removal of manganese, a pH > 7.5 is required. With the pH range of the Woodburn well water (7.2 - 7.9), biological iron removal may require the addition of an acid (such as sulfuric acid) or the addition of CO_2 to lower the pH to optimal conditions. Following biological iron removal the pH may have to be raised by the addition of a base (such as caustic soda) to bring the pH up to the required level and the water aerated to increase the dissolved oxygen level. Because of Woodburn's high alkalinity a significant amount of the acid or CO_2 and base would be required to accomplish the pH changes. Pilot testing would establish the feasibility and operating conditions of the process.

Proprietary Treatment Processes

Due to the prevalence of iron and manganese in groundwater, there are processes on the market that are specifically designed to remove these metals. These processes offer advantages in ease in operation or simplification of the process and can result in operational savings to the City. The disadvantage is that the process is tied to a single supplier and the City must work with that company for the life of the treatment plant.

One of these processes is manufactured by Filtronics of Pasadena, California and utilizes chlorine to oxidize both the iron and manganese. The process relies on a specially coated media that is a trade secret and only available from Filtronics. The media has an affinity for manganese and holds the metal on the media and gives the chlorine an opportunity to oxidize it and remove it in the backwash stream. Chlorine is added to the raw water and the water enters a detention vessel that provides 1 minute of contact time. SO_2 is then added to the water as it enters a second detention vessel that provides another 1 minute of contact time. The SO_2 acts as a catalyst in the oxidation of the iron and manganese.

Backwashing of the Filtronics process is usually completed every 8 hours. The backwash is a high rate short flush of the media to remove the oxidized metals. This backwashing serves to free up adsorption sites on the media that allows the media to attach to the iron and manganese in the water. The media is sensitive to the organic content in the water and can be fouled if the TOC is greater than 1.0 mg/l. The media is also sensitive to H_2S and will foul if there is H_2S in the water.

The Filtronics process is less expensive to operate due to reduced chemical costs when compared to conventional treatment processes. Eliminating the need for $KMnO_4$ addition and relying totally on chlorine takes advantage of the low cost of chlorine. Elimination of the $KMnO_4$ feed also gets rid of a chemical feed system, reducing the cost further. The use of chlorine in the system provides primary disinfection to the system. The disadvantage of the Filtronics system is a higher capital cost due to the proprietary nature of the process and the fact that the City would be tied to a single supplier for service and repair. The Filtronics process would have to be pilot tested for acceptance in the State of Oregon.

Due to the proprietary nature of this process and the requirement to disinfect that would come with this system, this process will not be considered further.

Sequestering with Chlorination

Sequestering agents are often used in water containing low concentrations of iron and manganese to hold the metals in solution rather than remove them through treatment. Typical sequestering agents include polyphosphates and ortho-polyphosphates, which are also used as corrosion inhibitors. The poly/poly-ortho phosphate combines with the iron and manganese to slow and inhibit their oxidation and precipitation.

The sequestering agents are usually successful with combined levels of iron and manganese in the 0.5 to 1.0 mg/l range. The main advantage to the use of sequestering agents is the ease and low cost required to set up the chemical feed system and bring the system on line.

One disadvantage in the use of a sequestering agent is the possible enhancement of biological growth in the distribution system or wells. Polyphosphates can be food source for biofilms and thus can enhance their growth. The chlorine residual in the system must be sufficient to ensure that excessive growth does not occur. Where the sequesterants are added near wells, special care is needed to prevent back contamination of the well which can lead to biological growth problems. Bench scale testing of this treatment method would be recommended prior to it's use to ensure that it is a viable alternative.

Another disadvantage of the use of sequestering agents is that their effectiveness is generally exhausted after 48 to 72 hours. In systems with large storage volumes or with long dead end pipelines, sequestering is not recommended. Woodburn has one operating storage reservoir in the system which provides peak demand storage, emergency reserve, and hydraulic gradient control. The dead end pipelines exist mostly at the cul-de-sacs. Oxidation of the iron and manganese could potentially occur in these areas following the exhaustion of the effectiveness of the sequestering agents. This could lead to rusty or black water complaints and turbidity in the system.

The level of iron and manganese in the Woodburn system are above the recommended maximums for sequestering. The metals are not removed from the system and this process does not meet the City's treatment goals. Sequestering will not be considered for the Woodburn system.

10.3 TREATMENT METHODOLOGIES - DISINFECTION

Disinfection technologies used in drinking water systems include:

- Chlorination (gaseous and liquid)
- Chlorine Dioxide
- Chloramination
- Ozonation
- Ultraviolet light (UV) (not generally used in the USA)

A summary of the disinfection options is presented as Table 10-3. Following the overview of the available disinfection technologies, specific advantages and disadvantages of the various disinfection options will be presented based on a criteria specific to Woodburn. Each disinfection technology will then be ranked according to each criteria.

Disinfection for Woodburn will be designed to inactivate bacteria and viruses. Pathogenic protozoa, such as *Giardia* or *Crypto* are not considered to be a threat in groundwater.

There are two kinds of disinfection required: primary and secondary. Primary disinfection achieves the desired level of microorganism kill or inactivation. Secondary disinfection maintains a disinfectant residual in the finished water that prevents the regrowth of microorganisms. The effectiveness of primary disinfection is measured by the CT value where C is the residual disinfectant concentration and T relates to the contact time. For secondary disinfection, a minimum residual of 0.2 mg/L at any point in the distribution system is maintained. If the City were to experience violations with the TCR, secondary disinfection would most likely be required. The introduction of a disinfectant with treatment for the removal of iron and manganese would trigger the requirement for secondary disinfection. The proposed GWDR would require the City to implement both primary and secondary disinfection.

Chlorination

Chlorine is an effective bactericide and viricide and produces a residual in the distribution system. It has been successfully used for disinfecting public drinking water systems since the turn of the century. It is the most common form of drinking water disinfection in the USA. Chlorine may serve as both a primary and a secondary disinfectant. Chlorination is generally provided by either chlorine gas or liquid sodium hypochlorite feed.

Table 10-3
Woodburn Water Master Plan
Summary of Disinfection Options

	Chlorination Gas	Chlorination Hypochlorite	Chlorine Dioxide	Chloramination	Ozonation	Ultraviolet Light (UV)
Bactericide	Excellent	Excellent	Excellent - more powerful biocide than chlorine.	Fair	Excellent - most potent used in water treatment	Good
Viricide	Excellent	Excellent	Excellent	Weak against virus requires long contact times	Excellent - most potent used in water treatment	Good
Suitable as Primary Disinfectant	Yes	Yes	Yes - If a means of reducing chlorine dioxide and chlorate ions is used (GAC or some strong chemical reducing agent.)	Yes - Although less effective than other disinfectants	Yes	Yes - Particularly groundwater not directly influenced by surface water (since there is a low *Giardia* cyst risk)
Suitable as Secondary Disinfectant	Yes - Provides residual in distribution system	Yes - Provides residual in distribution system	Yes - Provides residual in distribution system	Yes - Provides residual in distribution system	No - Does not provide residual in distribution system	No - Does not provide residual in distribution system
Required Contact Time for Primary Disinfection	Moderate	Moderate	Moderate	Long	Short	Short
Usage	Widespread U.S.	Widespread U.S.	Widespread use in Europe. Limited application in the U.S. - primarily for taste and odor applications.	Limited use in the U.S.	Widespread use in Europe. Gaining widespread use in U.S.	Used for groundwater disinfection, small systems, widespread use in wastewater disinfection
Taste and Odor	Produces taste and odor	Produces taste and odor	Effective against taste and odor	Produces taste and odor. Can produce "fruity taste" at high organic concentrations.[1]	Effective against taste and odor	None

Table 10-3
Woodburn Water Master Plan
Summary of Disinfection Options

	Chlorination Gas	Chlorination Hypochlorite	Chlorine Dioxide	Chloramination	Ozonation	Ultraviolet Light (UV)
DBP Formation[1]	Yes	Yes	When prepared in presence of chlorine; THMs and other DBPs, possible. Also chlorite and chlorate. (EPA recommends maximum residual for ClO_2, chlorite and chlorate ions of 0.1 mg/L).	Less potential to form DBP compared with chlorine.	Potential for formation of bromates in the presence of bromide and aldehydes in the presence of naturally occurring unsaturated aliphatic fatty acids.	None
Other Health Implications	None	None	None	Chloramines are detrimental to individual on kidney dialysis.	None	None
Factors Affecting Effectiveness	Effectiveness decreases with: • Increasing pH. (Ideal pH is 6-7). • Presence of ammonia or organic nitrogen • Presence of other oxidizable substances • Decreasing temperature (Ideal temp. is 20-25°C).	Effectiveness decreases with: • Increasing pH. (Ideal pH is 6-7). • Presence of ammonia or organic nitrogen • Presence of other oxidizable substances • Decreasing temperature (Ideal temp. is 20-25°C).	Effectiveness decreases with: • Decreasing temperature	Effectiveness decreases with: • Increasing pH. • Presence of ammonia or organic nitrogen • Decreasing temperature	Effectiveness decreases with: • Presence of other oxidizable substances. Ideal pH range is below 8.	Effectiveness decreases with increasing levels of: • Suspended solids • Color • Turbidity
Process Parameters Affecting effectiveness	Contact time Mixing Chlorine dosage	Storage time Contact time Mixing Chlorine dosage	Contact time Mixing Chlorine dioxide dosage	Contact time Mixing ratio of ammonia to chlorine Method of chloramination generation	Contact time Mixing Dosage	• Energy dose (lamp intensity x time of exposure) • Intensity governed by power and placement of lamp relative to water. • Exposure time

Table 10-3
Woodburn Water Master Plan
Summary of Disinfection Options

	Chlorination Gas	Chlorination Hypochlorite	Chlorine Dioxide	Chloramination	Ozonation	Ultraviolet Light (UV)
Operation and Maintenance	Easy to control and use	Hypochlorite decomposes - maximum storage time ~ one month. Increased storage space and transportation costs with NaHOCL purchase compared with gaseous chlorine. Easy O&M associated with pumping and metering equipment.	On-site generation required. Optimization of the generator performance is important. Storage not possible.	Requires two chemical feeds.	On-site ozone generation required Storage not possible.	Easy to operate. Requires cleaning of lamps.
Hazards	Toxic gas requires scrubber. Dangerous gas - lethal at conc. above 0.1 percent	Very corrosive. Containment required.	Unstable and explosive in concentrations > 10% by volume (~12 g/L). Gaseous chlorine dioxide toxic.	Same as chlorination hazards.	High levels of ozone are acutely toxic.	None
Capital Costs	Moderate	Low to Moderate	High	Moderate	High	Moderate to High
Operational Costs	Low	Low to Moderate - Overall operation costs are higher than chlorine gas.	High	Moderate	Moderate to High	Moderate

(1) Not a significant issue for Woodburn given the low TOC in the Woodburn water.

Chlorine Gas

Chlorine gas is the most widely used method for chlorinating drinking water in the USA. Chlorine gas is relatively inexpensive and easy to use.

Process Description. Elemental chlorine is supplied in high-pressure cylinders as a liquid. The most common type of a gas chlorinator is a vacuum operated solution-feed system. The equipment is inexpensive and easy to use and control. The chlorine gas is released from the cylinder in a vacuum tube which is connected to an injector in a side stream of water. The chlorine gas and the water form a solution of hypochlorous acid and hypochlorite ion, which is then fed to the water supply providing the disinfection power.

Process Considerations. Chlorine gas is extremely toxic in low concentrations in the atmosphere. Recent changes in the regulations for chlorine gas require that storage facilities have complete containment and for systems having more than two 150-pound cylinders in storage, a chemical neutralization (scrubber) system is required in case of a leak or a rupture.

Sodium Hypochlorite (Bulk)

Process Description. Hypochlorite may either be purchased directly or produced on-site. Sodium hypochlorite solution (the active component of household bleach) is supplied commercially in concentrations of 5 to 15 percent chlorine. The solution is metered directly into the water using a chemical feed pump.

Process Considerations. Sodium hypochlorite is more easily handled than gaseous chlorine and gives less maintenance problems with pumping and metering equipment. The use of a liquid rather than a gas provides operator and community safety and eliminates the need for a scrubber system. The volume of the hypochlorite solution required and the corresponding weight, as compared to chlorine gas, increases the cost of transporting and storing the chemical. In strengths greater than approximately 5%, sodium hypochlorite is unstable, and deteriorates rapidly over time producing chlorate ions. Chlorate has been linked to health problems. A 12% solution can be stored a maximum of one month. To slow the rate of decay and the formation of chlorate, it is recommended that the 12% solution be diluted to 4% or less. This requires additional handling and storage volume.

The solution is corrosive with a pH of 11, requiring secondary containment. If the carrier water used for dispersion of the hypochlorite has appreciable hardness, precipitation of calcium carbonate can occur in rotometers and piping. If undiluted hypochlorite is pumped directly to the point of application, off-gassing of chlorine due to long retention times in the piping can occur, causing inconsistent feed rates. Off-gassing can also burst pipes if not taken into account in design. Providing a dilution tank that would allow a 4% solution reduces the precipitation and off-gassing problems with the feed equipment.

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Sodium Hypochlorite (On-site Generation)
To eliminate the need to handle and store liquid sodium hypochlorite, systems have been developed that produce a low concentration of sodium hypochlorite using salt and electrodes. This system only requires the operator to handle salt and produces fresh low strength hypochlorite that is less susceptible to degradation over time. The dependability and cost effectiveness of on-site hypochlorite generation has been proven in recent years for small water systems.

Process Description. Hypochlorite at approximately 0.8% solution strength is generated electrolytically from a salt solution (brine). The system for on-site production of hypochlorite solution consists of a two-cell unit which electrolyzes a brine solution, producing hypochlorous acid in one cell and a solution of caustic soda (NaOH) in the other cell. The hypochlorite solution flows to a day tank that is connected to a chemical feed pump. The hypochlorite solution is then pumped from the day tank to the point of application. Because the concentration is low relative to bulk hypochlorite, larger metering pumps are required than for bulk hypochlorite feeding.

The on-site generation requires pure salt (99.7% NaCl) to protect the electrodes from contamination. Salt consumption is typically 3 to 4 pounds of salt to generate the equivalent of one pound of chlorine. In addition, 15 gallons of water and 2.5 kWh of electrical power per pound of chlorine equivalent is required.

Process Considerations. The capital costs for an on-site generation system are significantly higher than for a bulk delivered sodium hypochlorite feed system. However, operation and maintenance costs per pound of applied chlorine are considerably less for on-site generation when compared to delivered hypochlorite. The capital costs for the system must be amortized over several years to determine the relative economics of the system. During the generation process some hydrogen and caustic soda are produced that are hazardous to deal with if not properly handled.

Chlorination Considerations
Water quality parameters which affect the disinfection capabilities of chlorine include:

- Other oxidizable substances in the water which exert a chlorine demand that must be satisfied before an excess of free chlorine is available for disinfection
- Particulate concentration
- pH - the effectiveness of chlorine decreases with increasing pH
- Temperature - the effectiveness of chlorine decreases with decreasing temperature
- Ammonia or organic nitrogen which form chloramine complexes

Two drawbacks of chlorine disinfection are its tendency to form disinfection byproducts and the taste and odor associated with chlorine. Because the raw water in Woodburn's wells has a low organic content, the formation of disinfection byproducts is not a major concern.

Chlorine Dioxide

Chlorine dioxide has been used as a disinfectant by several large systems in Europe. In the U.S., its application has been primarily in taste and odor control. Chlorine dioxide is a strong bactericide and viricide and produces a residual in the distribution system so it may be used as both a primary and secondary disinfectant. Chlorine dioxide is a weaker oxidant than chlorine and would not benefit an iron and manganese removal system.

Process Description

Chlorine dioxide is an unstable gas, which must be generated on site. Chlorine dioxide is generated by oxidizing sodium chlorite (which may be either a 25 percent aqueous solution or a solid) with either chlorine gas, sodium hypochlorite solution and mineral acid, or mineral acid alone at a pH of 4 or less. The most common chlorine dioxide generation process uses chlorine gas and sodium chlorite. The aqueous solution of oxidant is metered into and mixed in a chlorine dioxide reactor. The resulting solution is pumped directly into the water to be treated.

Based on health effect studies the EPA recommends a maximum residual for chlorine dioxide and its decomposition products (chlorite and chlorate ions) of 0.1 mg/L. To meet the residual requirements, a 1.2 to 1.4 mg/L dose of chlorine dioxide is generally recommended. Because of the narrow range, optimization of the generator performance is important.

The majority of chlorine dioxide added to water is converted to chlorite ion. Excess chlorine dioxide and chlorite ions can be reduced to chloride ion with sulfur dioxide. Chlorate is formed as a by-product during the chlorine dioxide oxidation/disinfection step, especially when free chlorine is used. Unlike chlorite, chlorate cannot be removed from drinking water by currently available treatment techniques. Chlorate formation may be minimized by avoiding conditions of high pH values and/or low initial reactant concentrations, and the presence of free hypochlorous acid.

Process Considerations

The bactericidal effectiveness of chlorine dioxide has been shown to be unaffected by pH values in the range of 6.0 to 10.0, although some references have shown increasing effectiveness within a higher pH range (8.5 - 9). The efficiency of chlorine dioxide decreases with decreasing temperature. Design parameters which affect the efficiency of chlorine dioxide disinfection include contact time, mixing and chlorine dosage.

Another drawback of the use of chlorine dioxide is the requirement of on-site generation, which increases its cost of construction and operation relative to chlorination. Since chlorine dioxide must be generated and fed into the system, no storage is required and conversely no back up supply is available if the generator breaks down or requires maintenance. For this reason a backup system of chlorine gas or hypochlorite feed is required. Chlorine dioxide gas is toxic and unstable and explosive in concentrations greater than 10% by volume (~12 g/L).

Chloramination

Chloramines are formed by adding chlorine and ammonia into water. Chloramines are less effective bactericides and viricides than chlorine. They do produce a long lasting residual in the distribution system, and thus may in some cases be most effective as secondary disinfectants. Chloramines do not react with organic materials in the water as rapidly as chlorine and thus produce lower THM's, a disinfection byproduct. For this reason, the majority of utilities which rely on chloramination for disinfection, do so because they have THM concerns. Due to the low organic content found in the Woodburn well water, THM formation is not anticipated to be a problem.

Process Description

There are three methods to produce chloramines:

1) Adding ammonia to chlorinated water
2) Adding chlorine to water already treated with ammonia
3) Using a pre-formed solution of monochloramine

The first method is the most effective of the three because disinfection is provided by the free chlorine prior to adding the ammonia. THM and other DBPs will form in the chlorinated water (in the same way under chlorination) however the reaction time is controlled, thus reducing the THM formation. Once the ammonia is added, DBP formation will be inhibited. In the second and third methods the solution is less effective because the disinfection is provided by the chloramine, not free chlorine. Chloramine is a weaker disinfectant than free chlorine and requires a longer contact time to produce the same disinfection results.

The chlorination step requires the same process as for chlorination (chlorine gas or sodium hypochlorite). Ammonia is available as an anhydrous gas (150 lb. cylinders), an aqueous solution (aqua ammonia) (55-gallon drums) or as ammonium sulfate powder (100-lb bags). Ammonia gas is injected into treated water using a similar system as for chlorine gas. Aqua ammonia is similar to sodium hypochlorite. For ammonium sulfate powder, a 25 to 30 percent solution is prepared and injected using a chemical metering pump.

Process Considerations

Water quality parameters which affect the disinfection capabilities of chloramination include:

- pH - For chloramines, there is an increased effectiveness with an increasing pH. For free chlorine, there is an decreased effectiveness with increased pH.
- Temperature - decreasing effectiveness with decreasing temperature.
- Ammonia or organic nitrogen - decreased effectiveness with ammonia concentrations (this affects the process effectiveness only if the chlorination is provided prior to the ammonia addition)

Disadvantages of chloramination include the costs and operational concerns of an additional chemical feed (ammonia) and the longer required contact time prior to the first customer.

Advantages include lower THM formation. Chloramines residuals last longer than free chlorine, and therefore chloramination may be used as a post disinfectant in combination with other disinfects.

The hazards associated with chlorination apply to chloramination: toxicity in handling both gaseous chlorine and ammonia, or the corrosiveness in handling sodium hypochlorite or liquid aqua ammonia.

Ozonation

Ozone is among the strongest oxidants used in water treatment. Ozone will inactivate bacteria, viruses, and protozoa cysts. Ozone is becoming a more common disinfectant due to reduced equipment cost and ease in operation. Ozone is very unstable and has a short life, therefore, it can not be stored and must be generated on-site. Ozone does not form a persistent residual, and, therefore, cannot be used as a secondary disinfectant.

Process Description

The five major elements of an ozonation system are:

- Air/Oxygen feed
- Electrical power supply
- Ozone generator
- Contact Chamber
- Ozone exhaust gas destruction unit

Air/Oxygen Feed. Ozone can be generated using either dry ambient air or pure oxygen. For ambient air feed, the air is first dried before use in the ozonation system to prevent fouling of the ozone production tubes and increased corrosion in the ozone generator. A pure oxygen feed system has higher capital costs but offers the following advantages over ambient air:

- A smaller ozone generator and smaller ancillary equipment can be used (roughly half the size)
- Lower energy consumption
- Higher concentrations of ozone generated
- If used with a once-through system, gas recovery and pretreatment equipment are eliminated.

Oxygen may be purchased as a gas or as a liquid, or produced on-site. There are two methods for producing oxygen on-site for ozone generation: pressure swing adsorption of oxygen from air and cryogenic production (liquefaction of air followed by fractional distillative separation of oxygen from nitrogen). Pressure swing adsorption systems are generally used for smaller-sized plants. Cryogenic separation systems are practical for large systems (20 to 20,000 tons of O_2/day). Cryogenic oxygen production is more capital intensive than by pressure swing adsorption, but generally operation and maintenance costs are lower. Cryogenic systems are operationally sophisticated and operation and maintenance expertise is required.

Electrical Power Supply. Ozone generators use high voltages (generally >10,000 V) or high-frequency electrical current (up to 2,000 Hz), necessitating special electrical design considerations.

Ozone Generation. Ozone for water treatment is usually generated using a corona discharge cell. If ambient air is fed to the generator, the generator produces dry, cool air containing 1 to 3.5 percent ozone (by weight), which can be mixed with water. When pure oxygen is used, the concentration of the ozone is approximately doubled (up to 8 to 9 percent by weight).

Ozone Contractor. Ozone may be generated under positive or negative air pressure. Under positive pressure, the contractor most commonly used is a two-chamber porous plate diffuser, with a 16-ft high water column. Other positive pressure ozone contactors include packed columns, static mixers, and high speed agitators. Under negative pressure, a vacuum draws the ozone mixture from the generator providing contact as the gas mixes with the flowing water. Contactors are designed to provide 3 to 5 minutes of ozone contact with the water.

Destruction of Ozone. The ozone in the exhaust gases from the contacting unit must be destroyed or removed by recycling prior to venting. The primary methods of destroying excess ozone include: thermal destruction, thermal/catalytic destruction, and catalytic destruction (with metal catalysts or metal oxides). Moist granular activated carbon is used extensively at European plants treating less than 2 mgd.

Process Considerations

Water quality parameters which affect the disinfection capabilities of ozone include:

- pH
- Temperature
- Turbidity
- Organic material

Design parameters which affect the efficiency of ozonation include degree and type of mixing and the ozone dosage.

Ozone is more efficient than free chlorine, disinfection can be achieved with relatively small contactors or concentrations than with free chlorine. In the presence of significant concentrations of dissolved bromides, ozonation may result in formation of brominated THMs and bromate as well as the production of potentially hazardous by-products including aliphatic aldehydes and ketone compounds. Woodburn TOC levels are low (< 2 mg/L), which reduces the likelihood of the formation of these compounds. Woodburn has not tested for bromide concentrations.

Ozone is the strongest disinfectant and oxidizing agent available for water treatment. In the presence of iron and manganese, ozone will oxidize the metals causing the precipitation of metal oxides. In the presence of the iron and manganese, the measurement of the degree of disinfection (dissolved ozone concentrations) is impractical.

Ozone in the atmosphere is a toxic gas. An advantage of ozone gas toxicity over chlorine gas toxicity is that ozone has a distinct smell at concentrations much lower the harmful levels and dissipates very rapidly. Since ozone is generated on-site, transportation hazards are eliminated. Additionally, since ozone can not be stored, secondary containment or a scrubber system is not required.

Ultraviolet Light Disinfection (UV)

UV disinfection is an effective bactericide and viricide, but is ineffective as a cysticide. Consequently, it may be used as a primary disinfectant for groundwater's only, where there is no threat of *Giardia* cyst presence. In UV disinfection, the bacteria and viruses are inactivated by the radiation energy (254 nm wavelength) of ultraviolet light. To be effective, the light must strike the organism. The radiation destroys the cell's genetic material and the cell dies. UV disinfection does not produce a residual in the distribution system. Therefore, its application requires a second disinfectant, capable of providing a sustainable residual.

Process Description

The primary source of UV energy is the low pressure mercury arc lamp. UV lamps are usually submerged in the water, perpendicular or parallel to the water flow. Maintaining plug flow conditions is important. Lamp diameters are typically 0.6 to 0.8 inches. Arc lengths of lamps (the active light-emitting portion of the lamp) are generally 2.5 to 4.9 feet.

The most important operating factor for the UV reactor is the cleanliness of the surface. The need for cleaning is based on visual inspection of the surface. The surface of the lamps are cleaned manually with a mild soap solution and swabbed with isopropyl alcohol. In a drinking water application, the lamps will stay clean for extended periods of time.

Process Considerations

Water quality parameters which affect the disinfection capabilities of UV include:

- Suspended solids
- Color
- Turbidity

Design parameters which affect the efficiency of UV include UV energy and the time of interaction (contact time). Since there is no chemicals used, there essentially no hazards associated with the use of UV disinfection. A secondary chlorine feed will probably be required to produce a measurable residual in the distribution system.

Disinfection Criteria for Woodburn

An following criteria was developed to assess the various disinfection options for Woodburn:

- Effective primary disinfection
- Effective secondary disinfection (ability to maintain a residual in the distribution system)

- Minimization of hazards
- Economics
- Ease of Operation and Maintenance
- Applicability to various treatment scenarios (regional, central or wellhead treatment)

Table 10-4 presents a summary of the major advantages and disadvantages of each disinfection option. Table 10-5 presents a ranking within each criteria for each of the disinfection options. Because of low TOC (<1.0 mg/L) in the Woodburn well water, DBP formation (associated predominantly with chlorination) is not a significant issue. Likewise, oxidation demand from organic material would not be a problem. Because Woodburn's ammonia levels (approximately 0.075 mg/L) are low, complexation with ammonia (with chlorination) will not be a problem.

10.4 TREATMENT METHODOLOGIES - ARSENIC

Processes typically used for the removal of arsenic include:

- Removal with iron salts
- Adsorption onto iron oxides
- Adsorption on an activated alumina column

Arsenic Removal Processes

Arsenic Removal With Iron Salts
Chemical clarification with ferric sulfate has been successfully used in the removal of arsenic. Arsenic has a strong affinity for iron salts. Following oxidation of the water the arsenic is removed by coagulation, clarification, and filtration.

Adsorption Onto Iron Oxides
Because of the strong affinity between arsenic and iron, arsenic will attach to iron oxides. With the oxidation and removal of iron, the arsenic is also removed. It is common to note a reduction in arsenic concentration with the removal of iron from water.

Adsorption on an Activated Alumina Column
Arsenic will adsorb onto activated alumina, a byproduct of aluminum production. The water is passed through a contact column of activated alumina, reducing the arsenic level in the water. Regeneration or replacement of the activated aluminia is required following 20 to 30 thousand bed volumes, depending on the amount of arsenic removed.

Potential Treatment Alternatives for Arsenic Removal

The arsenic levels will be monitored with the iron levels. It is proposed that the arsenic will be removed with the iron during the treatment process and no special techniques will be necessary.

Table 10-4
Woodburn Water Master Plan
Advantages and Disadvantages of Disinfection Options

Disinfection Option	Advantages	Disadvantages
Chlorination Gas	• Primary and secondary disinfectant • Easy to use • Low chemical cost • City familiar with use • Most common approach used • Oxidant for taste & odor, Fe and Mn (limited)	• Toxicity • Safety (transport, handling & storage) • Need for containment, scrubbing • DBPs (not significant for Woodburn) • Chlorine taste
Sodium Hypochlorite - Bulk	• Primary and secondary disinfectant • Reduced safety concerns • No scrubbing required • Metering is relatively simple • Low capital cost • Easy maintenance and handling • Oxidant for taste & odor, Fe and Mn (limited)	• High chemical cost • Crystallization, gassification, corrosive • Chlorine taste • Increased storage requirements • Deterioration with storage • DBPs (not significant for Woodburn)
Sodium Hypochlorite - On-site Generation	• Primary and secondary disinfectant • Reduces safety concerns • Easy to use • Metering is relatively simple • Containment not required. • Oxidant for taste & odor, Fe and Mn (limited)	• High capital cost • Larger pumps required • DBPs (not significant for Woodburn) • Corrosive • Chlorine taste
Chlorine Dioxide	• Strong biocide • Oxidant for taste & odor, Fe and Mn (limited)	• On-site generation (higher capital costs) • Not widely used • Produces chlorite and chlorate • Unstable and explosive (>10% volume)
Chloramination	• Primary and secondary disinfectant (possible) • Lower DBP formation (not significant benefit)	• Involves two chemicals • Less powerful oxidant • Requires long detention

Table 10-4
Woodburn Water Master Plan
Advantages and Disadvantages of Disinfection Options

Disinfection Option	Advantages	Disadvantages
Ozonation	• Most powerful oxidant • Oxidant for taste and odor, Fe and Mn • Containment relatively easy	• Need additional secondary disinfectant • High capital cost • High energy cost • More sophisticated equipment to maintain • Toxic gas • Bromate and aldehyde formation
Ultraviolet Light (UV)	• Simple to maintain and operate • No chemicals • Minimal safety issues • Suitable for remote sites • Minimal space requirements	• Primary disinfectant only • Weak oxidant • High energy cost • Not widely used for potable water treatment

Table 10-5
Woodburn Water Master Plan
Criteria and Assessment of Disinfection Options

	Chlorination Gas	Chlorination Hypochlorite	On-Site Cl_2 Generation	Chlorine Dioxide	Chloramination	Ozonation	Ultraviolet Light (UV)
Disinfectant Effectiveness							
Bacteria	Excellent	Excellent	Excellent	Excellent	Moderate	Excellent	Good
Virus	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Good
Ability to Maintain a Residual	Yes	Yes	Yes	Yes	Yes	No	No
Ease of Operation and Maintenance	Simple	Simple	Simple	Moderate	Moderate	Moderate	Simple
Hazards	Moderate to High	Moderate	Low	Moderate to High	Moderate	Moderate	Low
Relative System Capital Cost (1-10)	6	3	6	7	6	10	4
Applicable for Regional Plant	Excellent	Excellent	Excellent	Fair	Excellent	Excellent	Excellent
Applicable for Central Plant	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Applicable for Wellhead Treatment	Fair	Excellent	Excellent	Poor	Excellent	Excellent	Excellent
Secondary Impact Problems	Taste and Odor	Taste and Odor	Taste and Odor	None	None	Secondary Disinfection Required	Secondary Disinfection Required

10.5 FATAL FLAW SCREENING OF TREATMENT METHODOLOGIES

The iron and manganese treatment options which were eliminated from consideration along with the fatal flaw of each include:

- Aeration/Filtration - Not effective in removing manganese
- Proprietary Process Filtration - Process tied to single supplier
- Sequestering - Does not reduce iron and manganese concentrations; only effective for 48 to 72 hours.
- Cl_2/ Filtration - Not effective in removing manganese
- Greensand Filtration - High cost and short run lengths

The disinfection options which were eliminated from further consideration along with the fatal flaw of each include:

- Chloramination - Requires two chemical feeds
- Chlorine Dioxide - High relative capital costs

Four processes were selected as viable treatment options for the removal of iron and manganese for the City of Woodburn. Three of the four selected would also provide primary disinfection to the system. The fourth, $KMnO_4$ oxidation and filtration would initially not have disinfection, however, chlorination could be added at a later date. Features of the four selected alternatives are summarized in Table 10-6 and are illustrated in Figures 10-1, 10-2, 10-3, and 10-4.

10.6 TREATMENT LOCATION SCENARIOS

The treatment location scenarios that are being considered by Woodburn are as follows:

1) One treatment plant (located in the north central part of the City in the vicinity of Well 10). Conceptual layout is shown in Figure 10-5.
   Requires
   - Raw water transmission piping from the other wells
   - Examination of the distribution system hydraulics

2) Neighborhood treatment plants (one located at Well 10 and one located in the southwest corner of the City). Conceptual layout is shown in Figure 10-6.
   Requires
   - Multiple facilities
   - Raw water transmission piping from neighboring wells
   - Examination of the distribution system hydraulics
   - Property acquisition for some sites

3) Wellhead treatment plants (five plants at Well 7, 8, 9, 10, and in the southwest corner of the City). Conceptual layout is shown in Figure 10-7.

Requires

- Multiple facilities
- Property acquisition for some sites

10.7 EVALUATION OF TREATMENT FINALISTS

Water Treatment Alternative Evaluation

The four treatment alternatives and three plant location scenarios were developed in order to evaluate each treatment scheme. The evaluation was based on general treatment facility layouts, the actual details would be developed during pre-design of the treatment plant. The four treatment alternatives considered are:

- oxidation with potassium permanganate followed by filtration;
- oxidation with sodium hypochlorite and potassium permanganate followed by filtration;
- oxidation by ozonation followed by filtration; and
- biological filtration.

The three plant location scenarios considered are:

- one centralized treatment plant;
- two neighborhood treatment plants, and;
- five wellhead treatment plants.

All required improvements and any phasing that may occur for a plant location were included in the cost estimates to assess the full costs of the alternative.

Conceptual layouts for each of the plant location scenarios used in alternative evaluation are shown in Figures 10-5, 10-6, and 10-7. The total minimum treatment system capacity was set at 10.5 mgd (the maximum day demand in 2020) with an average day demand of 4.5 mgd. In order to meet the maximum day demand, four new wells with a total capacity of 5.7 mgd would be required. The basic treatment facilities included in each alternative are filtration, chemical feed, backwash handling, process pumping, operations, and electrical. Future facilities are included in the layouts and may or may not be required for each facility.

The conceptual design is to maintain the process stream under pressure throughout treatment and pump to a ground level reservoir. The well pumps would provide most of the pumping head needed. Additional head would be provided by process pumps, before or after filtration, in order to feed the reservoir. A distribution system booster pump station will be constructed to pump water from the reservoir. Process pumps may not be required with treatment plants located at the wellheads. Filtration costs are based on using 12 foot diameter pressure filters. The loading rates assumed were 4 gpm/ft^2.

Table 10-6
Woodburn Water Master Plan
Summary of Viable Treatment Alternatives

Criteria	$KMnO_4$ - Filtration	$KMnO_4$ - Chlorination - Filtration	Ozonation - Filtration - Chlorination	Biological Filtration - Chlorination
Reliability	Proven iron and manganese removal technology, capable of consistently producing high quality water	Proven iron and manganese removal technology, capable of consistently producing high quality water, use of pre-chlorination reduces the quantity of $KMnO_4$ required.	Becoming more common in iron and manganese removal, once adjusted, capable of consistently producing high quality water, use of ozone requires expensive complex equipment, ozone can not be stored on site.	New technology, not proven in Oregon, once the biomass is established, it is stable and easy to operate
Includes Primary Disinfectant and a Residual	No	Yes, with the introduction of chlorine, the Oregon Health Department will require keeping a residual in the distribution system.	Yes with the introduction of ozone, a primary disinfectant, the Oregon Health Department will require keeping a residual in the distribution system.	Yes
Water quality	Once fine tuned, capable of achieving low concentrations of iron and manganese. Need to monitor the water quality to prevent over dosing of chemical and producing "pink water"	Commonly use treatment technique capable of achieving high quality finished water. Need to adjust dosage of KMnO4 to prevent an over dose and produce "pink water".	Properly dosed ozone followed by filtration is capable of achieving low concentrations of iron and manganese. Potential for overdosing an producing permanganate or pink water.	Once established, the biological reactors are capable of consistently reducing both the iron and manganese to non-detectable levels.
Ease of Operation	Requires the addition and handling of a hazardous chemical. $KMnO_4$ is delivered in crystal form and must be mixed in a day tank for feeding. $KMnO_4$ feeding by diaphragm chemical feed pump. Easy to control and monitor.	Requires the addition and handling of two hazardous chemicals $KMnO_4$ and Cl_2. $KMnO_4$ is delivered in crystal form and must be mixed in a day tank for feeding. $KMnO_4$ feeding is by diaphragm chemical feed pump. Chlorine feed would be sodium hypochlorite. Easy to control and monitor.	Complex equipment to operate and maintain. Easy to control with a stable groundwater chemistry. Requires the addition of chlorine for secondary disinfection and maintaining a residual in the distribution system Ozone can not be stored, it must be generated on site.	Easy to control and operate once established. Continuous operation produces highest best results. Requires the addition and handling of three chemicals (CO_2, NaOH, chlorine). Longer filter runs compared to conventional filtration.
Hazards	$KMnO_4$. is a strong oxidant that requires care in handling.	Hazards association with chlorination, $KMnO_4$.	Hazards association with chlorination, ozonation.	Hazards association with chlorination, caustic, and CO_2.

The filters would be backwashed using treated water from the distribution system and blowers for air scour. Backwash basins are included to allow settling of the waste backwash water and then recycle of the decant to the head of the plant. A backwash residuals pump station would be used to send settled material from the backwash basin to the sewer.

Each alternative, except biological filtration, include polymer dosing facilities. Polymer is often used to improve the filtration process and also to provide better settling in the backwash basins.

Other Required Facilities

The three proposed treatment configurations, 1) a centralized plant, 2) two neighborhood plants, and 3) five wellhead plants all require certain other facilities. Each alternative and the necessary distribution system improvements are illustrated on the three system maps attached to the back of this report. Depending on the location of the treatment plant and the number of plants constructed, the distribution system will require improvements to meet all of the operational criteria established for the system. These factors have to be considered when recommending the treatment plant configuration for the City of Woodburn.

Recommended Treatment Process

The recommended treatment process is $KMnO_4$ oxidation followed by pressure filtration. This process was selected over the other three for ease in operation, economics, flexibility, only one chemical is required, compact equipment layout, the process has a proven track record all across the United States, the process is readily accepted by the Health Department, and its ease of phasing.

Water Treatment Plant Costs

Budgetary water treatment plant costs were developed for the three proposed locations for the selected process. These costs are presented in Table 10-7, 10-8, and 10-9. The construction costs are for the treatment facilities, transmission piping, and new wells, and included a 30 percent contingency. The total capital costs represent the construction costs plus the indirect costs such as property acquisition, engineering, administration, and permitting.

The present worth is the cost adjusted for inflation and then discounted back to 1996. Using a present worth allows the impact of phasing to be evaluated as to total project costs.

The present worth of the construction costs for the three alternatives indicate that the neighborhood and the wellhead treatment plants are the most cost effective. This is due to the phasing of facilities and only building what is needed now. The central plant present worth cost is higher than the other two due to a lack of phasing and the significant amount of raw water transmission piping that is required for the alternative. Although both the neighborhood and the wellhead alternatives require multiple facilities, the phasing and the reduced raw water transmission piping required make them attractive to the City. The central treatment plant alternative will not be considered further.

ADVANTAGES of the **Neighborhood plant alternative** over wellhead treatment:

- Regionalized facilities
- Reduced operation and maintenance costs due to fewer facilities to operate
- Lower present worth costs
- Fewer plants may make it easier to find acceptable treatment plant sites
- Chemical delivery simplified to two locations
- Telemetry and control system simplified to two locations

DISADVANTAGES of the **Neighborhood plant alternative** over wellhead treatment:

- Larger individual facilities are more costly to construct
- Larger facilities required, may limit sites available and public acceptance
- More raw water transmission piping required
- Higher well pumping costs
- More impact on system hydraulics

ADVANTAGES of the **Wellhead plant alternative** over neighborhood treatment:

- Phasing of construction very flexible
- Small localized facilities
- Less raw water transmission mains required
- Lower well pumping costs
- Least impact on system hydraulics

DISADVANTAGES of the **Wellhead plant alternative** over neighborhood treatment:

- Three more facilities to operate and maintain
- May have trouble finding acceptable treatment plant sites for some wells in residential neighborhoods
- Highest individual plant construction cost due to multiple facilities
- Highest operation and maintenance costs due to multiple facilities
- May have to hire additional staff
- Delivery of chemicals complicated by multiple locations
- Telemetry and control system complicated by multiple facilities

Based on the budgetary estimates, the treatment objectives, and the operational characteristics, it is recommended that Woodburn construct two neighborhood treatment plants using $KMnO_4$ to oxidize the iron and manganese. The first would be constructed and be operational by the year 2002 and would be located in the vicinity of Well 10. The treatment plant would treat water from Wells 8, 9, 10, and 11. Well 7 would pump untreated water into the system during peak demands until the second plant is built. The second plant would be located in the southwest corner of the city and would treat water from Well 7 and the four proposed wells. This plant would be constructed in the year 2010.

It is recommended that the City conduct a pilot study on the well to verify that the $KMnO_4$ process will meet their treatment objective. A engineering pre-design report will provide detail and refinement to the plant configuration and cost estimate.

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Figure 10-1
Woodburn Water Master Plan
$KMnO_4$ with Filtration

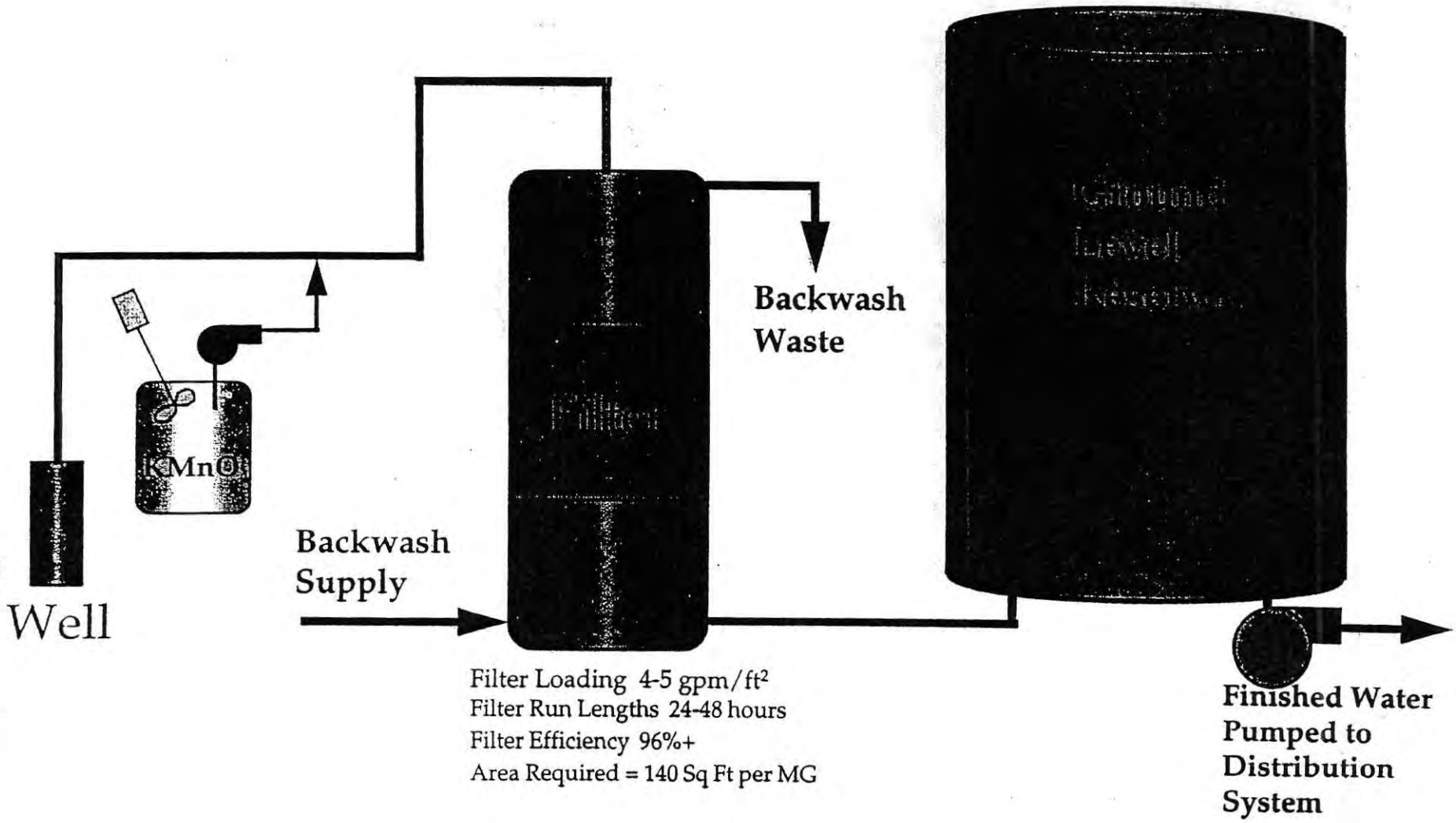


Figure 10-2
Woodburn Water Master Plan
$Cl_2/KMnO_4$ with Filtration

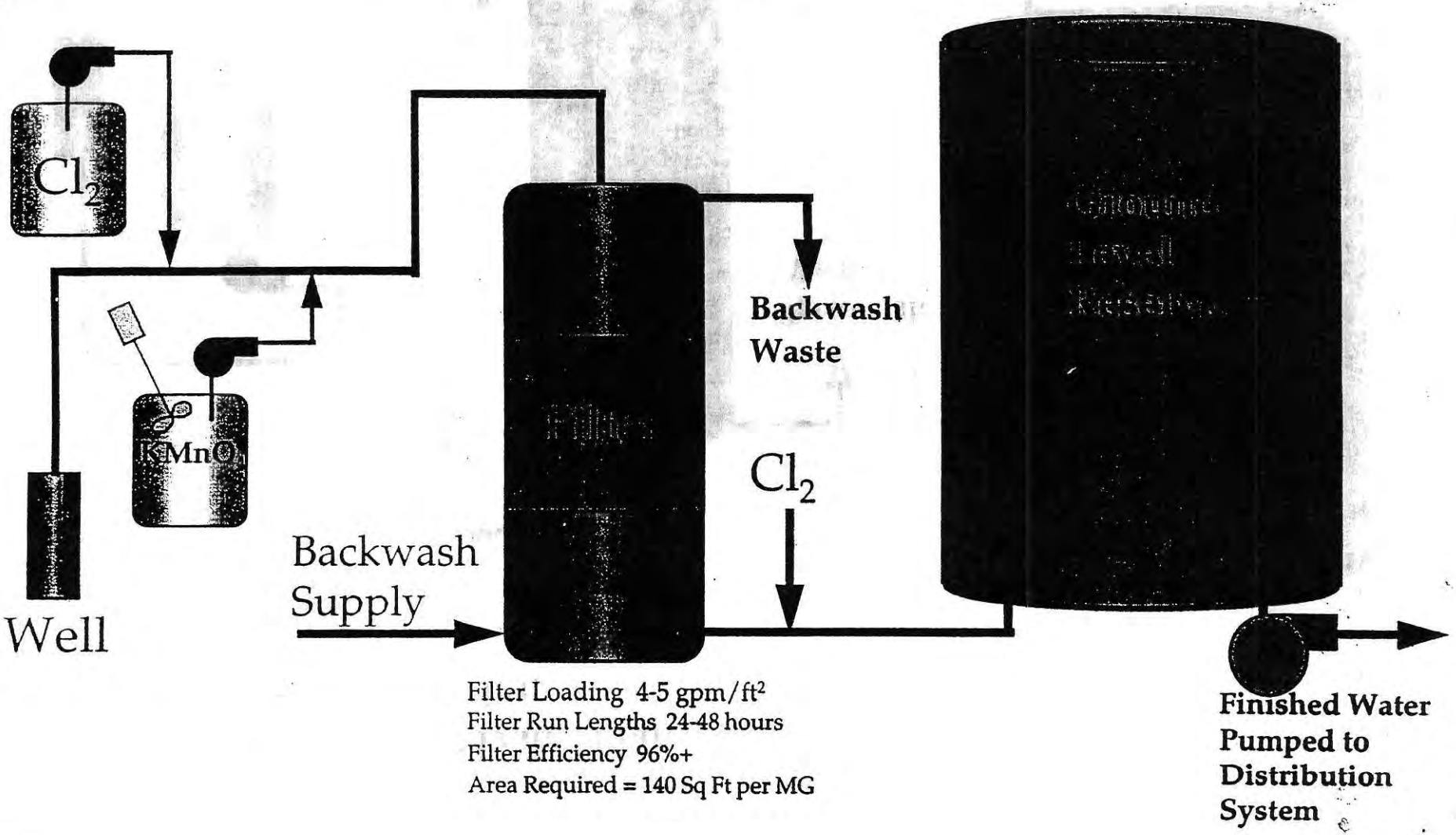


Figure 10-3
Woodburn Water Master Plan
Ozone Oxidation & Filtration

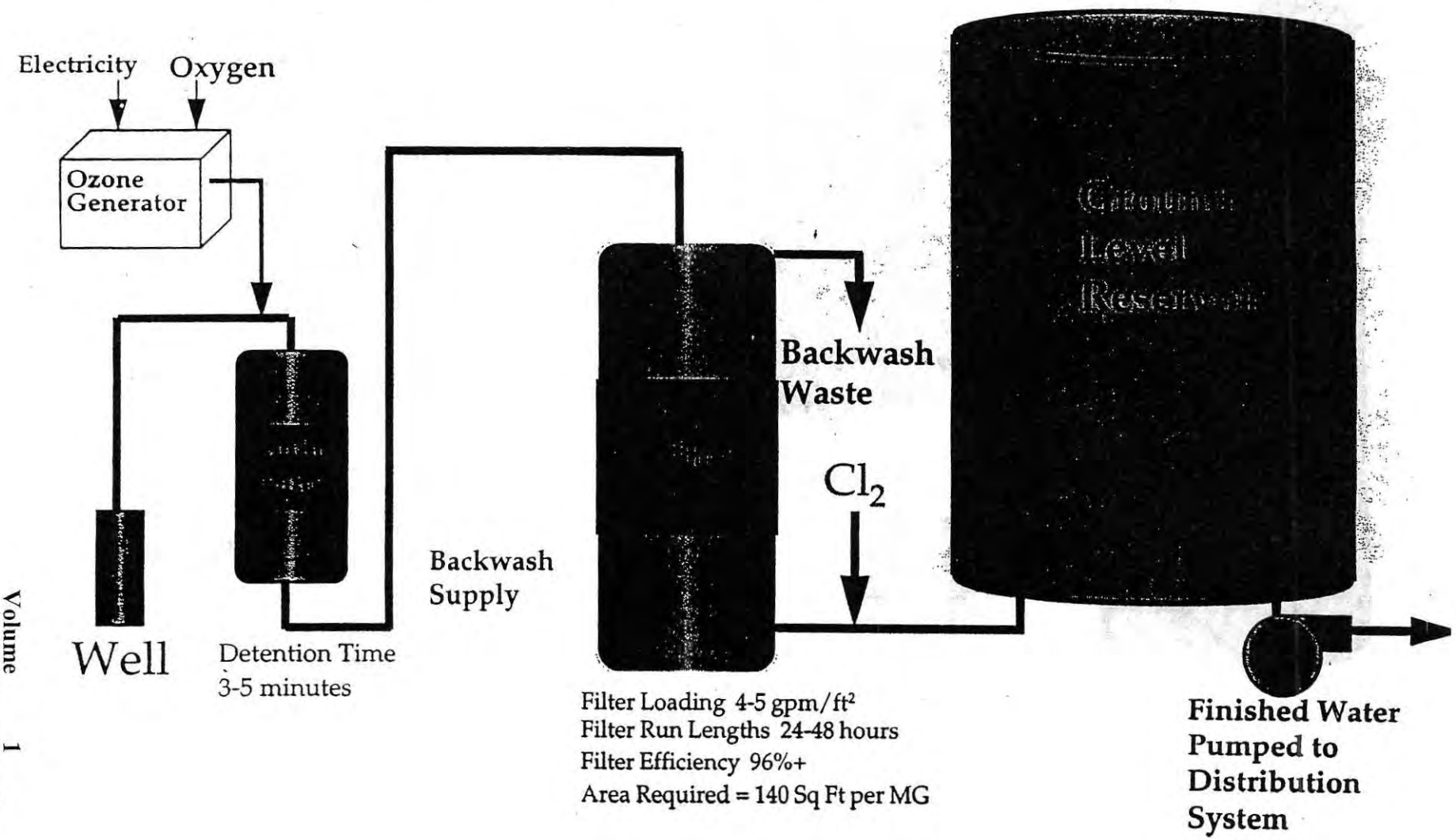
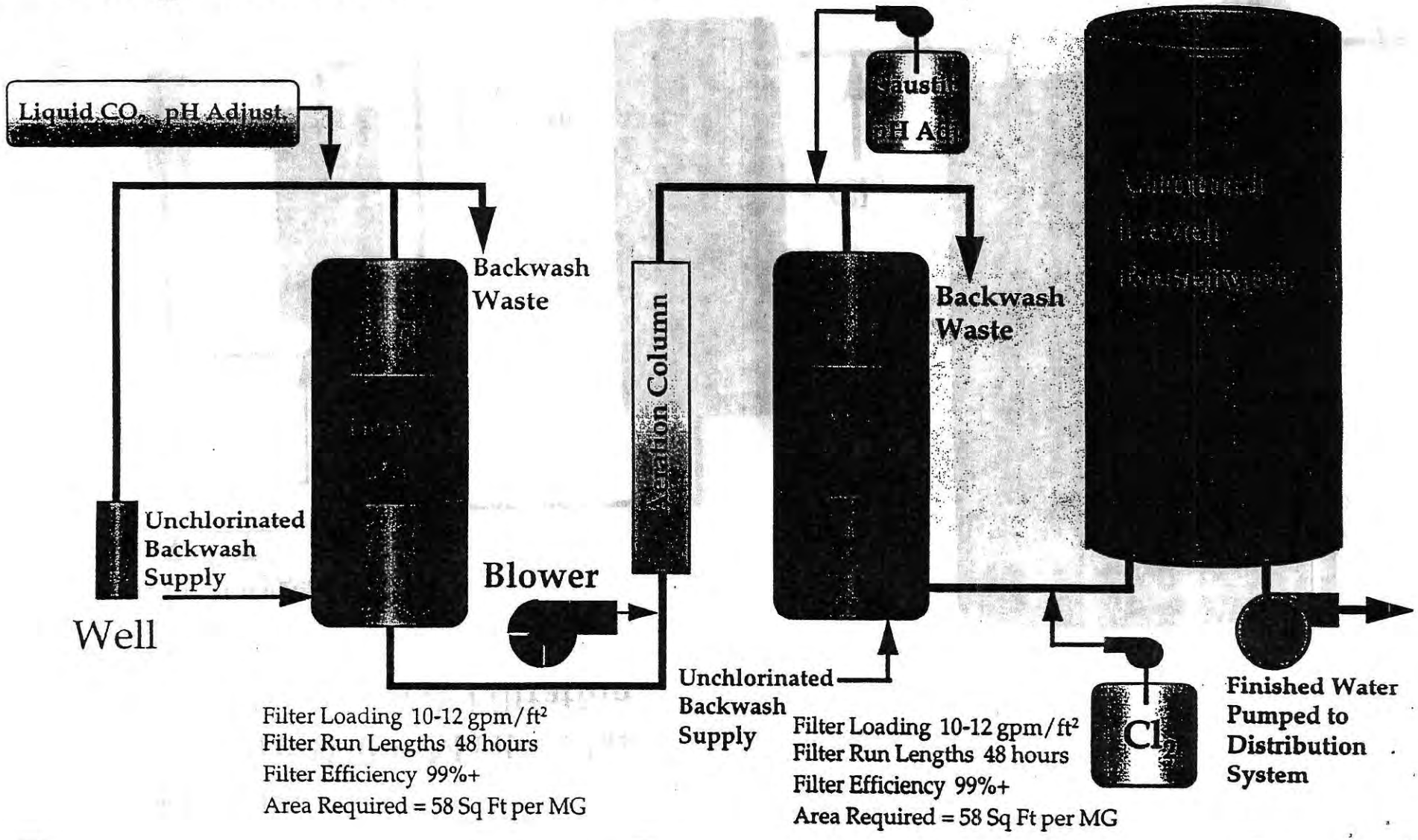
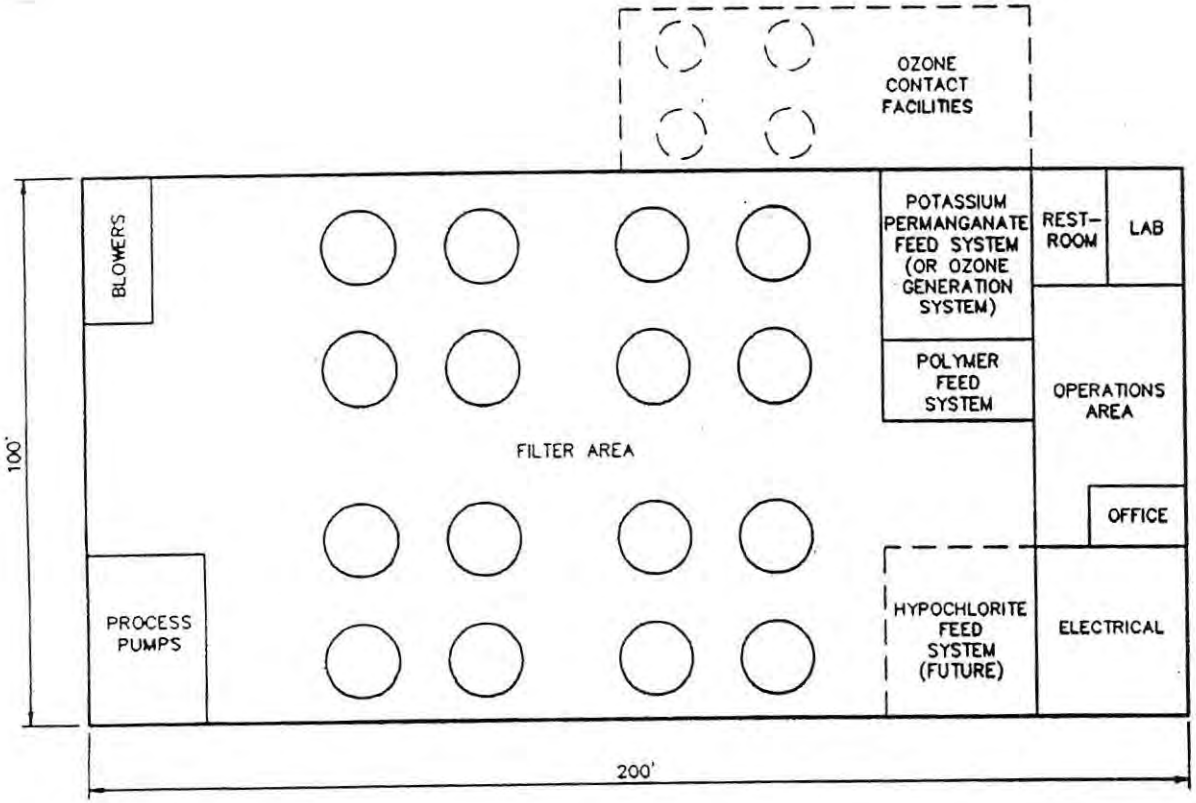
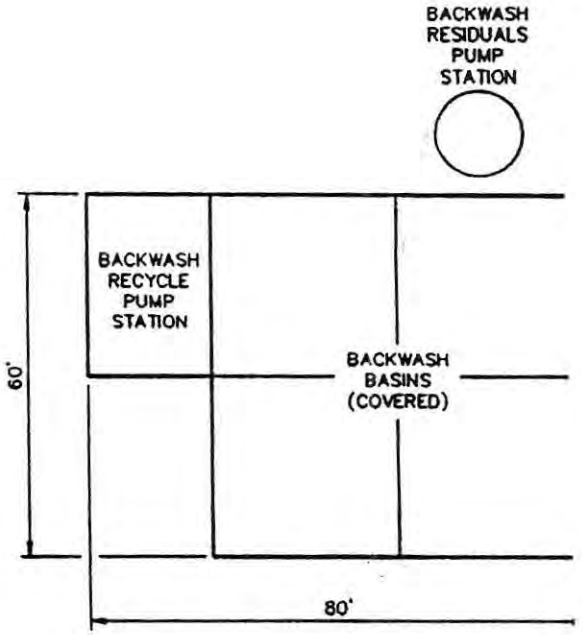


Figure 10-4
Woodburn Water Master Plan
Biological Filtration





TREATMENT BUILDING



BACKWASH HANDLING FACILITIES

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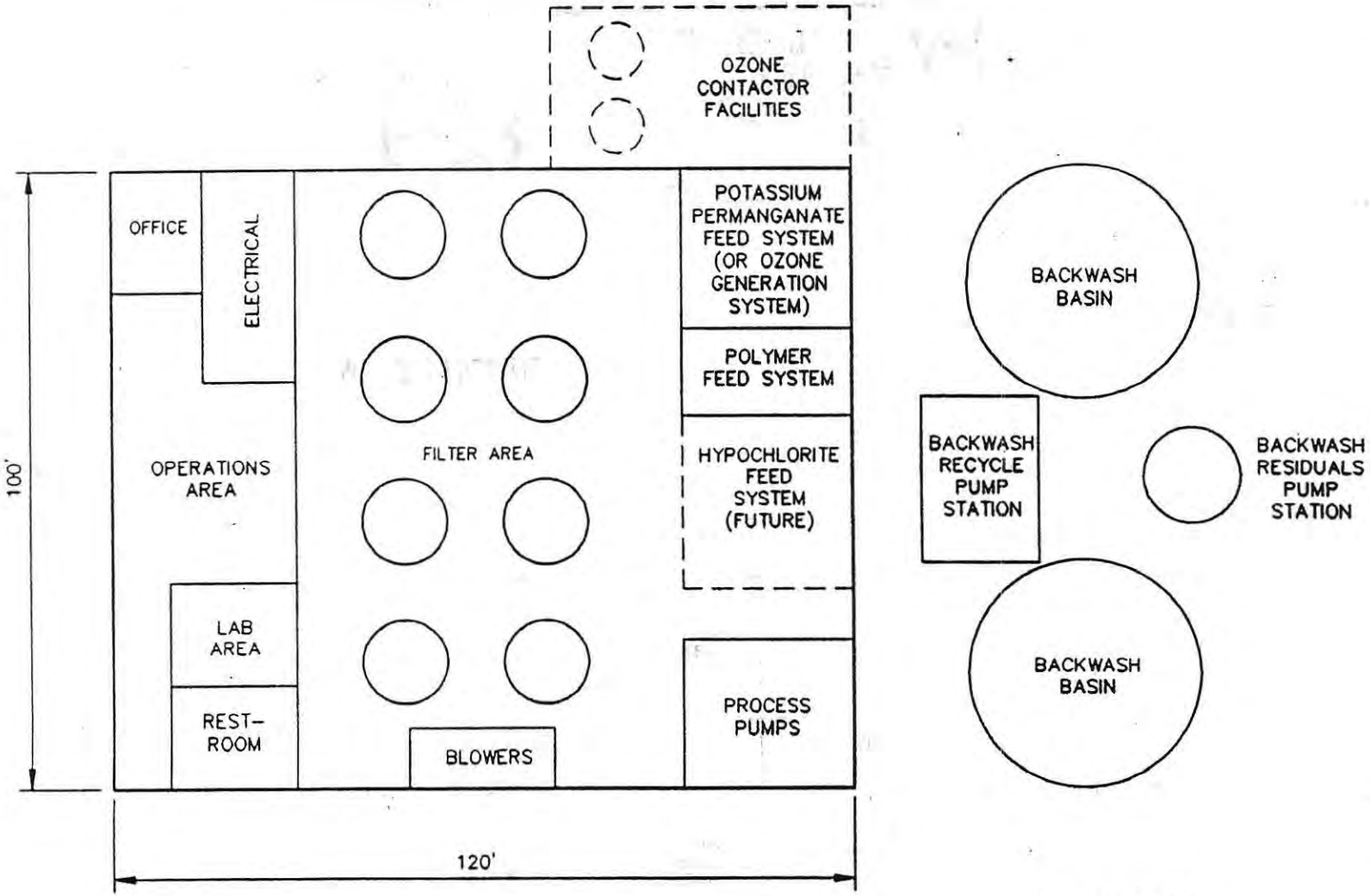
HDR Engineering, Inc.

Project Title: WOODBURN, OREGON WATER MASTER PLAN	Date: DECEMBER 1996
Sheet Title: CENTRALIZED PLANT CONCEPTUAL LAYOUT (10.5 MGD)	Figure No. 10-5

FILENAME: P:\08307.001\MODEL\DWGS\NEIGPLN DATE: 12/2/96

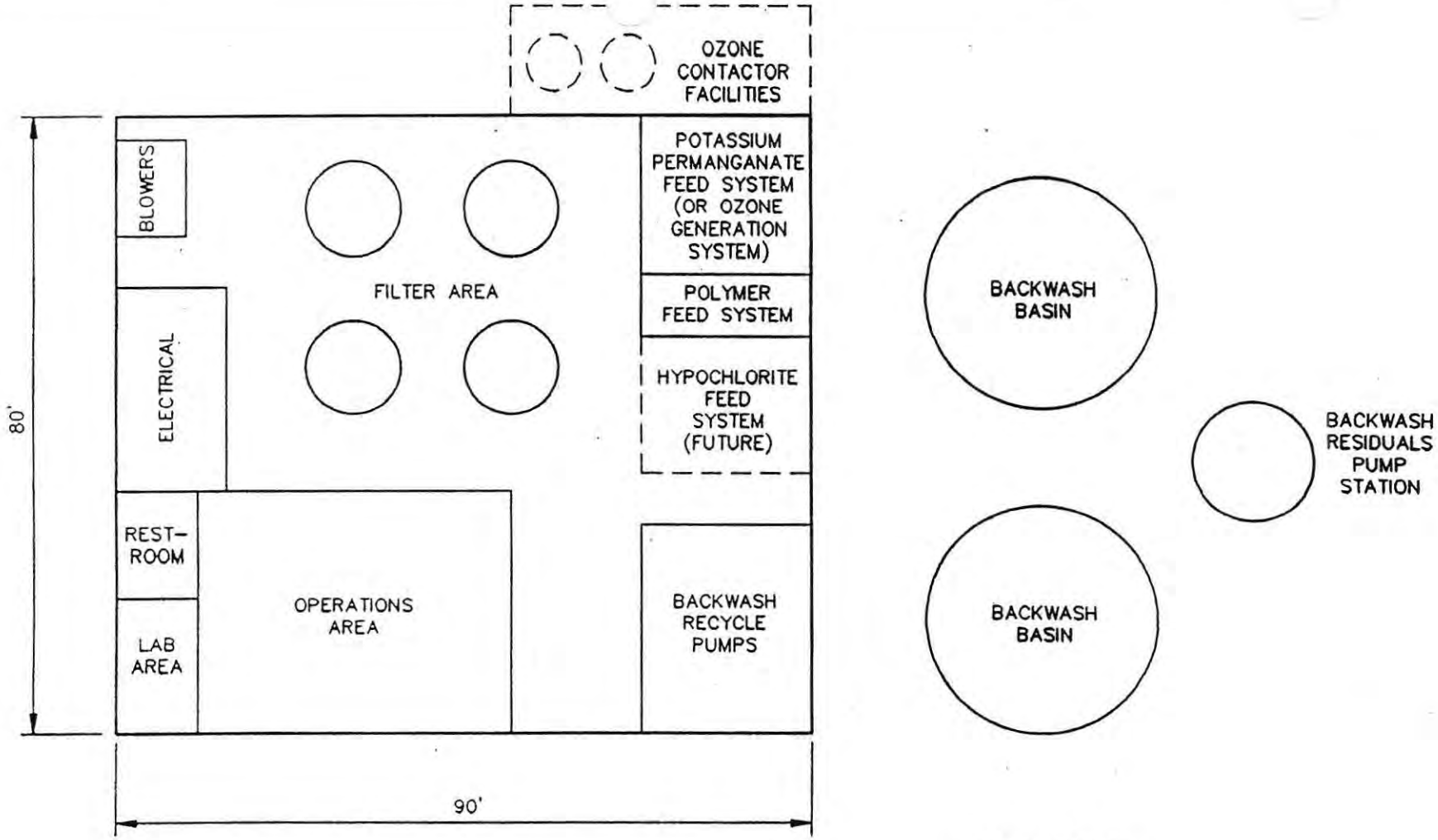


TREATMENT BUILDING

BACKWASH HANDLING FACILITIES

HDR Engineering, Inc.

Project Title: WOODBURN, OREGON WATER MASTER PLAN	Date: DECEMBER 1996
Sheet Title: NEIGHBORHOOD PLANT CONCEPTUAL LAYOUT (5 MGD)	Figure No. 10-6



TREATMENT BUILDING

BACKWASH HANDLING FACILITIES

HDR Engineering, Inc.

Project Title: WOODBURN, OREGON WATER MASTER PLAN	Date: DECEMBER 1996
Sheet Title: WELLHEAD PLANT CONCEPTUAL LAYOUT (2.5 MGD)	Figure No. 10-7

Table 10-7
WOODBURN WATER MASTER PLAN
ESTIMATED COSTS OF CENTRALIZED TREATMENT PLANT

Project No.	Project Description		1996 Project Cost	Construction Year	Present Worth
Water Treatment Plant at Well 10 and Associated Piping		**Total**	**$19,620,000**	**2002**	**$16,520,000**
WTP-1	Construct 10.5 MGD water treatment plant, and raw water pump station.		$10,260,000		
WTP-2	Install 570 lf of parallel 12-inch dia. pipe.		$68,400		
WTP-3	Replace existing pipe with 560 lf of 20-inch dia. pipe.		$112,000		
WTP-4	Replace existing pipe with 1,130 lf of 16-inch dia. pipe.		$180,800		
WTP-5	Replace existing pipe with 740 lf of 16-inch dia. pipe.		$118,400		
WTP-6	Install raw water transmission main for Wells 7-11		$5,033,600		
WT-1	Construct 4.4 MG water tank, and finished water pump station.		$3,850,000		
Westside Supply		**Total**	**$460,000**	**1998**	**$440,000**
WS-1	Install 1,340 lf of parallel 12-inch dia. pipe.		$229,944		
WS-2	Install 990 lf of 16-inch dia. pipe.		$226,512		
Fireflow Supply		**Total**	**$1,180,000**	**2005**	**$910,000**
FF-1A	Install 60 lf of parallel 10-inch dia. pipe (Boones Ferry Road crossing).		$8,580		
FF-1B	Install 1,320 lf of parallel 8-inch dia. pipe.		$151,008		
FF-2	Install 480 lf of parallel 8-inch dia. pipe.		$54,912		
FF-3	Install 850 lf of parallel 8-inch dia. pipe.		$97,240		
FF-4	Install 720 lf of parallel 8-inch dia. pipe.		$82,368		
FF-5	Install 1,250 lf of parallel 10-inch dia. pipe.		$178,750		
FF-6	Replace existing pipe with 230 lf of 16-inch dia. pipe.		$52,624		
FF-7	Install 980 lf of parallel 10-inch dia. pipe.		$140,140		
FF-8A	Replace existing pipe with 280 lf of 12-inch dia. pipe.		$48,048		
FF-8B	Install 820 lf of parallel 12-inch dia. pipe.		$140,712		
FF-8C	Replace existing pipe with 850 lf of 16-inch dia. pipe.		$194,480		
FF-9	Install 200 lf of parallel 10-inch dia. pipe.		$28,600		
High Velocity Pipelines		**Total**	**$310,000**	**1997**	**$300,000**
HV-1	Install 520 lf of parallel 8-inch dia. pipe.		$59,488		
HV-2	Extend parallel 8-inch dia. pipe 400 lf to Hwy 99E/Mt. Hood Ave.		$45,760		
HV-3	Extend parallel 8-inch dia. pipe 730 lf on Hwy 99E from Mt. Hood Ave to Alexandra Ave.		$83,512		
HV-4	Realign 12-inch dia. pipe Hwy 99E crossing to connect directly to 12" x 8" wye on westside.		$5,000		
HV-5	Extend parallel 8-inch dia. pipe 980 lf on Hwy 99E from E. Lincoln Rd. to Aztec Dr.		$112,112		
Wells		**Total**	**$2,760,000**		**$2,040,000**
W-NH	Drill well at Church on Newberg Highway plus raw water piping		$514,000	2000	$460,000
W-ST	Drill well at Settlemier/Tout St. plus raw water piping		$1,082,000	2005	$840,000
W-CP	Drill well at Centennial Park plus raw water piping		$730,000	2010	$490,000
W-CR	Drill well at County Rd. 517. plus raw water piping		$434,000	2015	$250,000
					$20,210,000

Table 10-8
WOODBURN WATER MASTER PLAN
ESTIMATED COSTS OF NEIGHBORHOOD TREATMENT PLANTS

Project No.	Project Description	1996 Project Cost	Construction Year	Present Worth
Water Treatment Plant at Well 10 and Associated Piping		**$9,380,000**	**2002**	**$7,900,000**
WTP1-1A	Construct 4.8 MGD water treatment plant.	$4,920,000		
WTP1-1B	Upgrade existing well pumps in 8, 9, 10, and 11.	$294,000		
WTP1-2	Install raw water transmission main from Wells 8, 9, 10, & 11	$2,270,000		
WT-1	Construct 2.2 MG water tank, and finished water pump station.	$1,900,000		
Water Treatment Plant at Centennial Park and Associated Piping		**$9,320,000**	**2010**	**$6,240,000**
WTP2-1A	Construct 5.6 MGD water treatment plant.	$5,750,000		
WTP2-1B	Upgrade Well 7 pump and housing	$74,000		
WTP2-2	Install raw water transmission main from well 7 and NH	$1,598,000		
WT-2	Construct 2.2 MG water tank, and finished water pump station.	$1,900,000		
Westside Supply	**Total**	**$230,000**	**2000**	**$180,000**
WS-1	Install 990 lf of 16-inch dia. pipe.	$227,000		
Fireflow Supply		**$250,000**		**$180,000**
FF-1	Install 60 lf of parallel 10-inch dia. pipe (Boones Ferry Road crossing).	$9,000	1998	**$10,000**
FF-2	Install 810 lf of parallel 8-inch dia. pipe.	$93,000	1998	**$80,000**
FF-3	Install 850 lf of parallel 10-inch dia. pipe.	$122,000	2005	**$70,000**
FF-4	Install 200 lf of parallel 10-inch dia. pipe.	$29,000	2005	**$20,000**
Wells	**Total**	**$1,459,200**		**$1,010,000**
W-NH	Drill well at Church on Newberg Highway	$250,000	2000	**$220,000**
W-CP	Drill well at Centennial Park with new treatment plant	$250,000	2005	**$190,000**
W-ST	Drill well at Settlemier/Tout St. plus raw water piping	$574,800	2010	**$380,000**
W-CR	Drill well at County Rd. 517 plus raw water piping	$384,400	2015	**$220,000**
				$15,510,000

Table 10-9
WOODBURN WATER MASTER PLAN
ESTIMATED COSTS OF WELLHEAD TREATMENT PLANTS

Project No.	Project Description		1996 Project Cost	Construction Year	Present Worth
Water Treatment Plant and Tank at Well 10 and Associated Piping		**Total**	**$3,725,000**	**2002**	**$3,137,000**
WTP1-1A	Construct 1.3 MGD water treatment plant.		$1,740,000		
WTP1-1B	Upgrade existing pumps, controls, and housing		$74,000		
WTP1-2	Install raw water transmission main.		$11,000		
WT-1	Construct 2.2 MG water tank, and finished water pump station.		$1,900,000		
Water Treatment Plant at Well 8 and Associated Piping		**Total**	**$1,555,000**	**2002**	**$1,311,000**
WTP2-1A	Construct 1.1 MGD water treatment plant.		$1,470,000		
WTP2-1B	Upgrade existing pumps, controls, and housing		$74,000		
WTP2-2	Install raw water transmission main.		$11,000		
Water Treatment Plant at Well 9 and Associated Piping		**Total**	**$3,547,000**	**2006**	**$2,664,000**
WTP3-1A	Construct 2.4 MGD water treatment plant for Well 9 and 11		$3,220,000		
WTP3-1B	Upgrade existing pumps, controls, and housing		$103,000		
WTP3-2	Install raw water transmission main.		$224,000		
Water Treatment Plant at Church (new well site) and Associated Piping		**Total**	**$4,358,000**	**2010**	**$2,915,000**
WTP4-1A	Construct 2.9 MGD water treatment plant for Well 7 and NH		$3,890,000		
WTP4-1B	Upgrade existing pumps, controls, and housing		$84,000		
WTP4-2	Install raw water transmission main.		$384,000		
Water Treatment Plant at Centennial Park (new well site) and Associated Piping		**Total**	**$7,701,000**	**2015**	**$4,462,000**
WTP5-1A	Construct 4.3 MGD water treatment plant.		$5,760,000		
WTP5-1B	Pump Controls and Telemetry		$41,000		
WTP5-2	Install raw water transmission main.		$0		
WT-2	Construct 2.2 MG water tank, and finished water pump station.		$1,900,000		
Fireflow Supply		**Total**	**$200,000**	**1998**	**$187,000**
FF-1	Install 60 lf of parallel 10-inch dia. pipe (Boones Ferry Road crossing).		$8,580		
FF-2	Install 810 lf of parallel 8-inch dia. pipe.		$92,664		
FF-3	Install 850 lf of parallel 8-inch dia. pipe.		$97,240		
Wells		**Total**	**$1,459,200**		**$1,023,000**
W-NH	Drill well at Church on Newberg Highway		$250,000	2000	$223,000
W-CP	Drill well at Centennial Park		$250,000	2005	$193,000
W-ST	Drill well at Settlemier/Tout St. plus raw water transmission		$574,800	2010	$384,000
W-CR	Drill well at County Rd. 517. plus raw water transmission		$384,400	2015	$223,000
					$15,699,000

CHAPTER 11
DISTRIBUTION SYSTEM

11.1 HYDRAULIC ANALYSIS

Methodology

The City of Woodburn water system was analyzed using the 1,000 pipe version of the Haestad Methods hydraulic network distribution model, Cybernet. Cybernet is a program that runs in AutoCAD which allows the model to be constructed from AutoCAD drawings or by inputting a database. Pipes lengths and diameters, nodes, velocities, flows, elevations, hydraulic grade, pressures, and elevation and pressure contours can be selected to be shown on water system AutoCAD maps.

The City created a water system map in AutoCAD. This map was converted into the system model. The model contains 890 pipes, 688 nodes, eight wells, and two tanks. To account for all facilities, Wells 2 and 3, and the 60,000 gallon elevated water tank were included in the model. However, because they are not typically being used, they were disconnected from the system. As the system continues to grow beyond a 1,000 pipes, the City will eventually have to upgrade to a larger version of Cybernet.

Nodes were assigned numbers in the 1000's. Pipes were assigned numbers in the 2000's. Wells were modeled as static nodes with a pump on their discharge line. Their number designations correspond to the number the City has given each well. The tanks were also modeled as static nodes and numbered in the 50's.

Data Collection

Water system data which included pipe sizes and lengths, pump curves and depths for each well, tank elevations, ground elevation contours, billing information and other input data was obtained from the Woodburn Water Division. Locations of pipes, tanks, and wells were obtained from the AutoCAD water system map.

Calibration

HDR provided fire hydrant flow test procedures and locations to the City. Utility crews then completed the series of hydrant tests to determine flow, static and residual pressure, and pressure drop in known segments of pipe. This information was utilized to more accurately determine typical pipe roughness coefficients to be input to the model. In the calibration procedure, pipe characteristics were modified until the model more accurately reproduced field obtained data. This procedure resulted in reasonable agreement between the model results and measured pressures.

Existing System Demand

Demands were distributed based on the number and type (residential, commercial, and industrial) of connections within each billing zone. The total average day demands (ADD) and maximum day demands (MDD) for the existing system are 1.8 mgd and 4.1 mgd respectively. The maximum instantaneous demand is approximately 7.0 mgd. Maximum day demands (MDD) were established in the model by multiplying the ADD by 2.3. For the maximum instantaneous demands a multiplier of 3.9 was used. A complete discussion of current and future demands is included in Chapter 4.

Results from the computer analysis indicate that during ADD, typical service pressures range from approximately 50 psi to 60 psi. Depending upon location, MDD and MID maximum pressures were somewhat lower, but still greater than the minimum desired pressure of 40 psi. Low transmission/distributionsystem pressures do not appear to be a problem during normal operations.

The system pressures are established by the 130-foot-high, 750,000 gallon elevated water reservoir located near Broadway and Front Street. As system demand draws down the reservoir level, wells are turned on to pump into the system and replenish the reservoir supply. If the level in the tank continues to drop after the first well pump has turned on, more pumps will receive signals to turn on and pump into the system until the tank water level begins increasing. The current MID of 7.0 mgd is approximately equal to the total existing pumping capacity of all of the active wells (6.8 mgd).

Future System Demands

By the year 2020, the ADD is expected to increase to approximately 4.2 mgd. The MDD and MID are expected to increase to 9.6 mgd and 16.4 mgd respectively. Future demands were distributed based on the population growth and future areas of development. The multiplying factors used to determine future MDD, and MID were again 2.3, and 3.9 respectively. Results from the computer analysis indicate that with system improvements recommended in the Capital Improvement Plan, the system will be capable of meeting peak day demands and maintain suitable minimum pressures within the system.

Fireflows

The affects of fireflows demands were modeled at five locations throughout the system, including two locations in future developed areas. Table 11-1 lists these locations along with the maximum demand that can be placed at these nodes while maintaining a minimum residual pressure at any point in the system of approximately 20 psi during MDD plus fire events. Depending on the type of land-use and occupancy, fireflow capacity goals ranged from 1,000 gpm for residential up to 5,000 gpm in industrial areas. The rationale for development of minimum desired fireflow capacities is discussed in Chapter 6.

Table 11-1 Modeled Fireflows 1996-2020 (Approximately 20 psi Residual Pressure)			
		Fireflows (cfs)	
Node	Description	1996	2020
1001	Ten Oaks Ln./Senecal Cr. (res.)	1,480	1,530
1180	French Prairie M.S. (school)	4,200	4,490
1601	Progress Way/Mt. Hood Ave. (ind.)	4,050	5,210
5003	Southwest of W. Hayes/Evergreen (future comm.)	-	5,000
5016	McClaren School	-	5,000

Future fireflow service design for the City of Woodburn should be based on ISO requirements. As areas are developed, transmission lines will have to be extended into those areas. Fireflow delivery capabilities need to be recognized and considered when approving building type and occupancy in all areas of Woodburn. City ordinances should be in place to require commercial and high occupancy development to utilize fire resistant construction, and fire sprinkler systems to reduce fireflow requirements to that which is available from the system. Hydrant tests should be completed to determine actual fire delivery capability prior to approving development plans.

Based on the City's minimum requirements for fireflow, the existing system configuration is able to provide adequate fireflow supply. However, as part of routine system maintenance and prior to final transmission/distributionsystem design, the actual fireflow delivery capacity should be measured at existing schools and other high occupancy buildings to determine if other special measures should be taken for fire protection. With identified improvements in place, the model analysis indicates that industrial/commercialareas will meet desired fireflow capacities. Proposed improvements include additional supply, transmission, and storage facilities. Proposed improvements are detailed in Chapter 12, Capital Improvement Plan.

Sources of Supply

The existing configuration of six active well sources located throughout the distribution system provides an excellent distribution of sources of supply into the system. As a result, system pressures remain relatively uniform throughout the system and there is less reliance on large transmission and distribution piping to move water to high demand locations.

Future fireflow capability was modeled assuming that the City will construct three additional wells which along with the six existing wells will be pumped to two neighborhood water treatment facilities. Computer model analysis indicated that with the two proposed treatment facilities sources of supply, construction of the recommended raw and finish water piping improvements, and

construction of at least one new reservoir, the system will be able to provide the required future fireflows.

11.2 WATER PIPING REPLACEMENT

Repair History Summary

There is currently approximately 66 miles of transmission and distribution piping ranging from 1-inch to 18- inches in diameter. Approximately four miles are piping with sizes of 4-inches or less. The majority of their system is ductile and cast iron pipe. There is a significant amount of asbestos-cement pipe in the Senior Estates area of Woodburn. This asbestos-cement pipe has not caused any water quality problems, however, the City is replacing sections of it as part of its normal line replacement program. The City routinely repairs and replaces older leaking or undersized pipes as part of an annual maintenance program.

Line Replacement Priorities

Implementing a schedule for the replacement of pipelines could avoid any emergency situations or future capacity problems. This scheduled should be spread over a period of years. Following are the priorities for water line replacement:

- Pipes in areas of related frequent customer complaints.
- Leaking pipes.
- Pipes identified by either maintenance or operations as problem pipes.
- Pipes identified by the computer model as having high velocities and head losses.
- Pipes four inches or less in diameter, and are in areas that have the potential for growth.
- Undersized transmission mains.
- Aged asbestos cement pipe.
- Aged steel or cast iron pipe.

An annual budget of $50,000 (1996 dollars) is recommended to fund an ongoing substandard main replacements program.

11.3 TELEMETRY AND CONTROLS

System Summary

The existing telemetry and control system is approximately 30 years old and it utilizes water levels in the elevated reservoir to start and stop the system wells pumps. The control panel located in the maintenance building provides information on which pumps are operating, elapsed pump operating times, high and low elevated tank level alarms, and system pressures. The data is manually

recorded by system operators. The on-off sequencing priority of pumps and operating set points are selected by the operator. The telemetry system has no power or system control redundancy.

It is recommended that the City upgrade their telemetry and control system to a non-proprietary solid state digital IBM PC compatible computer based system. The water system module can be designed to "piggy back" onto the planned upgrade of the wastewater treatment plant telemetry and control system. This updated water system module should be designed to provide significantly enhanced automated control and monitoring functions. System control and performance data such as pumping rates, treatment plant production rates, reservoir levels, and other system conditions can be monitored and stored electronically for recall and insertion into weekly, monthly, and annual reports. This computer based system will allow the two proposed treatment facilities to operate with minimal on-site attention. The treatment plants would be designed to typically operate automatically with daily visits to check on-site systems. The "on-call" operators could also use a laptop computer loaded with the software and a modem to remotely call into the monitoring and control system to check on system operation or to determine the cause of a system alarm.

Compliance with Reporting Requirements

Water Division staff compile and report operating system characteristics manually per current OHD requirements. The staff monitor water quality per state requirements and regularly sample and submit water for bacterial analysis. The staff will routinely flush water mains to maintain water quality in the system. If samples indicate bacterial contamination of the system, crews will flush and disinfect the area to eliminate the problem. Regular reports include the volume of water pumped, sample results, and other maintenance information.

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CHAPTER 12
CAPITAL IMPROVEMENT PLAN

12.1 SUMMARY OF DEFICIENCIES

Sources of Supply

Currently, the City of Woodburn is meeting maximum day demands with their existing supply and distribution system. The water system is supplied by six wells in the Troutdale Aquifer with a total capacity of 6.8 mgd. To meet future demands, the City plans to drill four new wells in the southwestern area of the City to increase the total well capacity to 12 mgd. To stay ahead of the projected growth in water demands, the City will need to install these four new wells at an approximate rate of one well every five years. Proposed well projects are listed in Table 12-1 the Capital Improvement Plan. Three system maps illustrate the proposed improvements for each different treatment location/configurationalternative. The locations of the proposed four new wells are shown on each map.

Reservoirs/Storage

Storage is a significant deficiency in the existing Woodburn system. A 750,000 gallon elevated steel tank is the only storage facility currently being used by the City. A second 60,000 gallon elevated steel tank has been taken out of service due to leaks and the need for maintenance. Based on existing system demands and supply capacities for 1996, the 750,000 gallon reservoir provides equalizing storage and minimal fire flow reserves but no emergency standby storage.

It is recommended that additional storage be provided for equalizing flow to meet peak hour demands and for the larger of either the required ISO fire flow reserves or a emergency-standby storage. An alternative to providing additional storage in the system is to increase the capacity of the source of supply and treatment. Since it costs on the order of 85-90 cents per gallon for storage and pumping versus more than a dollar per gallon to develop additional sources and treatment, it is recommended that storage be utilized to meet peak hour demands and to provide water for fire flow or other emergency conditions.

An additional 4.4 million gallons of new storage capacity should be constructed during the next 15 years. This additional storage capacity will increase the total system storage volume to 5.15 million gallons comprised of 2.25 million gallons equalizing and 2.9 million gallons of emergency-standby/fire flow reserve storage. This additional volume of storage will be sufficient for the selected two neighborhood treatment plant configuration to serve the system beyond year 2020.

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It is recommended that the additional storage facilities be sited at each of the two proposed treatment plant sites. The northeast treatment and storage site is at the existing Well 10 site at the south end of National Way. This site was selected because the City currently owns the property and the area is predominately industrial development. The southwest treatment and storage site is at Centenial Park on Parr Road. Locating storage at northeast industrial area and southwest residential parts of the system on either side of the centrally located existing elevated reservoir, will serve to improve the hydraulic efficiency of the transmission and distribution systems.

Because of the flat Woodburn topography, storage can either be configured as elevated tanks, standpipes, or at-grade storage. Elevated tanks have the highest per-gallon cost, followed by standpipes, and finally by the least expensive at-grade storage.

An advantage of elevated tanks and standpipes is that flow is pumped into storage so that it can flow by gravity out to the system. The capacity of pumps feeding into high tanks only needs to be equal to the maximum day demands. Peak flows and fire demands are then fed from storage by gravity flow. During power outages, water stored at these higher elevations is still be available to the system by gravity. However, besides cost, a major disadvantage to these high tanks is that they are visible from long distances and therefore have significant visual and aesthetic impacts to the area. Standpipes also have a significant volume of unusable or "dead" storage at the bottom of the tank unless booster pumps are provided to use this volume of water.

The major advantage of at-grade cylindrical storage tanks is that they have the lowest per-gallon cost and reduced visual impact wide areas. However, at-grade tanks have a larger "footprint" and therefore require a larger site than high tanks. Their most significant disadvantage is that all of the water from the tank will have to be fed to a low head booster pump station to increase the pressure water being fed into the system. The combined capacity of these low head booster pump stations will have to equal anticipated peak demands flow rates. Automated auxiliary power should be provided for these "downstream of storage" booster pump stations to insure that stored water is available at system pressures during a power failure. Woodburn has the advantage of already having 750,000 gallons of elevated storage which can be available to gravity feed to the system during fire and other emergency conditions.

Based upon discussions with the City staff which identified probable high sensitivity of citizens to more large water standpipes or elevated tanks in the area, it is recommended that economical at-grade storage be constructed at each of the treatment plant sites. Assuming that forty-foot-high tanks would be acceptable, two equally sized 2.2 million gallon tanks would each be about 100 feet in diameter.

The booster pumping station capacities will work in concert with the elevated storage to meet typical peak hour demands and provide capacity for emergency and fire flow conditions. Recommended treatment plant capacities are 4.8 mgd at Well 10 and 7.2 mgd at Centenial Park. The treatment plant capacities are designed to meet maximum day demands. Peak hour demands are projected to be approximately 170 percent of the maximum day demand. Multiplying the treatment plant capacities by 1.7 results in corresponding booster pump station capacities of 8.2

mgd (5,700 gpm) and 12.2 mgd (8,500 gpm). Because approximately 15 percent of the system storage should be available in elevated gravity fed storage, the maximum firm capacities of these booster pump stations can be reduced to 5,000 gpm at Well 10 and 7,200 gpm at Centenial Park.

Each booster pump station should be capable of providing this rate of flow during a primary source of power failure. This can either provided by a secondary power grid source, diesel engine driven pumps, or an emergency standby generator.

The first storage reservoir and booster pump station system should be constructed with the Well 10 treatment plant by year 2002. The second storage reservoir and booster pump station should be constructed as part of the Centenial Park treatment plant project by year 2010. The proposed storage and pump station projects are listed in Table 12-1.

Transmission

The system's primary transmission mains appear to be adequate for the existing system. With the construction of water treatment plants and storage in the northeast and southwest parts of the system, raw water transmission mains will be constructed to pipe water from the wells to the water treatment plants. With this arrangement, the hydraulics of the system will change significantly with all of the water supplied to the system from two locations. Even with this change in the system, no significant changes or improvements to the systems were noted from the computer model of the proposed system.

Possible future transmission/distributionproblems could occur when trying to maintain adequate fire flows in currently undeveloped areas. As areas are developed, developers will be required to extend the transmission mains into these areas and make any improvements necessary to the distribution system. The hydraulics of the system will have to be monitored to ensure that as these improvements are phased in, temporary hydraulic problems do not develop because of missing sections of the piping network. For some developments, it may be necessary to upgrade large sections of the system to ensure a high level of service to all of the new areas.

Distribution

The existing distribution system pressures throughout the system are generally between 50 and 60 psi. The computer model did not identify significant deficiencies during maximum day flows. Modeling fire flow conditions on the maximum day identified several areas that need to be upgraded to meet the required flows while maintaining a minimum pressure of 20 psi throughout the system. The recommended distribution system improvements are listed in Table 12-1 and are illustrated on the neighborhood treatment system alternative map included in the back of this report. The improvements listed in Table 12-1 are based on the two treatment plant (neighborhood) system. The required improvements are dependent upon the location and the number of treatment plants.

Treatment

Treatment alternatives and budgetary costs were fully developed in Chapter 10. Table 10-7, 10-8, and 10-9 lists the estimated costs for treatment to the year 2020 for the 3 location scenarios being considered. It is recommended that the City construct two neighborhood treatment plants. The first plant would be on line by the year 2002. The second plant would be constructed and on line by the year 2010.

To provide for the increased flows in the areas of the proposed water treatment plants piping capacities will have to be increased. A 16-inch parallel pipe would be constructed along Country Club Road and Boones Ferry Road. A 16-inch pipe would be constructed to make the connection from Woodburn Senior High School to Highway 214 and Front Street. This would supply water to the proposed reservoir at Well 10.

Telemetry and Controls

Woodburn is in the process of upgrading their wastewater treatment plant. As a part of this upgrade, a new telemetry and control system will be developed. It is recommended that the City coordinate the installation of this system with the requirements of the water treatment system to upgrade the water system telemetry and controls.

12.2 PROPOSED IMPROVEMENTS

Project alternatives were developed, selected, and prioritized in the following order:

1. Compliance with regulatory/health and safety requirements
2. Transmission, distribution, storage improvements
3. System reliability/repair
4. Sources of supply to meet projected growth
5. Scheduling of project budgets for financing

Budgetary costs for improvement projects were estimated in 1996 dollars. The projects and the estimated costs are listed in Tables 12-1, Table 12-2 and Table 12-3. Table 12-1 lists all of the projects by type of improvement. Table 12-2 lists the projects by year of construction. Table 12-3 groups projects by classification of improvement. Projects were scheduled over a 24 year period. For the first four years, schedules are developed for each year. For the next 20 years, projects are scheduled in five year periods. It is recognized that projects in the final 15 years of the 20 year schedule will be revised as the plan is regularly updated.

The CIP table does not include project costs for distribution improvements in future developed areas. CIP figures show possible pipe sizes and locations.

Capital Improvement Summary

Approximately of $20.6 million (1996 dollars) in improvement projects have been identified and detailed for the next 24 years. These improvements will provide needed treatment, storage, supply, and distribution improvements for the Woodburn system. Completing the capital improvements will allow the City of Woodburn to continue to provide City residents with a high quality water service well into the 21st century. For reference purposes, the improvement projects are shown on the Capital Improvement Project maps.

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TABLE 12-1
WOODBURN WATER MASTER PLAN
CAPITAL IMPROVEMENT PLAN - BY PROJECT TYPE

Project No.	Project Description	1996 Project Cost	Construction Year	Present Worth
Transmission Improvements				
WTP1-2	Install raw water transmission main from Wells 8, 9, 10, & 11	$2,270,000	2002	**$1,910,000**
WTP2-2	Install raw water transmission main from well 7 and NH	$1,598,000	2010	**$1,070,000**
	Subtotal	$3,868,000		**$2,980,000**
Distribution Improvements				
FF-1	Install 60 lf of parallel 10-inch dia. pipe (Boones Ferry Road crossing).	$9,000	1998	**$10,000**
FF-2	Install 810 lf of parallel 8-inch dia. pipe.	$93,000	1998	**$90,000**
FF-3	Install 850 lf of parallel 10-inch dia. pipe.	$122,000	2005	**$90,000**
FF-4	Install 200 lf of parallel 10-inch dia. pipe.	$29,000	2005	**$20,000**
WS-1	Install 990 lf of 16-inch dia. pipe.	$227,000	2000	**$200,000**
	Subtotal	$480,000		**$410,000**
Water Treatment Plant Improvements				
WTP1-1A	Construct 4.8 MGD water treatment plant.	$4,920,000	2002	**$4,140,000**
WTP1-1B	Upgrade existing well pumps in 8, 9, 10, and 11.	$294,000	2002	**$250,000**
WTP2-1A	Construct 5.6 MGD water treatment plant.	$5,750,000	2010	**$3,850,000**
WTP2-1B	Upgrade Well 7 pump and housing	$74,000	2010	**$50,000**
	Subtotal	$11,038,000		**$8,290,000**
Reservoir Improvements				
WT-1	Construct 2.2 MG water tank, and finished water pump station.	$1,900,000	2002	**$1,600,000**
WT-2	Construct 2.2 MG water tank, and finished water pump station.	$1,900,000	2010	**$1,270,000**
	Subtotal	$3,800,000		**$2,870,000**
Proposed Wells				
W-NH	Drill well at Church on Newberg Highway	$250,000	2000	**$220,000**
W-CP	Drill well at Centennial Park with new treatment plant	$250,000	2005	**$190,000**
W-ST	Drill well at Settlemier/Tout St. plus raw water piping	$574,800	2010	**$380,000**
W-CR	Drill well at County Rd. 517 plus raw water piping	$384,400	2015	**$220,000**
	Subtotal	$1,459,200		**$1,010,000**
				$15,560,000

TABLE 12-2
WOODBURN WATER MASTER PLAN
CAPITAL IMPROVEMENT PLAN - BY SCHEDULED YEAR

Project No.	Project Description	1996 Project Cost	Construction Year	Present Worth
FF-1	Install 60 lf of parallel 10-inch dia. pipe (Boones Ferry Road crossing).	$9,000	1998	**$10,000**
FF-2	Install 810 lf of parallel 8-inch dia. pipe.	$93,000	1998	**$90,000**
W-NH	Drill well at Church on Newberg Highway	$250,000	2000	**$220,000**
WS-1	Install 990 lf of 16-inch dia. pipe.	$227,000	2000	**$200,000**
WT-1	Construct 2.2 MG water tank, and finished water pump station.	$1,900,000	2002	**$1,600,000**
WTP1-1A	Construct 4.8 MGD water treatment plant.	$4,920,000	2002	**$4,140,000**
WTP1-1B	Upgrade existing well pumps in 8, 9, 10, and 11.	$294,000	2002	**$250,000**
WTP1-2	Install raw water transmission main from Wells 8, 9, 10, & 11	$2,270,000	2002	**$1,910,000**
FF-3	Install 850 lf of parallel 10-inch dia. pipe.	$122,000	2005	**$90,000**
FF-4	Install 200 lf of parallel 10-inch dia. pipe.	$29,000	2005	**$20,000**
W-CP	Drill well at Centennial Park	$250,000	2005	**$190,000**
WT-2	Construct 2.2 MG water tank, and finished water pump station.	$1,900,000	2010	**$1,270,000**
WTP2-1A	Construct 5.6 MGD water treatment plant.	$5,750,000	2010	**$3,850,000**
WTP2-1B	Upgrade Well 7 pump and housing	$74,000	2010	**$50,000**
WTP2-2	Install raw water transmission main from well 7 and NH	$1,598,000	2010	**$1,070,000**
W-ST	Drill well at Settlemier/Tout St.	$574,800	2010	**$380,000**
W-CR	Drill well at County Rd. 517.	$384,400	2015	**$220,000**
				$15,560,000

TABLE 12-3
WOODBURN WATER MASTER PLAN
CAPITAL IMPROVEMENT PLAN - BY IMPROVEMENT CLASSIFICATION

Project No.	Project Description	1996 Project Cost	Construction Year	Present Worth
Improvements Required to Improve Fire Protection & Correct Deficiences in the Existing System				
FF-1	Install 60 lf of parallel 10-inch dia. pipe (Boones Ferry Road crossing).	$9,000	1998	**$10,000**
FF-2	Install 810 lf of parallel 8-inch dia. pipe.	$93,000	1998	**$90,000**
FF-3	Install 850 lf of parallel 10-inch dia. pipe.	$122,000	2005	**$90,000**
FF-4	Install 200 lf of parallel 10-inch dia. pipe.	$29,000	2005	**$20,000**
WT-1	Construct 2.2 MG water tank, and finished water pump station.	$1,900,000	2002	**$1,600,000**
	Subtotals 12%	$2,153,000		**$1,810,000**
Improvements Required to Accommodate Growth				
WS-1	Install 990 lf of 16-inch dia. pipe.	$227,000	2000	**$200,000**
W-NH	Drill well at Church on Newberg Highway	$250,000	2000	**$220,000**
W-CP	Drill well at Centennial Park with new treatment plant	$250,000	2005	**$190,000**
W-ST	Drill well at Settlemier/Tout St. plus raw water piping	$574,800	2010	**$380,000**
W-CR	Drill well at County Rd. 517 plus raw water piping	$384,400	2015	**$220,000**
WT-2	Construct 2.2 MG water tank, and finished water pump station.	$1,900,000	2010	**$1,270,000**
	Subtotals 16%	$3,586,200		**$2,480,000**
Improvements to Provide Treatment to Remove Iron and Manganese				
WTP1-1A	Construct 4.8 MGD water treatment plant.	$4,920,000	2002	**$4,140,000**
WTP1-1B	Upgrade existing well pumps in 8, 9, 10, and 11.	$294,000	2002	**$250,000**
WTP1-2	Install raw water transmission main from Wells 8, 9, 10, & 11	$2,270,000	2002	**$1,910,000**
WTP2-1A	Construct 5.6 MGD water treatment plant.	$5,750,000	2010	**$3,850,000**
WTP2-1B	Upgrade Well 7 pump and housing	$74,000	2010	**$50,000**
WTP2-2	Install raw water transmission main from well 7 and NH	$1,598,000	2010	**$1,070,000**
	Subtotals 72%	$14,906,000		**$11,270,000**
				$15,560,000

CHAPTER 13
FINANCIAL PLAN

13.1 INTRODUCTION

Over the next decade, the Woodburn Water System will be faced with number of significant capital expenditures. The main project will include the installation of water treatment facilities for iron/manganese removal and possibly disinfection, and the installation of four additional wells to meet the future water demand. A sound financial plan is essential for the successful completion of these projects. This chapter reviews the financial status of the Woodburn Water System during the last five years. From the annual net available income which was available for capital expenditures during that time period, the amount of financing currently available to the water system is estimated. The available funds are compared with the required funds for the water projects. Recommendations for financing the planned facilities are made.

13.2 FINANCIAL STATUS

Table 13-1 summarizes the last five years (1991 through 1995) of financial audits for the City's water system. The City allocates its budget into six funds: Water Fund, Water Capital Improvement Fund, Water Well Construction Fund, Water Equipment Replacement Reserve Fund, and the Water System Development Trust Fund. The available sources of revenues come from water user fees, connection and service fees, interest revenues, and miscellaneous revenues.

The Cities' financial audits indicate that during the last five years, the following ranges of revenues and expenditures were experienced:

- Revenues (excluding interest): $863,000 to $1,190,000
- Total expenditures: $598,000 to $1,000,400
- Net income (excluding interest): $185,000 to $382,000
- Net income (excluding interest) and eliminating capital expenditures: $265,000 to $450,000, with an average of approximately $372,000

13.3 WATER RATE HISTORY

Table 13-2 summarizes the water rate history over the last 25 years. The last rate increase, which was about 15%, occurred in 1992. The majority of the residential meters are 3/4-inch. The monthly flat rate for the 3/4-inch meters is currently $7.45 for 400 cubic feet. For consumption over the basic quantity, a rate of $0.70 per 100 cubic feet is charged for up to 3,200 cubic feet. Above 3,200 cubic feet, there is a charge of $0.85 per 100 cubic feet.

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13.4 FUNDS AVAILABLE FOR CAPITAL IMPROVEMENTS

The amount of money currently available for financing the proposed capital improvements was calculated based on the historical financial status of the water system. The following assumptions were made:

- It is assumed that ~~75%~~ 80% of the average net income of approximately $372,000 is available each year for the capital expenditures, which amounts to approximately ~~$280,000.~~ $298,000
- The projects will be funded with 20-year bonds purchased at 6 % interest.
- It is assumed that for expenditures and revenues are affected about the same by inflation, as such inflation is disregarded.

Based on these assumption, the City could raise bonds to a total of about $3,200,000, with no rate increase.

13.5 COMPARISON OF AVAILABLE FUNDS WITH CAPITAL IMPROVEMENTS

The capital improvement plan in Chapter 12 estimated approximately ~~$ 22.4~~ $20.6 million in recommended improvements (1996 dollars). The current rate structure is not adequate to fund the recommended projects and the City needs to study its rate structure and find additional sources of funding to complete these projects.

To fully fund the recommended projects using bonds at ~~6~~ 5 percent , the City would have to provide revenue of ~~$ 1,953,000~~ $1,653,000 per year. This is an increase of almost 700% over current levels. Other sources that the City could consider include, developer extension fees, connection fees, low interest loans, in addition to a planned rate increase.

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Table 13-1
Woodburn Financial Summary 1991 - 1995

Description	1991	1992	1993	1994	1995
SUMMARY					
Revenues					
Charges for Services	822,447	1,070,719	1,054,444	1,162,802	1,120,147
Miscellaneous Revenues	40,546	2,257	5,845	26,509	12,849
Interest Revenues	43,252	36,713	31,425	31,190	49,055
TOTAL REVENUES	906,245	1,109,689	1,091,714	1,220,501	1,182,051
Total Revenues Minus Interest Revenues	862,993	1,072,976	1,060,289	1,189,311	1,132,996
Expenditures					
Admin., Dist., & Transmission	479,659	533,044	575,458	598,964	621,971
Meter Read, Accounting, Collect	96,213	102,535	110,129	112,857	113,486
Misc. Water Accounts	15,027	14,656	17,909	14,526	14,658
Materials and Services	7,368	1,300	16,596	12,155	995
Capital Outlay	-	39,877	53,612	265,940	67,942
TOTAL EXPENDITURES	598,267	691,412	773,704	1,004,442	819,052
Revenues (excluding interest) Over Expenditures	264,726	381,564	286,585	184,869	313,944
Rev. (exc. interest) Over Expenditures (exc. capital outlay)	264,726	421,441	340,197	450,809	381,886
WATER FUND					
Revenues					
Charges for Services	729,310	883,060	941,216	980,752	1,002,102
Miscellaneous Revenues	3,483	2,207	5,178	4,134	12,849
Interest Revenues	18,221	7,704	7,113	5,655	8,167
TOTAL REVENUES	$ 751,014	$ 892,971	$ 953,507	$ 990,541	$ 1,023,118
Expenditures					
Admin., Dist., & Transmission	479,659	533,044	575,458	598,964	621,971
Meter Read, Accounting, Collect	96,213	102,535	110,129	112,857	113,486
Misc. Water Accounts	15,027	14,656	17,909	14,526	14,658
TOTAL EXPENDITURES	$ 590,899	$ 650,235	$ 703,496	$ 726,347	$ 750,115
Excess (Deficiency) of Revenues Over Expenditures	160,115	242,736	250,011	264,194	273,003
Other Financing Sources (Uses)					
Operating Transfers In	36,500	37,000	39,000	39,000	40,000
Operating Transfers Out	(216,268)	(255,503)	(214,000)	(357,500)	(273,130)
TOTAL OTHER FINANCING SOURCES (USES)	$ (179,768)	$ (218,503)	$ (175,000)	$ (318,500)	$ (233,130)
Excess (Deficiency) of Revenues Over Expenditures and Other Sources (Uses)	(19,653)	24,233	75,011	(54,306)	39,873
Fund Balances at Beginning of Year	118,662	99,008	123,241	198,283	143,977
Fund Balances at End of Year	$ 99,009	$ 123,241	$ 198,252	$ 143,977	$ 183,850

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Table 13-1
Woodburn Financial Summary 1991 - 1995

Description	1991	1992	1993	1994	1995
WATER CAPITAL IMPROVEMENTS FUND					
Revenues					
Charges for Services	93,137	187,659	113,228	144,785	(991)
Miscellaneous Revenues	37,063	50	667	22,375	-
Interest Revenues	14,669	17,921	14,498	16,711	18,347
TOTAL REVENUES	$ 144,869	$ 205,630	$ 128,393	$ 183,871	$ 17,356
Expenditures					
Materials and Services	7,368	1,300	500	-	-
Capital Outlay	-	14,747	24,071	37,133	37,689
TOTAL EXPENDITURES	$ 7,368	$ 16,047	$ 24,571	$ 37,133	$ 37,689
Excess (Deficiency) of Revenues Over Expenditures	137,501	189,583	103,822	146,738	(20,333)
Other Financing Sources (Uses)					
Operating Transfers Out	(21,503)	(70,000)	(54,074)	(29,074)	(252,396)
TOTAL OTHER FINANCING SOURCES (USES)	$ (21,503)	$ (70,000)	$ (54,074)	$ (29,074)	$ (252,396)
Excess (Deficiency) of Revenues Over Expenditures and Other Sources (Uses)	115,998	119,583	49,748	117,664	(272,729)
Fund Balances at Beginning of Year	80,418	196,416	315,999	365,747	483,411
Fund Balances at End of Year	$ 196,416	$ 315,999	$ 365,747	$ 483,411	$ 210,682
WATER WELL CONSTRUCTION FUND					
Revenues					
Interest Revenues	3,377	5,749	6,206	6,166	4,979
TOTAL REVENUES	$ 3,377	$ 5,749	$ 6,206	$ 6,166	$ 4,979
Expenditures					
Materials and Services		-	16,096	12,155	995
Capital Outlay	-	-	-	172,078	5,573
TOTAL EXPENDITURES	$ -	$ -	$ 16,096	$ 184,233	$ 6,568
Excess (Deficiency) of Revenues Over Expenditures	3,377	5,749	(9,890)	(178,067)	(1,589)
Other Financing Sources (Uses)					
Operating Transfers In	20,000	85,000	20,000	95,000	43,335
TOTAL OTHER FINANCING SOURCES (USES)	$ 20,000	$ 85,000	$ 20,000	$ 95,000	$ 43,335
Excess (Deficiency) of Revenues Over Expenditures and Other Sources (Uses)	23,377	90,749	10,110	(83,067)	41,746
Fund Balances at Beginning of Year	27,720	51,097	141,846	151,957	68,890
Fund Balances at End of Year	$ 51,097	$ 141,846	$ 151,956	$ 68,890	$ 110,636

Table 13-1
Woodburn Financial Summary 1991 - 1995

Description	1991	1992	1993	1994	1995
WATER EQUIPMENT REPLACEMENT RESERVE FUND					
Revenues					
Interest Revenues	6,985	5,339	3,608	2,330	3,723
TOTAL REVENUES	$ 6,985	$ 5,339	$ 3,608	$ 2,330	$ 3,723
Expenditures					
Capital Outlay		25,130	29,541	56,729	24,680
TOTAL EXPENDITURES	$ -	$ 25,130	$ 29,541	$ 56,729	$ 24,680
Excess (Deficiency) of Revenues Over Expenditures	6,985	(19,791)	(25,933)	(54,399)	(20,957)
Other Financing Sources (Uses)					
Operating Transfers In	15,000	15,000	15,000	45,000	30,000
TOTAL OTHER FINANCING SOURCES (USES)	$ 15,000	$ 15,000	$ 15,000	$ 45,000	$ 30,000
Excess (Deficiency) of Revenues Over Expenditures and Other Sources (Uses)	21,985	(4,791)	(10,933)	(9,399)	9,043
Fund Balances at Beginning of Year	60,847	82,832	78,041	67,108	57,709
Fund Balances at End of Year	$ 82,832	$ 78,041	$ 67,108	$ 57,709	$ 66,752
WATER SYSTEM DEVELOPMENT TRUST FUND					
Revenues					
Charges for Services				37,265	119,036
Interest Revenues				328	13,839
TOTAL REVENUES				$ 37,593	$ 132,875
Expenditures					
Capital Outlay					
TOTAL EXPENDITURES				$ -	$ -
Excess (Deficiency) of Revenues Over Expenditures				37,593	132,875
Other Financing Sources (Uses)		New fund in 1994			
Operating Transfers In				-	204,061
TOTAL OTHER FINANCING SOURCES (USES)	$ -	$ -	$ -	$ -	$ 204,061
Excess (Deficiency) of Revenues Over Expenditures and Other Sources (Uses)				37,593	336,936
Fund Balances at Beginning of Year					37,593
Fund Balances at End of Year				$ 37,593	$ 374,529
TOTAL BALANCES AT END OF YEAR FOR ALL FUNDS	$ 429,354	$ 659,127	$ 783,063	$ 791,580	$ 946,449

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Table 13-2
Woodburn Rate Structure History

Meter Size	Quantity (cu ft)	Basic Rate ($)												
		May-81	Nov-81	May-82	Nov-82	Nov-83	Nov-84	Nov-85	Jan-87	Jan-88	Jan-89	Feb-90	Jan-91	Jan-92
3/4"	400	3.50	3.90	4.05	4.25	4.50	4.75	5.00	5.25	5.25	5.25	5.85	6.45	7.45
1"	800	5.30	5.78	6.14	6.45	6.80	7.20	7.60	8.00	8.00	8.00	7.85	8.45	9.75
1-1/2"	1,800	9.50	10.50	11.00	11.55	12.20	12.90	13.60	14.35	14.35	14.35	16.00	17.65	20.40
2"	3,200	15.50	16.80	17.94	18.90	19.95	21.05	22.20	23.40	23.40	23.40	26.00	28.65	33.10
3"	7,500	32.50	35.70	37.62	39.40	41.55	43.85	46.25	48.80	48.80	48.80	54.50	60.10	69.40
4"	15,000	64.50	71.40	74.67	78.75	83.10	87.70	92.50	97.60	97.60	97.60	108.90	119.95	138.55
6"	32,000	132.50	147.00	153.39	162.75	171.70	181.15	191.10	201.60	201.60	201.60	224.20	247.20	285.55
8"	57,000	230.50	254.10	266.83	283.50	299.10	315.55	332.90	351.20	351.20	351.20	390.20	430.20	496.90

Meter Size	Quantity (cu ft)	Percent Increase Over Previous Year												
		May-81	Nov-81	May-82	Nov-82	Nov-83	Nov-84	Nov-85	Jan-87	Jan-88	Jan-89	Feb-90	Jan-91	Jan-92
3/4"	400	-	11.4	3.8	4.9	5.9	5.6	5.3	5.0	0.0	0.0	11.4	10.3	15.5
1"	800	-	9.1	6.2	5.0	5.4	5.9	5.6	5.3	0.0	0.0	-1.9	7.6	15.4
1-1/2"	1,800	-	10.5	4.8	5.0	5.6	5.7	5.4	5.5	0.0	0.0	11.5	10.3	15.6
2"	3,200	-	8.4	6.8	5.4	5.6	5.5	5.5	5.4	0.0	0.0	11.1	10.2	15.5
3"	7,500	-	9.8	5.4	4.7	5.5	5.5	5.5	5.5	0.0	0.0	11.7	10.3	15.5
4"	15,000	-	10.7	4.6	5.5	5.5	5.5	5.5	5.5	0.0	0.0	11.6	10.1	15.5
6"	32,000	-	10.9	4.3	6.1	5.5	5.5	5.5	5.5	0.0	0.0	11.2	10.3	15.5
8"	57,000	-	10.2	5.0	6.2	5.5	5.5	5.5	5.5	0.0	0.0	11.1	10.3	15.5

CHAPTER 14
OPERATIONS PLAN

14.1 INTRODUCTION

Currently the Woodburn Water Division does not have a detailed Operations Plan. This chapters presents elements of the operation based on current procedures. The operations plan described here consists of four elements:

- Key Personnel
- System Operation and Control
- Water Quality Monitoring and Reporting
- Emergency Response

14.2 KEY PERSONNEL

The Woodburn Water Division operates within the Public Works Department, under the public works director, Frank Tiwari. The Program Manager for water and transportation is Randy Rohman. Within the water division there are currently eight staff positions, including four certified personnel. Five additional positions are planned within 10 years, including two water treatment operator positions. Key personnel within the Water Division are listed in Table 14-1, along with planned positions. The Public Works Department organizational chart is presented in the Appendix.

Table 14-1
Water Division Key Personnel
City of Woodburn

Name	Job Title	Certification
Randy Rohman	Public Works Program Manager	
Dennis Schooler	Water Superintendent	WD II # 1476
Frank Sutter	Foreman	WD III # 1526
Dennis Samson	Water Tech I	WD I # 1467
Floyd Barth	Water Tech I	WD I # 1029
Future Position	Water Treatment Lead Operator	
Future Position	Water Treatment Operator	
Future Position	Asst. Superintendent	
Future position	Cross Connection Inspector	

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14.3 SYSTEM OPERATION AND CONTROL

Components

The Woodburn water system includes six active wells, six inactive wells, approximately 66 miles of water pipe varying in size from 4 inches to 24 inches in diameter, one operating water storage reservoir and one elevated water reservoir which is currently out of service. The distribution system operates under a single pressure zone. System pressures are generally 45 psi to 60 psi. A more complete description of the facilities is presented in Chapter 5, *Existing System Inventory/Review.*

Normal Operation

The wells pump directly into the distribution system. The pumps are controlled by an Autocon telemetry system based on the water level in the water reservoir. The order in which the individual pumps come on-line is set by the operator, and is based on which well produces the highest water quality. Currently, Well No. 7 is the most frequently used well.

Telemetry and Controls

The central control panel for the Autocon telemetry system is located near the elevated storage tank. The central panel contains the following information:

- Indication lights for current status information
- Elevated tank level indicator and recorder
- System pressure indicator and recorder
- HAND/OFF/AUTO switches for well pump control
- Elapsed pump operating time
- High and low elevated tank level alarms

Field data are telemetered to the central panel using leased telephone lines. The high and low tank level alarm signals are sent to a monitoring service which relays the alarm to the Woodburn police station. There are no operating or intrusion alarms at the wells. The telemetry system has no battery backup and is approximately 30 years old.

Maintenance and Repair Program

The City has an ongoing program of repair of their system, which is done by the City staff. The preventive maintenance program is summarized in Table 14-2.

Table 14-2 Maintenance Program City of Woodburn		
Item	**Maintenance**	**Frequency**
Reservoir	Drain, clean and internally inspect to ensure water quality and structural integrity; Remove silt build-up on the bottom and algae growth off of interior walls	Every three years
Valves	Operate full open/closed; check for water tightness; uncover where buried; clean out valve boxes	Annually
Water Mains	Flush dead end lines	Semi-Annually
Water Mains	Inspection and service line repairs	Annually and As Needed
Hydrants	Inspection and Repair Operate; check drain rate; lubricate as necessary; measure pressure; paint as necessary	Annually
Pressure Regulating Valves	Testing and Repair	Annually
Pumps	Brief Inspection. Log and record motor current draw, check packing, log and record gallons delivered and pump motor hours; check motor oil level; measure and record static or pumping water level; check motor noise, temperature; and vibration	Daily
Pumps	Detailed inspection. Change oil, perform maintenance required by manufacture	Annually
Meters	Inspection and Repair	Annually
Equipment: Backhoe, trucks	Check all fluid levels and lights, and other safety related items.	Daily
	Replace fluids and filters in accordance with manufacturers recommendations	As needed
Tools	Clean after each use; lubricate as necessary	As needed

Cross Connection Control

The City conducts an active program for systematically identifying and controlling cross connections. The program includes a careful review of all proposed construction for potential cross connections. During construction, the City ensures proper compliance by inspection according to code requirements. All backflow preventers are inspected annually to ensure proper function. The City maintains records of cross connection control and backflow prevention device testing. The City plans to bring a cross connection inspector on staff.

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Equipment and Supplies Tracking

The City maintains a stockpile of all critical repair parts, tools, and equipment. The City maintains a complete inventory of all repair parts. As repair parts are used, they are reordered to keep supplies current. The City maintains an adequate supply of chlorine for superchlorinating lines as necessary.

Response to Water Quality Complaints

Every customer complaint concerning water quality is received and investigated promptly. The City maintains records of customer complaints pertaining to water quality and the follow-up action undertaken.

14.4 WATER QUALITY MONITORING AND REPORTING

Monitoring

The City routinely collects and submits water samples for laboratory analyses at the frequencies prescribed by OAR 333-061-0036. The water quality monitoring program is summarized in Chapter 9, Water Quality Assessment. The City monitors for the following parameters:

- Coliform
- Lead and Copper
- Inorganic Chemicals (IOCs) (Phase II and V)
- Volatile Organic Compounds (VOCs) (Phase II and V)
- Synthetic Organic Compounds (SOCs)
- Gross alpha activity
- Sulfate
- Arsenic

Reporting, Public Notification, and Record Keeping

Reporting requirement are described in Chapter 9 for the individual contaminants. The City maintains records of all raw water quality, both chemical and microbiological, as well as current records relating to the sampling and analysis undertaken to assure compliance with the maximum contaminant levels.

The City has established procedures in conformance with ORD 333-061-0042 Public Notice for cases when the system violates a primary water quality standard; or they fail to meet monitoring, and analytical testing requirements. Standard notices provide a clear explanation of the violation, adverse health effect, remedial action being taken, and steps the consumer should take to minimize risk.

The procedures call for notices by publication in a daily newspaper within 14 days after the violation and by direct mail or hand delivery within 45 days after the violation. The OHD may waive the mail or hand delivery requirement if the violation is corrected within 45 days. For an acute violation, including acute coliform, nitrate, and a water borne disease outbreak, a copy of the notice is to be furnished to the radio and television stations serving Woodburn within 72 hours after the violation.

14.5 EMERGENCY RESPONSE PROGRAM

The City has an Emergency Response Plan which includes:

- Vulnerability Assessment
- Contingency Procedures
- Emergency Response Procedures

A copy of the Emergency Response Plan is included as Appendix _. The City has taken appropriate measures to develop a reliable system. The City's six active wells provide a multiple water source. In the event of pump failure, all areas within the distribution system may be served by the remaining wells. In the event of electrical power outage, all pumps are connected with diesel-driven engines.

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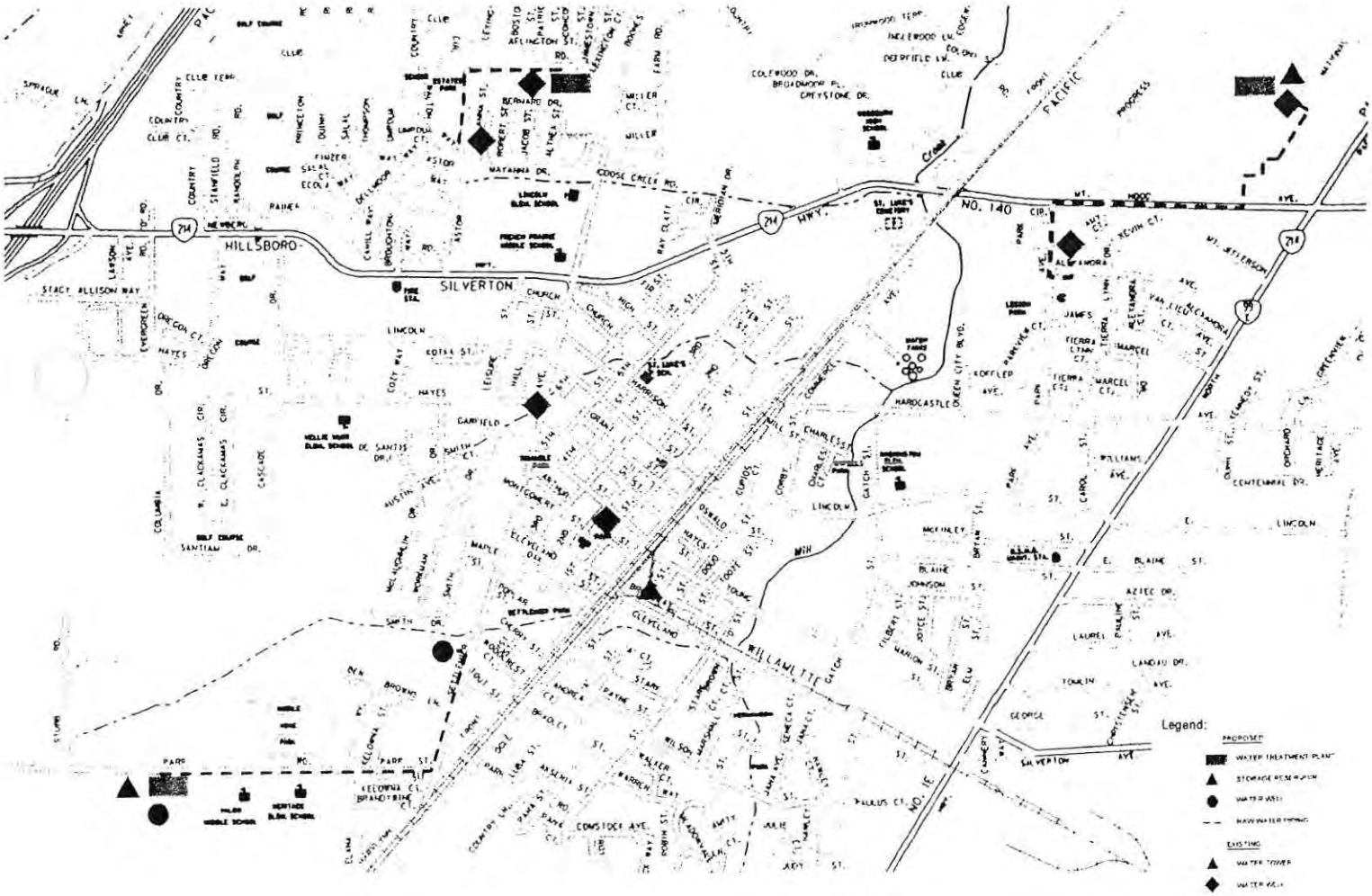
Water Master Plan

City of Woodburn

December 1997 — Amended July 2001



Prepared by

HDR Engineering, Inc.

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CITY OF WOODBURN
OREGON

WATER MASTER PLAN

DECEMBER 1997 – AMENDED JULY 2001

HDR

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CHAPTER 1
EXECUTIVE SUMMARY

1.1 PURPOSE AND OBJECTIVES

The City of Woodburn has decided to prepare a Water Master Plan to address the following main points:

- **To Satisfy Public Requirements:** Currently Woodburn's well water contains elevated levels of iron and manganese. These two metals produce staining on plumbing fixtures and laundry, can cause turbidity and color in the water, and taste and odor problems. While iron and manganese do not endanger the public health, consumers have demanded a better quality water in the Woodburn system.
- **To Comply with Changing Regulations:** The Safe Drinking Water Act is implementing many new and challenging regulations. The Groundwater Rule (GWR) could require the City of Woodburn to implement disinfection. The Maximum Contaminant Level (MCL) for arsenic will be lowered, and EPA has proposed establishing a new MCL for radon. Planning for these new regulations will allow the City to efficiently meet the regulations if they come into being.
- **To Provide Reliable Fire Protection:** A water supply and distribution system must be capable of providing water where it is needed in the quantities needed to provide reliable fire protection to Woodburn residents. Adequate quantities of water must be stored in the system, pipelines in the distribution system must be properly sized and looped, and sufficient fire hydrants must exist in the system. Design standards and planning will help to ensure that the highest level of fire protection is available in Woodburn.
- **And to Economically meet future needs:** Woodburn is a rapidly growing and expanding City. It is projected that the population of the City will more than double in the next 25 years. Providing safe, plentiful drinking water at a reasonable price to Woodburn residents requires good sound planning. Woodburn must look for sources of water, decide on treatment and water quality goals, and establish standards for system expansion that will most efficiently meet the City's needs. Developing a Master Plan that is regularly updated will guide the City efficiently through this anticipated growth.

The objectives of the plan will be:

- Project the water needs of the system over a 25-year planning period and evaluate the water resources and infrastructure to meet the future projected demands.
- Conduct an assessment of the water quality with regard to the Safe Drinking Water Act (SDWA)
- Establish treatment goals which address the upcoming regulations of the SDWA and other water quality issues facing Woodburn, in particular, the reduction of iron and manganese concentrations.
- Develop water treatment alternatives to meet the treatment goals.
- Develop a Capital Improvements Plan to meet the water distribution system goals, water storage capacities, and future water supply needs.

- Outline the current financial condition of the City's Water Division and assess the ability of the City to complete the needed improvements.
- Meet the requirements of OAR 333-061-0060.

1.2 AUTHORIZATION

On March 26, 1996, the City of Woodburn entered into a contract with HDR Engineering, Inc. to complete a Water Master Plan to bring the City into compliance with the requirements stipulated in the OAR 333-061-0060. The Water Master Plan will take a holistic look at the water supply system to develop criteria and tools that the City can use over the next 25 years to ensure that as the City grows, residents will have plenty of safe high quality drinking water. This planning document will be a guide outlining needed improvements to meet growth needs, regulations, and treatment objectives. The City again contracted HDR Engineering, Inc. in 2001 to update the Water Master Plan.

1.3 SERVICE AREA AND PROJECTED WATER DEMANDS

The City of Woodburn is located in Marion County approximately 17 miles north of Salem and 30 miles south of Portland. It is situated within the Pudding River basin in the Willamette Valley. The City's sole water source is groundwater from the Troutdale aquifer, a large semi-confined aquifer. Woodburn has 12 wells in the Troutdale, 6 of these wells are active. The water system has approximately 4,800 connections which include single family, multi-residential, commercial, industrial, city owned and fire service connections. The service area covers approximately 3,285 acres. The current Woodburn service area population is approximately 16,727 permanent residents with an estimated 1,777 seasonal residents bringing the total to 18,504. By the year 2020 it is projected that the permanent population of Woodburn may reach 38,586 with a seasonal population of 4,099 bringing the total to 42,685.

Woodburn has sufficient water rights to meet the projected water demands through the year 2020. It is anticipated that Woodburn will continue to utilize the Troutdale aquifer as their sole source of water. In the long term, if the area continues to grow, Woodburn will have to look to other sources of water to meet their demands. Current planning by the City of Portland indicates that they do not plan to provide water as far south as the Woodburn area. Developing a new regional source of water has been discussed with neighboring communities however no definite plan has been developed and no agreements have been reached. For the long term, it is recommended that Woodburn continue to investigate the possibility of regional water supply with neighboring communities.

Since the Troutdale aquifer will remain the main source of water for the City of Woodburn for the next twenty five years, it is in the City's best interest to protect the source. The City is currently developing and implementing a Source Water Protection Plan for state certification. The plan will identify potential sources of contamination, it will establish best management practices for industries within the influence zone of the City's wells, it will allow the City to develop ordinances that will provide protection for the aquifer, and it will map the flow patterns of the aquifer. All of these actions will serve to protect the aquifer.

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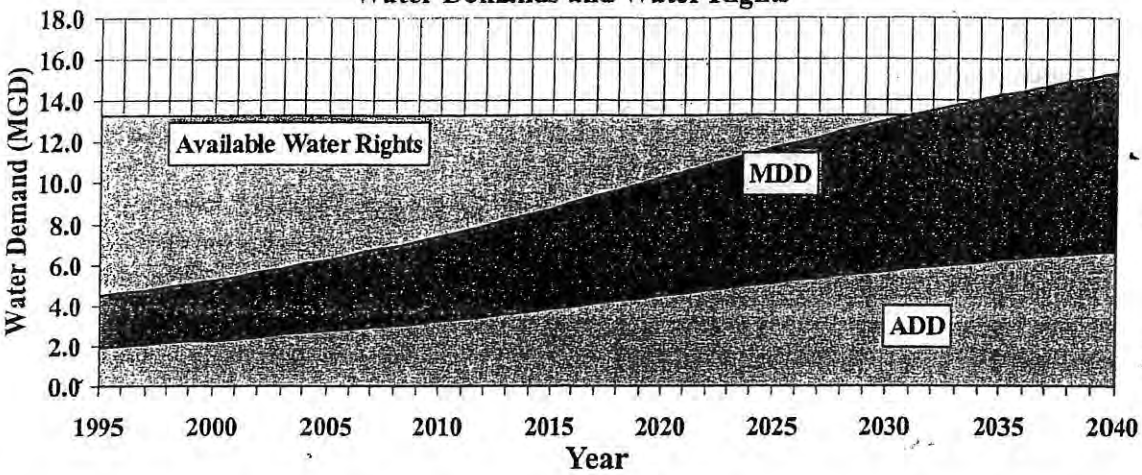
2,667 Extra People
Compared to interim 34,919

Figure 1-1
Woodburn Water Master Plan
Water Demands and Water Rights



2,667 × 97 gpd
258,699
.057
4.47 258,697

By the year 2020 it is estimated that average day demands (ADD) may increase to 4.47 million gallons per day. Maximum day demand (MDD) in the year 2020 is estimated to be 10.28 million gallons per day. These projected demands and the current water rights are illustrated in Figure 1-1. It is recommended that the City construct a minimum of 4 each 1,000 gpm wells over the next 25 years to meet the projected demands. The estimated cost and year of construction for the proposed 4 wells is listed in Table 1-1.

Table 1-1
Woodburn Water Master Plan
Estimated Budgetary Costs – Proposed Wells

Project No.	Description	Project Year	Const. Cost (2000 Dollars)
W-NH	New Well at Church on Newberg Highway plus piping	2000	$275,000
W-CP	New Well at Centennial Park	2010	$250,000
W-ST	New Well at Settlemier/Tout St. plus piping	2005	$275,000
W-CR	New Well at County Rd. 517 plus piping to system	2015	$390,000

Water conservation measures can have a significant impact on the water demand in a water system. Water conservation is a function of education, availability of water resources, water rates, and public participation. Woodburn's current water conservation program includes:

- Leak detection and water line repair and upgrading.
- Annual water audit to calculate the amount of unaccounted-for water.
- Metering of all service connections.

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The following additional water conservation measures are recommended for the Woodburn system:

- A public education program using bill inserts to publicize the need for water conservation.
- Technical assistance measures including a bill showing the consumption history and customer assistance for questions related to water conservation.
- Incentives such as the distribution of water-saving devices including shower flow restrictors, toilet tank water displacement bags, and leak detection dye tablets.
- Promotion of conservation for nurseries and park department facilities and low water demand landscaping in all retail customer classes.
- Increasing Block Structure and/or Seasonal Pricing for water rates.

It is expected that a moderate conservation program could reduce demands between 5 and 8 percent. An approximate 8% reduction in water demand as the result of conservation efforts, could reduce 2020 demands to approximately 4.13 mgd for ADD and 9.50 mgd for MDD.

1.4 STORAGE AND FIRE FLOW REQUIREMENTS

The City currently has one 750,000 gallon elevated storage tank that maintains system pressures and provides equalizing and fire flow reserve storage. For a system the size of Woodburn, this tank does not provide adequate water storage capacity for equalizing or emergency uses. It is recommended that the City construct an additional 4.4 million gallons of water storage over the next 25 years. The storage reservoirs will be ground level reservoirs located at the proposed water treatment plants. Pumps will be used to move the water into the distribution system and maintain pressure. Diesel powered generators or diesel powered pumps will provide emergency pumping capabilities. The first tank will be constructed in 2002 and will make up a significant portion of the storage deficiency. If the City decides not to proceed with the construction of water treatment plants in the system, it is still recommended that the proposed reservoirs be constructed.

Water storage in a distribution system consists of 3 parts: 1- equalizing storage, 2- fire flow reserves, and 3- emergency standby storage. Equalizing storage provides water supply when the instantaneous demand exceeds the production capacity of the system. Fire flow reserve is the volume of water required to provide the fire flow demand for the duration of the fire. Emergency standby storage is water used to supply the city when a portion of the production system is out of commission. This is usually due to either natural disasters such as earthquakes or floods, or subsequent power outages associated with natural disasters. Fire flow reserve will be considered to be a part of the emergency standby storage for the Woodburn system. The recommended storage volumes required for the Woodburn system by the year 2020 are illustrated in Figure 1-2. Estimated costs for the proposed water storage reservoirs are listed in Table 1-2.

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Figure 1-2
Woodburn Water Master Plan
Storage Volume Breakdown - Year 2020

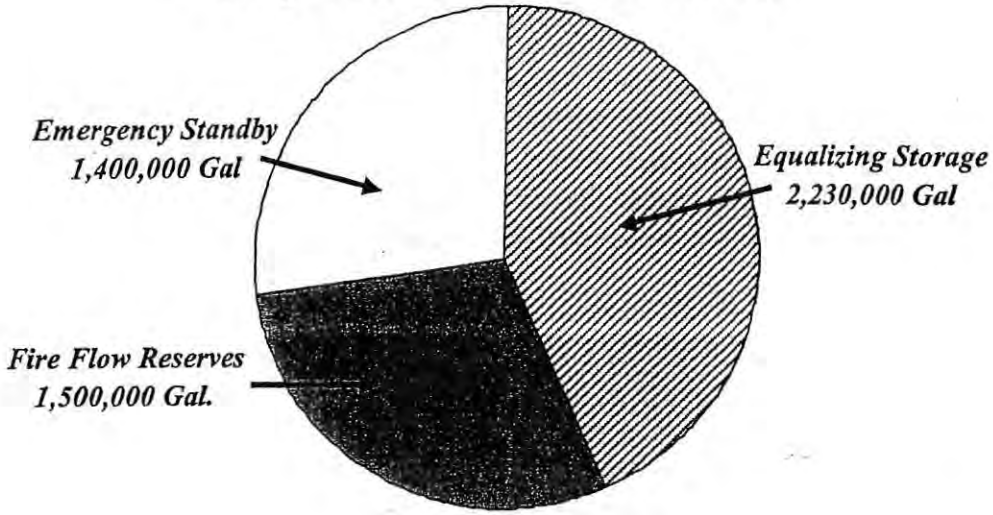

Table 1-2
Woodburn Water Master Plan
Water Reservoir Estimated Budgetary Costs

Project No.	Description	Project Year	Const. Cost (2000 Dollars)
WT-1	2.2 MG Reservoir at Well 10 Treatment Plant with attached booster pump station	2002	$2,060,000
WT-2	2.2 MG Reservoir at Centennial Park Treatment Plant with attached booster pump station	2002	$2,067,000

1.5 WATER QUALITY AND TREATMENT ISSUES

The key water quality issues facing the City of Woodburn that may drive the City to construct treatment for the system include:

- Iron and Manganese which exceed the Secondary Maximum Contaminant Levels (SMCL).
- The possibility of the Groundwater Disinfection Rule requiring disinfection.
- Arsenic levels that may be above the proposed new regulations.

Currently the City of Woodburn provides no water treatment of any kind or disinfection for their system. Generally speaking, Woodburn's water is excellent quality. It is characterized as being moderately hard and well buffered. The water has very low organic content that will not be a problem if the City is required to disinfect the water at some point. The pH of the water is above 5 and the City is in compliance with the Lead and Copper Rule. Woodburn is in compliance with the parts of the Safe Drinking Act that are currently in force and apply to the City.

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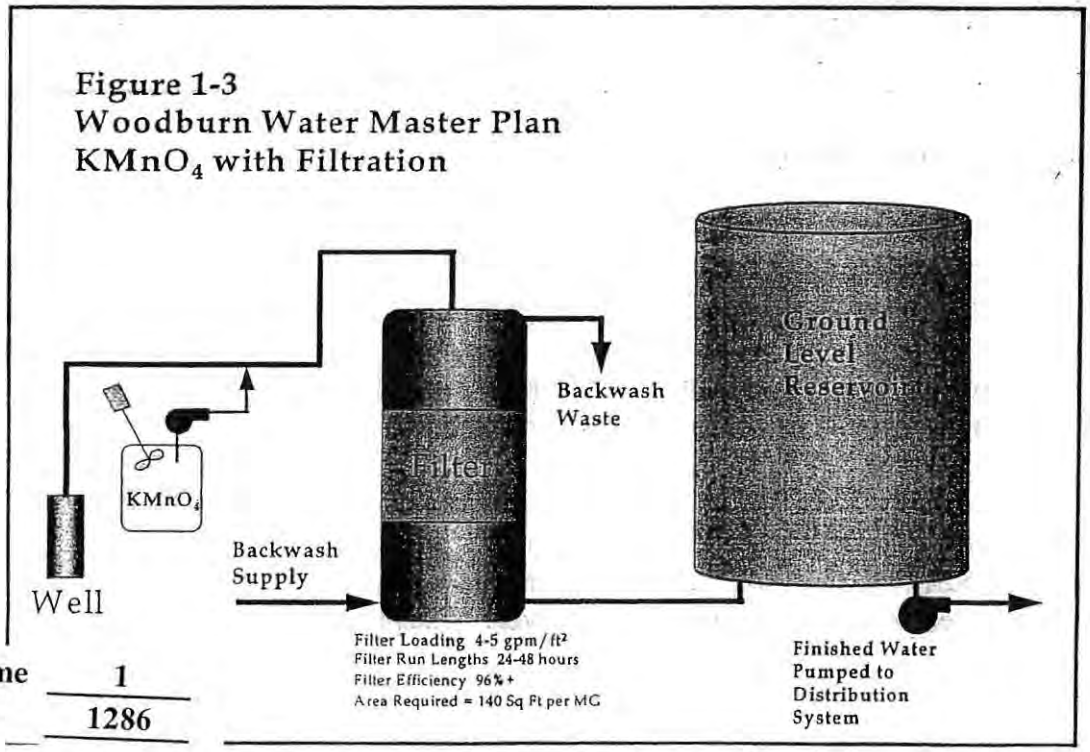
Iron and Manganese: Iron at levels from 0.4 to 2.1 mg/l and manganese at levels of 0.3 to 0.6 mg/l both exceed the SMCL. Secondary contaminants are not a threat to the public health but are a nuisance due to aesthetics. Woodburn receives numerous complaints about the water quality due to the elevated levels of iron and manganese found in the water. Iron and manganese will stain plumbing fixtures and laundry, they will cause turbidity in the water after exposure to the atmosphere, and they are linked to taste and odor problems. Oxidized iron and manganese will accumulate in the distribution system piping and will be mobilized during hydrant flushing, fire flow events, or other high pipe velocity episodes. Once mobilized, the metal oxides will show up at customer taps as rusty or black water that is not aesthetically pleasing yet it does not pose a health threat.

To eliminate the iron and manganese problem, the City will have to construct treatment plants that will oxidize and then remove the metal on a mixed media filter. After evaluating several available technologies for the removal of iron and manganese, four processes were selected for cost estimation and detailed evaluation. These alternatives included: 1- potassium permanganate ($KMnO_4$) oxidation and pressure filtration; 2- Prechlorination, $KMnO_4$ oxidation and pressure filtration; 3- ozone oxidation and pressure filtration; and 4- biological filtration. The recommended treatment process is $KMnO_4$ oxidation followed by pressure filtration. This process was selected for its economic advantages, it is proven technology for the removal of iron and manganese, its ease of operation, and its flexibility. This process is illustrated in Figure 1-3.

Since no treatment plants exist in the Woodburn system, determining how many plants to construct and where these plants should be located was a significant part of the treatment evaluation process. Four alternatives were considered: 1 - one centralized treatment plant located in the northeast part



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of the City; 2 - two neighborhood treatment plants, one in the northeast corner of the City and one in the southwest corner of the City; 3 - three neighborhood treatment plants, one in the northeast corner of the City, one in the western part of the City, and one in the southwest corner of the City and 4 - five wellhead treatment plants located at Wells 7, 8, 9, 10, and in the southwest corner of the system. Well 11 will be treated at the Well 9 treatment plant, the Well 7 plant will provide treatment for a new 1,000 gpm well located on the west side of I-5, and the plant in the southwest corner of the City will provide treatment for 3 new each 1,000 gpm wells. Evaluating each alternative with respect to construction cost, phasing capability, treatment capacity, operation and maintenance cost, raw water transmission main costs, and impacts to the distribution system, it is recommended that the neighborhood treatment plant option be implemented in the Woodburn system. The City Council appointed a Citizen Water Master Plan Committee to develop preferred alternatives for treatment and storage improvements. The committee evaluated the water system improvements program, and recommended that a potassium permanganate pressure filtration process be used for water treatment. The committee also recommended that improvements be implemented in three phases. During Phase 1, three treatment plants each with a capacity of 2.7 MGD would be constructed along with two 2.2 MG storage tanks and two pump stations, two new wells, and three raw water transmission lines. Recommendations for improvements in phases 2 and 3 are split into two different alternatives that achieve the same goals. Both alternatives provide for growth needs, and the only difference is the schedule for construction of the fourth treatment plant in the west Woodburn area. Recommended improvements for phases 2 and 3 include adding two 2.7 MGD treatment plants in south and west Woodburn, drilling 4 new wells, and constructing raw water transmission lines from the new wells to the treatment plants. Only three new wells may be required if existing Well #7 (Nazarene Well) is able to be upgraded and utilized. Construction of improvements for phases 1, 2, and 3 would begin in 2002, 2015, and 2022, respectively.

A budgetary level cost estimate for the recommended plan is presented in Table 1-3.

Currently the City is not required to disinfect the groundwater source. Parts of the Safe Drinking Water Act (SDWA), namely, the Total Coliform Rule (TCR) and the proposed Groundwater Rule (GWR), may change this requirement at some point and the City should consider this in any proposed treatment scheme. If the Groundwater Rule is enacted, the City would be required to provide primary and secondary disinfection. Primary disinfection is the elimination of any pathogenic organisms from the water. Secondary disinfection is providing a long term disinfectant residual in the system to kill any problem organisms that may enter the distribution system.

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Table 1-3 Woodburn Water Master Plan Treatment System Summary of Budgetary Cost Estimates		
Treatment Component	**Year of Improvement**	**Estimated Costs (2000 Dollars)**
Raw Water Transmission Pipelines	2003	$1,079,000
Raw Water Transmission Pipelines	2015	$413,000
Raw Water Transmission Pipelines	2022	$195,000
Reservoir Improvements	2004	$4,127,000
Drill 2 Wells at S. Woodburn Site	2002	$680,000
Drill 2 Wells at S. Woodburn Site	2015	$425,000
Drill 2 Wells at W. Woodburn Site	2022	$335,000
Construct Three 2.7 MGD Treatment Plants	2005	$10,288,000
S. Woodburn Treatment Plant Expansion	2015	$1,500,000
Construct W. Woodburn Treatment Plant	2022	$1,720,000
	Totals (2000 Dollars)	**$20,762,000**

The City can not implement disinfection without implementing treatment for the removal of iron and manganese. Using disinfectants such as chlorine or ozone, both strong oxidants, will oxidize the iron and manganese in the water and exacerbate the color and aesthetics problems the City is already experiencing due to the iron and manganese. Conversely, if Woodburn utilizes a primary disinfectant in the treatment process, i.e. chlorine or ozone, they will be obligated to provide a secondary disinfectant in the distribution system. The selected treatment process, $KMnO_4$ oxidation followed by filtration does not use a primary disinfectant and therefore secondary disinfection is not provided in the process.

Disinfection processes considered included chlorine, ozone, chloramines, chlorine dioxide, and UV light. After evaluating all of the operational and cost components of the various systems, chlorine is recommended if disinfection is required for its ease of use and low cost. Chlorine is widely used for disinfection due to the fact that it is inexpensive, it can be used as a primary disinfectant, and it will maintain a residual in the distribution system. Chlorine can combine with organic matter in the water to produce disinfectant byproducts that are regulated by the Safe Drinking Water Act. Due to the low organic matter found in the Woodburn water, disinfectant byproducts are not anticipated to be a problem. It is estimated that providing disinfection to the treatment plants would cost $100,000.

During 1993 and 1994, Woodburn had non-acute violations of the Total Coliform Rule (TCR). Woodburn conducted an investigation of the source of the contamination problem, flushed and superchlorinated waterlines in the problem areas, and switched coliform testing methods from the MMO-MUG test to the multiple tube fermentation (MTF) test method. No contamination was found in the wells, so the source is out in the distribution system. After completing this work and switching methods for coliform testing in 1994, only two samples have tested positive for total coliform; one repeat sample in November 1994, and one sample in October 1995. No definite source of the contamination problem has ever been identified in the Woodburn System. It is

recommended that Woodburn continue their diligent efforts to control the non-acute violations with the TCR through operational changes and cross connection control.

Arsenic has been detected in one of the abandoned wells in the Woodburn water system at concentrations up to 31 μg/L. This is below the current MCL of 50 μg/L, but above the anticipated future MCL of between 3 to 20 μg/L. Arsenic is lower in the operating wells, however the City must be diligent in monitoring the levels of arsenic in the water to ensure that they meet the regulations. Some arsenic would be removed gratuitously with treatment for the removal of iron. During pilot testing of the proposed iron removal process, the arsenic level was reduced from 12 μg/L to 9 μg/L in Well #10. Use of a ferric chloride chemical feed resulted in finished arsenic concentrations of 5 μg/L or less.

1.6 DISTRIBUTION SYSTEM

To evaluate the distribution system, a computer model was developed as a part of this Water Master Plan. The software package Cybernet, produced by Haestad Methods, was used in conjunction with the City's water system map in AutoCAD to develop a model data base. The model was calibrated using field tests and pressure readings. Once the model was calibrated, average and maximum day demands for both 1996 and the year 2020 conditions were modeled. Results from the computer analysis indicate that during both the average day and the maximum day demand, typical service pressures range from approximately 50 to 60 psi and the system does not have significant hydraulic deficiencies.

Available fire flows were calculated at five locations throughout the system using the model. Based on the recommended minimum requirements for fire flow, current water demands, and projected future demands, in the current distributed well configuration, the distribution system can generally provide the required fire flow throughout the system. It is recommended that the City use the computer model in evaluating system expansions, development proposals, and other work in the system to ensure that adequate fire flow is provided to all areas of the system. Fire flow capabilities also need to be recognized and considered when approving building type and occupancy in all areas of Woodburn.

Construction of water treatment facilities and the centralizing of the water supply to the distribution system will alter the hydraulics of the distribution system. Rather than the distributed supply system that exists now with the wells pumping directly into the system, supply to the system will be centered around the treatment plants. In evaluating the treatment plant locations, the impact on the distribution system was studied using the computer model. This study was completed to determine what and if any improvements would be required in the system due to particular treatment plant locations. The required piping system improvements for each treatment plant location is illustrated on the system maps included in this Water Master Plan in Chapter 10. The recommended improvements to the distribution system are listed in Table 1-4.

Table 1-4 Woodburn Water Master Plan Distribution System Improvements and Estimated Costs			
Project No.	**Description**	**Project Year**	**Const. Cost (2000 Dollars)**
FF-1	Install 60 feet of 10-inch pipe to cross Boones Ferry Road to tie system together	1998	$10,000
FF-2	Install 810 feet of parallel 8-inch pipe to increase capacity on State Highway 214	1998	$103,000
FF-3	Install 850 feet of parallel 10-inch pipe to increase capacity	2005	$135,000
FF-4	Install 200 feet of parallel 10-inch pipe to increase capacity	2005	$32,000
WS-1	Install 990 feet of 16-inch pipe to improve the flow from the treatment plant area to west of I-5	2000	$251,000

The existing telemetry and control system is over 30 years old and it is recommended that it be upgraded to conform to current industry standards. Modern computerized control, monitoring, and data storage and reporting systems will allow the operators to optimize the system and provide the City with high quality water service. Woodburn is in the process of upgrading their wastewater treatment plant and a new SCADA system will be developed for this new facility. The proposed water treatment plants will use this system and will expand its function and abilities. Remote monitoring and control, modem connections to wells, treatment plants, reservoirs, and pump stations will allow the operators the freedom to operate the system from either the office or from home via computer modem hookup. This will reduce operator hours and improve system performance while ensuring a high quality water is delivered to the public.

1.7 CAPITAL IMPROVEMENT PLAN

All of the projects identified during the preparation of this Water Master Plan and listed in the tables in this Chapter, were entered into the Capital Improvement Plan (CIP). The CIP schedules and prioritizes the projects and improvements over the next 24 years. Tables 12-1, 12-2 and 12-3 list all of the recommended projects by type, year of construction, and classification respectively. The total estimated present worth of the CIP is over $21,000,000 and includes transmission piping, distributions system improvements, treatment plants, reservoirs, and new wells. To ensure that Woodburn residents continue to receive a high level of water service, it is recommended that the City adopt this CIP and work toward completing the recommended projects as scheduled.

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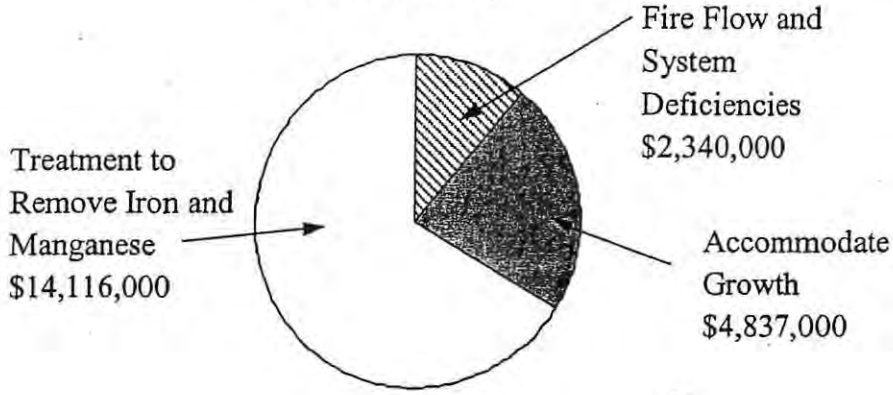
Figure 1-4
Woodburn Water Master
Breakdown of Costs for CIP
(2000 Dollars)



To adjust and refine the CIP and to conform to changing conditions, it is recommended that the City evaluate system performance and the CIP projects at a minimum of every five to seven years. This will allow projects to be modified, projects to be added, and projects to be deleted as the City grows and develops into the 21st century.

1.8 FINANCIAL PLAN

The City's financial audits indicate that from 1991 through 1996, the following ranges of revenues and expenditures were experienced:

- Revenues (excluding interest): $863,000 to $1,190,000
- Total expenditures: $598,000 to $1,000,400
- Net income (excluding interest): $185,000 to $382,000
- Net income (excluding interest) and eliminating capital expenditures: $265,000 to $450,000, with an average of approximately $372,000

The last rate increase, which was approximately 15%, occurred in 1992. In April 2001, Financial Consulting Solutions Group, Inc. completed a water rate study for the City based on improvements developed for the capital improvements plan. The study concluded that rate increases should begin in October, 2001, and continue through 2006. The water bill for an average single family residence (SFR) would increase by 27 percent each year in 2002 and 2003, then by 20 percent each year in 2004 and 2005. Rate adjustments would end with with an 8% increase in 2006. A typical bill for a SFR (1000 cf usage) would increase from $11.65 in 2001 to $29.24 in 2006. These rate increases would provide enough revenue for the proposed projects.

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Since Woodburn will be experiencing significant growth over the next twenty years, it is recommended that the City establish the proposed fee structure to allow them to adequately charge for improvements to their system that result from development and growth. Such fees as developers extension fees, connection fees, or general facilities fees should be used to spread the costs of improvements to the right sources. Figure 1-4 illustrates the breakdown of the proposed improvements by 1- Improve fire flow and correct deficiencies; 2- Accommodate growth; and 3- provide treatment to remove iron and manganese.

1.9 PLAN IMPLEMENTATION

Implementation of this Water Master Plan should proceed through the following steps:

1. Adopt this Water Master Plan by City Council Resolution.
2. Submit the plan to the Oregon Health Division for review and approval.
3. Proceed with the development of a Source Water Protection Plan.
4. Start the process of pilot testing and evaluating the proposed treatment process.
5. Start the implementation of the Capital Improvement Plan as outlined herein.
6. Authorize a full water rate structure study to develop sources of project funding.
7. Update and review the recommendations of this plan at least every 5 to 7 years.

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CHAPTER 2
INTRODUCTION

2.1 BACKGROUND

The City of Woodburn has been supplying city residents for decades with water with no treatment and no disinfection. Changes in the water regulations over the last 10 to 15 years, continued customer complaints about water quality, anticipated regulations that will impact the Woodburn system, and anticipated significant growth have all pointed toward the need for a Water Master Plan. A plan is needed to allow the City to:

- ensure that the water supply system will satisfy all public requirements,
- water quality will comply with the changing regulations,
- the distribution and storage system will provide reliable fire protection in the system,
- and the water system can be expanded to economically meet future needs.

This master plan will be a replacement for the Water Plan contained in the Woodburn 2000 Comprehensive Plan completed in 1978. The Woodburn Water Division, operating under the direction of the Public Works Department, currently (1997) supplies water to approximately 18,500 part time and full time residents. It is estimated that the City will more than double in size over the course of the next 25 years.

AUTHORITY, MANAGEMENT AND BUSINESS LOCATION

The City of Woodburn has the responsibility and authority to plan for and to provide water services to its customers within its boundaries. The Water Division operates under the jurisdiction of the City Council of the City of Woodburn. The City Council has final say in setting policy and making planning decisions for the Woodburn water system.

The day to day operation of the Water Division is headed up by the Director of Public Works, with direct supervision by the Public Works Program Manager. The Engineering Department provides technical expertise and guidance and day to day operations are handled by the field operations staff. The water engineering and operations staff respond to complaints, make system repairs, and monitor construction projects for the City.

The Water Division offices are located at:

City of Woodburn
City Hall
270 Montgomery Street
Woodburn, Oregon 97071
(503) 982-5245

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2.2 PURPOSE

This Water Master Plan will look at the whole system to determine how to best meet the water needs of City residents as the City grows and develops. The plan will incorporate current growth projections to estimate the quantity of water required over the next 25 years. This plan will evaluate the impact of current and projected Federal drinking water regulations on the City of Woodburn. Water quality characteristics will be assessed and treatment objectives will be developed to meet the regulations and public demand for a high quality drinking water. Using the treatment goals, processes will be studied and developed that will meet these treatment goals. Budgetary cost estimates will be prepared, phasing of projects will be considered, and operations and maintenance characteristics will be evaluated in the recommendation of a treatment system.

A computer system model will be developed to study the distribution system and determine what if any deficiencies exist in the system. The model will identify pipes that are causing restrictions in the system, it will provide sizing information for proposed pipe extensions, and it will pin point any areas where pressures may be a problem. Once developed, the City engineering staff will use the computer model on a regular basis to evaluate the impact of proposed water system improvement projects.

This Water Master Plan will look at the water storage in the system and its ability to provide fire protection and emergency supply. Protection of the public is a vital part of a water system and recommendations will be made on the Woodburn storage systems ability to meet the required demand.

The Water Master Plan will report on the financial status of the water system and the operations and maintenance of the system. The Water Divisions' ability to finance the recommended projects will be critical to the implementation of the Plan. Operations and maintenance procedures will be itemized and outlined to establish the current system status and methods.

The overall purpose of this Water Master Plan will be to develop a guide that can be used by the City to efficiently and effectively plan for and meet growth needs, regulations, and treatment objectives within the water system for the next 25 years.

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CHAPTER 3
PLANNING DATA INFORMATION

3.1 EXISTING/FUTURE SERVICE AREA

The Woodburn service area is defined as the area within the city limits. With the exception of approximately 10 units, residents outside the city limits but within the urban growth boundary (UGB) are not serviced by city water.[1] The current service area includes approximately 3285 acres within the Woodburn city limits. The UGB includes 4110 acres. The city of Woodburn services approximately 18,504 full- and part-time residents.

It was assumed for this report that the UGB will remain constant during the planning period and that all growth will occur within the UGB. Expansion of the city limits and service area to the UGB will be expected as areas are developed according to their zoned uses. Industrial expansion will occur in the northeast, southeast and southwest. Commercial development will occur along major thoroughfares and residential expansion is expected in the north and south areas of the city. Buildout of underdeveloped areas in the city is also expected.

3.2 SERVICE AREA CHARACTERISTICS

Woodburn is located in Oregon's Willamette Valley approximately 17 miles north of Salem and 30 miles south of Portland in the Pudding River basin. The topography of the service area is relatively flat, sloping slightly to the northeast with an elevation range of 150 to 200 feet above sea level. The service area drains through Mill Creek and the Pudding River. Senecal Creek drains a small portion of the service area west of I-5. There are no other physical formations of significance in the city. The climate is mild with wet winters and dry summers.

The soils in the area are of two associations, Amity silt loam and Woodburn silt loam. Both of these formations are found throughout the city in all areas except drainage channels. The Amity series consists of poorly drained soils formed in mixed alluvial silts. The layer is generally 17 inches thick overlaying a 7-inch silt loam subsurface layer and a 13-inch silty clay loam subsoil. The Woodburn series consists of moderately well-drained soils formed in silty alluvium and loess. The 17-inch surface layer overlays 37 inches of subsoil and a silt loam substratum to a depth of 68 inches. The course of Mill Creek is etched in Bashaw clay and Dayton soils and terrace escarpment are also found in the service area.

The geology of the study area consists of Troutdale formation materials and Willamette silts overlying Columbia River basalt. Depth to basalt is unknown but thought to be approximately 600 feet. The Troutdale formation consists of alternate layers of clay, silt, sand and gravel. The Willamette silt formation consists of stratified silt, sandy silt, clayey silt and silty clay and has poor drainage characteristics. (Wastewater Facilities Plan, 1995) The city is located in a Seismic Zone 3. All structures associated with the water system will be considered essential facilities according to the Uniform Building Code.

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[1] From discussions with city staff.

Currently the city's source of water supply is the Troutdale aquifer. City wells extend to depths of 186 to 333 feet. Well yields range from 400 to 1200 gpm.

3.3 SERVICE AREA AGREEMENTS

The following summarizes the agreements that have been initiated that are related to the City of Woodburn Water System:

Agreement Between Birdseye Division, General Foods Corporation (Agripac) and the City of Woodburn

This agreement, dated April, 1971, is for the City to provide the facility with unmetered water to their fire sprinkler system in exchange for the facility supplying the City with water from its well should it be needed during a fire emergency. The agreement, originally with Birdseye was transferred to Agripac when they purchased the facility.

3.4 SERVICE AREA POLICIES

The following summarizes the policies/ordinances that have been adopted relating to the Woodburn water system:

Woodburn Resolution 1097

This resolution establishes the current water rates for the City.

Woodburn Ordinance 1515

This ordinance provides for the payment of costs of extending water or sewer service lines by the property owner who benefit from the extensions.

Woodburn Ordinance 1866

This ordinance establishes regulations and rates for the city water system. It defines the service provided, discusses meter policy, sets fees, charges and rates and discusses discontinuance of service. It establishes general policy items such as damage to City property, source development, cross connections, access and water conservation.

Woodburn Ordinance 2070

This ordinance, dated September, 1991, establishes the current System Development Charges for the City of Woodburn as authorized by ORS 223.297-223.314.

3.5 STATE LEGISLATION/REGULATIONS/GUIDELINES

The following describes legislation that has been enacted by the State of Oregon, regulations and guidelines that are applicable to water supply planning.

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ORS 448.115 - 448.285 Oregon Drinking Water Quality Act

This legislation, enacted in 1981, sets forth the mechanism for the state of Oregon to administer the federal Safe Drinking Water Act. It authorizes the Health Division to administer the legislation. The stated purpose of the legislation is to:

- Assure all Oregonians safe drinking water
- Provide a simple and effective regulatory program for drinking water systems
- Provide a means to improve inadequate drinking water systems.

It establishes the jurisdiction of municipalities, defines penalties and operator certification requirements.

ORS 197 Comprehensive Land Use and Planning Coordination

This legislation requires comprehensive land use planning within the state and gives authority to local governments to conduct the planning. It also requires coordination of planning efforts.

ORS 215 and 227 County and City Planning Authority

This legislation establishes and defines the authority of counties and cities to conduct local planning.

ORS 536.220-536.360

This statute establishes the need for a statewide integrated, coordinated water resources policy and authorizes the Water Resources Department to administer it.

Oregon Administrative Rules - Chapter 333, Division 61

This document, dated January, 1996, provides the basis for implementing the Oregon Drinking Water Quality Act of 1981 as required in ORS 448.131.. The Chapter sets forth responsibilities of water suppliers, establishes maximum contaminant levels and treatment and performance standards for water supplies. It also establishes sampling and analytical, reporting and record keeping and public notice requirements. It outlines permit requirements, construction standards and land use coordination requirements. Operation and maintenance and product standards are also addressed.

Oregon Administrative Rules - Chapter 660, Division 11

The purpose of this rule is to implement ORS 197.712(2)(e) which requires that a city or county shall develop and adopt a public facility plan for areas within a urban growth boundary. The purpose of the plan is to ensure that urban development is guided and supported by appropriate types and levels of facilities and services and that the facilities are developed in a timely manner. The division contains definitions relating to a public facility plan, procedures and standards for developing, adopting and amending such a plan, the date for submittal of the plan and standards for review.

Oregon Administrative Rules - Chapter 660, Division 31

The purpose of this rule, entitled "State Permit Compliance and Compatibility," is to specify state agency responsibilities for goal compliance and comprehensive plan compatibility for agency land use programs which involve the issuance of state permits.

3.6 ZONING/LAND USE

Figure 3-1 shows land uses within the UGB. The land uses shown on Figure 3-1 are based on current zoning designations and indicate types of activities that are currently authorized on the property. Approximately 17 percent of the city is zoned for multi-family development and 33 percent is zoned for low density, single family development. A total of 50% of the city's area is zoned for residential development. Approximately 12 percent of the land use is designated as commercial and 14 percent as industrial. The industrial area includes the Woodburn Industrial Park located north of Highway 214 and four other areas in the City. Parks and open areas make up approximately 9 percent of the service area. Publicly owned lands comprise 15 percent of the area.

3.7 POPULATION

The population projection for the City of Woodburn is shown in Table 3-1. The population projection shown in Table 3-1 were derived from the Wastewater Facilities Plan (1995). Four forecasts were shown in the Wastewater Plan. They were based on the following:

- Woodburn's highest historical growth rate held constant at 4.2 percent
- Facilities plan growth rate (3.4 percent)
- Woodburn's average historical growth rate
- Portland State University (PSU) Population Research and Census Center projection

The 3.4 percent population growth rate was approved by the Wastewater Advisory Committee and City Council because it was considered to represent a conservative and reasonable projection that is greater than the average historical growth rate but less than the maximum historical growth rate and reflects the high population growth rate projections for the Portland metropolitan area. At the City's direction, the same population projection was used in this plan.

Table 3-1
City of Woodburn Population Forecast

Year	Permanent	Summer Only	Total
1996	16,727	1,777	18,504
2000	19,771	2,100	21,871
2005	23,368	2,482	25,850
2010	27,620	2,934	30,554
2015	32,646	3,468	36,114
2020	38,586	4,099	42,685

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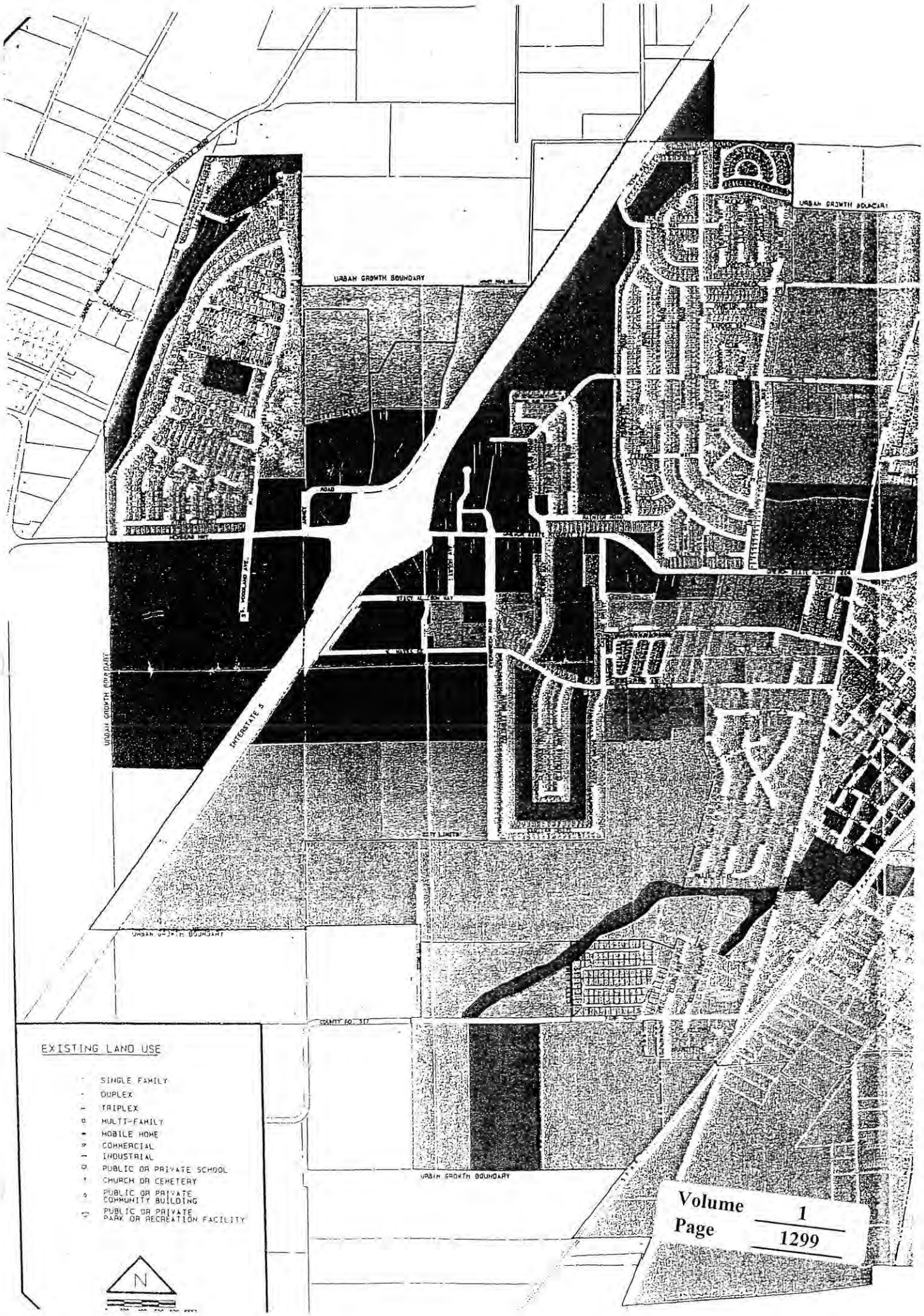

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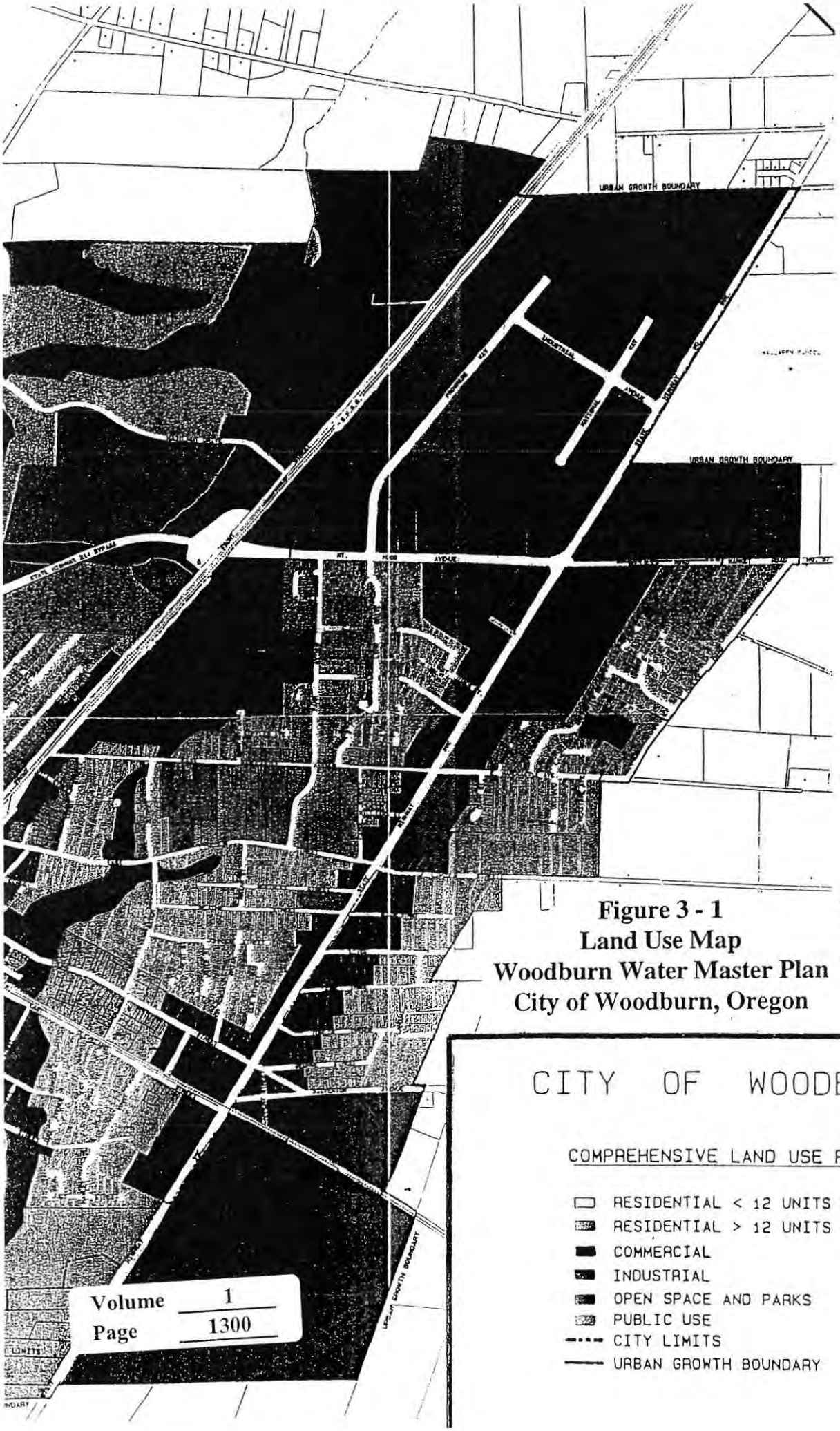

Figure 3 - 1
Land Use Map
Woodburn Water Master Plan
City of Woodburn, Oregon

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CHAPTER 4
WATER SYSTEM DEMANDS

4.1 INTRODUCTION

This chapter looks at existing and projected water demands for the City of Woodburn. In addition, water conservation measures to reduce future water demands are presented. The water demands are projected for a 25-year planning horizon. The projections are based on the assumption that all growth will be contained within the existing Urban Growth Boundary (UGB) and the current zoning will remain.

4.2 EXISTING SYSTEM DEMANDS

Based on metering records from 1992 to 1995, the average daily water demand (ADD) for the City of Woodburn ranged from 1.6 to 1.8 million gallons per day (mgd). The maximum daily water demand (MDD), which occurred during the summer months, ranged from 3.5 to 4.3 mgd. The values are summarized in Table 4-1. The average ratio of MDD/ADD from pumping records is 2.3. It is reasonable to assume the ratio of MDD/ADD for pumping and demand are the same.

Seasonal variation of water demand is illustrated in Figure 4-1, which shows the average daily demand by month during the period of July 1994 through June 1995. The demand follows the typical pattern of summer highs and winter lows. Superimposed on Figure 4-1, are the ADD and the MDD during the same time period.

Table 4-1
Woodburn Yearly Water Demand[1]

	Average Daily Demand	Maximum Daily Demand[2]	
Year	MGD	MGD	Month in which MDD Occurred
1992/1993	1.57	3.53	August
1993/1994	1.65	3.83	July
1994/1995	1.78	4.34	July

(1) Based on metering records.
(2) Based on ratio of MDD/ADD from pumping records.

There are no specific historical data available to determine the ratio of the maximum instantaneous system demand (MID) to the ADD. The maximum peak hour demand generally occurs during the evening dinner hours at typically 170 percent of the average demand for that day. During a maximum day, this demand would, therefore, be approximately 2.3 times 1.7 or 3.9 times the ADD. For this master plan analysis, a MID/ADD factor of 3.9 was used.

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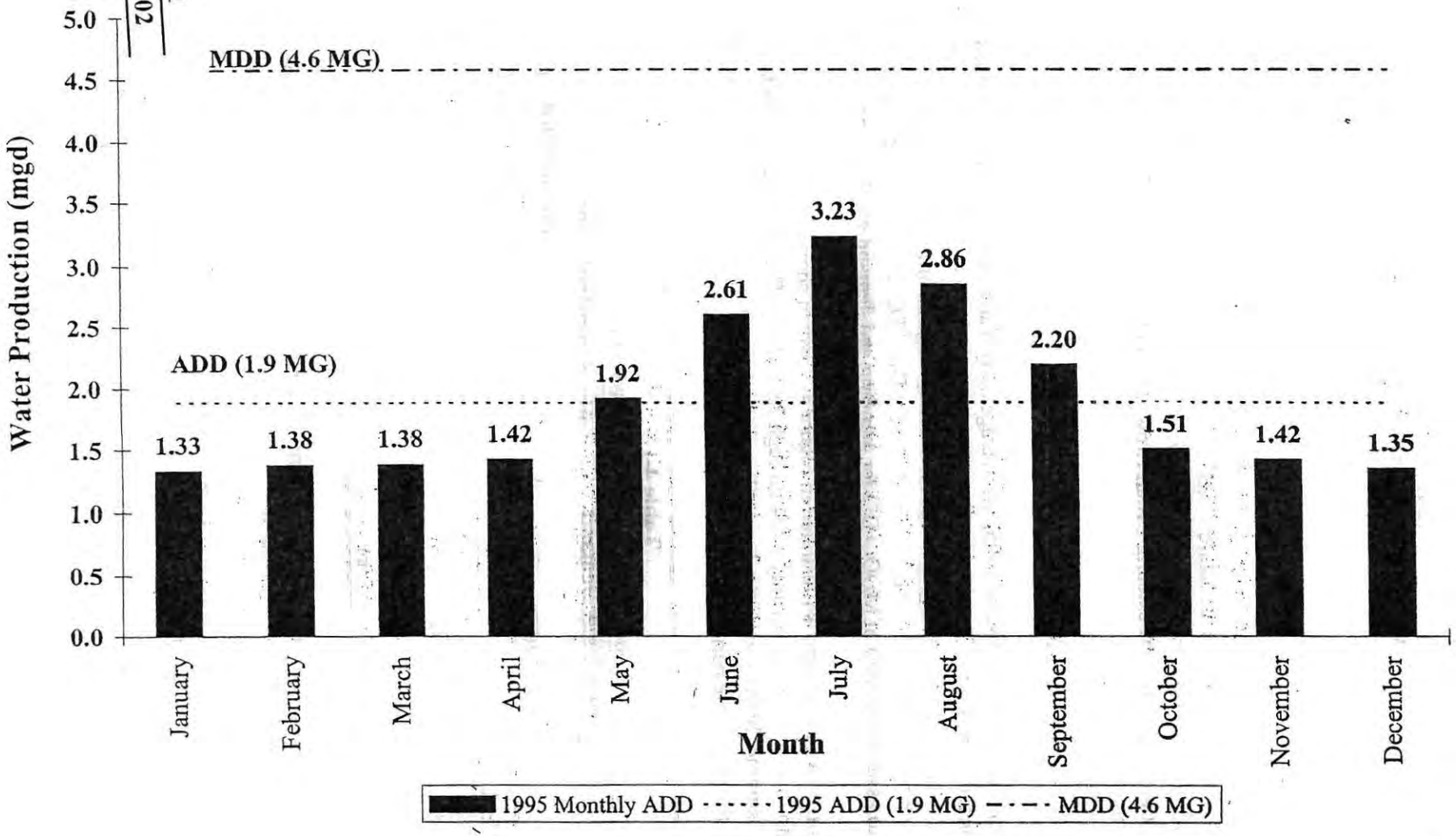
Figure 4 - 1
Woodburn 1995 Water Production



4.3 DEMAND CATEGORIES

System demands were categorized by single-family, multi-family, commercial and industrial. The utility bill data base provided information regarding the number of connections in each category. All of Woodburn's service connections are currently metered. Included in Table 4-2 are the total demand by category, the total number of connections (in 1996) per demand category, unit demands for each category, and the percent of the total demand per category.

Table 4-2
Woodburn Existing Water Demand Per Demand Category

Demand Category	Total Demand (gpd)	No. of Connections[1]	Unit Demand[2,3] (gpd/connection)	Percent of Total Demand (%)
Single Family Residential	1,098,000	4,176	266	62
Multi-residential	310,400	127	2,440	17
Commercial	315,800	386	820	18
Industrial	520	3	173	0.03
City Owned	38,300	56	697	2
Fire Service	1,300	53	26	0.07
Other (Flushing)	13,800			0.08
Total	1,778,000	4,800	--	100

(1) As of April 1996.
(2) Based on number of connections in June 1995 and demand from June 1994 through June 1995.
(3) gpd = gallon per day.

The unit demand per single family residence was approximately 266 gpd/connection. The unit demand per multi-family connection was calculated as 2,440 gpd/connection. The number of multi-family dwelling units per unit connection varies significantly, from 2 to 192, with an average of 23.4 units per connection (excluding duplexes) and a median of 12. The estimated per capita water demand based on a 1995 full-time residential population of 16,727 and a part-time residential population of 1777 and the 1995 ADD of 1.8 mgd is 97 gallons per capita per day (gpcd).

As indicated on Table 4-2, residential water demand accounts for about 80 percent of the total water demand. Commercial water demand accounts for 18 percent. City connections account for the remaining 2 percent of the water demand. Less than one percent of the water demand comes from the industrial and fire service categories.

Fire flow places a high demand on the system for a relatively short period of time. Fire flow requirements must be added to the calculated service demands presented in this chapter. Fire flow demands are discussed in Chapter 6.

4.4 UNACCOUNTED-FOR WATER

Unaccounted-for water results from un-metered demands, meter inaccuracies, leakage, hydrant and line flushing and testing, and authorized or unauthorized hydrant use. Typical water systems can average from 5 to 10 percent unaccounted-for water.

Woodburn conducts annual audits of pumping and water consumption records to measure its unaccounted-for water. A comparison of the past 10 years data, summarized in Table 4-3, shows the unaccounted-for water in Woodburn to range from 5 to 11 percent of production with a median and average of 8 percent. To minimize unaccounted-for water, leaking pipelines have priority replacement in Woodburn's distribution system maintenance budget. Unaccounted-for water in the City of Woodburn appears to be reasonable, and no special corrective action is recommended.

Table 4-3
Woodburn Unaccounted For Water

Year	Unaccounted for Water	
	MG	Percent
1994 - 95	56.6	9
1993 - 94	55.3	8
1992 - 93	64.4	10
1991 - 92	86.3	11
1990 - 91	50.4	8
1989 - 90	67.0	11
1988 - 89	50.1	8
1987 - 88	30.9	5
1986 - 87	31.0	5
Average	**54.7**	**8**

4.5 WATER CONSERVATION PROGRAM

Water conservation requirements for cities pursuing additional water rights have been established by the Oregon Department of Water Resources (ODWR). The basic philosophy of the requirements is that in looking at a range of water supply options, a utility must include water conservation measures as a water supply option. Water conservation measures can be used to reduce both overall demand and peak demand. Conservation measures include both demand side strategies, which lessen the demand, and supply side strategies, which supply the demand through an alternative source or through a more efficient system. Water conservation measures are grouped into four categories:

- Public Education
- Technical Assistance
- System Measures
- Incentive/Other Measures

Woodburn's current water conservation program includes:

- Leak detection and water line repair and upgrading
- Annual water audit to calculate the amount of unaccounted-for water
- Metering of all service connections

The following water conservation measures are recommended for consideration:

Public Education

The ODWR requires some type of public information program to publicize the need for water conservation. Options may include television and radio public service announcements, news articles, and public water system bill inserts. It is recommended that Woodburn implement this measure through bill inserts. The AWWA has pre-printed brochures with which can be used as bill inserts.

Technical Assistance

Bill Showing Consumption History
In this conservation measure, the customer's water bill lists the percentage of increase/decrease of water use for a time period compared with the same period in the previous year. This technique has been used successfully by electric utilities.

Customer Assistance
This includes responding to customers questions related to water conservation. Woodburn could implement this measure through appointing a current staff member to become a specialist in water conservation, who could address customer concerns or questions which may develop.

System Measures

Limit Unaccounted Water/Leak Detection
This measure involves a regular and systematic program of finding and repairing leaks in system mains and laterals. A water audit is a mandatory conservation measure of the ODWR. Woodburn's current water conservation program includes both a leak detection and water line repair and upgrading program and an annual water audit.

Require Meters
This measure involves the installation of meters for all service connections. The ODWR requires that all connections be metered. Woodburn has metered all service connections. The City should maintain their periodic meter testing and repair program.

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Incentives/Other Measures

Single-Family/Multi-Family Kits

Kits are distributed which contain easily installed, water-saving devices to single-family residential homes and the owners and managers of apartment buildings and condominiums. Devices in the kits include shower flow restrictors, toilet tank water displacement bags, leak detection dye tablets, and an informational brochure.

The toilet tank displacement bag lessens the amount of water used to flush by holding a small amount of water out of use. Non-conserving toilets equipped with tank displacement bags use 4.8 gallons per flush versus 5.5 gallons per flush for a non-conserving toilet without a tank displacement bag.

Part of the National Energy Policy Act of 1992 governs water fixtures and requires water saving plumbing fixtures for new construction. Existing fixtures do not have to be removed, but new construction must include water fixtures which meet the requirements. This regulation requires a maximum flow 2.5 gpm from a shower head (a "low flow" shower head).

Nurseries/Agriculture

This technique includes the application of current technology to water use practices of large agriculture/irrigation operations, such as nurseries and park department facilities. The practices include moisture sensors, flow timers, low volume sprinklers, drip irrigation, and other practices to increase irrigation efficiency.

Landscape Management/Playfields

In this technique, low water demand landscaping in all retail customer classes (private, public, commercial, industrial, etc.) is promoted. Local nurseries are encouraged to ensure the availability of plants that achieve this objective.

Increasing Block Structure and/or Seasonal Pricing

Water conservation can be encouraged by increasing the unit price of water as consumption increases (an increasing block rate or inverted block rate) and seasonal pricing, in which the unit price of water is increased during the high seasonal use period (the summer months for Woodburn). With this structure, the customer is more conscious of the quantity of water consumed which may encourage water conservation.

Woodburn currently charges a flat unit rate up to a basic quantity, then a lower unit rate for quantities above the basic quantity. The ODWR requires that systems evaluate the feasibility of an increasing block and/or seasonal rate structure, although implementation of this rate structure is not required.

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Program Effects on Demand

It is expected that a water conservation program for Woodburn would have some measurable effects on system demand. A 15 percent reduction in residential water use over a 10 year period has been indicated as a goal for a utility conservation program which involves plumbing code changes for new construction, an aggressive fixture retrofit program and a landscape water conservation program. It is expected that a moderate conservation program would reduce demands between 5 and 8 percent over the ensuing 10 year period.

4.6 PROJECTION METHODOLOGY

The population forecast for Woodburn through the year 2020 is shown in Table 3-1. Projected water demands through the year 2020 were based on the population projections and per capita demands. This approach assumes commercial and industrial demand growth rates of 3.4%, the same as the population growth rate. The Woodburn Wastewater Master Plan (1995) projects a commercial flow growth rate of 3.4% and an industrial flow growth rate of 0.5%. Since the industrial component of the water demand is very small, the difference made by this simplifying assumption will be negligible.

Water demand projections from 2020 to 2040 are estimates provided to allow the City of Woodburn some guidance in planning for water supply and water rights needs. These projections assume that the growth will level out some throughout this time period. It is recommended that when population estimates become available for this time period, that the water demand projections be recalculated.

4.7 FUTURE DEMAND PROJECTIONS

Projected water demands at five year increments through 2040 are summarized in Table 4-4. Water projections were made assuming two water conservation impact scenarios. They include a "no impact" scenario, in which water conservation measures fail to reduce the per capita water demand, and a "moderate impact" scenario in which the reduction achieved from conservation measures is 8 percent. It is assumed that the 8 percent reduction is accomplished linearly over a 10 year period beginning with program implementation in 1997 and resulting in an ultimate reduction of per capita water demand to 90 gpcd in 2007. Unit demands are then expected to remain constant through the year 2040.

The MDD was calculated based on the ratio of MDD/ADD of 2.3. The MDD projections for both scenarios are summarized in Table 4-4.

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Table 4-4 Water Demand Projections				
	No Conservation Impact		Moderate Conservation Impact	
Year	ADD (mgd)	MDD (mgd)	ADD (mgd)	MDD (mgd)
1995	1.78	4.34[1]	1.78	4.34[1]
2000	2.10	4.83	2.05	4.72
2005	2.51	5.77	2.36	5.43
2010	2.96	6.81	2.73	6.28
2015	3.51	8.07	3.23	7.43
2020	4.14	9.52	3.82	8.79
2025	4.70	10.82	4.36	10.02
2030	5.25	12.08	4.86	11.18
2035	5.74	13.20	5.32	12.23
2040	6.17	14.19	5.71	13.14

[1] Actual demand

Production requirements are the sum of the demand requirements plus unaccounted-for water. It is assumed that Woodburn will continue their maintenance program and that unaccounted-for water will remain unchanged at 8% of production. Table 4-5 summarizes projected water production requirements. Figure 4-2 illustrates production projections for both conservation scenarios.

Table 4-5 Water Production Projections				
	No Conservation Impact		Moderate Conservation Impact	
Year	ADD (mgd)	MDD (mgd)	ADD (mgd)	MDD (mgd)
1995	1.92	4.46 [1]	1.92	4.46 [1]
2000	2.27	5.22	2.21	5.10
2005	2.71	6.23	2.55	5.86
2010	3.20	7.35	2.95	6.78
2015	3.79	8.72	3.49	8.03
2020	4.47	10.28	4.13	9.50
2025	5.08	11.68	4.70	10.82
2030	5.67	13.05	5.25	12.08
2035	6.20	14.26	5.74	13.20
2040	6.66	15.32	6.17	14.19

[1] Actual production.

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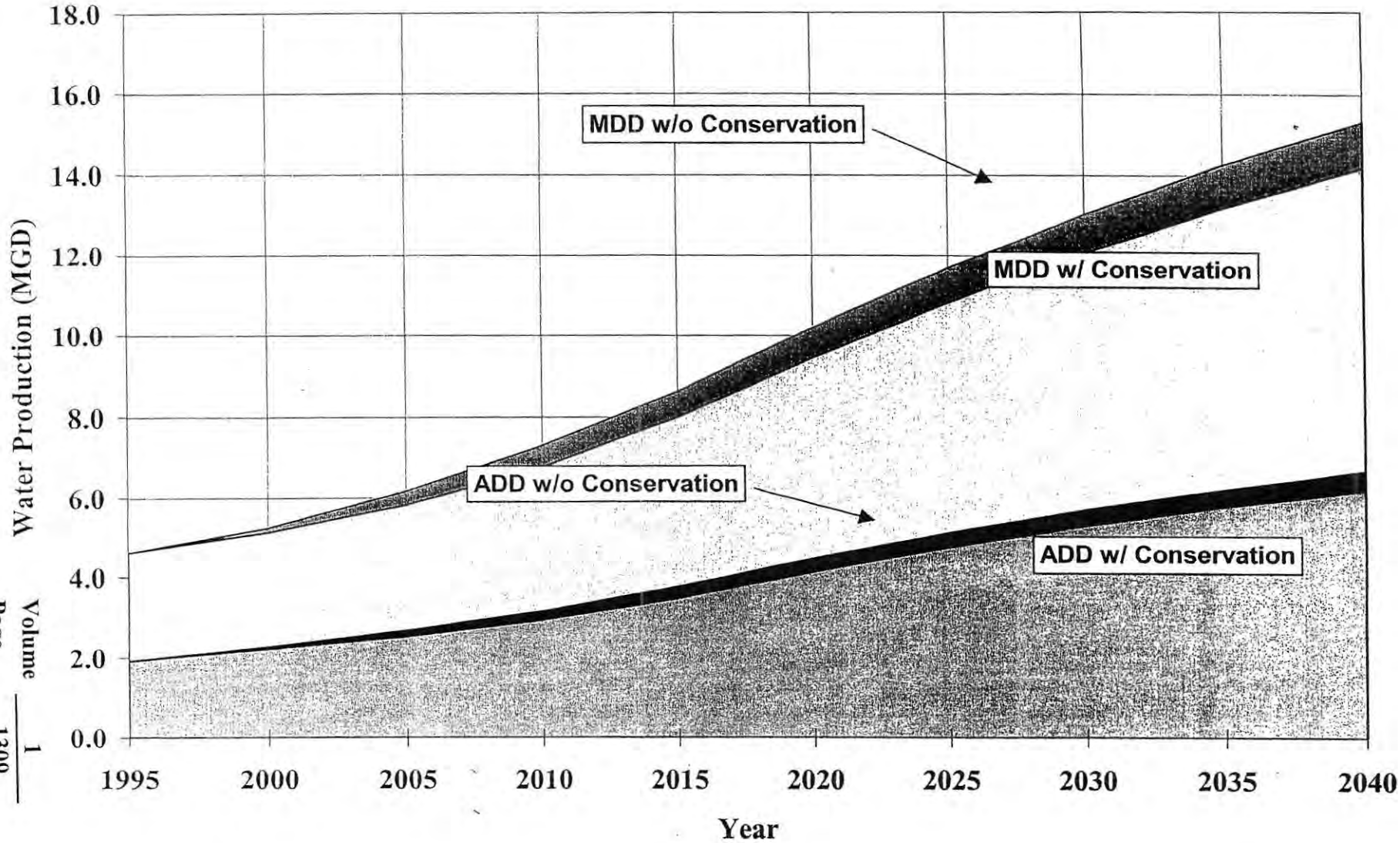
Figure 4-2
Woodburn Water Production Projections



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CHAPTER 5
EXISTING SYSTEM INVENTORY/REVIEW

5.1 SUMMARY OF AVAILABLE INFORMATION

Information on the existing system was primarily provided by City of Woodburn staff, and a site visit. The general characteristics of the City's water system are illustrated on the water system map found in the back of this Master Plan.

The City of Woodburn currently draws water from the Troutdale Aquifer from six wells. Water is distributed to customers through approximately 66 miles of water pipe varying in size from 4 inches to 24 inches in diameter. The system also includes substandard piping of 1 and 2 inch size. One operating water storage reservoir serves as a system pressure regulator and provides some emergency reserves. A second elevated water reservoir is currently out of service. The system consists of a single pressure zone. Detailed descriptions and inventories are summarized in this chapter.

5.2 FACILITIES DESCRIPTION/CONDITION

Source of Supply

e City of Woodburn has 6 active production wells supplying groundwater to the system. The .ty has six other wells that are not in production at this time. The wells are described in detail in Table 5-1. In 1995, average day production from the wells was 1.78 mgd (1236 gpm), with a maximum day production in July of 4.58 mgd (3180 gpm). The location of the wells within the system are shown on the Water System Map which is inserted in the back of this Water Master Plan.

The well pumps feed directly into the system during operation The pumps are controlled through an Autocon control system based on the level in the water reservoir. The system rides on the level of the tank and system pressures are generally 45 psi to 60 psi.

Storage Facilities

The City of Woodburn currently has one operating reservoir in the system. This reservoir is an elevated steel tank and has a capacity of 750,000 gallons. There is also one reservoir which is out of service. The reservoirs are described in Table 5-2. The operating reservoir provides peak demand storage, emergency reserve, and hydraulic gradient control for the system.

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Table 5-1
City of Woodburn
Existing Wells

No.	Description	Capacity	Function	Comments
1	Shop No. 1		Not in Service	
2	Shop No. 2		Not in Service	
3	Library		Not in Service	
4	Settlemeir Well located at the intersection of West Hayes St. and Settlemeir Avenue. Drilled in 1952.	600 gpm Depth = 183'	Provides water to the central part of Woodburn.	Well is manually controlled through Autocon panel.
5	Old SPRR		Not in Service	
6	Abandoned			
7	Nazarene Well located on Woodland Avenue. Drilled in 1967	1,000 gpm Depth = 333'	Provides water to the northwest part of Woodburn.	Well is manually controlled through Autocon panel.
8	Legion Park Well located on Alexandra Avenue. Drilled 1974.	868 gpm Depth = 194'	Provides water to the southern area of Woodburn.	Well is manually controlled through Autocon panel.
9	Warren Donner Well located on Country Club Road.	1,000 gpm Depth = 280'	Provides water to the north central area of Woodburn.	Well is manually controlled through Autocon panel.
10	Centennial Well located 2205 National Way. Drilled in 1988.	1,000 gpm Depth = 273'	Provides water to the northeast area of Woodburn.	Well is manually controlled through Autocon panel.
11	Astor Way Well located at 1108 Astor Way. Drilled in 1989.	1,000 gpm Depth = 279'	Provides water to the north central area of Woodburn.	Well is manually controlled through Autocon panel.
A	King Way		Not in Service	
-	Senior Estate		Not in Service	

Table 5-2 City of Woodburn Existing Water Storage Reservoirs			
Description	**Capacity (gallons)**	**Overflow Elevation**	**Comments**
Elevated Steel Tank. Located near Broadway and Front Street.	750,000	140 feet	
Elevated Steel Tank. Located near Broadway and Front Street.	60,000	140 feet	Currently not in use due to leakage problems.

Transmission and Distribution Piping

The City of Woodburn has a network of transmission and distribution piping ranging in size from 4 inches to 24 inches in diameter. Substandard pipe of 1 and 2 inch diameter that exists is being routinely replaced. Transmission lines connect major service areas of the city. A pipe inventory lists approximately 66 miles of pipe with the majority being 6-inch or 8-inch diameter service piping. A summary of the quantity of pipe by diameter is illustrated in Figure 5-1. Figure 5-2 is a system piping map that shows the location of all of the pipes and is color coded by pipe size. The pipe materials in the distribution system include PVC, cast iron, ductile iron, steel, galvanized steel and asbestos cement. Ductile iron and cast iron pipe make up the majority of the system. The City an ongoing program of repair of their system, which is done by the City staff. The system has hydrants and valves throughout the system to provide customers with fire protection.

Telemetry and Controls

The City of Woodburn uses an Autocon telemetry system to monitor and control the water supply and distribution system. The heart of the system is a central control panel located near the elevated storage tank. The central panel contains the following information:

- indication lights for current status information
- elevated tank level indicator and recorder
- system pressure indicator and recorder
- HAND/OFF/AUTO switches for well pump control
- elapsed pump operating time
- High and low elevated tank level alarms

Field data are telemetered to the central panel using leased telephone lines. The high and low tank level alarm signals are also sent to a monitoring service which relays the alarm to the Woodburn police station. The telemetry system has no battery backup and is approximately 30 years old.

There are no operating or intrusion alarms at the wells. Flow metering is by turbine-type flow meters.

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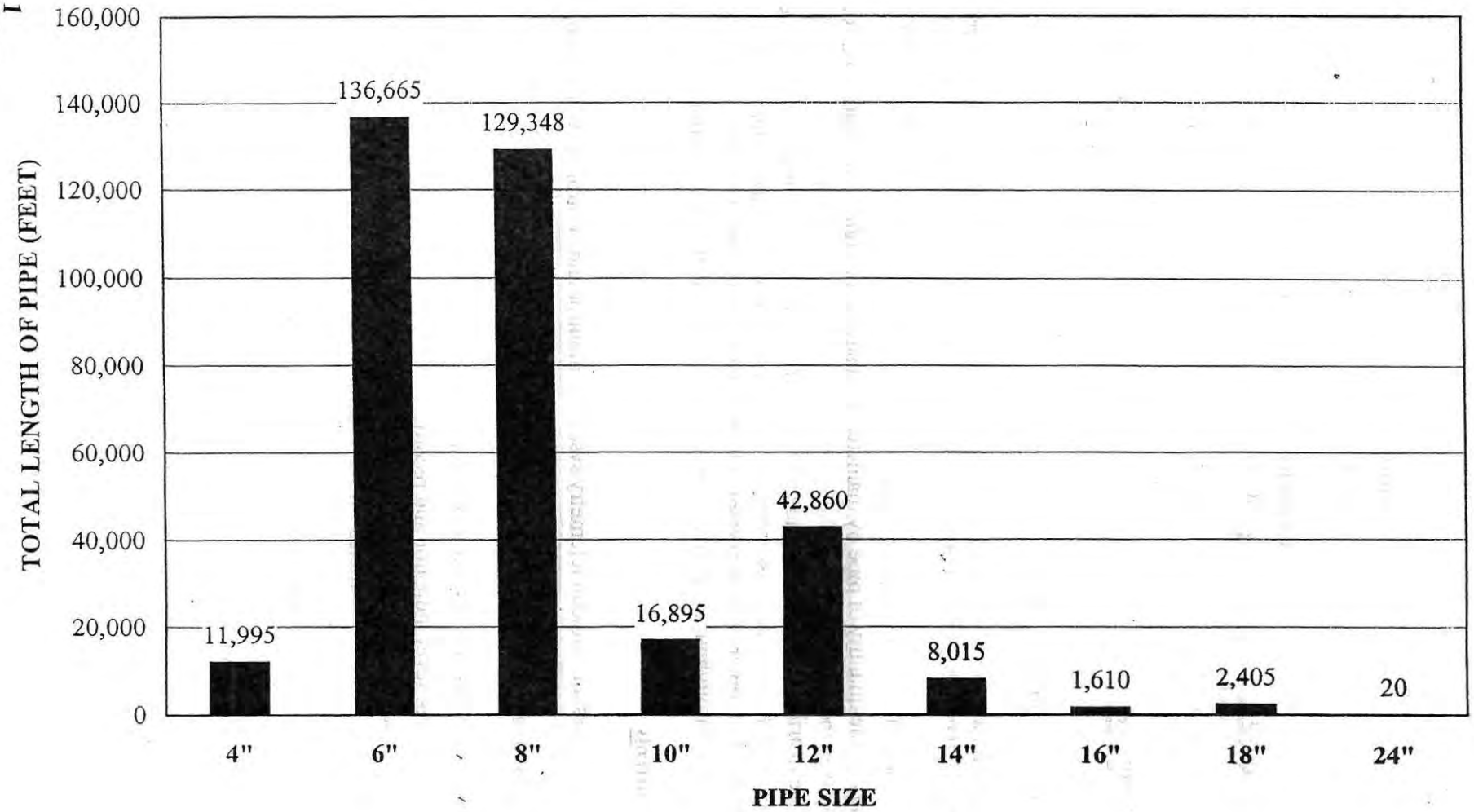
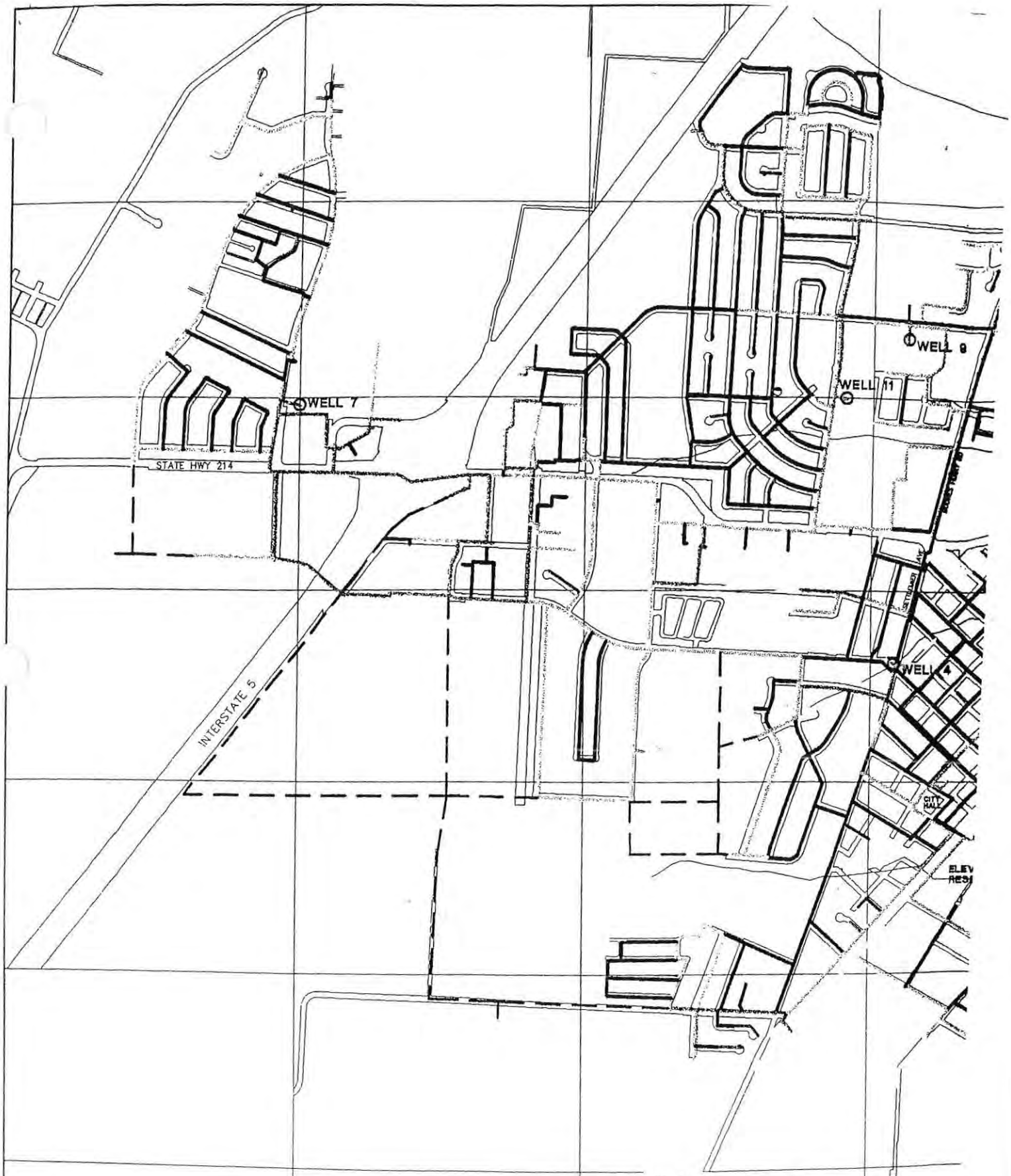
FIGURE 5-1
WOODBURN 1995 WATER SYSTEM PIPE INVENTORY





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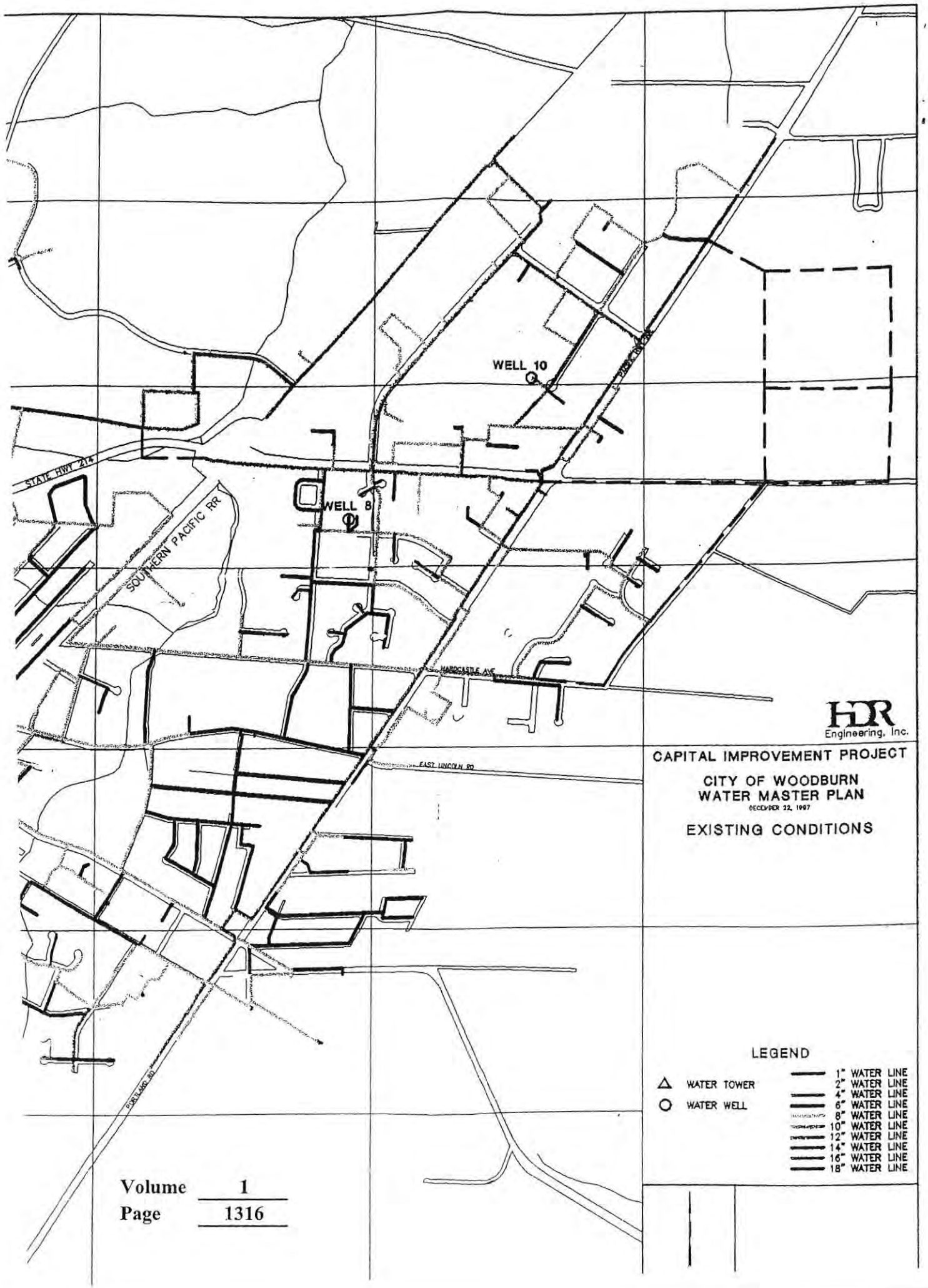

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CHAPTER 6
STORAGE AND FIRE FLOW REQUIREMENTS

6.1 FIRE FLOW STANDARDS

Fire flow demand refers to the required water flow rate that is available for fighting fires. The high fire flow rates place a high stress on the distribution and supply system for relatively short periods. A fire flow demand usually occurs at one location, but can affect a large part of the water distribution system. To ensure that the system is capable of providing the minimum required flows under most conditions, fire flows are calculated while imposing maximum day demands on the system with the largest source of supply out of service. If the water system is not designed properly for fire flow demands, high water main velocities will cause excessive head loss in the system and water pressures will drop to unacceptable levels. Systems without adequate storage facilities or production capabilities, will have difficulty meeting the required fire flow demands.

Woodburn's minimum fire flow requirements are based on fire flow demands specified in the 1994 Standard Uniform Fire Code and set forth by the Insurance Service Office (ISO) in the *Guide for Determination of Required Fire Flow* (December 1974).

6.2 FIRE FLOW REQUIREMENTS

In the City of Woodburn, fire flow requirements for large facilities are determined on a case-by-case basis. The fire flow requirements are established by Woodburn's Fire Marshall, based on recommendations of the underwriting insurance company for the facility. Woodburn's minimum fire demands by land use classification are summarized in Table 6-1. Also presented in Table 6-1 are ISO requirements for each zoning classification. Duration's of ISO fire flows are based on Table 4 of ISO's Grading Schedule for Municipal Fire Protection.

To comply with OAR 333-61-025, during a maximum day demand fire flow event, the pressure at any point in the system should not drop below 20 pounds per square inch (psi). The distribution system, storage reservoirs, and sources of supply all work together to provide the required flow at the site of the fire while maintaining the system pressure above 20 psi.

The fire flow requirements shown are used as a guideline. The actual fire flow required for a specific structure is dependent upon the following items:

- Size of the Structure(s)
- Location of the Structure/Project
- Type of Construction Materials (Wood vs. Concrete/Brick, etc.)
- Number of Stories
- Building Fire Protection Systems (Sprinklers, Automatic Fire Doors, etc.)
- Proximity of Adjacent Structures
- Type of Occupancy/Building Use (Any flammable chemicals being stored, etc.)

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Table 6-1 Required Fire Flows on the Peak Day				
	Insurance Services Office		Woodburn Fire District - Minimum Requirement	
Class	Fire flow (gpm)	Duration (Hours)	Fire Flow (gpm)	Duration (Hours)
Residential/ Single Family	1,000[1]	2	1,000[2]	2
Residential Multiple Family	3,000[3]	3	1,500 - 2,000[4]	2
Commercial	3,000[5]	4	1,500	2
Schools	4,000[6]	4	-	-
Industrial	5,000[7]	5	1,500	2

[1] Based on Wood-frame house with approximately 2,600 square feet or smaller houses grouped closer than 40 feet apart. Add 500 gpm for shingle roofs.

[2] Based on Rural, Semi-Rural, Semi-Urban, Urban, and Planned Unit Developments with 10 or more Residential Units.

[3] Based on Wood-frame construction of an apartment complex with approximately 23,000 square feet.

[4] For Multi-Family structures having over 4,000 gross square feet.

[5] Based on Ordinary construction materials, and an approximate gross area of 50,000 square feet.

[6] Based on Non-combustible materials with a gross area of approximately 125,000 square feet.

[7] Based on Ordinary construction materials with a gross area of approximately 81,000 square feet.

[8] No consideration is given towards sprinkler systems in any of the above calculations. Sprinkler systems can reduce the required fire flow by 50 percent or more in some cases.

6.3 FIRE FLOW REQUIREMENTS BY ZONING CLASSIFICATION

Table 6-2 summarizes the recommended fire flow demand for Woodburn by zoning classification. Zoning information was obtained from the City of Woodburn's Comprehensive Plan (1978, amended 1996). The fire flow recommendations were developed based on the ISO requirements listed in Table 6-1.

Future project development will be required to be designed and constructed using fireproof materials, partitions, and fire sprinklers to keep fire protection demands less than those shown on Table 6-2. When a new development is proposed, the City will analyze the development's impact on the water system. Using the distribution system computer model, the City will calculate the available maximum day demand fire flow at the site of the proposed development. Calculated available fire flow will be compared to the values listed in Table 6-2. If the available fire flow is less than the required value, the developer may be required to either modify the proposed method of construction to reduce the required fire flow or make system improvements to increase the available fire flow in the water system within the development. Proposed improvements to the Woodburn water system should be consistent with the latest version of the Woodburn Water Master Plan.

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Table 6-2 Fire Flow Demands by Zoning Classification (All flows are calculated on the Maximum Day)		
Zoning Classification	**Minimum Required Fire Flow (gpm)**	**Duration (Hours)**
Residential (<12 units/acre)	1,000	2
Residential (>12 units/acre)	3,000	3
Commercial	3,000	4
Public Use	4,000	4
Industrial	5,000	5

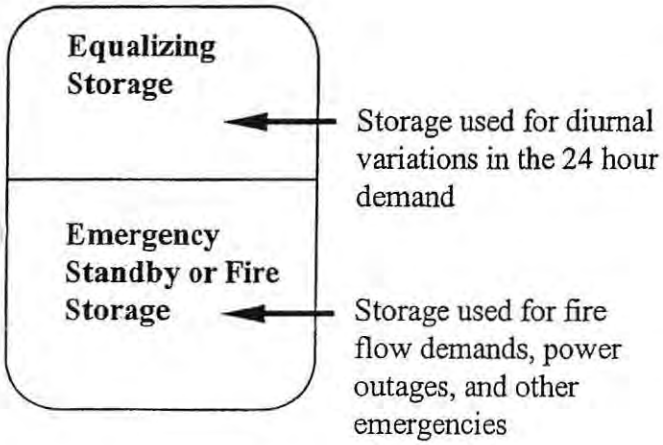


Figure 6-1
Typical Storage Reservoir Breakdown

6.4 STORAGE REQUIREMENT STANDARDS

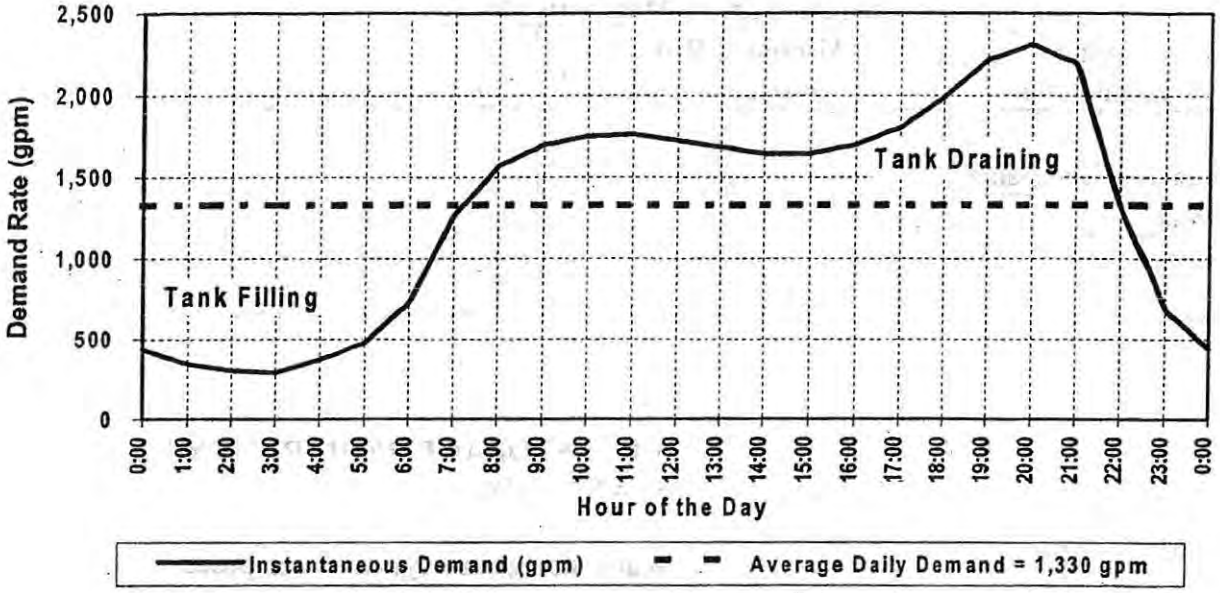
Water storage in a system is composed of two parts: 1) equalizing storage and 2) emergency standby or fire reserve storage. This is illustrated graphically in Figure 6-1. Each of these storage components is described as follows:

Equalizing Storage

Equalizing storage within a water system allows the components of a water supply and transmission grid to be sized for the average rate of demand on the maximum day. Over the course of a 24 hour day, there are significant variations in the water demand. The maximum instantaneous demand (MID) can be as much as 75 percent to 80 percent higher than the 24-hour average flow. Adding wells to the system and constructing the treatment plant and pumping system to provide the MID flow is not economical. Therefore, stored water is utilized to make up the deficit between the average daily and the maximum instantaneous demands. The quantity of equalizing storage required is dependent on the capacity of the production system with the largest source out of service. In the case of Woodburn this would be with one of the large wells out of service.

The City of Woodburn has not recorded its specific daily or diurnal demand curve. For the purposes of this Water Master Plan analysis, a typical water system diurnal curve was used to determine the quantity of equalizing storage required for the Woodburn system. This typical em diurnal curve is shown in Figure 6-2.

Figure 6-2
City of Woodburn, Oregon
Textbook Diurnal Demand Curve



If the production capacity significantly exceeds the average daily demand, the volume of equalizing storage can be minimal. If the production capacity of the water sources is limited to the maximum day demand, more equalizing storage is required to meet peak demands. For Woodburn, it will be less costly to add storage capacity (on the order of 50 cents per gallon) than to construct and operate treatment plants (on the order of one dollar per gallon). Therefore, this plan recommends installing wells and building treatment to meet maximum day demands and using less costly storage facilities to meet peak demands. Using the diurnal curve illustrated in Figure 6-2, the projected demands for Woodburn, and the projected well capacities, the required equalizing storage was calculated and is presented in Table 6-3.

Table 6-3
Required Equalizing Storage

Year	Maximum Day Demand (MGD)	Treatment Plant Production Capacity[1] (MGD)	Minimum Equalizing Storage Required[2] (Gal)	Maximum Equalizing Storage Required[2] (Gal)
1995	4.46	5.47	480,000	480,000
2000	5.22	6.12 to 10.44	190,000	730,000
2005	6.23	7.56 to 10.44	290,000	720,000
2010	7.35	7.56 to 10.44	360,000	1,520,000
2015	8.72	9.00 to 10.44	1,010,000	1,800,000
2020	10.28	10.44	2,230,000	2,230,000

1. Largest well source out of service.
2. Depends on the production capacity available.

Emergency Standby Storage

Emergency standby storage provides water supply during fires, equipment failures, power failures, or during natural disasters such as earthquakes or floods. Although, unlike equalizing storage, emergency standby storage is seldom used, it is important part of the safety and reliability of the water system. The volume required for emergency standby storage is determined based on the amount of water needed for both fire-fighting reserves and/or emergency conditions.

Fire flow storage is described earlier in this chapter. Fire fighting storage is the product of the required fire flow multiplied by the duration of the fire. Fire flow storage is one component of emergency standby storage. Depending upon the methods used fire flow storage can either be considered to be included in or be in addition to emergency standby storage.

Emergency standby storage is based on the projected emergency duration and consequence in conjunction with the rate of supply available. It is difficult to quantify emergency standby storage and the quantity provided in a system should be based on an analysis of the vulnerability of the system and its ability to provide drinking water to the public. With only one source of supply the minimum recommended emergency standby storage is on the order of 800 gallons of storage for each equivalent residential connection. Based on an estimated average day demand of 266 gallons per connection, 800 gallons is approximately equal to three days of standby storage per connection.

However, each water system is unique and in systems like Woodburn's with multiple sources of supply, the 800 gallons per connection standard can be reduced because it is not likely that all of the well sources will be out of service at the same time. The Woodburn emergency standby storage volume required is reduced significantly if it is assumed that the "source of supply" are the wells rather than planned treatment plants. This is because taking one large well out of service reduces source production by only 1.4 mgd while the reduction in source production of taking a treatment plant out of service varies depending upon the number of treatment plants. Even if it were assumed that the wells were "sources of supply" in the emergency-standby storage calculation and that it would be acceptable to supply untreated water into the system under emergency conditions, it is recommended that a minimum of 200 gallons per connection be set aside for emergency-standby storage.

If it is assumed that only treated water should be introduced into the system, one centralized plant would required more storage than two or more treatment plants. Based upon 13,300 year 2020 ERU's, the following calculations show the range of emergency standby storage:

Minimum

Minimum storage = 200 gpc x 13,300 ERU's **2.7 million gallons**

One Centralized Treatment Plant

Maximum emergency standby storage required - one treatment plant

(800 x 13,300) = **10.6 million gallons**

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Two Neighborhood Treatment Plants

Total water production capacity	12.0 mgd
Largest water source out of service	7.2 mgd
Remaining capacity (firm production capacity)	4.8 mgd
Emergency Standby Storage Required - Two Treatment Plants (10.6 mg - 4.8 mg) =	**5.8 million gallons**

Five Wellhead Treatment Plants

Total water production capacity	12.0 mgd
Largest water source out of service	4.3 mgd
Remaining capacity (firm production capacity)	7.7 mgd
Emergency Standby Storage Required - Five Treatment Plants (10.6 mg - 7.7 mg) =	**2.9 million gallons**

Considering the unique nature of the Woodburn system, multiple well sources with two neighborhood treatment plants it is recommended that an equivalent emergency standby storage of 2.9 million gallons be provided. With this storage volume it will be important that the City have established procedures to promptly notify all customers of emergency conditions to request that they conserve water. A summary of the storage requirements are listed in Table 6-4.

Table 6-4
Summary of Year 2020 Storage Components

Storage Component	Recommended Volume (Gallons)
Equalizing Storage	2,230,000
Maximum Fire Flow Reserves (5,000 gpm for 5 hours)	1,500,000
Emergency Standby	2,900,000

Since emergency standby storage volumes exceed fire flow reserve storage the minimum total recommended storage volume is approximately 5,150,000 gallons. Allowing credit for the existing 750,000 gallons of elevated storage leaves a remaining required storage volume of 4,400,000 gallons. Therefore, it is recommended that a 2.2 million gallon storage reservoir be constructed at each of the two treatment plant sites.

Construction of this storage can be phased so that the first 2.2 million gallons is constructed with the first treatment plant by year 2002 and the second 2.2 million gallons is constructed along with the second treatment plant by 2010. The need for storage beyond that recommended for 2020 should be reevaluated within the next five to ten years based upon actual population growth rates and corresponding increases in demand. However, it is likely that it will be beneficial in the distant future to site additional storage in the northwest and/or southeast parts of the system.

CHAPTER 7
PERFORMANCE AND DESIGN CRITERIA

7.1 WATER QUALITY PARAMETERS

Water quality must conform with the Federal Safe Drinking Water Act (SDWA) as amended and Oregon Health Division (OHD) criteria as specified in ORS 448.115 to 448.285. The State of Oregon under OAR Chapter 333 has established rules for the regulation and operation of water systems. Section 333-61-030 of these rules identifies water quality requirements that must be met. These regulations define monitoring requirements, maximum primary and secondary contaminant levels (MCL's), follow-up action that must be taken, and define when public notification is required. Water quality requirements are presented in detail in Chapter 9.

7.2 TREATMENT ISSUES (SDWA)

The water source for the Woodburn water system is groundwater from the Troutdale Aquifer. This source is untreated and has been exempt from disinfection under OAR 333-61-032(6). Treatment and water quality issues are discussed in detail in other sections of this Master Plan.

7.3 SYSTEM DEMANDS

The average daily demand (ADD) for 1995 was approximately 1.8 mgd for the City's system. Based on a full-time service area population of 16,727 and a part-time population of 1,777 within the City's service area, the average per capita domestic demand is 97 gpcd.

The maximum day demand (MDD) in 1995 was approximately 4.3 mgd. The ratio of this demand to the average daily demand is 2.39, slightly higher than the average of 2.3 for 1992-1995. For purposes of analyzing the water system, the ADD will be multiplied by 2.3 to determine MDD. The 1995 maximum Instantaneous Demand (MID) has been estimated to be approximately 3.9 times ADD or 4,820 gpm.

Recommended fire flows are summarized in Table 6-2. Fire flows will be combined with MDD for system hydraulic analysis.

Refer to Chapter 4 for additional information regarding current and future water system demands.

7.4 BACKUP SUPPLY/SYSTEMS

It is highly desirable to have as much redundancy as economically feasible within the water system. This is particularly true with respect to meeting fire flow requirements. Frequently fires occur when natural disasters such as earthquakes strike, or major fires often can cause power outages which can severely impact fire fighting efforts if the water is supplied from a nearby well. For these reasons, the Insurance Services Office (ISO) looks very closely at all aspects of a water system when valuating and grading the system for fire protection effectiveness.

Backup or redundant considerations and criteria for water systems include:

- Back-up emergency power, or dual power sources for well stations (depending on available storage).
- Multiple storage tanks.
- Looped or dual transmission mains.
- Telemetry systems with alarms for critical components in the system.
- A broad, looped distribution system.
- Redundant components in the supply works.
- Isolation valves at critical connections, and frequently spaced along major transmission mains so that damaged portions of main can be easily isolated and repaired.
- Adequate number and location of fire hydrants.
- Adequate storage of water in reservoirs to supply fire flows with the largest source component of the system, such as a well pump or transmission line out of service.

7.5 FIRE FLOW STORAGE

Using the fire flows and fire duration's listed in Table 6-2, the fire flow storage required for the largest fire flow demand in the Woodburn system is 5000 gpm for 5 hours or 1.5 million gallons. Using the current city minimum fire flow guidelines, the maximum fire flow is 2000 gpm with a duration of 2 hours for residential multi-family structures or 240,000 gallons. Even the largest fire flow volume is less than the recommended emergency standby storage volume. Therefore, the more stringent ISO criteria can be met by considering that the fire flow reserve storage is contained within the emergency standby storage volume.

7.6 EQUALIZING STORAGE

Equalizing storage requirements are defined in Chapter 6. It is recommended that the treatment system be designed to meet the demand of the maximum day and that sufficient equalizing storage be constructed to meet the maximum instantaneous demands during the maximum day.

7.7 EMERGENCY STANDBY STORAGE

Emergency standby storage requirements are defined in Chapter 6. The City has the advantage of having multiple sources of supply, therefore the volume of recommended emergency standby storage is reduced significantly from that which would be required with a single source of supply.

7.8 SYSTEM DESIGN STANDARDS

This section presents the general design criteria for the distribution system. These criteria along with the fire flow standards listed in Table 6-1 are considered to be the minimum standards for all facilities within the Woodburn water system.

The standards presented in this section will be used to analyze the existing system to identify deficiencies that may exist and will serve as a basis of design of the proposed system. The analysis of the system will be discussed in more detail in later chapters.

General

- All new developments connecting to the system shall be designed by a Professional Engineer registered with the State of Oregon.
- City of Woodburn retains the right to inspect all new facilities during construction, and prior to being placed in service.
- Connections to the existing water system must be in accordance with City standards.
- Service lines shall be installed so that each residential, commercial, and industrial structure will have a separate meter. If approved by the designated utility, domestic water consumption may be measured by a master meter for service to a complex, under single ownership, and where water line subdivision is impractical. Service lines providing fire flow may be required to be equipped with a fire detection check valve and/or appropriate cross-connection control devices as required by OAR 333-61-070.

Pipelines

- Water lines should be constructed within City or County right-of-ways or within private easements. Easements should be at least 16-feet wide. Pipelines should be located at least 5 feet inside all easements and right-of-ways.
- Minimum pipe sizes:
  6 inch for looped distribution pipes
  8 inch for dead-end pipes
  12 inch for transmission pipes
  Actual pipe size may be larger in some areas due to system requirements
- Pipelines should be looped where possible.
- Maximum pipeline flow velocities
  Maximum Day Demand - 5 feet per second
  Fire Flow Condition under maximum day demand conditions - 10 feet per second
- System pressure
  Maximum Day Demand - 40 psi minimum at any point
  Fire Flow Condition - MDD - 20 psi minimum at any point
  Maximum allowable pressure - 100 psi
- As a minimum, pipe materials should meet AWWA Standard C100 for ductile iron pipe and fittings unless approved by the City.
- All water mains should have a minimum cover of 30 inches over the top of the pipe.
- Minimum separation distances between water mains and sanitary sewer mains should conform to OAR 333-61-050 (Figure 1) when the mains are parallel, and the water main shall be a minimum of 1.5 feet above the sanitary sewer when crossing. Adjustments to these requirements may be allowed if the proposed adjustments are within the latest guidelines published by the Health Division of the Oregon Department of Human Resources.

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- A minimum separation distance of 5 feet horizontally be maintained between water mains and storm sewer systems. Lesser separations will be allowed if it is shown that it is not feasible to locate the water main further away.
- All new piping should be pressure tested to a minimum of 150 psi over normal working pressures for 15 minutes.

Valves

- A sufficient number of valves should be installed in the system to allow isolation of the system for maintenance and repair. As a guideline, valves should be located at all tees and crosses, at all intersections, and have a maximum spacing of 800 feet.
- Two-inch minimum air and vacuum release valves should be installed at all high points in the piping system.

Fire Hydrants

- Fire hydrants should be 5-1/4 inch or larger. Hydrants should be spaced a maximum of 700 feet apart in residential areas and a maximum of 300 feet apart in multi-family residential areas, commercial areas, and industrial areas. Actual hydrant spacing and location will be determined on a project by project basis in consultation with the Fire Marshall.
- Maximum length of six-inch fire hydrant leads shall be 50 feet of equivalent length pipe including fittings.
- Dry-barrel type of construction conforming to AWWA C502 and equipped with National Standard Threads, or devices.
- Fire hydrant type, features, and spacing must be approved by the City and the Fire Marshall.

Disinfection and Testing

- All new pipe, reservoirs, and appurtenances must be flushed, disinfected, and tested in accordance with the standards of OAR 333-61-050, AWWA C600 and D105.

Cross Connection Control

- Where there exists a possibility of contamination of the potable water system, appropriate cross connection control measures must be taken to protect the water system. Refer to OAR 333-61-070, Cross Connection Control.

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CHAPTER 8
WATER SUPPLY RESOURCES

8.1 INTRODUCTION

This chapter presents an evaluation of Woodburn's water supply resources. Included is:

- A summary of the projected water needs of the City through 2020
- A look at the supply and capacity requirements to meet the water needs
- An identification and assessment of the potential sources to meet the supply requirements including the long-term reliable/sustainable yield of the source
- The City's legal ability to acquire the source (i.e. the water rights), and:
- The quality of the source

8.2 FUTURE SUPPLY NEEDS

Water supply projections for Woodburn as described in Chapter 4 indicate that by 2020 an average daily demand (ADD) of 4.47 mgd and a maximum daily demand (MDD) of 10.28 mgd will be required. The water production requirements for Woodburn expressed in 5-year increments through 2020 are summarized in Table 4-5. The ADD and MDD projections as developed in Chapter 4 represent the demand requirements plus provisions for unaccounted-for water, which is assumed to be 8% of the demand. To be conservative, projections for the supply needs assume that conservation efforts have no impact on future water demand or production.

8.3 EXISTING SUPPLY

The City's existing source of water is the Troutdale aquifer. The City has existing water rights of 20.45 cfs (13.25 mgd) in the Troutdale aquifer, which are sufficient to meet the projected year 2020 ADD supply needs of 4.47 mgd and MDD needs of 10.28 mgd. The Troutdale aquifer and the City's water rights are described below.

8.4 CAPACITY REQUIREMENTS

The City has six active wells, designated Wells Nos. 4, 7, 8, 9, 10, 11. Existing information on the individual wells is summarized in Chapter 5, Table 5-1. The total capacity of these six wells is approximately 6.77 mgd. Because of Well No. 4's low capacity and poor water quality, the City intends to abandon Well No. 4. Eliminating the capacity of Well No. 4, the remaining wells have a total capacity of 6.12 mgd. With Well No. 4 in service and assuming that the largest source is out of service, the City of Woodburn currently has a firm supply capacity of 5.47 million gallons per day.

Table 8-1 summarizes the minimum required system production capacity to meet the MDD through the year 2020. The water production capacity to meet the MDD must be provided by the firm capacity of the system (i.e. with the largest production well out of service). Consequently,

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1,000 gpm (the highest production capacity of a well in the Woodburn system) was subtracted from the total available well capacity to determine the additional capacity required to meet the projected MDD for the year noted in Table 8-1.

Table 8-1
Additional Production Capacity Requirements to Meet the MDD[1]
City of Woodburn

Year	MDD	Additional Supply Required (mgd)[2]	Additional Supply Required (gpm)
2000	5.22	0.54	380
2005	6.23	1.55	1,085
2010	7.35	2.67	1,870
2015	8.72	4.05	2,835
2020	10.28	5.60	3,920

(1) Existing Total Well Capacity (Wells 7, 8, 9, 10, and 11) is 6.12 mgd. (Well 4 abandoned)
(2) Assume largest well (1,000 gpm) out of service, therefore current available firm capacity 4.68 mgd.

Experience with wells drilled in the Troutdale aquifer indicates that the City can reasonably expect to be able to develop new wells with a production capacity of 1,000 gpm. Based on the information presented in Table 8-1, the City will have to develop a new 1,000 gpm well approximately every 5 years to the year 2020.

8.5 POTENTIAL SOURCES

The City's long term water source should provide a reliable/sustainable yield. The City must have the legal ability to acquire the source through the water rights, and the source should be high quality. Woodburn's 20-year water needs may be met with the continued reliance on the Troutdale aquifer. Another potential water supply source for the City of Woodburn could be the Pudding River.

Troutdale Aquifer

Description

The regional Troutdale aquifer is characterized as an unconsolidated to semi-consolidated sedimentary aquifer overlying a deeper basalt aquifer. In the vicinity of Woodburn, the Troutdale aquifer has been characterized as a semi-confined aquifer. The aquifer is confined underneath by the sandy river mudstones formation and is confined somewhat above by Willamette silts. The Troutdale aquifer is comprised of fine to coarse sand and gravel with interspersed layers of clay and silt occurring with increasing depth. Wells in the Troutdale aquifer extend to depths of approximately 120 to 300 feet. Well depths for Woodburn range from 186 to 333 feet.

Above the Troutdale aquifer is a shallow unconfined aquifer in the Willamette silts. Wells within this shallow aquifer extend to depths of 40 feet. Groundwater in the shallow Willamette aquifer flow northwestward toward Senecal Creek at a rate of about 25 feet per year. Regionally, the aquifer is unconfined and is recharged from local sources and infiltration from direct

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precipitation. The Willamette silts near Woodburn have been characterized as tight, so downward migration of groundwater from the lower Willamette silt may provide only slight recharge to the underlying Troutdale aquifer. The downward movement of groundwater in the Willamette silt has been estimated to be in the range of one to four feet per year.

Locally, the groundwater in the Troutdale aquifer has been observed to flow north/northwest. Regionally, the ground water table has the shape of a broad mound, and follows the shape of the land surface. The overall shape is modified in local areas by cones of depression produced by the seasonal pumping of wells. The groundwater flows radially outwards towards the Willamette River to the west and the Pudding River to the east.

Water Rights

The City has existing water rights of 13.25 mgd (20.45 cfs) for the Troutdale aquifer, which are sufficient to meet the projected water demand through the planning period to the year 2020. The City has 12 separate water right permits, registration statements and certificates which are summarized in Table 8-2. These water rights have priority dates ranging from 1913 to 1993. The total existing capacity of the City's six wells is 6.76 mgd. It is assumed that the City will be permitted to drill the needed additional wells under currently held water rights permits.

Table 8-2
City of Woodburn
Water Rights Summary
Certificates of Water Rights (Supply)

WRD Designation	Amount (gpm)	Well Name	Well No.	Status
Permit No. G-10931	1000	Centennial	Well 10	Active
Permit No. G-11921	1400	Donner	Well 9	Active
Permit No. G-11922	2100	Nazerene	Well 7	Active
Permit No. G-12029	600	Astor Way	Well 11	Active
Cert. No. 36537	500	Senior Estate		Not in Service
Cert. No. 36538	750	King Way	Well A	Not in Service
Cert. No. 56379	750	Legion Park	Well 8	Active
Regis. GR 2267	300	Shop No. 1	Well 1	Not in Service
Regis. GR 2268	500	Shop No. 2	Well 2	Not in Service
Regis. GR 2269	500	Library	Well 3	Not in Service
Regis. GR 2270	500	Settlemeir	Well 4	Active
Regis. GR 3815	300	Old SPRR	Well 5	Not in Service
TOTAL	9,200 gpm (13.25 mgd)			

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The City's water rights permits, registration statements and certificates, authorize the appropriation of groundwater for municipal use within the city limits. They require the City to pump and use water from each well in accordance with the terms and conditions of the particular registration, permit or certificate covering that well. With this arrangement, the delivery of the water is inflexible. Additional flexibility could be gained by filing applications with the WRD to

operate the system as an integrated wellfield, pumping from each well as needed, without the constraints of water right permit or certificate of the individual wells. The place of use should be modified to refer generically to all areas within the city's urban growth boundary.

Water Availability

The future availability of groundwater in the Troutdale aquifer depends on the recharge via infiltration. Because of declining water levels and well production rates, there are two areas within the southern end of the Pudding River drainage area which have been designated as "groundwater limited". Wells in the Woodburn area have not shown declining levels in production. An on-going water level monitoring program is important for long term water management planning.

One of the current issues regarding the water supply for the Willamette Valley as a whole, is the interaction of the groundwater and surface water and how the appropriation of groundwater affects the surface water supplies. The majority of the surface waters in the basin are closed to further appropriation.

Contamination Potential

For any unconfined aquifer in a developed area there are many potential sources of groundwater contamination. A site of recent investigations is the North Marion County Disposal Facility (NMCDF). The NMCDF is the only active landfill in the area, it is located approximately two miles north of Woodburn.

The NMCDF has been in operation since September 1974. Groundwater sampling at the NMCDF found concentrations of VOCs and nickel above the MCLs in the Willamette silt aquifer (Dames & Moore, 1996). The Remedial Investigation Report (RI) reported that long-term aquifer pumping tests conducted to assess the hydraulic connection between the Troutdale aquifer and the shallow Willamette aquifer indicated some leakage between the confining layer separating the two aquifers. The vertical hydraulic conductivity of the aquitard at the NMCDF was measured to be 2.8×10^{-7} cm/sec and 6.8×10^{-7} cm/s. These values are below the DEQ threshold level of 10^{-6} cm/sec, which is considered sufficiently tight to protect the Troutdale aquifer from compounds of concern observed in the shallow Willamette aquifer. Based on the investigation results, the RI recommended continued monitoring with no further action at this time. It should be emphasized that Woodburn is upgradient of the landfill, and does not obtain its water from the shallow Willamette aquifer.

In 1993, the DEQ conducted groundwater sampling in the Woodburn area as part of the statewide ground water monitoring program. The results of the monitoring program, as well as discussions with DEQ personnel, indicated that there are no trends of groundwater quality degradation of wells.

To further evaluate the potential for groundwater contamination and protect the groundwater resource, it is recommended that the City prepare a Wellhead Protection Plan. Further recommendations for Woodburn regarding a Wellhead Protection Plan are presented in Chapter 9.

Other Sources

Under current water rights, the City has the ability to meet the 20-year demand relying on the Troutdale Aquifer. The City should begin to develop strategies to meet demand beyond the 20-year planning period when the water rights are exceeded. Strategies that the City may consider include purchasing water rights currently used by agriculture or acquiring water rights for properties that develop within the urban growth boundary.

Currently, Woodburn has no surface water rights. Nearby surface water bodies include Mill Creek and Senecal Creek which flow through Woodburn and the Pudding River, which runs east of Woodburn. Mill Creek and Senecal Creek are small with seasonal flow, they are not considered potential drinking water sources. Both creeks drain to the Pudding River, which is a tributary to the Molalla River. Under consideration for the City is the purchase of water rights for the Pudding River, currently used by agriculture. The Pudding River is classified as a "Water Quality Limited Stream" because of unacceptable temperature, nutrient and turbidity levels. This indicates that the out-of-stream or instream use of the Pudding River has been reached or exceeded. The Pudding River Basin Water Resources Development Association, a non-profit group of which the City is a member, is exploring the possibility of developing a storage reservoir to augment the flow of the Pudding River primarily for additional irrigation water. There is a potential that Pudding River stream flows could be augmented to allow the City to utilize some of the flow as an additional drinking water source. The City should continue to monitor the progress of this association and its efforts. Developing a local surface source for the City may not be a feasible alternative due to water availability and water quality issues.

8.6 POTENTIAL REGIONAL WATER USERS

Nearby municipalities providing water include Hubbard and Gervais. These utilities all rely solely on groundwater for their water supply needs. Both communities treat their water to remove the iron and manganese. Because Woodburn and the adjacent cities rely on groundwater, a regional supply system has not been pursued. These communities share similar interests with Woodburn in the maintenance of the local ground water and surface water resources.

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CHAPTER 9
WATER QUALITY ASSESSMENT

9.1 INTRODUCTION

This chapter presents an evaluation of Woodburn's water quality with regard to the Safe Drinking Water Act (SDWA). The key water quality issues facing Woodburn include:

- Iron and manganese levels which exceed Secondary Maximum Contaminant Levels (MCLs) and cause consumer complaints due to taste and odor problems and staining on plumbing fixtures and laundry.
- Disinfection to meet potential requirements of the Groundwater Rule.
- Eliminating non-acute violations of the Total Coliform Rule (TCR).
- Arsenic levels in the range of potential new maximum contaminant levels.

9.2 WOODBURN WATER QUALITY

Woodburn's water quality is summarized in Table 9-1. The groundwater may be characterized as moderately hard and well buffered. The water exceeds the SMCLs for iron and manganese and will require treatment. Organics are very low and will not be a problem.

Table 9-1
City of Woodburn
Summary of Water Quality

	Active Wells Only			All Wells
Parameter (in mg/L unless noted)	**Range**	**Average**	**Median**	**Range**
pH (std. pH units)	7.3 - 7.9	-	7.6	7.1 - 7.9
Alkalinity (as $CaCO_3$)	80 - 155	115	114	80 - 155
Calcium	12 - 35	18	18	12 - 35
Conductivity (μmhos/cm)	185	185	185	185
Hardness (as $CaCO_3$)	67 - 104	88	87	67 - 120
Total Dissolved Solids (TDS)	125 - 175	142	138	116 - 175
Chloride	0.75 - 5.5	2.7	2.5	0.75 - 6.5
Sulfate	2.2 - 16.4	6.3	2.4	1.5 - 16.4
Sodium	7 - 29	13.7	11.8	5.3 - 29
Nitrate	0.1 - 1	0.5	0.4	0.1 - 1
Total Organic Carbon (TOC)	< 1	< 1	< 1	< 1
Iron	0.15 - 2	0.5	0.4	0.1 - 2.1
Manganese	0.2 - 0.4	0.3	0.3	0.2 - 0.6
Magnesium	1.8 - 22	12.2	10.8	1.8 - 26
Arsenic	0.003 - 0.013	0.008	0.008	0.003 - 0.031
Radon (pCi/L)	108 - 532	358	361	108 - 532
Volatile Organic Compounds (VOCs)	nd	nd	nd	nd
Synthetic Organic Compounds (SOCs)	nd	nd	nd	nd

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9.3 WATER QUALITY AESTHETICS - IRON AND MANGANESE

Requirements

Iron and manganese are groundwater contaminates that produce objectionable precipitates in drinking water. When the soluble metals are oxidized, the precipitates of iron and manganese turn the water rusty colored or black and cause stains on plumbing and laundered clothing and disagreeable tastes in water and beverages. The secondary standards for iron and manganese are 0.3 mg/l for iron and 0.05 mg/l for manganese. Iron and manganese are not health concerns. Secondary standards are established for guidance, based on aesthetic issues, not health issues.

Status of Woodburn System

Iron and manganese concentrations for Woodburn exceed the SMCLs, as summarized in Table 9-2. Over time with the exposure to oxygen these metals will oxidize insoluble forms, which can accumulate in the distribution system piping and cause problems at the consumer tap. Treatment to reduce the iron and manganese concentrations is recommended.

Table 9-2
City of Woodburn
Summary of Iron and Manganese Concentrations of Wells In Service

Detected Concentrations	Iron	Manganese
Maximum	2.0	0.4
Median	0.4	0.3
Average	0.5	0.3
Secondary MCLs	0.3	0.05

Recommendations for Iron and Manganese

1. Continue to monitor the iron and manganese levels.
2. Treatment will be required to reduce the iron and manganese in the system to reduce the number of customer complaints.

9.4 HEALTH PROTECTION - SDWA COMPLIANCE

This section presents results of the evaluation of the status of the Woodburn system with existing and proposed regulations including the TCR, the Lead and Copper Rule (LCR), the Standardized Monitoring Framework (SMF) (Phases I, II, and V), the anticipated Disinfectants/Disinfection By-Products (D/DBPs) Rule, the Groundwater Rule (GWR), radionuclides, arsenic, sulfates, and the Source Water Protection Plan.

The Oregon Health Division (OHD) is responsible for the administration of both the federal and state drinking water laws, under ORS Chapter 448, the Oregon Drinking Water Quality Act. The basic regulatory requirements for drinking water quality in the State of Oregon are published in the Oregon Administrative Rules (OAR) 333-061 Public Water Systems. In most cases, the regulations adopted by OHD are the minimum requirements from the federal SDWA.

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However, OHD has the option to adopt and enforce standards that are more stringent than the federal regulations.

The application of the drinking water regulations is guided by the source water type and the treatment technology employed. Woodburn relies on unchlorinated groundwater. Key health related water quality issues for Woodburn are summarized in Table 9-3.

Table 9-3
City of Woodburn
Summary of SDWA Compliance Concerns[1]

Regulation	Status	Area of Concern
TCR	In effect	Episodes of non-acute violations.
GWR	Future	Disinfection may be required in the future.
Arsenic	In effect, Future	Treatment would be required to meet anticipated lower MCL.
Source Water Protection	Voluntary Program	The City is developing and implementing a Source Water Protection Plan.

[1] Woodburn's status with secondary standards established for iron and manganese is discussed in Section 9.3.

A review of the relevant requirements of each existing or proposed regulation affecting Woodburn is presented, followed by the specific monitoring and reporting requirements. This includes the requirements under the federal regulation as well as those listed under the OAR. The status of Woodburn's system with each regulation is discussed and recommendations are made.

SDWA Reauthorization

The SDWA Reauthorization was signed into law on August 6, 1996. Components specific to a rule that affect the City of Woodburn are included in the discussion of the particular rule.

Monitoring Flexibility

The SDWA requires the EPA to review the monitoring requirements for not less that 12 contaminants and promulgate any necessary modifications within two years. The EPA is required to promulgate regulations for the monitoring of unregulated contaminants and promulgate a list of not more than 40 contaminants to be subject to monitoring.

Process for Setting New Contaminants

The reauthorization of the SDWA gives the EPA the authority to decide which contaminants to regulate based on several criteria, including: i) whether the contaminant is known to occur or there is substantial likelihood that the contaminant will occur in public water systems with a frequency and level of public health concern; and ii) regulation of the contaminant presents a meaningful opportunity for public health risk reduction.

Standard-Setting
The SDWA sets maximum contaminant level goals (MCLGs) "at the level at which no known or anticipated adverse effects on the health of persons occur". The SDWA requires that the EPA make such determinations on the bases of the best-available information and that the level be as close to the MCLG "as is feasible". At the time MCLs are proposed, EPA is required to publish an analysis of quantifiable and non-quantifiable health risk reduction benefits and costs associated with the MCL and the effects of the contaminant on the general population and identified sub-populations.

Under the SDWA, the EPA is not required to set an MCL at a level where the benefits outweigh the costs, but must set the MCL at a level that maximizes health risk reduction benefits at a cost that is justifiable by the benefits. The EPA is granted discretionary flexibility to establish an MCL at a level other than the "feasible" level if the feasible level would result in an increase in the concentration of other contaminants in drinking water. In other words, if a certain MCL or treatment technique would result in increasing risks from other contaminants, the EPA is authorized to "balance" the risks involved and minimize the overall risks. Interim regulations are authorized without risk, cost and benefit determinations where there is an "urgent "threat to public health, subject to after the fact determinations and repromulgation.

Public Notification
The SDWA specifies that the EPA promulgate regulations to prescribe the form and content of giving public notification, and to distinguish between violations that are serious and frequent or continuing and violations that do not present a significant risk to public health.

The SDWA requires an annual report to consumers which must be published in local newspapers and mailed to each customer. Some of the information which must be included in the report is information on the source water, the level of regulated contaminants in the water, and brief statements on health concerns.

State Revolving Loan Fund (SRF)
The SRF for drinking water systems was created to address economic needs and secure the ability of systems to come into compliance with standards under the SDWA. States will receive federal capitalization grants. SRF funds are to be used for providing loans, loan guarantees, or as security leveraged loans for expenditures that will facilitate compliance with MCLs or "otherwise significantly further the health protection objectives" of the SDWA.

Operator Certification
The SDWA requires EPA to promulgate regulations to specify minimum standards for operator certification, but directs such regulations take into account existing state programs, reasonable costs and system size. The SDWA allows states to use preexisting programs for operator certification.

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Time Frames Allowed to Comply With Regulations
The SDWA provides that MCLs take effect three years after promulgation unless the EPA determines an earlier date is practicable. The EPA or state may allow an additional two years for compliance where additional time is necessary for capital improvements.

Total Coliform Rule

Requirements
The Total Coliform Rule (TCR), which became effective on December 31, 1990, prescribes monitoring and compliance protocols for assuring the bacteriological quality of water in distribution systems. It applies to all types of systems, and establishes a maximum contaminant level goal of zero for total coliform, fecal coliform, and *E. coli*. The key monitoring elements of the rule are summarized below. Requirements of the TCR have been adopted by the OHD in Chapter 333-061 OAR.

The TCR requires that the system have a written coliform monitoring plan which must include the following:

- System Map or diagram showing:
  - Water sources
  - Storage, treatment, and pressure regulation facilities
  - Distribution systems
  - Pressure zones
  - Interconnections
  - Coliform sample collection sites
- Narrative which includes:
  - Public water system identification number
  - Population served and services
  - Water sources
  - System facilities and processes for storage, treatment, and pressure regulation
  - Coliform sample collection sites
  - Sampling schedule

Woodburn's coliform monitoring plan was reviewed and appears to meet the intent of the requirements.

Monitoring
The water system is responsible for collection and submittal of coliform samples from representative points throughout the distribution system. Monitoring frequency is a function of the population served. Based on a population of 15,475 as determined by the Center for Population Reserarch at Portland State University, the City of Woodburn is required to take a minimum of 20 samples per month.

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When total coliform bacteria are present in any sample and the sample is validated, the following must take place:

- Analyze the sample for fecal coliform or E. coli.
- Collect repeat samples as follows:
  1) A set of three repeat samples shall be collected and submitted for every sample in which the presence of coliform is detected. The samples shall be collected on the same day and submitted for analysis within 24 hours after notification by the laboratory of a coliform presence except when waived by the OHD on a case-by-case basis.
  2) At least one repeat sample must be taken from the site of the original positive coliform sample. Two repeat samples must be within 5 active services of the site of the sample with coliform presence, one upstream and one downstream.
  3) When repeat samples have coliform presence, the system must collect one additional set of repeat samples for each sample where coliform presence was detected.
- Notify the OHD (OHD notification is presented below under Reporting).
- Determine and correct the cause of the coliform presence.

There are both acute MCLs and non-acute MCLs for coliform bacteria. An acute MCL occurs when there is: 1) Fecal coliform or *E. coli* presence in a repeat sample; or 2) Coliform presence in a set of repeat samples collected as a follow-up to a sample with fecal coliform or *E. coli* presence. For systems collecting fewer than 40 routine coliform samples per month, no more than one positive coliform test per month is allowed.

Reporting

A written coliform sampling plan as delineated above must be on file, ready for inspection by the OHD.

Reporting requirements associated with the TCR are as follows:

1) Within ten days of notification by the laboratory of a positive sample, the system must notify the OHD of the results of the fecal coliform and/or total coliform bacteria test on the raw (untreated) source water.
2) Within 24 hours or by the end of the business day on which the system is notified by the laboratory, the system must notify the OHD of analyses indicating any positive coliform bacteria.

Status of Woodburn System

Woodburn collects 20 samples per month from 25 permanent sampling sites located throughout the system. The sample locations are arranged in five groups, each week one group is sampled. The samples are submitted to a certified independent laboratory.

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Table 9-4 summarizes results of TCR monitoring for Woodburn since 1993. The table lists the number of episodes in which total coliform was detected in the Woodburn distribution system. No fecal coliform nor *E. coli* has been detected during the TCR monitoring.

Table 9-4
Summary of Coliform Testing Results (1993 - 1995)
Woodburn Water System

Month	No. of Positive Total Coliform Results	
	Routine Testing	Repeat
February 1993	1	1
June 1993	1	15
July 1993	0	12
August 1993	2	0
June 1994	1	0
July 1994	1	0
August 1994	1	0
September 1994	1	5
October 1994	0	7
November 1994	2	6
October 1995	1	0

Beginning in June 1993, Woodburn experienced several non-acute violations, testing positive for total coliform in both routine and repeat samples. The violations in 1993 were limited to a specific area, within a neighborhood known as Senior Estates. However, subsequent violations were spread throughout the system. In 1993, an investigation was undertaken to identify the potential cause(s) for the waterborne contamination as well as recommend strategies to remedy the situation (*Water System Analysis Report*, OTAK, Inc., October, 1993). In the OTAK report, cross-contamination with a non-potable water source was identified as the potential cause of contamination However, the specific source of the contamination was not identified.

The OTAK Report recommended the following strategies to control and eliminate the contamination problems and improve management of the water system:

- Begin testing of all failed water samples from the affected area sampling station using a laboratory procedure to identify and speciate bacteria that could be the cause for the problem.
- In the absence of any definitive bacteria speciation, begin a program of flushing and chlorination throughout the affected area.
- Install pressure monitors with recording capabilities throughout the system. Use the information to understand how the system responded (i.e. pressure, flow, etc.) during normal operation and fire flow scenarios for varying groundwater pumping configurations. Use the information to calibrate the hydraulic system computer model to identify any low pressure or other problem areas.

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- Conduct a door to door survey within the affected area to inform residents of the problems and causes and dispense information about cross connection control and also perform an informal survey of residences to identify any potential problems.
- Continue to test groundwater from wells for the absence of bacteria.

Woodburn has responded to contamination problems by:

- Flushing and superchlorinating waterlines in the problem areas.
- Conducting an investigation of the source of the contamination problem.
- In November 1994, Woodburn switched coliform testing methods from the MMO-MUG test to the multiple tube fermentation (MTF) test method.

Since switching methods coliform testing methods in 1994, only two samples have tested positive for total coliform; one repeat sample in November 1994, and one sample in October 1995. No definite source to the contamination problem has ever been identified in the Woodburn System.

Due to these non-acute violations of the TCR, the OHD has discussed primary and secondary disinfection with the City of Woodburn. The City is currently investigating its disinfection options. The selected method of disinfection must be compatible with other water quality characteristics.

Recommendations for Woodburn TCR Compliance

1. Continue monitoring for coliform bacteria.
2. Develop a contingency plan to provide for a system to maintain a chlorine residual throughout the system.
3. Identify sources of potential contamination and take action to eliminate the source.
4. Develop a regularly scheduled main flushing program.
5. Identify low pressure areas and develop corrective measures.
6. Promote a cross connection control program with inspection and the training of cross connection control specialists.
7. Implement a public education program through bill stuffers and a newsletter.
8. Develop a Source Water Protection Plan.

Lead And Copper Rule

Requirements

The Lead and Copper Rule (LCR), published June 1991, sets treatment technique requirements for lead and copper. The LCR calls for monitoring to establish compliance with action levels for lead and copper of 0.015 mg/L and 1.3 mg/L, respectively. Should either action level be exceeded, the utility is required to conduct an assessment of corrosion control alternatives and implement an "Optimal" corrosion control program and/or treat the source water. Systems that remain in non-compliance after implementing "optimal" corrosion-control strategies are required to locate and replace lead service lines, according to a prescribed schedule.

The specific provisions of the rule vary depending on the size of the system. The following provides a summary of the rule provisions that apply to medium-sized systems (3,301 to 50,000 people), such as the Woodburn system.

A system is deemed to have optimized corrosion control and is not required to complete the applicable corrosion control treatment steps if it meets the lead and copper action levels during each of two consecutive six-month monitoring periods. The requirement for any medium-sized system to implement corrosion control treatment steps deemed to have optimized corrosion control is triggered when the system exceeds the lead or copper action level.

Monitoring

Medium-sized systems were to have begun the first round of compliance monitoring in July 1992, during which the water system analyzed a minimum of 60 samples from customer taps for lead and copper concentrations.

If a system meets the lead and copper action levels during each of two consecutive monitoring periods, the system may request from the OHD to reduce the required frequency of monitoring to once per year. A medium-sized water system that meets the lead and copper action levels during three consecutive years of monitoring may reduce the frequency of monitoring from annually to once every three years.

Status of Woodburn System

Woodburn has completed four monitoring rounds for lead and copper. The 90th percentile levels are summarized in Table 9-5. The results indicate the 90th percentile levels to be below the action levels for both lead and copper during all sampling rounds. Because of its compliance during the first two 6-month monitoring rounds, Woodburn was allowed a reduced sampling frequency of once per year and a reduced number of required samples for the subsequent rounds from 60 to 30.

Table 9-5
City of Woodburn
LCR Compliance Monitoring

	90th Percentile Action Levels				
	Round 1 1992	Round 2 1993	Round 3 1994	Round 4 1995	Action Level
Lead	0.004	0.009	0.0077	0.0015	0.015
Copper	<0.05	<0.05	0.014	0.007	1.3

Recommendations for Woodburn LCR Compliance

1. If 1996 LCR monitoring results meet the lead and copper action levels, request a further reduction in sampling frequency to once every 3-years.
2. No treatment or operational changes are required for compliance with the LCR. It is not anticipated that treatment for the removal of iron and manganese and providing primary disinfection will result in a violation of the LCR.

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Standardized Monitoring Framework

Requirements

The Standardized Monitoring Framework (SMF) is the EPA's attempt to streamline the drinking water monitoring requirements. To date, the rules included under the SMF are divided into three phases: Phase I, Phase II, and Phase V. The contaminant groups included are inorganic chemicals (IOCs), volatile organic compounds (VOCs), and synthetic organic compounds (SOCs), plus three individual contaminants: asbestos, nitrate, and nitrite.

Appendix A contains two tables which describe the various contaminant groups and the phases under which they are regulated. Table 1 of Appendix A lists the contaminants regulated under Phases I, II, and V. Table 2 lists the contaminants along with the MCLs and the best available technology (BAT) for removing the contaminant.

Monitoring

Table 9-6 presents the monitoring requirements under the SMF groundwater systems serving a population greater than 3,300. The SMF was implemented on a 9-year compliance cycle, consisting of three consecutive 3-year sampling periods. When a regulation is promulgated during the 9-year cycle, the initial round of monitoring is scheduled to begin during the next full 3-year compliance period. The initial period ran from January 1, 1993 through December 31, 1995. The OHD requires that sampling for a system with a population of 300 or greater must have completed initial monitoring by December 31, 1993.

Repeat monitoring is based on initial results and vulnerability. As shown in Table 9-6, if a contaminant is not detected (or is detected at relatively low levels), then the frequency of monitoring is considerably reduced. However, if a contaminant is found above the "trigger," then the City would have to sample for that contaminant on a quarterly basis.

The degree of vulnerability of groundwater systems to contamination from chemicals and/or pathogens is important in many of the regulations. Vulnerability of the source water helps determine the degree to which monitoring is required. Sampling frequencies for Phase I, II, and V chemicals may be reduced or eliminated if the system obtains a waiver based on initial or previous monitoring or the results of a vulnerability assessment.

The vulnerability assessment must prove that the water system is not vulnerable to a particular contaminant, either through showing that the contaminant was never used in the source area, or that the susceptibility to the contaminant does not exist (due to source water production programs, prior test results, wellhead protection programs, etc.). Further, the OHD requires a state approved wellhead protection plan for reduced SOC and VOC monitoring. It may be less costly for a water purveyor to perform the required testing under the SMF than to perform the vulnerability assessment.

Reporting
Results of the analyses must be reported to the OHD within 10 days after the end of the required monitoring period, unless the results exceed the MCL. In that case, the results must be reported to the OHD within 24 hours, or by the next business day after the results are reported to Woodburn.

Status of Woodburn System
The discussion below focuses on the SMF's impact on the City by examining available water quality test results for the various contaminants included in the SMF.

Asbestos. The City tested for asbestos in 1993. No asbestos was detected.

Nitrate. The City has performed annual nitrate analyses. A review of data since 1991, indicates maximum nitrate levels of 1.0 mg/L, which do not exceed the "trigger" value of 5 mg/L (50 percent of 10 mg/L).

Nitrite. The City has performed nitrite tests on their water supplies as part of their inorganic chemical analysis. The results have always been below the detection limit.

Inorganic Chemicals. The City been in compliance with all currently regulated IOCs. Woodburn should continue to monitor as required for IOCs.

Volatile Organic Compounds. Quarterly testing of each source for VOCs is required during the initial monitoring year. Repeat sampling is based on initial results and vulnerability.

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Table 9-6
Woodburn Compliance Monitoring Requirements
Under the Standardized Monitoring Framework (Groundwater Source; > 3,300 Population)

Contaminant	Initial Monitoring Requirements	Trigger that Increases Sampling	Requirements for Waivers	Monitoring Frequency With Waiver and All Concentration < MCL
Asbestos	1 Sample every 9 years	> MCL	Based on vulnerability assessment of asbestos contamination due to source water or corrosion of asbestos-cement pipe.	Waiver may be granted.
Nitrate	Annual	[3] 50% MCL	No waivers allowed	No waiver allowed. Annual
Nitrite	1 Sample during compliance period.	[3] 50% MCL	No waivers allowed	No waiver allowed. If first sample is 50% of MCL, then once each subsequent compliance period
Inorganic Chemicals (IOCs)	1 Sample every 3 years	> MCL	Analytical results of 3 rounds are less than MCL.	A minimum of one sample not to exceed one 9-year compliance period following 3 rounds of monitoring.
Volatile Organic Compounds (VOCs)	4 Quarterly samples at every sampling point during first 3 year monitoring period.	Detection (0.5 μg/L)	Based on initial results, state certified wellhead protection plan, and vulnerability assessment.	One sample every 6 years with state certified Wellhead Protection Plan. One sample every 9 years if portion of aquifer is of "low susceptibility" according to Use and Susceptibility Waiver Document.
Synthetic Organic Compounds (SOCs)	4 Quarterly samples at every sampling point during first 3 year monitoring period.	Detection	Based on initial results, state certified wellhead protection plan, and vulnerability assessment.	One sample every 6 years with state certified Wellhead Protection Plan. One sample every 9 years for SOCs i) "not used" in delineated wellhead protection area or ii) "used" in portion of aquifer in delineated wellhead protection area with "low susceptibility" according to Use and Susceptibility Waiver Document.
Unregulated IOCs SOCs VOCs	1 Sample in the first 3 year cycle. 4 Quarterly samples at every sampling point during first 3 year monitoring period.	Not applicable	Based on initial results, state certified wellhead protection plan, and vulnerability assessment.	IOCs - same as regulated IOCs SOCs - same as regulated SOCs VOCs - same as regulated VOCs

Source: U.S. Environmental Protection Agency, OAR 333-061

The City performed quarterly VOC analyses of both regulated and unregulated compounds in Wells 4, 7, 8, 9, and 10 in 1993. The results demonstrated that all the VOCs were below the detection limit of 0.0005 mg/L.

Synthetic Organic Compounds. SOCs include certain man-made volatile organic compounds, as well as pesticides, herbicides, and polychlorinated biphenyl compounds (PCBs) (see Table 2, Appendix A). The monitoring requirements are similar to those of VOCs. Quarterly sampling of SOCs was required during the first round of monitoring, which Woodburn conducted in 1993.

Results showed PCBs concentrations which ranged from 0.00023 to 0.00051 mg/L. A follow-up investigation dismissed the PCB levels, attributing the concentrations to laboratory interference. All other SOC were undetected.

Unregulated IOCs and SOCs. IOCs and SOCs that have not yet been assigned MCLs are referred to as unregulated. These are included in Table 1 of Appendix A. These compounds must be include in the testing for regulated IOCs and SOCs.

Recommendations for Woodburn SMF Compliance

1. Sample the water quality at each entrance to the distribution system after treatment.
2. Continue to monitor as required.
3. Develop a Source Water Protection Plan.
4. Following state certification of the Source Water Protection Plan, request reduced monitoring frequency.
5. No treatment or operation changes are required for Woodburn as a result of this monitoring.

Disinfectants/Disinfection Byproducts Rule

Requirements

The D/DBPs rule will apply to all water systems that add a disinfectant during any part of the treatment process including addition of a residual disinfectant. The D/DBPs rule was proposed in July 1994. The SDWA reauthorization bill required that the EPA promulgate the Information Collection Rule (ICR) to facilitate revisions to the D/DBP rule. (The ICR requirements only apply to large systems and does not affect Woodburn). A 180 day extension is allowable based on progress toward Cryptosporidium regulation.

A two-step negotiated rule making process has been underway to arrive at a consensus proposal for DBPs, consisting of Stage 1 and Stage 2. Stage 1 has been completed. The bill allows for "risk-risk" analysis of Stage 2. Requirements of Stage 1 are shown in Table 9-7.

Table 9-7 City of Woodburn Disinfectants/Disinfection Byproducts Rule Proposed Limits/Monitoring Requirements		
Disinfectant/ Disinfection Byproducts[1]	**Stage I**	**Monitoring Requirements**
Disinfectant By-Products (MCL):		
Total trihalomethanes (TTHMs)	80 µg/L	Quarterly
Total haloacetic acids (THAAs)	60µg/L	Quarterly
Bromate (systems using ozone)([3])	10 µg/L	1 sample/month
Chlorite (systems using chlorine dioxide)[3]	1 mg/L	3 Samples/month
Disinfectants (MRDL):		
Chlorine	4 mg/L	With Coliform Sampling
Chloramines	4 mg/L	With Coliform Sampling
Chlorine dioxide	0.8 mg/L	Daily

Notes:
1. MCL=Maximum Contaminant Level; MRDL = Maximum residual disinfectant level.
2. Stage 2 regulations are pending and may adjust Stage 1.

The flexibility to comply with these potential modifications should be incorporated into any future treatment system. However, review of Woodburn's water quality suggests that compliance will not be a problem, even if chlorine is required in the future for disinfection.

Monitoring
Proposed monitoring requirements are listed in Table 9-7.

Status of Woodburn System
The D/DBP Rule will apply to Woodburn if the City begins disinfection.

Recommendations for Woodburn Proposed D/DBP Compliance

1. Conduct simulated distribution system THMFP tests.
2. Conduct simulated distribution system THAAFP tests.
3. Based on the results of the THMFP and THAAFP tests, develop a primary disinfection scheme to comply with the D/DBP Rule.
4. Following installation of primary disinfection, monitor the levels of DBPs in the system.

Groundwater Rule (GWR) (Proposed)

Requirements
The amended SDWA requires the EPA to establish disinfection requirements for all public water supply systems. To date, only disinfection of surface waters and groundwater's under the direct influence of surface water have been regulated under the Surface Water Treatment Rule (SWTR).

Under development is the Groundwater Rule (GWR), which covers the disinfection of groundwater.

The goal of the GWR is not to require disinfection of all groundwater sources. Instead, it will specify the appropriate use of disinfection based on specific characteristics of the groundwater supply. The GWR specifically targets groundwater systems at high risk for fecal contamination. The requirements of the proposed GWR include:

- System sanitary surveys conducted by the State and identification of significant deficiencies;
- Hydrogeologic sensitivity assessments for undisinfected systems;
- Source water microbial monitoring by systems that do not disinfect and draw from hydrogeologically sensitive aquifers or have detected fecal indicators within the system's distribution system;
- Corrective action by any system with significant deficiencies or positive microbial samples indicating fecal contamination; and
- Compliance monitoring for systems which disinfect to ensure that they reliably achieve 4-log (99.99 percent) inactivation or removal of viruses.

Sanitary Surveys

The State would perform Sanitary Surveys for Woodburn every 3 years to identify significant deficiencies. Sanitary surveys would include the following key components:

- State must perform each system's sanitary survey and address the 8 elements from the joint EPA and Association of State Drinking Water Administrators guidance.
- State must have authority to enforce corrective action requirements.
- State must provide a list of significant deficiencies (e.g., those that require corrective action) to the system within 30 days of identification of the deficiencies.

Hydrogeologic Sensitivity Assessment

The State would conduct a one-time hydrogeologic sensitivity assessment for Woodburn. Systems determined to be sensitive are subject to more intensive monitoring. Key components of the sensitivity assessment include:

- State must conduct a one-time assessment of Woodburn's groundwater to determine if it is located in a sensitive aquifer.
- EPA considers karst, gravel, or fractured bedrock aquifers to be "sensitive" to microbial contamination.
- States may waive source water monitoring for sensitive systems if there is a hydrogeologic barrier to fecal contamination.

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Source Water Monitoring

Source water monitoring is required for ground water systems that are determined to be sensitive or have contamination in their distribution system ("triggered monitoring") and do not treat to 4-

log removal or inactivation of viruses. Monitoring frequency would be monthly for sensitive systems; once for triggered monitoring. Key components of source water monitoring include:

- Routine Monitoring: For systems determined by the State to be hydrogeologically sensitive, the system must conduct monthly source water monitoring for fecal indicators. Sampling frequency may be reduced after twelve negative samples.
- Triggered Monitoring: If a total coliform-positive sample is found in the distribution system, then the system must collect one source water sample and monitor for a fecal indicator.

Corrective Actions

Corrective Actions apply to ground water systems that have a significant deficiency or have detected a fecal indicator in their source water. Corrective actions are required within 90 days or longer with a State-approved schedule. Key components of corrective actions include:

- Significant Deficiency or Source Water Contamination: If a ground water system is notified of significant deficiencies by the State, or notified of a source water sample positive, within 90 days it must correct the contamination problem by eliminating the contamination source, correct the significant deficiencies, provide an alternative source water or install a treatment process which reliably achieves 4-log removal or inactivation of viruses. A system may take longer than 90 days for corrective action with a State-approved plan. Systems must notify the State of completion of the corrective action or the State must confirm correction within 30 days after the 90-day period or scheduled correction date.
- Treatment: Systems providing treatment must monitor treatment to ensure at least 4-log virus inactivation and/or removal.

Compliance Monitoring

Compliance monitoring is required of all ground water systems that notify States they disinfect to avoid source water monitoring, and to systems that disinfect as a corrective action. Monitoring of disinfection would occur continuously. Key components of compliance monitoring include:

- If monitoring shows the disinfection concentration to be below the required level, the system must restore the disinfection concentration within 4 hours or notify the State.

Status of Woodburn System

The GWR will apply to Woodburn, but it is currently uncertain whether disinfection will be required. Because of the potential need for disinfection, disinfection options are investigated as part of this Plan. The primary disinfection chemical must be compatible with the water quality in the system and the selected iron/manganese treatment technique. In fact, several of the iron/manganese treatment options employ a primary disinfectant as part of the treatment process. The introduction of chlorine into the system would initially produce noticeable taste and odors in the water. This impact would lessen as consumers adjust to the chlorine residual in the water. In many cases, the addition of chlorine may actually be a benefit to the water quality by removing musty tastes and eliminating other objectionable tastes and odors. Because of the

taste and odor associated with chlorine, the City favors primary disinfection options which do not rely on chlorine.

The City intends to implement treatment for iron/manganese removal prior to the determination of whether disinfection will be required under the GWR. The introduction of the majority of the disinfectants (chlorine, ozone, hypochlorite) will oxidize any iron and manganese that exist in the well water, increasing staining problems. Removal of the iron and manganese is essential prior to adding disinfection to the system to prevent operation and maintenance problems.

Recommendations For Woodburn GWR Compliance
If the GWR is finalized, the City should:

1. Assist the State with sanitary surveys and sensitivity assessment.
2. Conduct any required monitoring.
3. If required, evaluate and install primary disinfection facilities.
4. If required, maintain a measurable residual in the distribution system.

Radionuclides (Proposed)

Requirements
EPA published a final rule for radionuclides in December, 2000. It included the MCLs shown in Table 9-9.

Table 9-8
City of Woodburn
MCLs for Radionuclides

Contaminant	MCL	Monitoring
Radium-226/228	50 pCi/l	Initial quarterly monitoring for one year.
Uranium	30 mg/l	Reduced monitoring-every 3, 6, or 9 years.
Adjusted gross alpha	15 pCi/l	Increased monitoring –quarterly.
Beta/photon emitters	4 mrem/yr	No monitoring unless classified vulnerable.

Reporting
Results of the analyses will be required to be reported to the OHD following the monitoring period.

Status of Woodburn
The Radionuclides Rule will apply to Woodburn. Woodburn has monitored for gross alpha activity with detected concentrations ranging from 0 to 0.6 pCi/l.

Recommendations for Woodburn Radionuclide Compliance

The City should continue to monitor for radionuclides to evaluate compliance.

Radon

Requirements

EPA proposed new regulations to reduce the public health risks from radon on November 2, 1999 in the Federal Register. The radon MCLs depend on whether a Mulitmedia Mitigation program is developed as noted in the following options.

First Option: States can choose to develop enhanced state programs to address the health risks from radon in indoor air -- known as Multimedia Mitigation (MMM) programs -- while individual water systems reduce radon levels in drinking water to 4,000 pCi/L or lower (picoCuries per liter, a standard unit of radiation). EPA is encouraging States to adopt this option because it is the most cost-effective way to achieve the greatest radon risk reduction.

Second Option: If a state chooses not to develop an MMM program, individual water systems in that state would be required to either reduce radon in their system's drinking water to 300 pCi/L or develop individual local MMM programs and reduce levels in drinking water to 4,000 pCi/L. Water systems already at or below 300 pCi/L standard would not be required to treat their water for radon.

Monitoring and reporting requirements will be established when and if the Radon rule is finalized.

Status of Woodburn

Recent testing for radon showed concentrations ranging from 108 to 532 pCi/L. Recommendations for compliance with Radon Rule are as follows:

1. Track development and changes in Final Radon Rule
2. Perform annual radon monitoring at wells using proper sampling technique

Arsenic

Requirements

Arsenic is currently regulated at 50 ug/L. Under the amended SDWA, the EPA is required to promulgate a new MCL for arsenic. An MCL between 3 to 20 μg/L is under consideration. There is considerable evidence that suggests that arsenic is hazardous at extremely low levels, including evidence that suggest that ingested arsenic causes cancer. Skin cancer data suggests that a 1 in 10,000 risk level for arsenic is 2 mg/L. Internal cancer studies could lower this figure even further. The EPA has estimated that nationwide capital costs for compliance with a 2 mg/L limit for arsenic would be over $6 billion. The final arsenic rule is expected in February 2002.

Monitoring

Currently, systems are required to monitor each groundwater source for arsenic every three years.

Reporting
Results of the analyses must be reported to the OHD within 10 days after the end of the required monitoring period, unless the results exceed the MCL. In that case, the results must be reported to the OHD within 24 hours, or by the next business day after the results are reported to Woodburn.

Status of Woodburn
Arsenic has been detected in active wells in Woodburn at concentrations up to 13 μg/L. This is below the current MCL of 50 μg/L, but may pose compliance issues if the new MCL is 10 μg/L or less.

Recommendations for Woodburn Arsenic Compliance

1. Monitor for arsenic levels.
2. Future removal requirements for arsenic will be dependent on the future MCL selected.
3. Pilot testing at Well #10 indicates that arsenic is reduced from 12 μg/L to 9 μg/L with the recommeded treatment process. If ferric chloride is aded, arsenic concentrations can be reduced to 5 μg/L or less. Design of the treatment system should include the flexibility to add a ferric chloride system in the future if needed.

Sulfate

Requirements
The original proposed rule for Phase V contaminants included an MCL for sulfates of 500 mg/L. Sulfate was removed from the final Phase V rule due to controversy over the cost versus benefits of meeting the MCL. The SDWA reauthorization bill requires additional study to determine a reliable dose-response level for sulfate. The bill also allows EPA to promulgate another national standard for sulfate which includes options for the provision of alternative water supplies and public notification.

Monitoring
Monitoring for sulfate was required during the initial three-year compliance period.

Status of Woodburn
The maximum detected sulfate concentration at Woodburn is 16.4 mg/L, well below 500 mg/L.

Recommendations for Woodburn Sulfate Compliance
No actions are required by the City of Woodburn.

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Source Water Protection Plan

Oregon has a voluntary Source Water Protection Program. A public water system that wishes to have a state certified source water protection program must comply with the requirements specified in 333-061-057, 0060, 0065, as well as OAR 340-040-0140 through 0200. A certified Source Water Protection Plan is required in applying for reduced monitoring of SOCs and VOCs. In addition, the OHD identifies compliance with wellhead protection program as one of the means available for achieving compliance with the MCL for total coliform.

Table 9-9
City of Woodburn
Summary of Drinking Water Regulations

Analyte	Federal Regulation	EPA/Oregon Status	Monitoring Location	Sampling Frequency	Comments
TTHMs, THAA	D/DBPs	In effect	Point reflecting maximum residence time in distribution system.	Proposed Rule: Quarterly Currently in accordance with OAR: system with only groundwater: one annual sample per source if THMFP is <0.1 mg/L with written request to OHD	
VOCs	Phase I, Phase II, Phase V	In effect	Entrance to Distribution System	In accordance with SMF - see Table 9-5.	
SOCs: Pesticides, Herbicides, PCBs, Organics	Phase II, Phase V	Phase II and V in effect.	In distribution system representative of each source after treatment.	In accordance with SMF - see Table 9-5.	
Radionuclides: Radium-226/228 Radon Uranium Beta/photon emitters Adjusted gross alpha	Rad	Final Regulation. Currently, under OAR 333-061-0036, monitoring is required for gross alpha activity.	Source	Current OHD: Requires once every four years. Compliance based on analysis of annual composite	
Sulfate	Sulfate	Anticipated OAR 333-061-0036 requires monitoring for sulfate	Source	Not Set	
Arsenic	Arsenic	OAR 333-061-0036 requires monitoring for arsenic	Source	Not Set	

CHAPTER 10
TREATMENT PROCESSES FOR WOODBURN

10.1 INTRODUCTION

The City of Woodburn is faced with the need to provide treatment for their well water. The City has three treatment objectives:

- The reduction of the elevated iron and manganese levels.
- The potential need for disinfection.
- The potential need for arsenic removal.

Driving Forces

Iron and Manganese Reduction
The existing concentrations of iron and manganese in the active wells exceed the EPA guidance standards and have led to frequent complaints from customers concerning taste, odor, and staining, particularly of yellow rusty laundry stains.

Disinfection
Two types of disinfection are employed in water treatment: primary and secondary. Primary disinfection achieves the desired level of microorganism kill or inactivation. Secondary disinfection ensures a stable residual concentration of disinfectant in the finished water to prevent microbial growth in the distribution system. Some disinfectants can serve either as primary or secondary disinfectants, while some can be used for both processes.

The key factors driving the potential requirement for disinfection for Woodburn include:

- Past non-acute violations with the Total Coliform Rule (TCR) (secondary disinfection only)
- The proposed Ground Water Rule (GWR) (both primary and secondary disinfection)
- The introduction of a disinfectant with treatment for the removal of iron and manganese (secondary disinfection only)

Woodburn implemented measures to address TCR violations and has been in compliance with the TCR since 1994. The OHD recognizes that these measures appear to be working and presently is not requiring the implementation of disinfection for TCR compliance. Several of the treatment methodologies for iron and manganese removal utilize traditional disinfectants. The OHD has stated that the use of a disinfectant for iron and manganese removal would trigger the requirement of a disinfectant residual in the distribution system. The last driver for disinfection is the GWR described in Chapter 9, "Water Quality Assessment." Depending on the outcome of monitoring and hydrogeologic assessments, disinfection could be triggered by the final GWR.

Arsenic Removal
As described in Chapter 9, depending on the future MCL for arsenic, the reduction of arsenic levels may be required.

Key Decisions To Be Made

Key treatment decisions facing the City are:

- The type of treatment to be provided: Several options exist from chemical/physical to biological methods to sequestering which does not remove the iron and manganese.
- Phasing of treatment: The City may wish to phase construction of the plant for budgetary concerns.
- The location and number of treatment facilities. Since the City does not currently treat its well water, the question of centralized treatment, neighborhood plants, or wellhead treatment must be addressed.

Organization of Chapter

The chapter is organized by:

- A general discussion of the treatment options for iron and manganese reduction, disinfection, and arsenic removal.
- An evaluation of the treatment methodologies. A "fatal flaw" screening is performed to narrow the treatment methodologies to four viable options for the City.
- A description of three treatment location scenarios.
- Budgetary cost estimates are provided for the four viable options for each of the treatment location scenarios.
- A treatment recommendation is made based on the budgetary estimates, the treatment objectives, storage requirements, and operational characteristics.

Evaluation Methodology

With several treatment methodologies and treatment location scenarios to consider, evaluation criteria was developed to rank the alternatives. The criteria was grouped into three main issues: cost, treatment plant performance, and siting/implementation. The following criteria will be considered:

Cost:
1) Capital Cost
2) Operating Cost

Treatment Plant Performance:
1) Reliability
2) Water quality
3) Siting/Implementation:

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4) Availability of Property
5) Ease of Operation
6) Safety
7) Impacts on the distribution system
8) Phasing of construction
9) Public Acceptance
10) Neighborhood Impacts (traffic, aesthetics, chemical transport)
11) Implementability

10.2 TREATMENT METHODOLOGIES - IRON AND MANGANESE

Processes typically used for the removal or stabilization of iron and manganese include:

- Chemical Oxidation followed by Filtration
- Biological filtration
- Sequestering

Table 10-1 summarizes the iron and manganese treatment options. The advantages and disadvantages of the iron and manganese removal options are summarized in Table 10-2.

One factor to consider for each of the iron and manganese removal options is whether the option triggers the requirement of a secondary disinfectant. The OHD has stated that if the selected method of iron and manganese removal introduces a disinfectant, as part of the treatment process, then the City must maintain a disinfectant residual in the distribution system. Disinfectants which are part of the iron and manganese treatment options include chlorination, ozone, and UV (a potential process of biological treatment).

Chemical Oxidation Followed by Filtration

Iron and manganese removal can be accomplished by chemically oxidizing the metals to their insoluble forms followed by the removal of the precipitates through either pressure or gravity filtration. Chemical oxidants that have successfully been used for the removal of iron and manganese include: air, chlorine, potassium permanganate, and ozone. Iron oxidizes relatively easily at a neutral pH and short contact time. Manganese oxidizes at a much slower rate and is more dependent upon pH, and is therefore more difficult to remove. Oxidation processes as they apply to Woodburn are discussed below.

Aeration and Filtration

Simple aeration can be accomplished with multiple tray aerators, pressure air saturation tank, forced draft aeration and induced draft aeration. Since the reaction time with air is slow, a detention tank is usually provided prior to filtration. The rate of oxidation for aeration is a function of pH, with oxidation increasing with increasing pH.

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Table 10-1
Woodburn Water Master Plan
Iron and Manganese Treatment Options

	Aeration - Filtration	Ozonation and Filtration	Chlorine, $KMnO_4$ and Filtration	Biological Filtration	Proprietary Process Filtration (Filtronics)	Sequestering
Raw Water Metal Concs. Applicable for Treatment (mg/L)	Fe: 1.0 - 10.0 Mn: Not effective at a pH <9.5	Fe: Unlimited Mn: Unlimited	Unlimited (Most effective at conc. < 2.0 mg/l Mn: Unlimited	Fe: Unlimited Mn: Unlimited	Fe: Unlimited Mn: Unlimited	Total Fe and Mn conc. must be less than 1.0 mg/l
Would Trigger Requirement for Disinfectant Residual	No	Yes	Yes (Because of chlorine)	No (Unless Chlorine were used)	Yes	Yes (If Chlorine used)
Filtration Type	Pressure or gravity filters with dual media of anthracite and silica sand	Pressure filters with dual media of anthracite and silica sand	Pressure or gravity filters with: 1. Dual media of anthracite and sand 2. Dual media of anthracite and green sand	Pressure or gravity filters with: 1. Silica sand to support bacteria 2. Silica sand to support bacteria	Pressure filters with proprietary media supplied by a single manufacturer	None required
Hydraulic Loading Rate	2 to 5 gpm/ft^2	4 to 5 gpm/ft^2	With silica sand: Gravity 2 to 5 gpm/ft^2 Pressure 4 to 5 gpm/ft^2 With green sand: ~ 4 gpm/ft^2	10 - 15 gpm/ft^2	5 - 10 gpm/ft^2 depending on approvals	Added directly into the pipe from the well
Detention Time	Fe: minimum of 20 minutes Mn: > 1 hour (at pH of 9.5)	Generally provide a Ozone contract tank with 3 to 5 minutes of contact time	Nothing additional required - sufficient time available in water above the media	None	2 contact tanks provided with a contact time of 1 minute each	Sequestering chemicals should be injected before the chlorine

Ta. 10-1
Woodburn Water Master Plan
Iron and Manganese Treatment Options

	Aeration - Filtration	Ozonation and Filtration	Chlorine, $KMnO_4$ and Filtration	Biological Filtration	Proprietary Process Filtration (Filtronics)	Sequestering
Factors Affecting Removal	Rate of removal and treatment performance is improved with: • Increasing temperature • Increasing pH • Decreasing organic content • Increased detention time	Rate of removal and treatment performance is improved with: • Increasing temperature • Decreasing organic content	Rate of removal and treatment performance is improved with: • Increasing temperature • Decreasing organic content	Optimum conditions for: Fe removal: • Zinc <0.45 mg/L • H_2S <0.1 mg/L • pH: 6.0-7.8 • Temp. >10°C • Redox: 0 - 500 mV Mn removal: • Zinc <0.45 mg/L • H_2S <0.1 mg/L • pH >7.4 • NH_4 < 0.1 mg/L • Fe <0.1 mg/L • DO >4.0 mg/L • Temp. >10°C • Redox > 200 mV	Rate of removal and treatment performance is improved with • Increasing temperature • Decreasing organic content	Role of pH uncertain
Theoretical Oxidant Dosage	Saturated dissolved oxygen conditions	Fe: 1 mg/L of ozone per 2.3 mg/L of Fe Mn: 1 mg/L of ozone per 1.5 mg/L of Mn	Fe: 1 mg/L of Cl per 1.6 mg/L of Fe Mn: 1 mg/L of $KMnO_4$ per 0.52 mg/L of Mn (generally lower dosage required in practice)		Fe: 1 mg/L of Cl_2 per 1.6 mg/L of Fe Mn: 1 mg/L of Cl_2 per 0.52 mg/L of Mn SO_2 used as a catalyst at a rate of approx 10% of Cl_2 dose	Varies depending on the chemical selected

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Table 10-1
Woodburn Water Master Plan
Iron and Manganese Treatment Options

	Aeration - Filtration	Ozonation and Filtration	Chlorine, $KMnO_4$ and Filtration	Biological Filtration	Proprietary Process Filtration (Filtronics)	Sequestering
Notes	Often used in systems where Fe is found alone, Recommended for high Fe conc. to save chemical costs	Potential to over-oxidize the Mn to $KMnO_4$, which can result in "pink" water complaints	Potential to over dose the $KMnO_4$ which will result in "pink" water complaints	Only one known permitted biological Fe removal plant in the USA that has not been constructed, no permitted biological Mn removal plants in the USA	Proprietary process from California that has shown good results at reduced operating costs, City is tied to one supplier and competition is limited for this process	General only effective for 48 to 72 hours, can cause problems in long dead-end lines or in storage reservoirs
Operational Consideration	Repumping usually required, pH adjustment up and then down would be required for Mn removal	Equipment is operationally complex and expensive to buy, requires significant electrical power, no chemicals to handle, easy to control with a stable groundwater chemistry, requires secondary disinfection	Requires the addition and handling of two chemicals, $KMnO_4$ is corrosive and requires special handling	Need to operate the plant continuously for best operational results, may require variable speed drives on the well pumps,	Process only uses Cl_2 to oxidize both the iron and the manganese, the process is sensitive to organic content in the water, operator friendly	Only requirements are chemical feed pumps and chemical storage, the use of phosphates may result in regrowth in the distribution system, does not remove the Fe and Mn from the water
Backwashing Requirements	Anticipated filter run times of 24 to 48 hours, backwash rates of 15 gpm/ft2 are typical with volumes of 2% to 5% of the water produced	Anticipated filter run times of 24 to 48 hours, backwash rates of 15 gpm/ft2 are typical with volumes of 2% to 5% of the water produced	Anticipated filter run times of 24 to 48 hours, backwash rates of 15 gpm/ft2 are typical with volumes of 2% to 5% of the water produced	Anticipated filter run times of 48 hours, backwash rates of 10 gpm/ft2 are typical with volumes of 0.5% to 2% of the water produced	Short backwashes at rates of 15 gpm/ft^2 are completed every 8 hours to flush the system and release contaminates	No backwashing facility required

Ta 10-1
Woodburn Water Master Plan
Iron and Manganese Treatment Options

	Aeration - Filtration	Ozonation and Filtration	Chlorine, $KMnO_4$ and Filtration	Biological Filtration	Proprietary Process Filtration (Filtronics)	Sequestering
Permitting	Widely accepted treatment technology and would be readily permitted OHD	Relatively new technology for Fe and Mn removal but should be readily permitted by OHD with secondary disinfection facilities	"Classical" method for the removal of Fe and Mn, widely used in the USA, it will be readily accepted by the regulatory agencies	Widely used in Europe but new to the USA, permitting would require extensive piloting to demonstrate to OHD that it is a viable and safe treatment technology	Would require pilot testing but do not anticipate any problems gaining approval of the system	Generally accepted by the regulatory agencies for low concentrations of Fe and Mn, may be viewed as a temporary measure

Table 10-2
Woodburn Water Master Plan
Advantages and Disadvantages of Iron/Manganese Removal Options

Disinfection Option	Advantages	Disadvantages
Aeration - Filtration	• Can reduce high concentrations of iron • Would not trigger a requirement for secondary disinfection	• Unsuccessful for manganese removal
Ozonation and Filtration	• Effective for both Fe and Mn removal • Should be readily permitted by OHD • Can serve as primary disinfectant • Provides taste and odor benefits	• Potential to over-oxidize Mn to $KMnO_4$, causing "pink" water • High capital and energy costs • Low filter loading rates • Operationally complex • Would trigger a requirement for secondary disinfection
$KMnO_4$ and Filtration	• Effective for both Fe and Mn removal • Relatively Rapid Reaction • Widely used method to remove Fe and Mn • Operationally simple • Would be readily accepted by OHD • Would not trigger a requirement for secondary disinfection	• Potential to overdose Mn to $KMnO_4$, causing "pink" water • High chemical costs • Low filter loading rates • $KMnO_4$ is corrosive, special handling required.
$KMnO_4/Cl_2$ and Filtration	• Effective for both Fe and Mn removal • Lower chemical costs compared with $KMnO_4$ only • Relatively Rapid Reaction • Operationally simple • Should be readily accepted by OHD	• Potential to overdose Mn to $KMnO_4$, causing "pink" water • Two chemicals required • Low filter loading rates • Would trigger a requirement for secondary disinfection • $KMnO_4$ is corrosive, special handling required.
Biological Filtration	• Capable of producing lowest concentrations of Fe and Mn • Simple operation • Reduced backwash requirements compared with conventional filtration • Small space requirement compared with conventional filtration • Higher hydraulic loading rates compared with conventional filtration • Less sludge production	• Would require pilot testing for acceptance by OHD • Two stage filtration required • Limited application in U.S. • Long initial start-up for manganese removal
Proprietary Process Filtration (Filtronics)	• Simple operation	• Process tied to single supplier • High capital cost due to proprietary nature of process • Would require pilot testing for acceptance by OHD
Sequestering	• Simple operation	• Would not remove iron and manganese, only hold in solution • Effectiveness exhausted after 48 to 72 hours, which could lead to staining problems with large storage volumes and long dead end pipelines • Possible enhancement of biological growth

Aeration alone can usually remove up to 5 to 10 mg/l of iron. A minimum detention time of 20 minutes is required. Complete manganese removal with aeration is difficult, and requires the raising of the pH to 9.5 or above. Even at a pH of 9.5, a detention time of more than one hour would be required. To successfully remove manganese with aeration may require the use of a catalyst or adsorption type media.

Following the aeration process the oxidized metals are removed by filtration. The filters can be either pressure or gravity design and generally operate in the 2 to 5 gpm/ft^2 range. Media's used for iron and manganese removal include silica sands, anthracite coal, and greensand. Filter runs are expected to be 24 to 48 hours with backwash rates of 12 to 15 gpm/ft^2. The manganese concentration in the Woodburn water do not lend itself to the use of simple aeration for removal. The requirement for pH adjustment and long detention times make this process impractical. Aeration will not be considered further for Woodburn.

Ozonation and Filtration

Theoretically, 1 mg/L of ozone will oxidize 2.3 mg/L of iron and 1.5 mg/L of manganese. The required dosages increase with increasing organic content. Given Woodburn's low TOC level (< 2 mg/L), the lower ozone dosages would be anticipated. Ozone is such a powerful oxidant when it is used for the removal of manganese, an overdose will tend to over-oxidize the manganese to permanganate. Permanganate is soluble and can pass through the filter, causing "pink" water and allowing manganese to enter the distribution system. This is usually only a problem if the water quality changes and the dosage remains the same.

Ozone is a very volatile gas that can not be stored but has to be generated on site. Ozone generators require electricity and either an air prep unit or a pure oxygen feed. The pure oxygen feed produces a higher concentration of ozone and is thereby more efficient. Pure oxygen can either be generated on site, which is usually only used for large systems, or purchased as a liquid and stored in pressure vessels on site. The ozone is injected into the water flow as it is produced and usually enters a reaction vessel that provides 3 to 5 minutes of detention time. All of the ozone gas does not go into solution and the excess gas must be handled through an ozone destruct unit.

Following the ozone contractor, the oxidized metals are removed by filtration. The filters are generally pressure filters and operate in the 4 to 5 gpm/ft^2 range. Media's used for iron and manganese removal include silica sands, anthracite coal, and greensand. Filter runs are expected to be 24 to 48 hours with backwash rates of 12 to 15 gpm/ft^2. Because this treatment method uses ozone, a primary disinfectant, the process would trigger the requirement of a residual secondary disinfectant in the distribution system.

$KMnO_4$ or Cl_2 Oxidation and Pressure Filtration

Chlorine and potassium permanganate have been used in the removal of iron and manganese throughout North America. Chlorine, a relatively inexpensive chemical can be used alone or in conjunction with $KMnO_4$ to oxidize the metals prior to filtration. Chlorine rapidly oxidizes iron at neutral pH and can be readily used alone if only iron is found in the water. Chlorine reacts

slower with manganese at neutral pH and requires either pH adjustment, a long contact time, or a specially coated media to be effective alone. It has been reported that at pH 8.0, approximately 2 to 3 hours would be required for chlorine oxidation of the manganese. At pH 6.0, 12 hours would be required for the reaction.

$KMnO_4$ is a much stronger oxidant than chlorine and can be readily used alone for the oxidation of both iron and manganese prior to filtration. $KMnO_4$ is not as pH dependent and complete oxidation of the metals generally occurs within a few seconds. For this reason, no additional contact time is provided in the system. $KMnO_4$ is pink in color and an overdose will produce pink water in the distribution system. $KMnO_4$ is highly corrosive and operators must take care in handling the chemical. It is generally delivered in crystal form and is mixed in a day tank for feeding with a chemical dosing pump. The chemical is relatively expensive when compared to chlorine.

It is common to use chlorine and $KMnO_4$ together in an iron and manganese removal plant to accomplish the treatment goals while reducing chemical costs. The chlorine is added first to oxidize the iron and reduce the $KMnO_4$ dose, $KMnO_4$ is then added to oxidize the manganese. Once oxidized, the iron and manganese are removed by a pressure filter. The chlorine in this system can also serve as a primary disinfectant and the utility can take the credit for the contact time in the filters.

The oxidation of iron by either chlorine or $KMnO_4$ is influenced by pH, organic content and temperature. It requires approximately 0.62 mg/l of Cl_2 for every mg/l of Fe and approximately 0.95 mg/l of $KMnO_4$ for every mg/l of Fe to fully oxidize the metal. The oxidation of manganese by potassium permanganate may be influenced by pH, organic content and temperature. Theoretically a dosage of 1 mg/L of potassium permanganate oxidizes 0.52 mg/L of manganese. Less is generally required, unless the manganese is organically bound, which should not be the case given Woodburn's low TOC levels. The oxidation of manganese is pH dependent within the low pH range. However, within the pH range of Woodburn water quality (7.15 to 7.94), the reaction is rapid. At a pH of 7.0, a reaction time of 1 minute has been reported. Above a pH of 7.5 the reaction is essentially instantaneous. Low temperatures have been reported to decrease the oxidation efficiency.

During the process of oxidizing the manganese with $KMnO_4$, manganese dioxides are formed that will coat the filter media. This coating will act as a catalyst and will aide in the oxidation and removal of the manganese from the water. This manganese dioxide coating has an attraction for manganese and has the ability to remove the manganese by adsorption. This allows the $KMnO_4$ dosage to be reduced thereby reducing chemical, operations, and maintenance costs. The manganese dioxide coating on the media must be periodically regenerated with $KMnO_4$.

Following the addition of Cl_2 and $KMnO_4$, the oxidized metals are removed by filtration. The filters are generally pressure filters and typically operate in the 4 to 5 gpm/ft^2 range. Media's used for iron and manganese removal include silica sands, anthracite coal, and greensand. Filter runs are expected to be 24 to 48 hours with backwash rates of 12 to 15 gpm/ft^2. Chlorination to produce a residual in the distribution system would be added after filtration.

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greensand media is a specially coated media that acts as a catalyst in the oxidation of manganese. Greensand has traditionally been used in small installations due to its high cost and the small size of the media. Manganese impregnated greensand (zeolite) is a purple-black material processed using a natural mineral called glauconite. The product is manufactured with manganous sulfate and potassium permanganate to provide an active supply of iron and manganese oxides on the sand grains. A typical greensand filter bed is composed of a top layer of anthracite and a lower layer of manganese greensand. Due to the small size of the media, it has a tendency to plug off quicker than conventional media and thereby reduce the length of the filter run. The anthracite layer reduces plugging of the finer greensand by removing most of the insoluble's in the upper layer of the filter. The manganese greens and acts as a "catalyst" removing iron and manganese chemically as well as physically. The greensand will adsorb some of the unoxidized iron and manganese thereby providing a second means of removal in the filter. The greensand also reduces the required dosage of $KMnO_4$ compared with the dual media anthracite/silica sand layer. The greensand is exhausted over time and must be regenerated. Regeneration of the greensand is accomplished in two ways, an intermittent batch process using $KMnO_4$ or continuously by feeding $KMnO_4$ into the raw water. Greensand media is fouled and exhausted by high loading of Fe and Mn, organic material, nitrogenous material, or H_2S. Greensand media has been known to be permanently fouled when used with waters having high organic loading. Filtration rates are generally lower than for conventional filter media and can be expected to be approximately 3 to 4 gpm/ft^2. Filter runs should be approximately 24 hours in length.

iological Filtration

Biological water treatment is widely used in Europe but has received little recognition in the USA. The US practice has been to minimize biological (pathogen) activity throughout the treatment process while the Europeans have tried to promote controlled biological activity for specific treatment processes. Biological process have been successfully used for 1) Iron removal, 2) Manganese removal, 3)Ammonium nitrification, 4) Nitrate removal, and 5) AOC removal.

In the biological filtration process, bacterial action would be used to oxidize the iron and manganese. For removal of both iron and manganese, two stages (reactors) are generally required. This is necessary because the optimal conditions for biological iron removal and biological manganese removal are significantly different. Typical loading rates for the biological reactors are quite high being 10 to 14 gpm/ft^2. Iron and manganese can be removed in a single reactor in some waters, however the filter loading rates must be very low typically 2 gpm/ft^2. The biological reactors are set up with the proper conditions for the bacteria to grow and thrive and remove the contaminate from the water. This is generally accomplished by the addition of air and pH adjustment to the influent water stream.

Startup times of 2 to 5 days for biological iron removal and 2 to 3 months for biological manganese removal would be expected. Once seeded the reactors will consistently remove the iron and manganese to well below the SMCL. Studies have shown that the biomass is relatively stable and easy to control once established. Although the bacteria recover rapidly from periods

of shutdown, it is recommended that the plant be operated continuously. This could be accomplished with the use of variable speed motors on the well and treatment plant pumps.

The filter run lengths in the biological processes are longer than conventional filters due to the compact nature of oxidized metals. The metals become a part of the bacteria and are flushed out during the backwashing process. It has been reported that as much as 5 times as much iron and manganese can be removed per filter volume when compared to conventional filters. The sludge has good settling characteristics and is easily handled.

Backwashing of the filter is accomplished using unchlorinated water to protect the bacteria. The objective of the backwashing is more of a flushing than a cleaning. Rinsing away the dead and old bacteria to maintain hydraulic capacity and sustain bacteria growth are the main functions of the backwash process. Due to these facts, the rate and length of backwashing is significantly lower than in conventional filtration. Anticipated filter runs are from 48 to 72 hours.

Due to the lack of use in North America, extensive pilot testing and consultation with the Health Division will be necessary to gain approval of the process. It is anticipated that once the process is demonstrated to the regulatory agencies, they will accept it as a viable option.

Advantages of biological treatment over conventional treatment include:

- cost savings due to smaller facilities
- space savings
- higher capacities
- better water quality
- simpler operation
- reduced backwash requirements

Disadvantages include slow startup times for manganese and ammonium removal and a sensitivity to zinc levels (>0.45 mg/L), H_2S levels (>0.1 mg/L) and ammonia levels. Woodburn's water quality data indicates low concentrations for these constituents. One water sample from Woodburn showed zinc concentrations of 0.87 mg/L, all other concentrations have historically been below 0.21 mg/L. Sulfide concentrations tested in the Woodburn source water in 1989 showed one detected concentration of 0.008 mg/L, well below 0.1 mg/L. Ammonia concentrations are low (~ 0.075 mg/L).

The pH of the process stream is critical. For optimal removal of iron, a pH of around 7.0 is ideal. Higher pH have been used if the dissolved oxygen in the water is low. For optimal removal of manganese, a pH > 7.5 is required. With the pH range of the Woodburn well water (7.2 - 7.9), biological iron removal may require the addition of an acid (such as sulfuric acid) or the addition of CO_2 to lower the pH to optimal conditions. Following biological iron removal the pH may have to be raised by the addition of a base (such as caustic soda) to bring the pH up to the required level and the water aerated to increase the dissolved oxygen level. Because of Woodburn's high alkalinity a significant amount of the acid or CO_2 and base would be required

to accomplish the pH changes. Pilot testing would establish the feasibility and operating conditions of the process.

Proprietary Treatment Processes

Due to the prevalence of iron and manganese in groundwater, there are processes on the market that are specifically designed to remove these metals. These processes offer advantages in ease of operation or simplification of the process and can result in operational savings to the City. The disadvantage is that the process is tied to a single supplier and the City must work with that company for the life of the treatment plant.

One of these processes is manufactured by Filtronics of Pasadena, California and utilizes chlorine to oxidize both the iron and manganese. The process relies on a specially coated media that is a trade secret and only available from Filtronics. The media has an affinity for manganese and holds the metal on the media and gives the chlorine an opportunity to oxidize it and remove it in the backwash stream. Chlorine is added to the raw water and the water enters a detention vessel that provides 1 minute of contact time. SO_2 is then added to the water as it enters a second detention vessel that provides another 1 minute of contact time. The SO_2 acts as a catalyst in the oxidation of the iron and manganese.

Backwashing of the Filtronics process is usually completed every 8 hours. The backwash is a high rate short flush of the media to remove the oxidized metals. This backwashing serves to free up adsorption sites on the media that allows the media to attach to the iron and manganese in the water. The media is sensitive to the organic content in the water and can be fouled if the TOC is greater than 1.0 mg/l. The media is also sensitive to H_2S and will foul if there is H_2S in the water.

The Filtronics process is less expensive to operate due to reduced chemical costs when compared to conventional treatment processes. Eliminating the need for $KMnO_4$ addition and relying totally on chlorine takes advantage of the low cost of chlorine. Elimination of the $KMnO_4$ feed also gets rid of a chemical feed system, reducing the cost further. The use of chlorine in the system provides primary disinfection to the system. The disadvantage of the Filtronics system is a higher capital cost due to the proprietary nature of the process and the fact that the City would be tied to a single supplier for service and repair. The Filtronics process would have to be pilot tested for acceptance in the State of Oregon.

Due to the proprietary nature of this process and the requirement to disinfect that would come with this system, this process will not be considered further.

Sequestering with Chlorination

Sequestering agents are often used in water containing low concentrations of iron and manganese to hold the metals in solution rather than remove them through treatment. Typical sequestering agents include polyphosphates and ortho-polyphosphates, which are also used as corrosion

inhibitors. The poly/poly-ortho phosphate combines with the iron and manganese to slow and inhibit their oxidation and precipitation.

The sequestering agents are usually successful with combined levels of iron and manganese in the 0.5 to 1.0 mg/l range. The main advantage to the use of sequestering agents is the ease and low cost required to set up the chemical feed system and bring the system on line.

One disadvantage in the use of a sequestering agent is the possible enhancement of biological growth in the distribution system or wells. Polyphosphates can be food source for biofilms and thus can enhance their growth. The chlorine residual in the system must be sufficient to ensure that excessive growth does not occur. Where the sequesterants are added near wells, special care is needed to prevent back contamination of the well which can lead to biological growth problems. Bench scale testing of this treatment method would be recommended prior to it's use to ensure that it is a viable alternative.

Another disadvantage of the use of sequestering agents is that their effectiveness is generally exhausted after 48 to 72 hours. In systems with large storage volumes or with long dead end pipelines, sequestering is not recommended. Woodburn has one operating storage reservoir in the system which provides peak demand storage, emergency reserve, and hydraulic gradient control. The dead end pipelines exist mostly at the cul-de-sacs. Oxidation of the iron and manganese could potentially occur in these areas following the exhaustion of the effectiveness of the sequestering agents. This could lead to rusty or black water complaints and turbidity in the system.

The level of iron and manganese in the Woodburn system are above the recommended maximums for sequestering. The metals are not removed from the system and this process does not meet the City's treatment goals. Sequestering will not be considered for the Woodburn system.

10.3 TREATMENT METHODOLOGIES - DISINFECTION

Disinfection technologies used in drinking water systems include:

- Chlorination (gaseous and liquid)
- Chlorine Dioxide
- Chloramination
- Ozonation
- Ultraviolet light (UV) (not generally used in the USA)

A summary of the disinfection options is presented as Table 10-3. Following the overview of the available disinfection technologies, specific advantages and disadvantages of the various disinfection options will be presented based on a criteria specific to Woodburn. Each disinfection technology will then be ranked according to each criteria.

Disinfection for Woodburn will be designed to inactivate bacteria and viruses. Pathogenic protozoa, such as *Giardia* or *Crypto* are not considered to be a threat in groundwater.

Woodburn Water Master Plan
Summary of Disinfection Options

	Chlorination Gas	Chlorination Hypochlorite	Chlorine Dioxide	Chloramination	Ozonation	Ultraviolet Light (UV)
Bactericide	Excellent	Excellent	Excellent - more powerful biocide than chlorine.	Fair	Excellent - most potent used in water treatment	Good
Viricide	Excellent	Excellent	Excellent	Weak against virus requires long contact times	Excellent - most potent used in water treatment	Good
Suitable as Primary Disinfectant	Yes	Yes	Yes - If a means of reducing chlorine dioxide and chlorate ions is used (GAC or some strong chemical reducing agent.)	Yes - Although less effective than other disinfectants	Yes	Yes - Particularly groundwater not directly influenced by surface water (since there is a low *Giardia* cyst risk)
Suitable as Secondary Disinfectant	Yes - Provides residual in distribution system	Yes - Provides residual in distribution system	Yes - Provides residual in distribution system	Yes - Provides residual in distribution system	No - Does not provide residual in distribution system	No - Does not provide residual in distribution system
Required Contact Time for Primary Disinfection	Moderate	Moderate	Moderate	Long	Short	Short
Usage	Widespread U.S.	Widespread U.S.	Widespread use in Europe. Limited application in the U.S. - primarily for taste and odor applications.	Limited use in the U.S.	Widespread use in Europe. Gaining widespread use in U.S.	Used for groundwater disinfection, small systems, widespread use in wastewater disinfection
Taste and Odor	Produces taste and odor	Produces taste and odor	Effective against taste and odor	Produces taste and odor. Can produce "fruity taste" at high organic concentrations.[1]	Effective against taste and odor	None

Table 10-3
Woodburn Water Master Plan
Summary of Disinfection Options

	Chlorination Gas	Chlorination Hypochlorite	Chlorine Dioxide	Chloramination	Ozonation	Ultraviolet Light (UV)
DBP Formation[1]	Yes	Yes	When prepared in presence of chlorine; THMs and other DBPs, possible. Also chlorite and chlorate. (EPA recommends maximum residual for ClO_2, chlorite and chlorate ions of 0.1 mg/L).	Less potential to form DBP compared with chlorine.	Potential for formation of bromates in the presence of bromide and aldehydes in the presence of naturally occurring unsaturated aliphatic fatty acids.	None
Other Health Implications	None	None	None	Chloramines are detrimental to individual on kidney dialysis.	None	None
Factors Affecting Effectiveness	Effectiveness decreases with: • Increasing pH. (Ideal pH is 6-7). • Presence of ammonia or organic nitrogen • Presence of other oxidizable substances • Decreasing temperature (Ideal temp. is 20-25°C).	Effectiveness decreases with: • Increasing pH. (Ideal pH is 6-7). • Presence of ammonia or organic nitrogen • Presence of other oxidizable substances • Decreasing temperature (Ideal temp. is 20-25°C).	Effectiveness decreases with: • Decreasing temperature	Effectiveness decreases with: • Increasing pH. • Presence of ammonia or organic nitrogen • Decreasing temperature	Effectiveness decreases with: • Presence of other oxidizable substances. Ideal pH range is below 8.	Effectiveness decreases with increasing levels of: • Suspended solids • Color • Turbidity

T 10-3
Woodburn W ter Master Plan
Summary of Disinfection Options

	Chlorination Gas	Chlorination Hypochlorite	Chlorine Dioxide	Chloramination	Ozonation	Ultraviolet Light (UV)
Process Parameters Affecting effectiveness	Contact time Mixing Chlorine dosage	Storage time Contact time Mixing Chlorine dosage	Contact time Mixing Chlorine dioxide dosage	Contact time Mixing ratio of ammonia to chlorine Method of chloramination generation	Contact time Mixing Dosage	• Energy dose (lamp intensity x time of exposure) • Intensity governed by power and placement of lamp relative to water. • Exposure time
Operation and Maintenance	Easy to control and use	Hypochlorite decomposes - maximum storage time ~ one month. Increased storage space and transportation costs with NaHOCL purchase compared with gaseous chlorine. Easy O&M associated with pumping and metering equipment.	On-site generation required. Optimization of the generator performance is important. Storage not possible.	Requires two chemical feeds.	On-site ozone generation required Storage not possible.	Easy to operate. Requires cleaning of lamps.
Hazards	Toxic gas requires scrubber. Dangerous gas - lethal at conc. above 0.1 percent	Very corrosive. Containment required.	Unstable and explosive in concentrations > 10% by volume (~12 g/L). Gaseous chlorine dioxide toxic.	Same as chlorination hazards.	High levels of ozone are acutely toxic.	None
Capital Costs	Moderate	Low to Moderate	High	Moderate	High	Moderate to High
Operational Costs	Low	Low to Moderate - Overall operation costs are higher than chlorine gas.	High	Moderate	Moderate to High	Moderate

(1) Not a significant issue for Woodburn given the low TOC in the Woodburn water.

There are two kinds of disinfection required: primary and secondary. Primary disinfection achieves the desired level of microorganism kill or inactivation. Secondary disinfection maintains a disinfectant residual in the finished water that prevents the regrowth of microorganisms. The effectiveness of primary disinfection is measured by the CT value where C is the residual disinfectant concentration and T relates to the contact time. For secondary disinfection, a minimum residual of 0.2 mg/L at any point in the distribution system is maintained. If the City were to experience violations with the TCR, secondary disinfection would most likely be required. The introduction of a disinfectant with treatment for the removal of iron and manganese would trigger the requirement for secondary disinfection. The proposed GWDR would require the City to implement both primary and secondary disinfection.

Chlorination

Chlorine is an effective bactericide and viricide and produces a residual in the distribution system. It has been successfully used for disinfecting public drinking water systems since the turn of the century. It is the most common form of drinking water disinfection in the USA. Chlorine may serve as both a primary and a secondary disinfectant. Chlorination is generally provided by either chlorine gas or liquid sodium hypochlorite feed.

Chlorine Gas

Chlorine gas is the most widely used method for chlorinating drinking water in the USA. Chlorine gas is relatively inexpensive and easy to use.

Process Description. Elemental chlorine is supplied in high-pressure cylinders as a liquid. The most common type of a gas chlorinator is a vacuum operated solution-feed system. The equipment is inexpensive and easy to use and control. The chlorine gas is released from the cylinder in a vacuum tube which is connected to an injector in a side stream of water. The chlorine gas and the water form a solution of hypochlorous acid and hypochlorite ion, which is then fed to the water supply providing the disinfection power.

Process Considerations. Chlorine gas is extremely toxic in low concentrations in the atmosphere. Recent changes in the regulations for chlorine gas require that storage facilities have complete containment and for systems having more than two 150-pound cylinders in storage, a chemical neutralization (scrubber) system is required in case of a leak or a rupture.

Sodium Hypochlorite (Bulk)

Process Description. Hypochlorite may either be purchased directly or produced on-site. Sodium hypochlorite solution (the active component of household bleach) is supplied commercially in concentrations of 5 to 15 percent chlorine. The solution is metered directly into the water using a chemical feed pump.

Process Considerations. Sodium hypochlorite is more easily handled than gaseous chlorine and gives less maintenance problems with pumping and metering equipment. The use of a liquid rather than a gas provides operator and community safety and eliminates the need for a scrubber system. The volume of the hypochlorite solution required and the corresponding weight, as

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compared to chlorine gas, increases the cost of transporting and storing the chemical. In strengths greater than approximately 5%, sodium hypochlorite is unstable, and deteriorates rapidly over time producing chlorate ions. Chlorate has been linked to health problems. A 12% solution can be stored a maximum of one month. To slow the rate of decay and the formation of chlorate, it is recommended that the 12% solution be diluted to 4% or less. This requires additional handling and storage volume.

The solution is corrosive with a pH of 11, requiring secondary containment. If the carrier water used for dispersion of the hypochlorite has appreciable hardness, precipitation of calcium carbonate can occur in rotometers and piping. If undiluted hypochlorite is pumped directly to the point of application, off-gassing of chlorine due to long retention times in the piping can occur, causing inconsistent feed rates. Off-gassing can also burst pipes if not taken into account in design. Providing a dilution tank that would allow a 4% solution reduces the precipitation and off-gassing problems with the feed equipment.

Sodium Hypochlorite (On-site Generation)
To eliminate the need to handle and store liquid sodium hypochlorite, systems have been developed that produce a low concentration of sodium hypochlorite using salt and electrodes. This system only requires the operator to handle salt and produces fresh low strength hypochlorite that is less susceptible to degradation over time. The dependability and cost effectiveness of on-site hypochlorite generation has been proven in recent years for small water systems.

Process Description. Hypochlorite at approximately 0.8% solution strength is generated electrolytically from a salt solution (brine). The system for on-site production of hypochlorite solution consists of a two-cell unit which electrolyzes a brine solution, producing hypochlorous acid in one cell and a solution of caustic soda (NaOH) in the other cell. The hypochlorite solution flows to a day tank that is connected to a chemical feed pump. The hypochlorite solution is then pumped from the day tank to the point of application. Because the concentration is low relative to bulk hypochlorite, larger metering pumps are required than for bulk hypochlorite feeding.

The on-site generation requires pure salt (99.7% NaCl) to protect the electrodes from contamination. Salt consumption is typically 3 to 4 pounds of salt to generate the equivalent of one pound of chlorine. In addition, 15 gallons of water and 2.5 kWh of electrical power per pound of chlorine equivalent is required.

Process Considerations. The capital costs for an on-site generation system are significantly higher than for a bulk delivered sodium hypochlorite feed system. However, operation and maintenance costs per pound of applied chlorine are considerably less for on-site generation when compared to delivered hypochlorite. The capital costs for the system must be amortized over several years to determine the relative economics of the system. During the generation process some hydrogen and caustic soda are produced that are hazardous to deal with if not properly handled.

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Chlorination Considerations
Water quality parameters which affect the disinfection capabilities of chlorine include:

- Other oxidizable substances in the water which exert a chlorine demand that must be satisfied before an excess of free chlorine is available for disinfection
- Particulate concentration
- pH - the effectiveness of chlorine decreases with increasing pH
- Temperature - the effectiveness of chlorine decreases with decreasing temperature
- Ammonia or organic nitrogen which form chloramine complexes

Two drawbacks of chlorine disinfection are its tendency to form disinfection byproducts and the taste and odor associated with chlorine. Because the raw water in Woodburn's wells has a low organic content, the formation of disinfection byproducts is not a major concern.

Chlorine Dioxide

Chlorine dioxide has been used as a disinfectant by several large systems in Europe. In the U.S., its application has been primarily in taste and odor control. Chlorine dioxide is a strong bactericide and viricide and produces a residual in the distribution system so it may be used as both a primary and secondary disinfectant. Chlorine dioxide is a weaker oxidant than chlorine and would not benefit an iron and manganese removal system.

Process Description
Chlorine dioxide is an unstable gas, which must be generated on site. Chlorine dioxide is generated by oxidizing sodium chlorite (which may be either a 25 percent aqueous solution or a solid) with either chlorine gas, sodium hypochlorite solution and mineral acid, or mineral acid alone at a pH of 4 or less. The most common chlorine dioxide generation process uses chlorine gas and sodium chlorite. The aqueous solution of oxidant is metered into and mixed in a chlorine dioxide reactor. The resulting solution is pumped directly into the water to be treated.

Based on health effect studies the EPA recommends a maximum residual for chlorine dioxide and its decomposition products (chlorite and chlorate ions) of 0.1 mg/L. To meet the residual requirements, a 1.2 to 1.4 mg/L dose of chlorine dioxide is generally recommended. Because of the narrow range, optimization of the generator performance is important.

The majority of chlorine dioxide added to water is converted to chlorite ion. Excess chlorine dioxide and chlorite ions can be reduced to chloride ion with sulfur dioxide. Chlorate is formed as a by-product during the chlorine dioxide oxidation/disinfection step, especially when free chlorine is used. Unlike chlorite, chlorate cannot be removed from drinking water by currently available treatment techniques. Chlorate formation may be minimized by avoiding conditions of high pH values and/or low initial reactant concentrations, and the presence of free hypochlorous acid.

Process Considerations

The bactericidal effectiveness of chlorine dioxide has been shown to be unaffected by pH values in the range of 6.0 to 10.0, although some references have shown increasing effectiveness within a higher pH range (8.5 - 9). The efficiency of chlorine dioxide decreases with decreasing temperature. Design parameters which affect the efficiency of chlorine dioxide disinfection include contact time, mixing and chlorine dosage.

Another drawback of the use of chlorine dioxide is the requirement of on-site generation, which increases its cost of construction and operation relative to chlorination. Since chlorine dioxide must be generated and fed into the system, no storage is required and conversely no back up supply is available if the generator breaks down or requires maintenance. For this reason a backup system of chlorine gas or hypochlorite feed is required. Chlorine dioxide gas is toxic and unstable and explosive in concentrations greater than 10% by volume (~12 g/L).

Chloramination

Chloramines are formed by adding chlorine and ammonia into water. Chloramines are less effective bactericides and viricides than chlorine. They do produce a long lasting residual in the distribution system, and thus may in some cases be most effective as secondary disinfectants. Chloramines do not react with organic materials in the water as rapidly as chlorine and thus produce lower THM's, a disinfection byproduct. For this reason, the majority of utilities which rely on chloramination for disinfection, do so because they have THM concerns. Due to the low organic content found in the Woodburn well water, THM formation is not anticipated to be a roblem.

Process Description

There are three methods to produce chloramines:

1) Adding ammonia to chlorinated water
2) Adding chlorine to water already treated with ammonia
3) Using a pre-formed solution of monochloramine

The first method is the most effective of the three because disinfection is provided by the free chlorine prior to adding the ammonia. THM and other DBPs will form in the chlorinated water (in the same way under chlorination) however the reaction time is controlled, thus reducing the THM formation. Once the ammonia is added, DBP formation will be inhibited. In the second and third methods the solution is less effective because the disinfection is provided by the chloramine, not free chlorine. Chloramine is a weaker disinfectant than free chlorine and requires a longer contact time to produce the same disinfection results.

The chlorination step requires the same process as for chlorination (chlorine gas or sodium hypochlorite). Ammonia is available as an anhydrous gas (150 lb. cylinders), an aqueous solution (aqua ammonia) (55-gallon drums) or as ammonium sulfate powder (100-lb bags). Ammonia gas is injected into treated water using a similar system as for chlorine gas. Aqua ammonia is similar to sodium hypochlorite. For ammonium sulfate powder, a 25 to 30 percent olution is prepared and injected using a chemical metering pump.

Process Considerations

Water quality parameters which affect the disinfection capabilities of chloramination include:

- pH - For chloramines, there is an increased effectiveness with an increasing pH. For free chlorine, there is an decreased effectiveness with increased pH.
- Temperature - decreasing effectiveness with decreasing temperature.
- Ammonia or organic nitrogen - decreased effectiveness with ammonia concentrations (this affects the process effectiveness only if the chlorination is provided prior to the ammonia addition)

Disadvantages of chloramination include the costs and operational concerns of an additional chemical feed (ammonia) and the longer required contact time prior to the first customer.

Advantages include lower THM formation. Chloramines residuals last longer than free chlorine, and therefore chloramination may be used as a post disinfectant in combination with other disinfects.

The hazards associated with chlorination apply to chloramination: toxicity in handling both gaseous chlorine and ammonia, or the corrosiveness in handling sodium hypochlorite or liquid aqua ammonia.

Ozonation

Ozone is among the strongest oxidants used in water treatment. Ozone will inactivate bacteria, viruses, and protozoa cysts. Ozone is becoming a more common disinfectant due to reduced equipment cost and ease in operation. Ozone is very unstable and has a short life, therefore, it can not be stored and must be generated on-site. Ozone does not form a persistent residual, and, therefore, cannot be used as a secondary disinfectant.

Process Description

The five major elements of an ozonation system are:

- Air/Oxygen feed
- Electrical power supply
- Ozone generator
- Contact Chamber
- Ozone exhaust gas destruction unit

Air/Oxygen Feed. Ozone can be generated using either dry ambient air or pure oxygen. For ambient air feed, the air is first dried before use in the ozonation system to prevent fouling of the ozone production tubes and increased corrosion in the ozone generator. A pure oxygen feed system has higher capital costs but offers the following advantages over ambient air:

- A smaller ozone generator and smaller ancillary equipment can be used (roughly half the size)
- Lower energy consumption
- Higher concentrations of ozone generated
- If used with a once-through system, gas recovery and pretreatment equipment are eliminated.

Oxygen may be purchased as a gas or as a liquid, or produced on-site. There are two methods for producing oxygen on-site for ozone generation: pressure swing adsorption of oxygen from air and cryogenic production (liquefaction of air followed by fractional distillative separation of oxygen from nitrogen). Pressure swing adsorption systems are generally used for smaller-sized plants. Cryogenic separation systems are practical for large systems (20 to 20,000 tons of O_2/day). Cryogenic oxygen production is more capital intensive than by pressure swing adsorption, but generally operation and maintenance costs are lower. Cryogenic systems are operationally sophisticated and operation and maintenance expertise is required.

Electrical Power Supply. Ozone generators use high voltages (generally >10,000 V) or high-frequency electrical current (up to 2,000 Hz), necessitating special electrical design considerations.

Ozone Generation. Ozone for water treatment is usually generated using a corona discharge cell. If ambient air is fed to the generator, the generator produces dry, cool air containing 1 to 3.5 percent ozone (by weight), which can be mixed with water. When pure oxygen is used, the concentration of the ozone is approximately doubled (up to 8 to 9 percent by weight).

Ozone Contractor. Ozone may be generated under positive or negative air pressure. Under positive pressure, the contractor most commonly used is a two-chamber porous plate diffuser, with a 16-ft high water column. Other positive pressure ozone contactors include packed columns, static mixers, and high speed agitators. Under negative pressure, a vacuum draws the ozone mixture from the generator providing contact as the gas mixes with the flowing water. Contactors are designed to provide 3 to 5 minutes of ozone contact with the water.

Destruction of Ozone. The ozone in the exhaust gases from the contacting unit must be destroyed or removed by recycling prior to venting. The primary methods of destroying excess ozone include: thermal destruction, thermal/catalytic destruction, and catalytic destruction (with metal catalysts or metal oxides). Moist granular activated carbon is used extensively at European plants treating less than 2 mgd.

Process Considerations

Water quality parameters which affect the disinfection capabilities of ozone include:

- pH
- Temperature
- Turbidity
- Organic material

Design parameters which affect the efficiency of ozonation include degree and type of mixing and the ozone dosage.

Ozone is more efficient than free chlorine, disinfection can be achieved with relatively small contactors or concentrations than with free chlorine. In the presence of significant concentrations dissolved bromides, ozonation may result in formation of brominated THMs and bromate as

well as the production of potentially hazardous by-products including aliphatic aldehydes and ketone compounds. Woodburn TOC levels are low (< 2 mg/L), which reduces the likelihood of the formation of these compounds. Woodburn has not tested for bromide concentrations.

Ozone is the strongest disinfectant and oxidizing agent available for water treatment. In the presence of iron and manganese, ozone will oxidize the metals causing the precipitation of metal oxides. In the presence of the iron and manganese, the measurement of the degree of disinfection (dissolved ozone concentrations) is impractical.
Ozone in the atmosphere is a toxic gas. An advantage of ozone gas toxicity over chlorine gas toxicity is that ozone has a distinct smell at concentrations much lower the harmful levels and dissipates very rapidly. Since ozone is generated on-site, transportation hazards are eliminated. Additionally, since ozone can not be stored, secondary containment or a scrubber system is not required.

Ultraviolet Light Disinfection (UV)

UV disinfection is an effective bactericide and viricide, but is ineffective as a cysticide. Consequently, it may be used as a primary disinfectant for groundwater's only, where there is no threat of *Giardia* cyst presence. In UV disinfection, the bacteria and viruses are inactivated by the radiation energy (254 nm wavelength) of ultraviolet light. To be effective, the light must strike the organism. The radiation destroys the cell's genetic material and the cell dies. UV disinfection does not produce a residual in the distribution system. Therefore, its application requires a second disinfectant, capable of providing a sustainable residual.

Process Description
The primary source of UV energy is the low pressure mercury arc lamp. UV lamps are usually submerged in the water, perpendicular or parallel to the water flow. Maintaining plug flow conditions is important. Lamp diameters are typically 0.6 to 0.8 inches. Arc lengths of lamps (the active light-emitting portion of the lamp) are generally 2.5 to 4.9 feet.

The most important operating factor for the UV reactor is the cleanliness of the surface. The need for cleaning is based on visual inspection of the surface. The surface of the lamps are cleaned manually with a mild soap solution and swabbed with isopropyl alcohol. In a drinking water application, the lamps will stay clean for extended periods of time.

Process Considerations
Water quality parameters which affect the disinfection capabilities of UV include:

- Suspended solids
- Color
- Turbidity

Design parameters which affect the efficiency of UV include UV energy and the time of interaction (contact time). Since there is no chemicals used, there essentially no hazards associated with the use of UV disinfection. A secondary chlorine feed will probably be required to produce a measurable residual in the distribution system.

Disinfection Criteria for Woodburn

An following criteria was developed to assess the various disinfection options for Woodburn:

- Effective primary disinfection
- Effective secondary disinfection (ability to maintain a residual in the distribution system)
- Minimization of hazards
- Economics
- Ease of Operation and Maintenance
- Applicability to various treatment scenarios (regional, central or wellhead treatment)

Table 10-4 presents a summary of the major advantages and disadvantages of each disinfection option. Table 10-5 presents a ranking within each criteria for each of the disinfection options. Because of low TOC (<1.0 mg/L) in the Woodburn well water, DBP formation (associated predominantly with chlorination) is not a significant issue. Likewise, oxidation demand from organic material would not be a problem. Because Woodburn's ammonia levels (approximately 0.075 mg/L) are low, complexation with ammonia (with chlorination) will not be a problem.

10.4 TREATMENT METHODOLOGIES - ARSENIC

Processes typically used for the removal of arsenic include:

- Removal with iron salts
- Adsorption onto iron oxides
- Adsorption on an activated alumina column

Arsenic Removal Processes

Arsenic Removal With Iron Coagulants

Chemical coagulation with ferric sulfate has been successfully used in the removal of arsenic. Arsenic has a strong affinity for iron salts and gets trapped in the ironhydroxide precipitates. Following oxidation of the water, the arsenic is removed by filtration. During pilot testing at Well #10, dosing ferric chloride resulted in finished water arsenic concentrations of 5 μg/L or less.

Adsorption Onto Iron Oxides

Because of the strong affinity between arsenic and iron, arsenic will attach to iron oxides. With the oxidation and removal of iron, the arsenic is also removed. It is common to note a reduction in arsenic concentration with the removal of iron from water. During pilot testing at Well #10, removal of the natural iron resulted in arsenic reduction from 12 μg/L to 9 μg/L.

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Table 10-4
Woodburn Water Master Plan
Advantages and Disadvantages of Disinfection Options

Disinfection Option	Advantages	Disadvantages
Chlorination Gas	• Primary and secondary disinfectant • Easy to use • Low chemical cost • City familiar with use • Most common approach used • Oxidant for taste & odor, Fe and Mn (limited)	• Toxicity • Safety (transport, handling & storage) • Need for containment, scrubbing • DBPs (not significant for Woodburn) • Chlorine taste
Sodium Hypochlorite - Bulk	• Primary and secondary disinfectant • Reduced safety concerns • No scrubbing required • Metering is relatively simple • Low capital cost • Easy maintenance and handling • Oxidant for taste & odor, Fe and Mn (limited)	• High chemical cost • Crystallization, gassification, corrosive • Chlorine taste • Increased storage requirements • Deterioration with storage • DBPs (not significant for Woodburn)
Sodium Hypochlorite - On-site Generation	• Primary and secondary disinfectant • Reduces safety concerns • Easy to use • Metering is relatively simple • Containment not required. • Oxidant for taste & odor, Fe and Mn (limited)	• High capital cost • Larger pumps required • DBPs (not significant for Woodburn) • Corrosive • Chlorine taste
Chlorine Dioxide	• Strong biocide • Oxidant for taste & odor, Fe and Mn (limited)	• On-site generation (higher capital costs) • Not widely used • Produces chlorite and chlorate • Unstable and explosive (>10% volume)
Chloramination	• Primary and secondary disinfectant (possible) • Lower DBP formation (not significant benefit)	• Involves two chemicals • Less powerful oxidant • Requires long detention

Table 10-4
Woodburn Water Master Plan
Advantages and Disadvantages of Disinfection Options

Disinfection Option	Advantages	Disadvantages
Ozonation	• Most powerful oxidant • Oxidant for taste and odor, Fe and Mn • Containment relatively easy	• Need additional secondary disinfectant • High capital cost • High energy cost • More sophisticated equipment to maintain • Toxic gas • Bromate and aldehyde formation
Ultraviolet Light (UV)	• Simple to maintain and operate • No chemicals • Minimal safety issues • Suitable for remote sites • Minimal space requirements	• Primary disinfectant only • Weak oxidant • High energy cost

Table 10-5
Woodburn Water Master Plan
Criteria and Assessment of Disinfection Options

	Chlorination Gas	Chlorination Hypochlorite	On-Site Cl_2 Generation	Chlorine Dioxide	Chloramination	Ozonation	Ultraviolet Light (UV)
Disinfectant Effectiveness							
Bacteria	Excellent	Excellent	Excellent	Excellent	Moderate	Excellent	Good
Virus	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Good
Ability to Maintain a Residual	Yes	Yes	Yes	Yes	Yes	No	No
Ease of Operation and Maintenance	Simple	Simple	Simple	Moderate	Moderate	Moderate	Simple
Hazards	Moderate to High	Moderate	Low	Moderate to High	Moderate	Moderate	Low
Relative System Capital Cost (1-10)	6	3	6	7	6	10	4
Applicable for Regional Plant	Excellent	Excellent	Excellent	Fair	Excellent	Excellent	Excellent
Applicable for Central Plant	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Applicable for Wellhead Treatment	Fair	Excellent	Excellent	Poor	Excellent	Excellent	Excellent
Secondary Impact Problems	Taste and Odor	Taste and Odor	Taste and Odor	None	None	Secondary Disinfection Required	Secondary Disinfection Required

Adsorption on an Activated Alumina Column
Arsenic will adsorb onto activated alumina, a byproduct of aluminum production. The water is passed through a contact column of activated alumina, reducing the arsenic level in the water. Regeneration or replacement of the activated aluminia is required following 20 to 30 thousand bed volumes, depending on the pH and the amount of arsenic removed.

Potential Treatment Alternatives for Arsenic Removal

The treatment process should be designed so that a ferric chloride feed system can be easily added in the future if needed. Addition of ferric chloride would give Woodburn the opportunity to produce water with 5 μg/L or less of arsenic.

10.5 FATAL FLAW SCREENING OF TREATMENT METHODOLOGIES

The iron and manganese treatment options which were eliminated from consideration along with the fatal flaw of each include:

- Aeration/Filtration - Not effective in removing manganese
- Proprietary Process Filtration - Process tied to single supplier
- Sequestering - Does not reduce iron and manganese concentrations; only effective for 48 to 72 hours.
- Cl_2/ Filtration - Not effective in removing manganese

The disinfection options which were eliminated from further consideration along with the fatal flaw of each include:

- Chloramination - Requires two chemical feeds
- Chlorine Dioxide - High relative capital costs

Four processes were selected as viable treatment options for the removal of iron and manganese for the City of Woodburn. Three of the four selected would also provide primary disinfection to the system. The fourth, $KMnO_4$ oxidation and filtration would initially not have disinfection, however, chlorination could be added at a later date. Features of the four selected alternatives are summarized in Table 10-6 and are illustrated in Figures 10-1, 10-2, 10-3, and 10-4.

10.6 TREATMENT LOCATION SCENARIOS

The treatment plant location scenarios that are being considered by Woodburn are as follows:

1) One treatment plant (located in the north central part of the City in the vicinity of Well 10). Conceptual layout is shown in Figure 10-5.

   Requires
   - Raw water transmission piping from the other wells
   - Examination of the distribution system hydraulics

2) Two neighborhood treatment plants (one located at Well 10 and one located in the southwest corner of the City). Conceptual layout of a typical treatment plant is shown in Figure 10-6.

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Table 10-6
Woodburn Water Master Plan
Summary of Viable Treatment Alternatives

Criteria	$KMnO_4$ - Filtration	$KMnO_4$ - Chlorination - Filtration	Ozonation - Filtration - Chlorination	Biological Filtration - Chlorination
Reliability	Proven iron and manganese removal technology, capable of consistently producing high quality water	Proven iron and manganese removal technology, capable of consistently producing high quality water, use of pre-chlorination reduces the quantity of $KMnO_4$ required.	Becoming more common in iron and manganese removal, once adjusted, capable of consistently producing high quality water, use of ozone requires expensive complex equipment, ozone can not be stored on site.	New technology, not proven in Oregon, once the biomass is established, it is stable and easy to operate
Includes Primary Disinfectant and a Residual	No	Yes, with the introduction of chlorine, the Oregon Health Department will require keeping a residual in the distribution system.	Yes with the introduction of ozone, a primary disinfectant, the Oregon Health Department will require keeping a residual in the distribution system.	Yes
Water quality	Once fine tuned, capable of achieving low concentrations of iron and manganese. Need to monitor the water quality to prevent over dosing of chemical and producing "pink water"	Commonly use treatment technique capable of achieving high quality finished water. Need to adjust dosage of KMnO4 to prevent an over dose and produce "pink water".	Properly dosed ozone followed by filtration is capable of achieving low concentrations of iron and manganese. Potential for overdosing an producing permanganate or pink water.	Once established, the biological reactors are capable of consistently reducing both the iron and manganese to non-detectable levels.
Ease of Operation	Requires the addition and handling of a hazardous chemical. $KMnO_4$ is delivered in crystal form and must be mixed in a day tank for feeding. $KMnO_4$ feeding by diaphragm chemical feed pump. Easy to control and monitor.	Requires the addition and handling of two hazardous chemicals $KMnO_4$ and Cl_2. $KMnO_4$ is delivered in crystal form and must be mixed in a day tank for feeding. $KMnO_4$ feeding is by diaphragm chemical feed pump. Chlorine feed would be sodium hypochlorite. Easy to control and monitor.	Complex equipment to operate and maintain. Easy to control with a stable groundwater chemistry. Requires the addition of chlorine for secondary disinfection and maintaining a residual in the distribution system Ozone can not be stored, it must be generated on site.	Easy to control and operate once established. Continuous operation produces highest best results. Requires the addition and handling of three chemicals (CO_2, NaOH, chlorine). Longer filter runs compared to conventional filtration.
Hazards	$KMnO_4$. is a strong oxidant that requires care in handling.	Hazards association with chlorination, $KMnO_4$.	Hazards association with chlorination, ozonation.	Hazards association with chlorination, caustic, and CO_2.

Figure 10-1
Woodburn Water Master Plan
$KMnO_4$ with Filtration

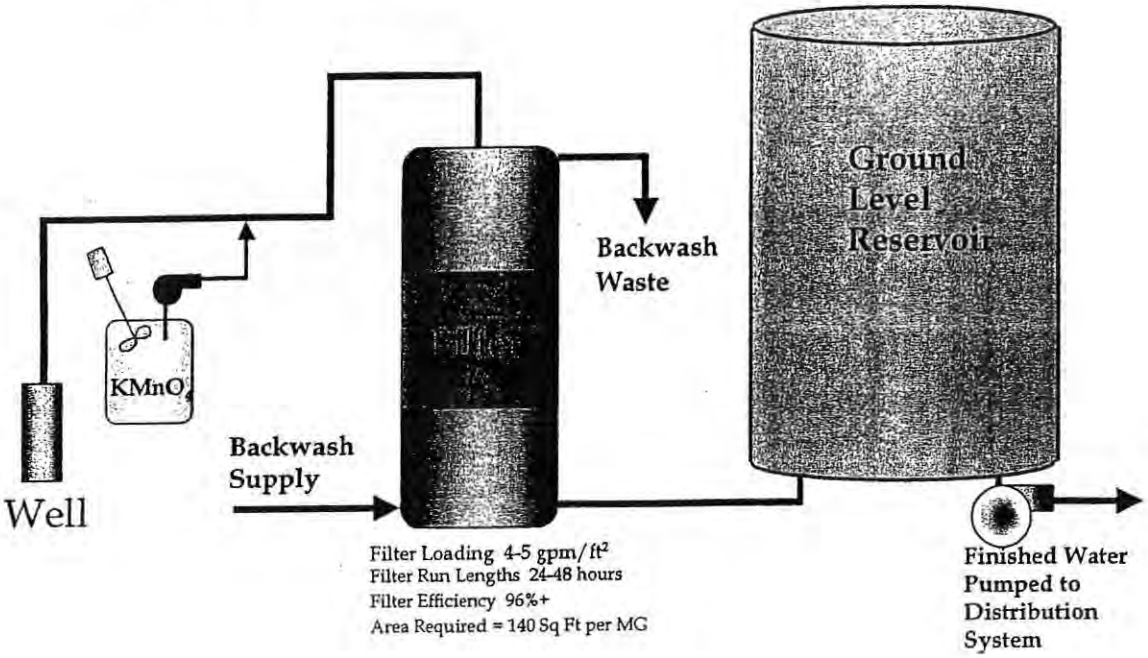

Figure 10-2
Woodburn Water Master Plan
$Cl_2/KMnO_4$ with Filtration

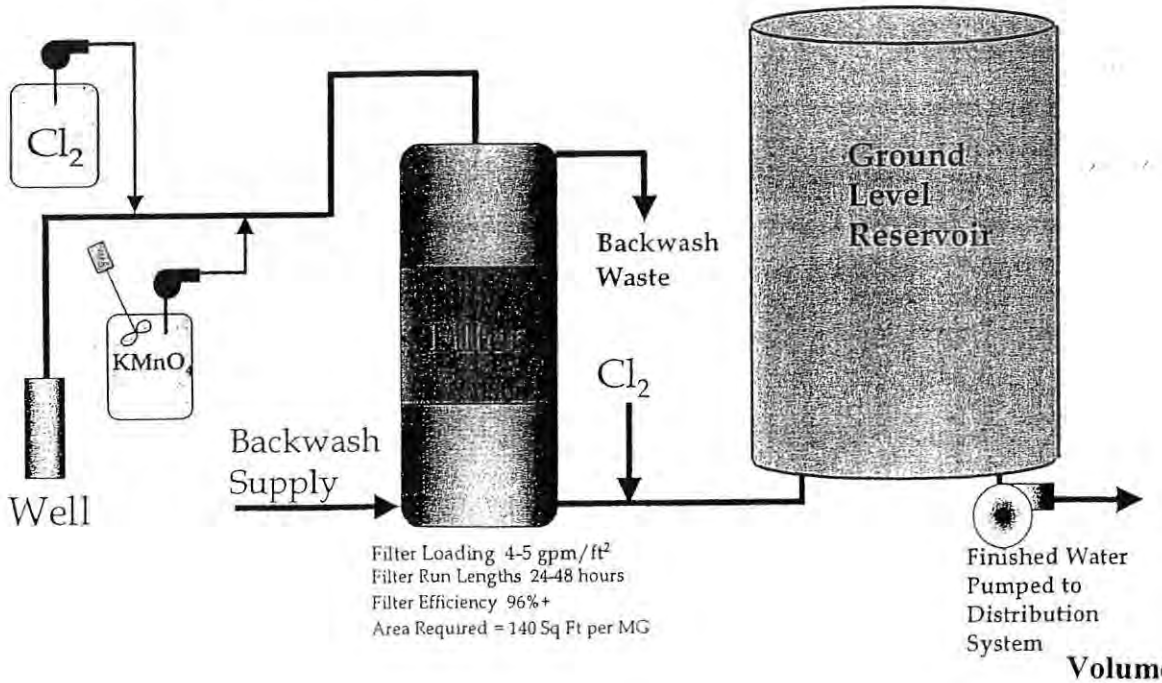

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Figure 10-3
Woodburn Water Master Plan
Ozone Oxidation & Filtration

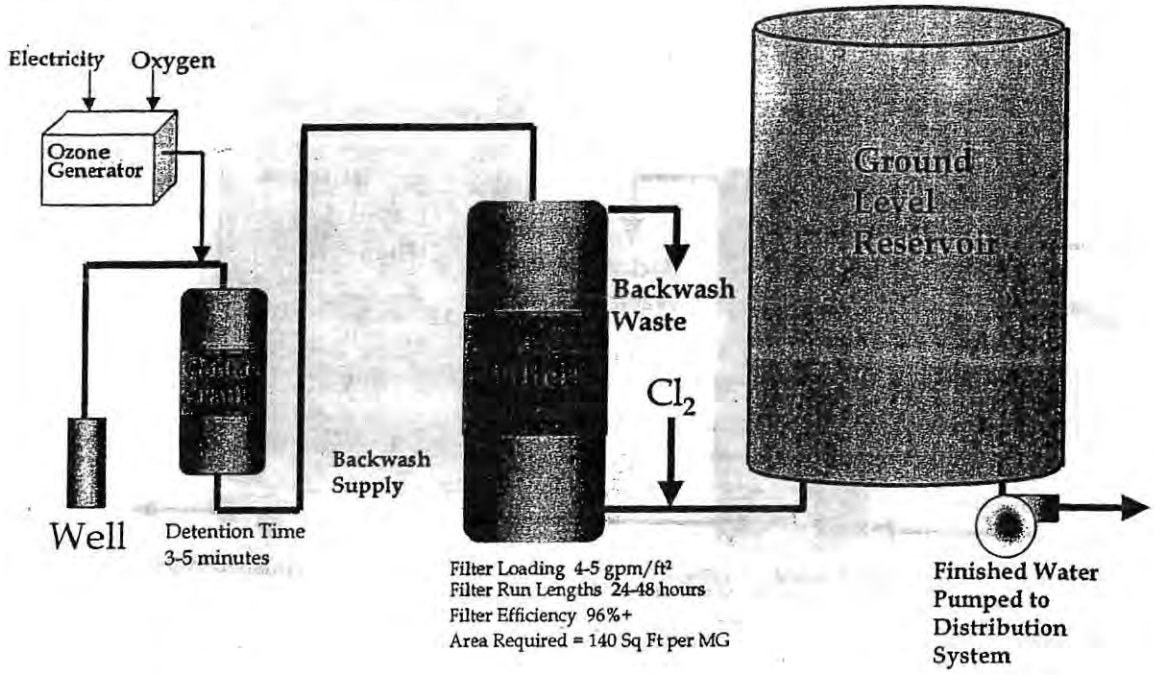
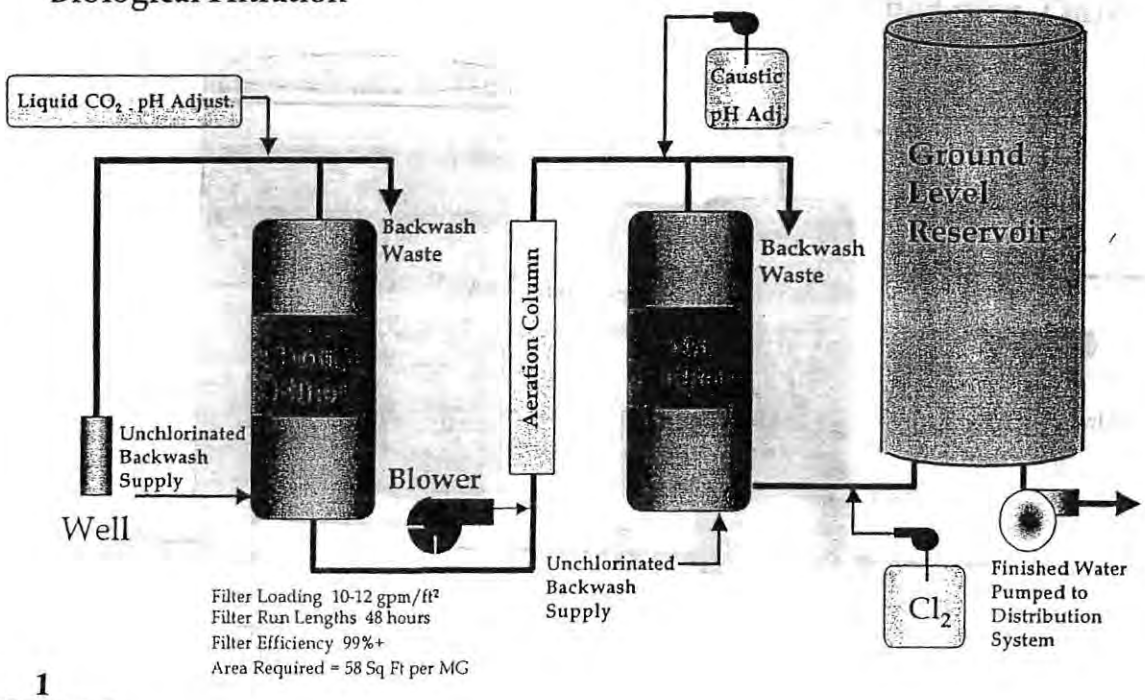


Figure 10-4
Woodburn Water Master Plan
Biological Filtration



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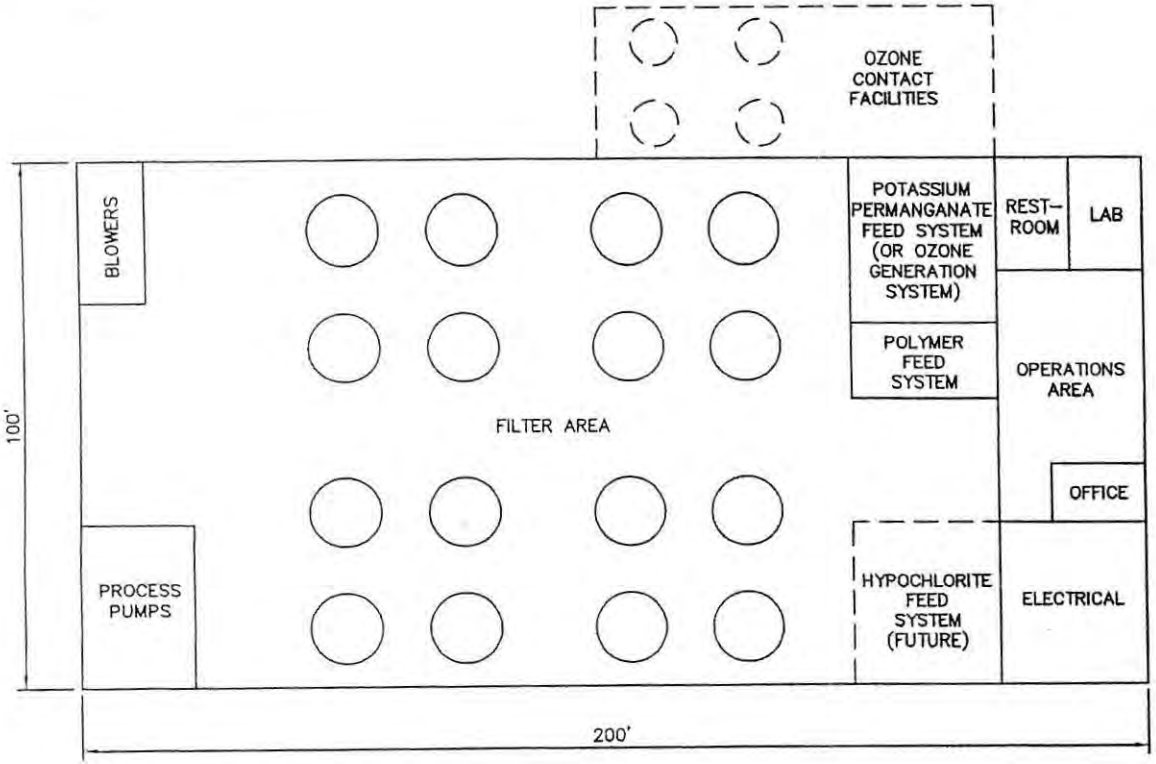
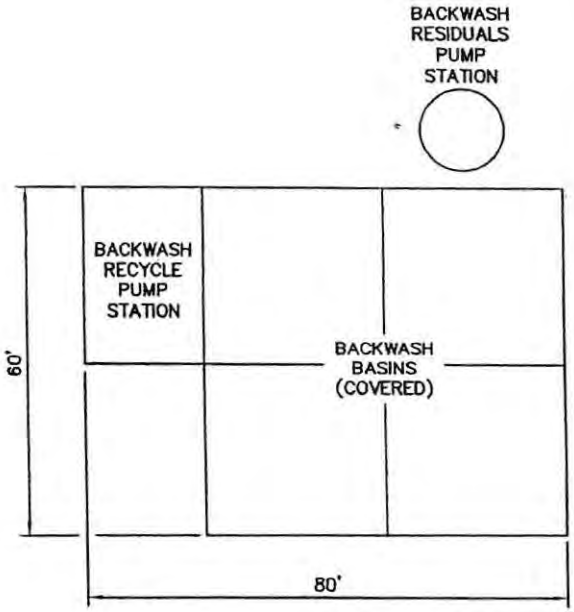


TREATMENT BUILDING



BACKWASH HANDLING FACILITIES

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HDR Engineering, Inc.

Project Title: WOODBURN, OREGON WATER MASTER PLAN	Date: DECEMBER 1996
Sheet Title: CENTRALIZED PLANT CONCEPTUAL LAYOUT (10.5 MGD)	Figure No. 10-5

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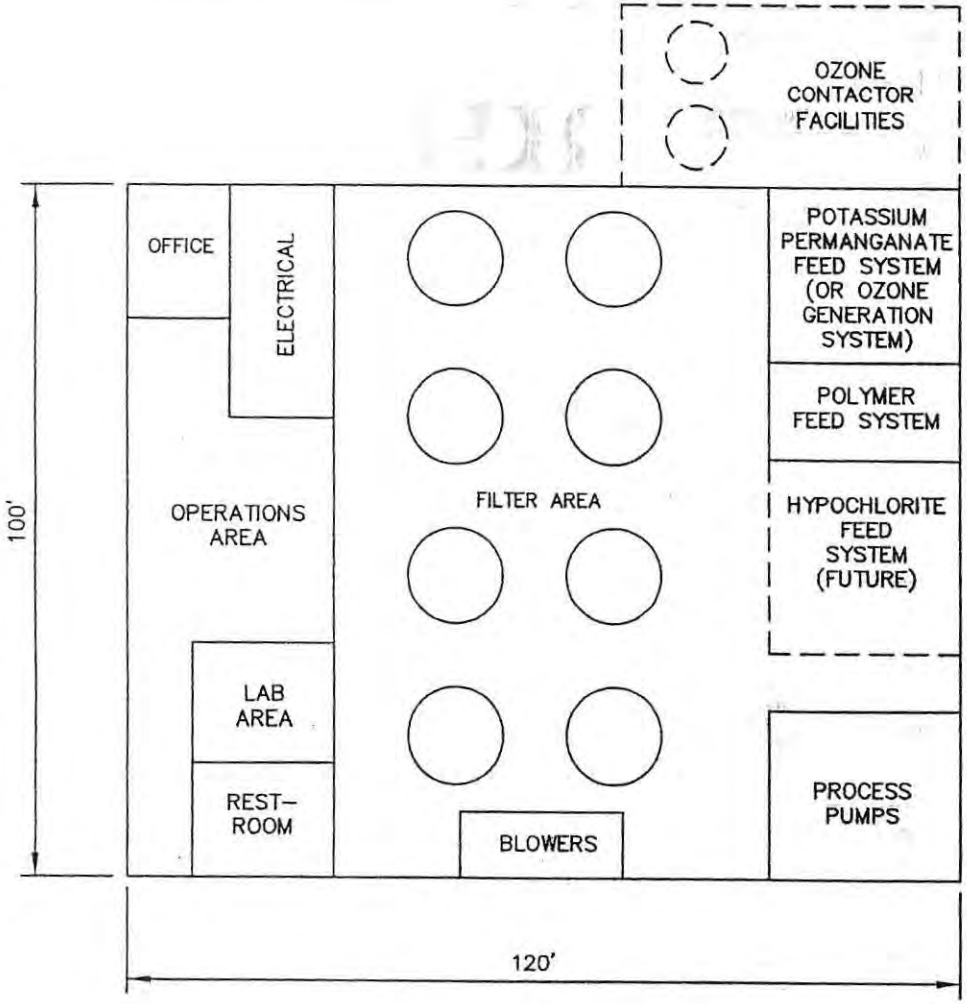
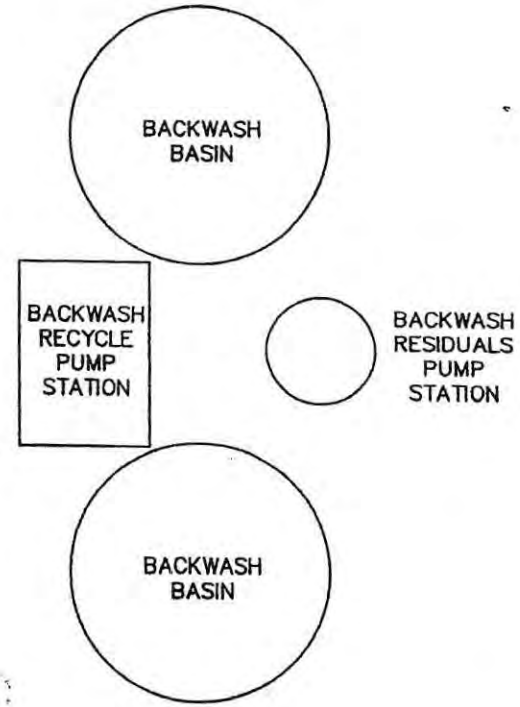


TREATMENT BUILDING



BACKWASH HANDLING FACILITIES

HDR Engineering, Inc.

Project Title: WOODBURN, OREGON WATER MASTER PLAN	Date: DECEMBER 1996
Sheet Title: NEIGHBORHOOD PLANT CONCEPTUAL LAYOUT (5 MGD)	Figure No.: 10-6

Requires

- Multiple facilities
- Raw water transmission piping from neighboring wells
- Examination of the distribution system hydraulics
- Property acquisition for some sites

3) Three neighborhood treatment plants (one located at Well 10, one located in west Woodburn, and one located in the southwest corner of the City). Conceptual layout of the typical neighborhood treatment plant is shown in Figure 10-6.

Requires

- Multiple facilities
- Raw water transmission piping from neighboring wells
- Examination of the distribution system hydraulics
- Property acquisition for some sites

4) Wellhead treatment plants (five treatment plants, one each at Well 7, 8, 9, 10, and in the southwest corner of the City, southwest plant will treat the three new wells). Conceptual layout of the typical wellhead treatment plant is shown in Figure 10-7.

Requires

- Multiple facilities
- Raw water transmission piping for the new wells
- Property acquisition for some sites

10.7 EVALUATION OF TREATMENT FINALISTS

Water Treatment Alternative Evaluation

The four treatment alternatives and four plant location scenarios were developed in order to evaluate each treatment scheme. The evaluation was based on general treatment facility layouts, the actual design details would be developed during pre-design of the treatment plant. The four treatment alternatives considered are:

- oxidation with potassium permanganate followed by filtration;
- oxidation with chlorine and potassium permanganate followed by filtration;
- oxidation by ozonation followed by filtration; and
- biological filtration.

The four plant location scenarios considered are:

- one centralized treatment plant;
- two neighborhood treatment plants;
- three neighborhood treatment plants, and;
- five wellhead treatment plants.

All required improvements and any phasing that may occur for a plant location were included in the cost estimates to assess the full costs of the alternative.

nceptual layouts for the different treatment plant capacities that will be required for the ocation scenarios used in alternative evaluation are shown in Figures 10-5, 10-6, and 10-7. The

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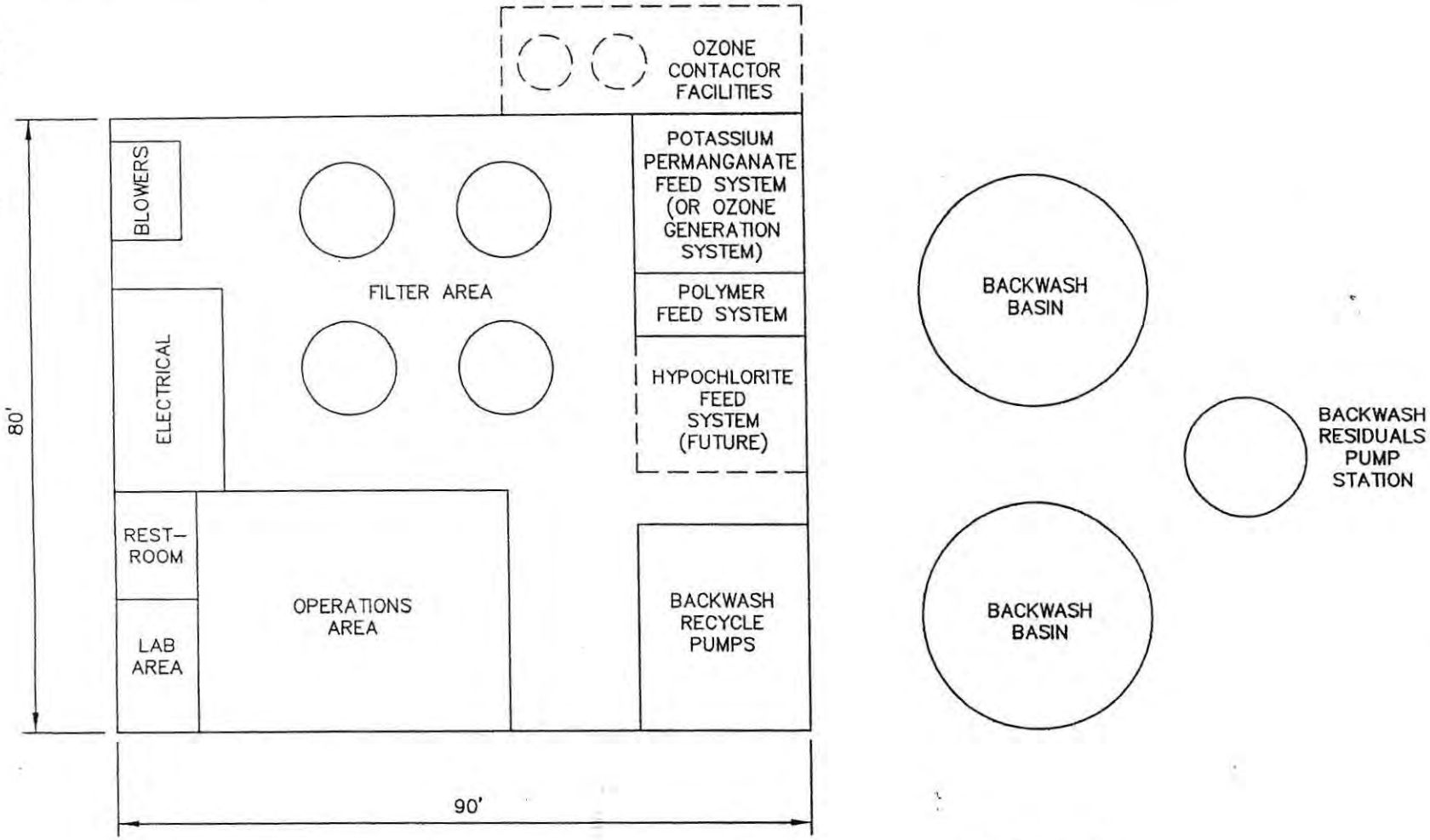

TREATMENT BUILDING

BACKWASH HANDLING FACILITIES

HDR Engineering, Inc.

Project Title: WOODBURN, OREGON WATER MASTER PLAN	Date: DECEMBER 1996
Sheet Title: WELLHEAD PLANT CONCEPTUAL LAYOUT (2.5 MGD)	Figure No. 10-7

total minimum treatment system capacity was set at 10.5 mgd (the maximum day demand in '020) with an average day demand of 4.5 mgd. To meet the maximum day demand, four new wells with a total capacity of 5.7 mgd would be required. The basic treatment facilities included in each alternative are filtration, chemical feed, backwash handling, process pumping, operations, electrical and control systems. Future facilities are included in the layouts and may or may not be required for each facility.

The conceptual design for the Woodburn treatment plants is to maintain the process stream under pressure throughout treatment all the way to either a proposed ground level reservoir located on the site or directly into the distribution system. The well pumps would typically provide most of the pumping head needed through the treatment process. Upgrading the existing well pumps is included as a part of the cost of treatment. Additional head would be provided, if needed, by process pumps, before or after filtration. Distribution system operating pressures will be maintained by the use of the existing elevated reservoir which will be fed by booster pump stations that will constructed at the ground level reservoirs proposed within the system. Process pumps may not be required with the treatment plants located at the wellheads. Filtration costs are based on using 12 foot diameter pressure filters. The loading rates assumed were 4 gpm/ft^2.

The filters would be backwashed using treated water from the distribution system and blowers for air scour. Backwash basins are included to allow settling of the waste backwash water and then recycle of the decant to the head of the plant. A backwash residuals pump station would be used to send settled material from the backwash basin to the sewer.

ch alternative, except biological filtration, include polymer dosing facilities. Polymer is often used to improve the filtration process and also to provide better settling in the backwash basins.

Other Required Facilities

The four proposed treatment configurations include the following: 1) a centralized plant; 2) two neighborhood plants; 3) three neighborhood plants; and 4) five wellhead plants Depending on which treatment arrangement is selected, all options will require certain other facilities. Each alternative and the necessary distribution system improvements are illustrated on the four system alternative maps included as Figure 10-8, 10-9, 10-10, and 10-11. Depending on the location of the treatment plant and the number of plants constructed, the distribution system will require improvements to meet all of the operational criteria established for the system. Piping improvement projects to increase fire flows and provide even water pressure distribution, and any raw water piping projects required are illustrated on the system maps. All of the required improvements and their associated costs have to be considered when recommending the treatment plant configuration for the City of Woodburn.

Recommended Treatment Process

The recommended treatment process is $KMnO_4$ oxidation followed by pressure filtration. This process was selected over the other three for ease in operation, economics, flexibility, only one chemical is required, compact equipment layout, the process has a proven track record all across the United States, the process is readily accepted by the Oregon Health Division, and its ease of sing.

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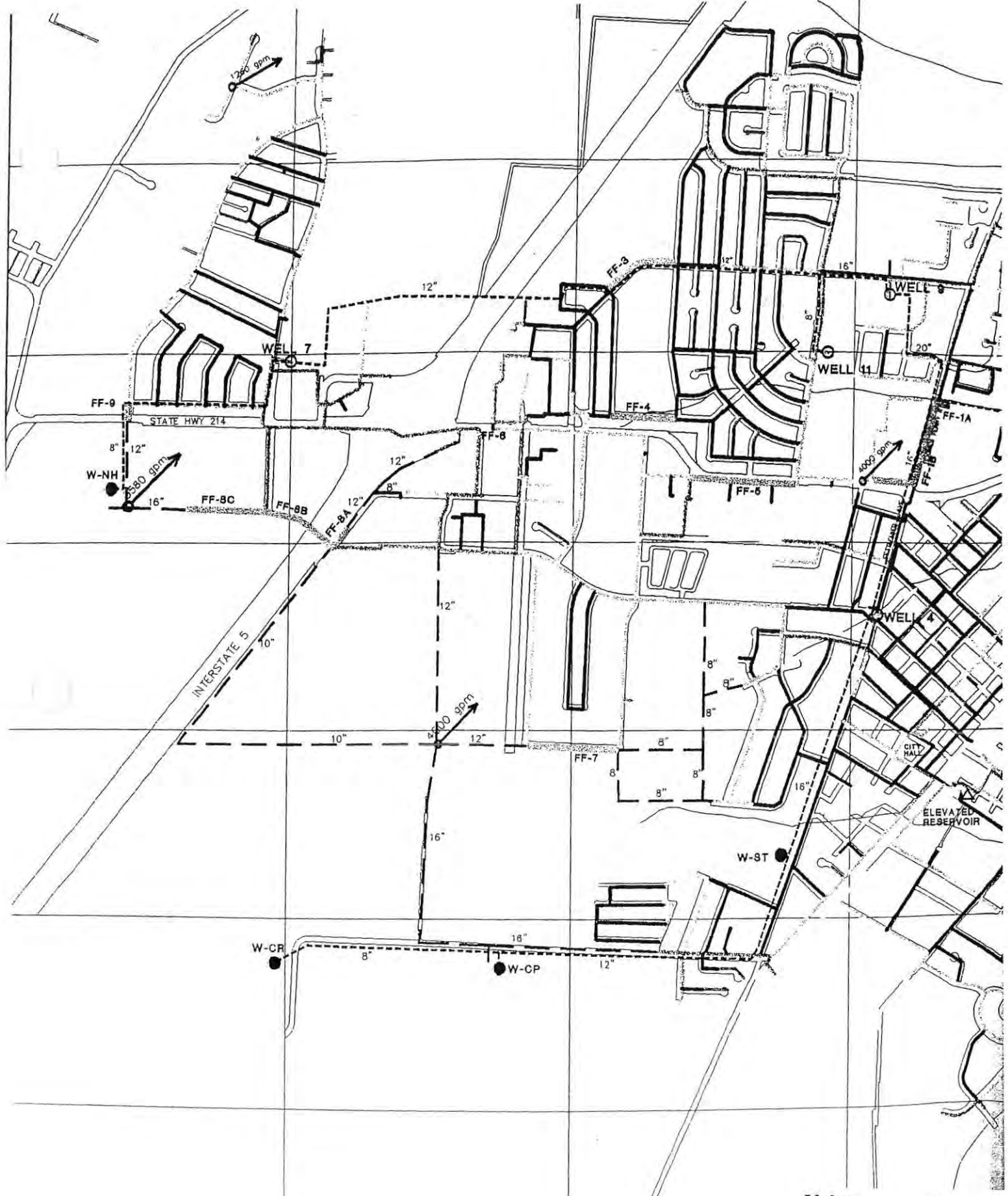

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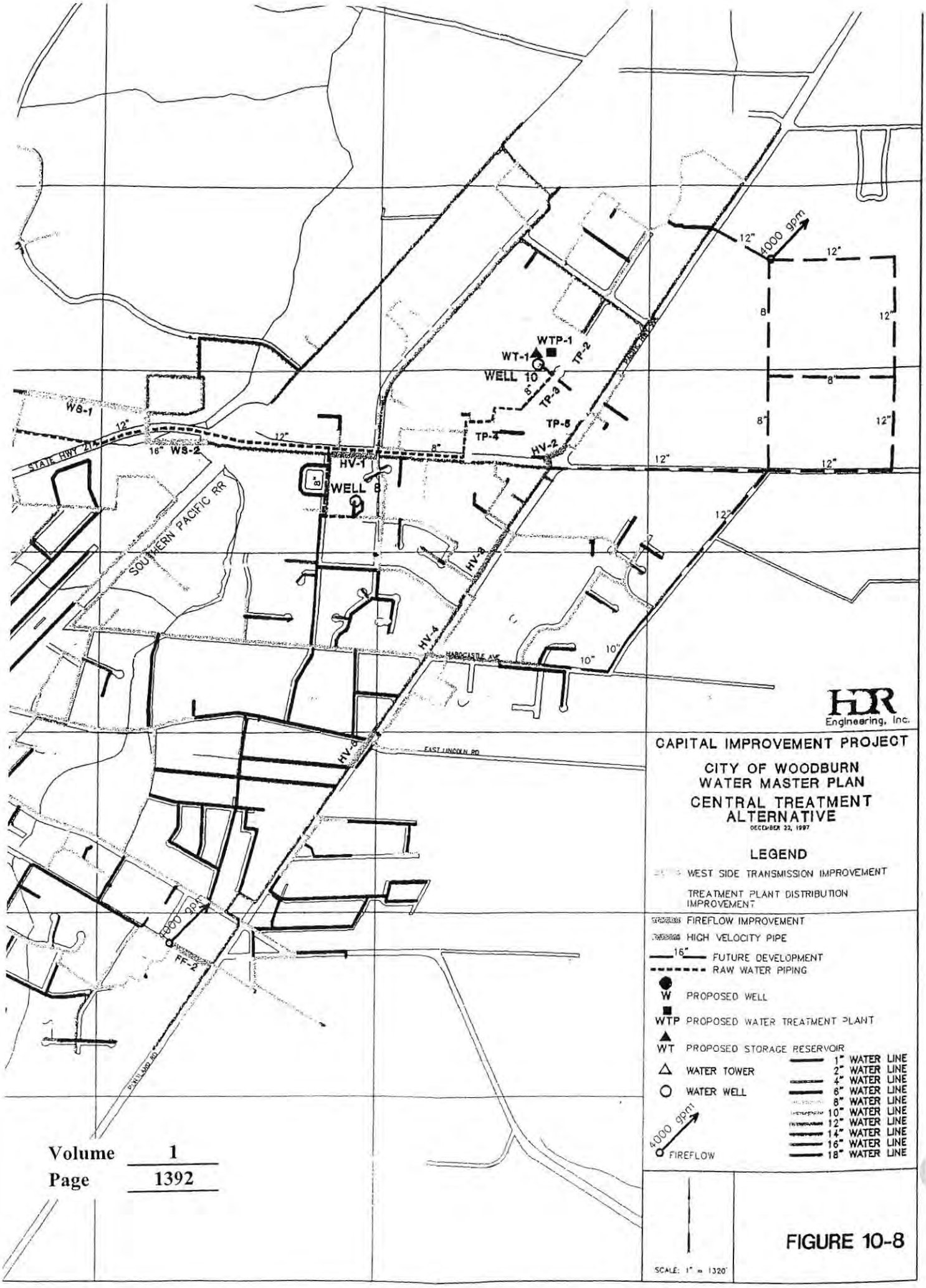

FIGURE 10-8

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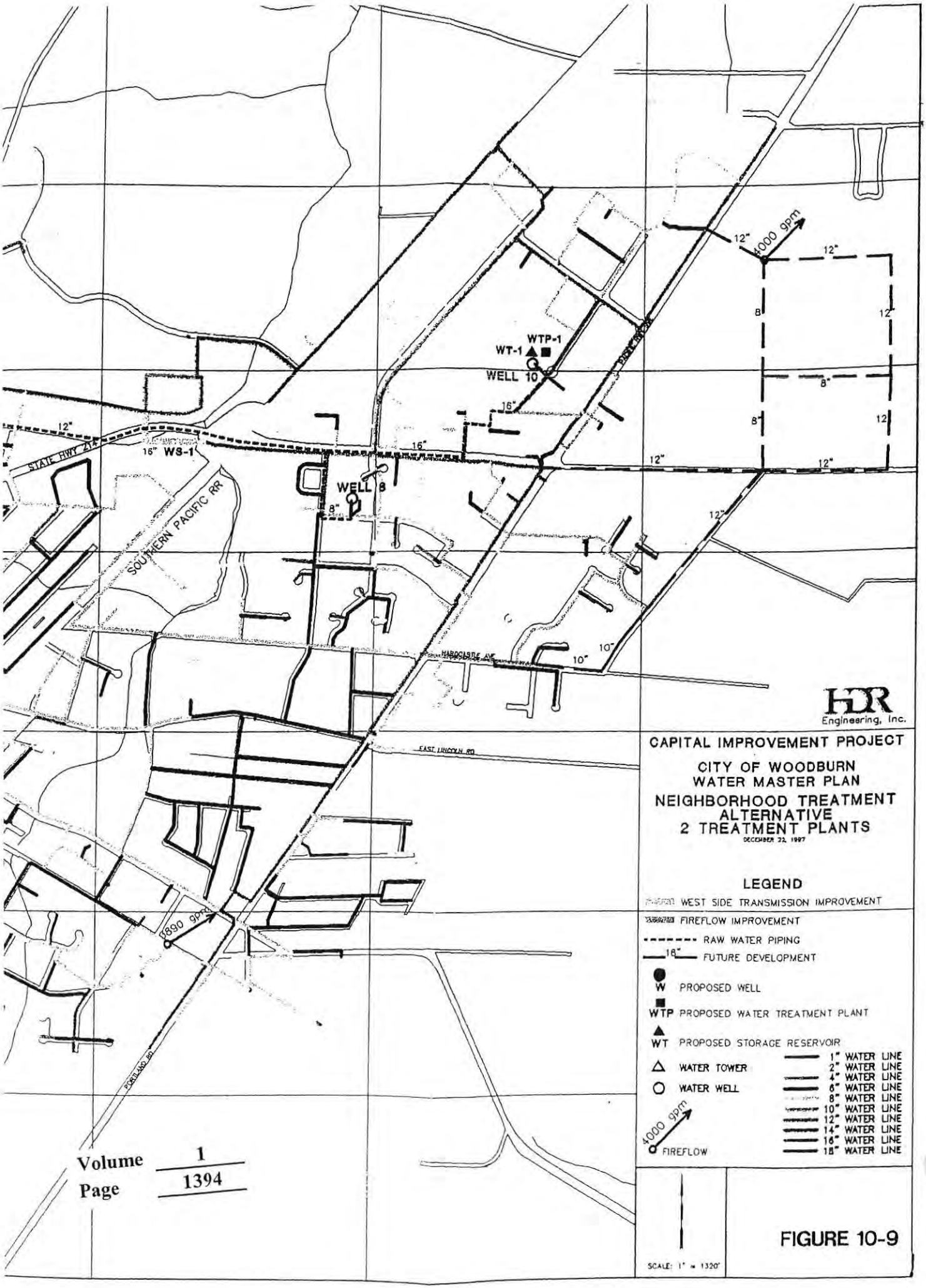

FIGURE 10-9

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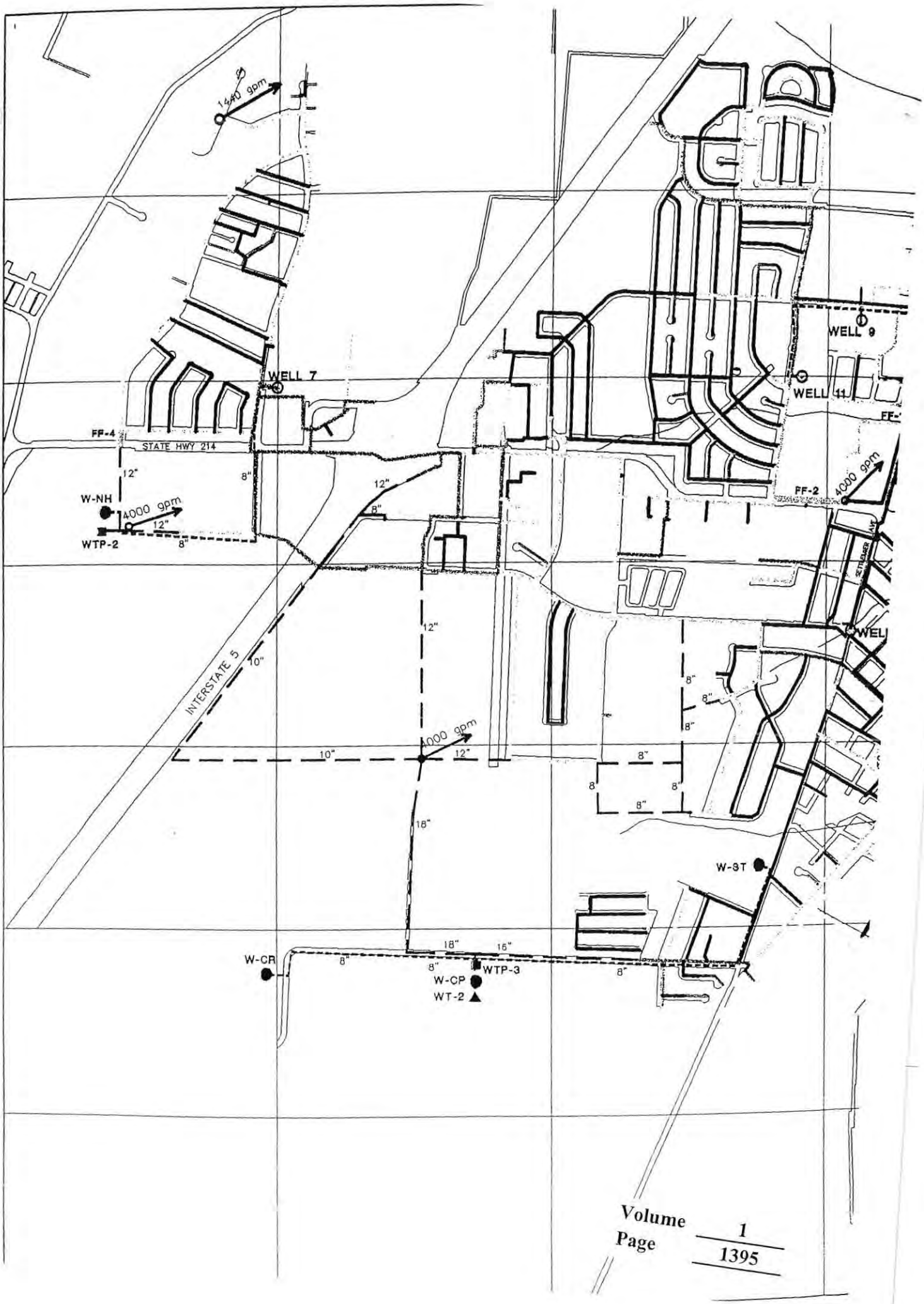

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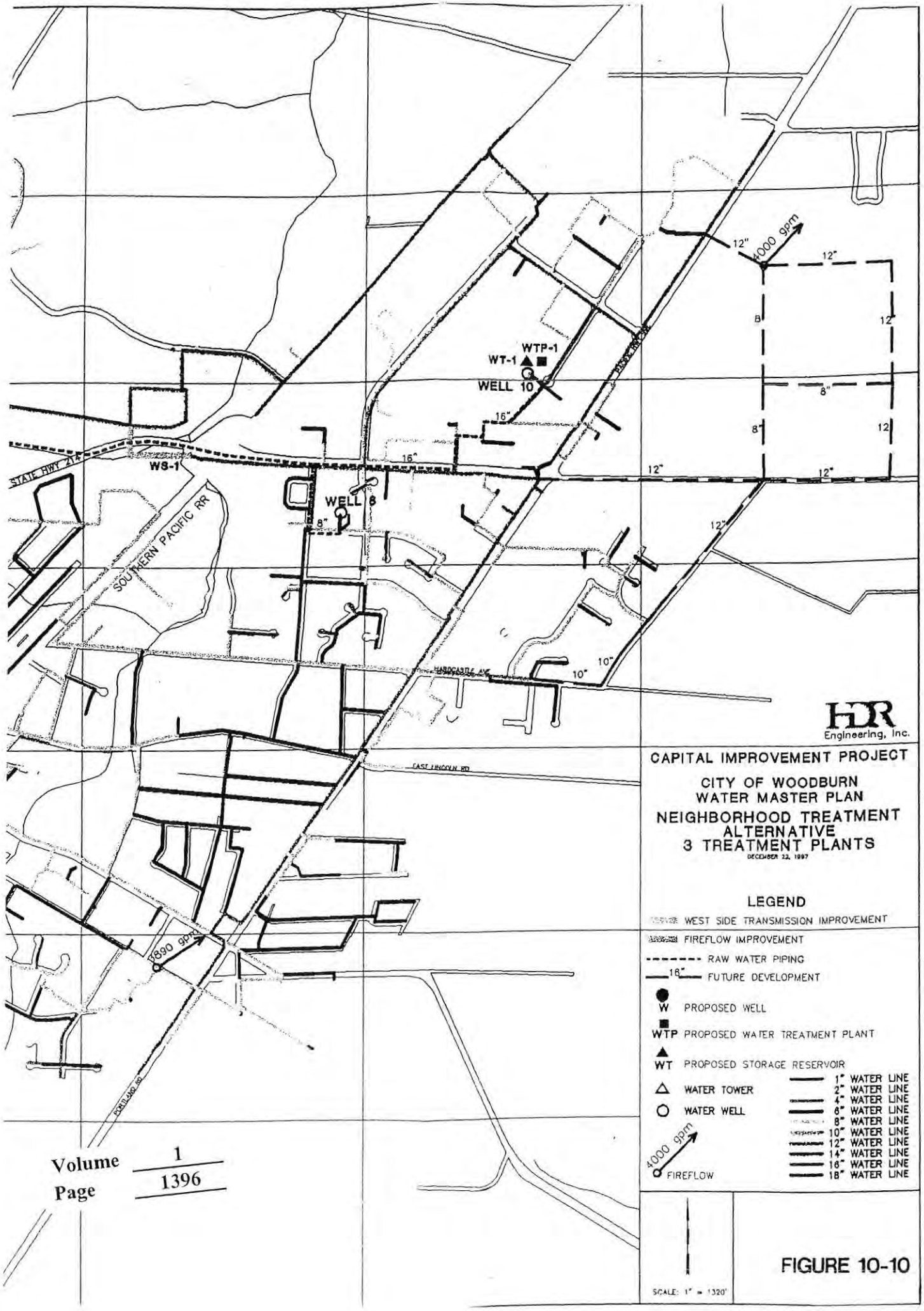

FIGURE 10-10

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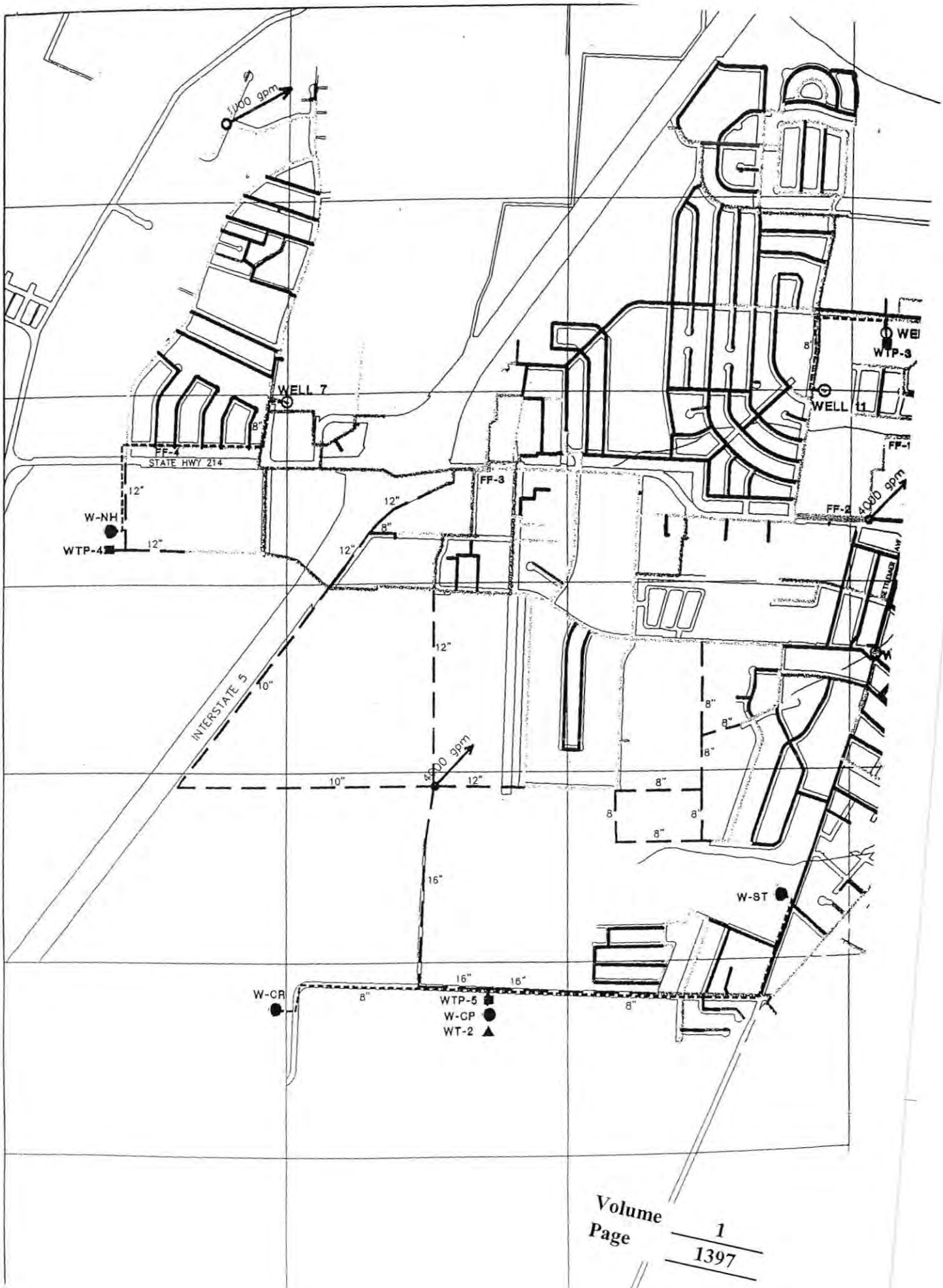

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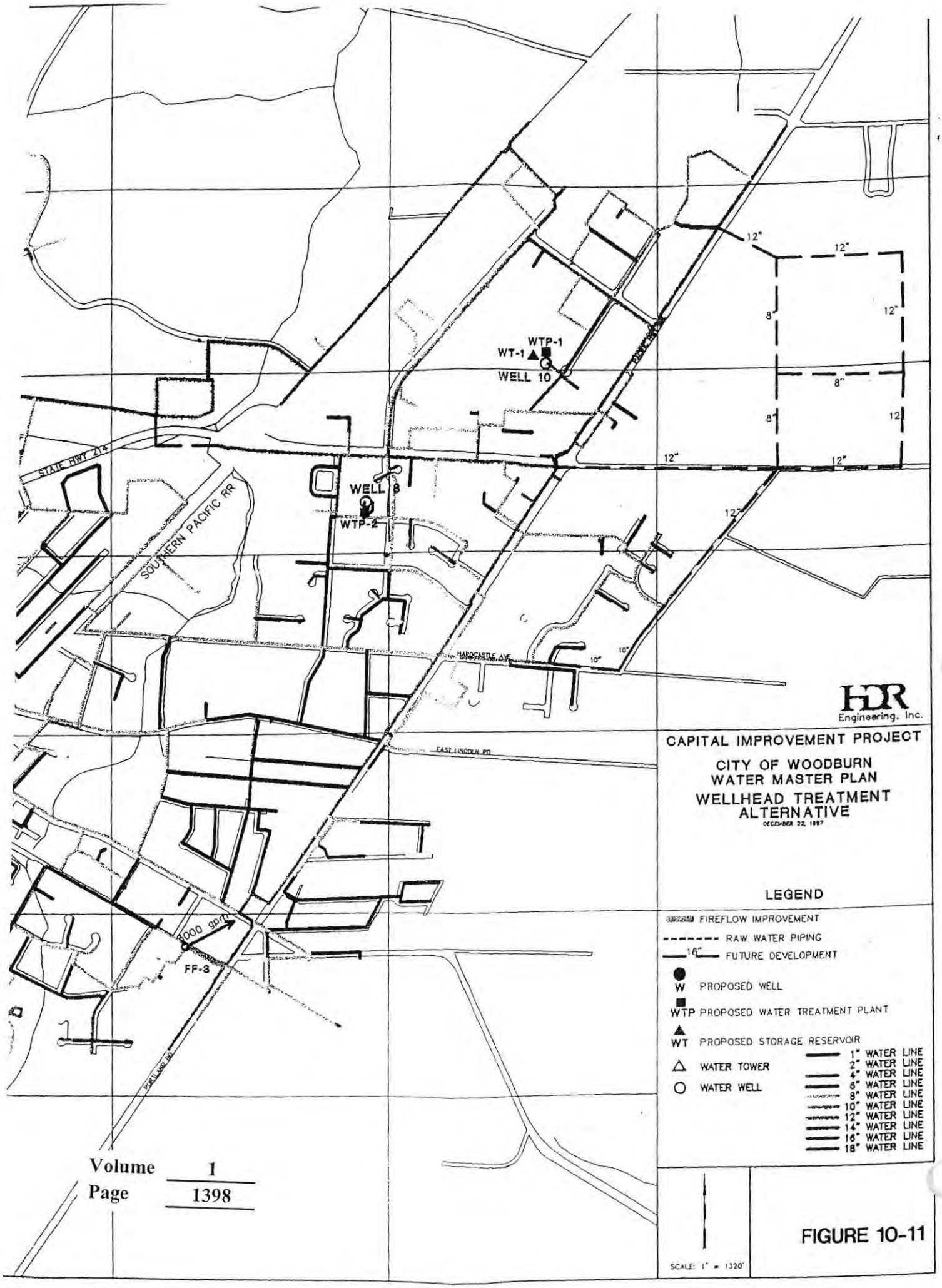

FIGURE 10-11

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Water Treatment Plant Costs

Budgetary water treatment plant costs were developed for the four proposed locations for the selected process. These costs are presented in Table 10-7, 10-8, 10-9, 10-10. The construction costs are for the treatment facilities, transmission piping, and new wells, and included a 30 percent contingency. The total capital costs represent the construction costs plus the indirect costs such as property acquisition, engineering, administration, and permitting.

The present worth is the cost adjusted for inflation and then discounted back to 1996. Using a present worth allows the impact of phasing to be evaluated as to total project costs.

The present worth of the construction costs for the four alternatives indicate that the neighborhood and the wellhead treatment plants are the most cost effective. This is the result of the phasing of facilities and only building when facilities are needed. The central plant present worth cost is higher than the other two due to a lack of phasing and the significant amount of raw water transmission piping that is required for the alternative. Although both the neighborhood and the wellhead alternatives require multiple facilities, the phasing and the reduced raw water transmission piping required make them attractive alternatives to the City and offer significant advantages. Therefore, the central treatment plant alternative will not be considered further.

ADVANTAGES of the **Neighborhood plant alternative** over wellhead treatment:

- A reduced number of regionalized facilities
- Reduced operation and maintenance costs due to fewer facilities to operate
- Lower present worth costs
- Fewer plants may make it easier to find acceptable treatment plant sites
- Chemical delivery simplified to fewer locations
- Telemetry and control system simplified to fewer locations

DISADVANTAGES of the **Neighborhood plant alternative** over wellhead treatment:

- Larger individual facilities are more costly to construct
- Larger facilities required, may limit sites available and public acceptance
- As scheduled, system will not be able to meet peak demands until all plants are constructed.
- More raw water transmission piping required
- Higher well pumping costs
- More impact on system hydraulics

ADVANTAGES of **Three Neighborhood plants** over two neighborhood treatment plants

- Additional flexibility in site selection and water quality usage
- Less raw water transmission piping required
- Smaller facilities
- Improved hydraulic distribution within the system
- As scheduled, full treatment provided for peak demands with the construction of two plants

Table 10-7
Woodburn Water Master Plan
Estimated Costs of Centralized Treatment Plant

Project No.	Project Description		1996 Project Costs	Construction Year	Present Worth
Water Treatment Plant at Well 10 and Associated Piping		**Total**	**$19,620,000**	**2002**	**$16,520,000**
WTP-1	Construct 10.5 MGD water treatment plant, and raw water pump station.		$10,260,000		
WTP-2	Install 570 lf of parallel 12-inch dia. pipe.		$68,400		
WTP-3	Replace existing pipe with 560 lf of 20-inch dia. pipe.		$112,000		
WTP-4	Replace existing pipe with 1,130 lf of 16-inch dia. pipe.		$180,800		
WTP-5	Replace existing pipe with 740 lf of 16-inch dia. pipe.		$118,400		
WTP-6	Install raw water transmission main for Wells 7-11		$5,033,600		
WT-1	Construct 4.4 MG water tank, and finished water pump station.		$3,850,000		
Westside Supply		**Total**	**$460,000**	**1998**	**$440,000**
WS-1	Install 1,340 lf of parallel 12-inch dia. pipe.		$229,944		
WS-2	Install 990 lf of 16-inch dia. pipe.		$226,512		
Fireflow Supply		**Total**	**$1,180,000**	**2005**	**$910,000**
FF-1A	Install 60 lf of parallel 10-inch dia. pipe (Boones Ferry Road crossing).		$8,580		
FF-1B	Install 1,320 lf of parallel 8-inch dia. pipe.		$151,008		
FF-2	Install 480 lf of parallel 8-inch dia. pipe.		$54,912		
FF-3	Install 850 lf of parallel 8-inch dia. pipe.		$97,240		
FF-4	Install 720 lf of parallel 8-inch dia. pipe.		$82,368		
FF-5	Install 1,250 lf of parallel 10-inch dia. pipe.		$178,750		
FF-6	Replace existing pipe with 230 lf of 16-inch dia. pipe.		$52,624		
FF-7	Install 980 lf of parallel 10-inch dia. pipe.		$140,140		
FF-8A	Replace existing pipe with 280 lf of 12-inch dia. pipe.		$48,048		
FF-8B	Install 820 lf of parallel 12-inch dia. pipe.		$140,712		
FF-8C	Replace existing pipe with 850 lf of 16-inch dia. pipe.		$194,480		
FF-9	Install 200 lf of parallel 10-inch dia. pipe.		$28,600		
High Velocity Pipelines		**Total**	**$310,000**	**1997**	**$300,000**
HV-1	Install 520 lf of parallel 8-inch dia. pipe.		$59,488		
HV-2	Extend parallel 8-inch dia. pipe 400 lf to Hwy 99E/Mt. Hood Ave.		$45,760		
HV-3	Extend parallel 8-inch dia. pipe 730 lf on Hwy 99E from Mt. Hood Ave to Alexandra Ave.		$83,512		
HV-4	Realign 12-inch dia. pipe Hwy 99E crossing to connect directly to 12" x 8" wye on westside.		$5,000		
HV-5	Extend parallel 8-inch dia. pipe 980 lf on Hwy 99E from E. Lincoln Rd. to Aztec Dr.		$112,112		
Wells		**Total**	**$2,760,000**		**$2,040,000**
W-NH	Drill well at Church on Newberg Highway plus raw water piping		$514,000	**2000**	**$460,000**
W-ST	Drill well at Settlemier/Tout St. plus raw water piping		$1,082,000	**2005**	**$840,000**
W-CP	Drill well at Centennial Park plus raw water piping		$730,000	**2010**	**$490,000**
W-CR	Drill well at County Rd. 517. plus raw water piping		$434,000	**2015**	**$250,000**
		Totals	**$24,330,000**		**$20,210,000**

Table 10-8
Woodburn Water Master Plan
Estimated Costs of Two (2) Neighborhood Treatment Plants

Project No.	Project Description	1996 Project Cost	Construction Year	Present Worth
Water Treatment Plant at Well 10 and Associated Piping		**$9,420,000**	**2002**	**$7,930,000**
WTP1-1A	Construct 4.8 MGD water treatment plant.	$4,956,000		
WTP1-1B	Upgrade existing well pumps in 8, 9, 10, and 11.	$294,000		
WTP1-2	Install raw water transmission main from Wells 8, 9, 10, & 11	$2,270,000		
WT-1	Construct 2.2 MG water tank, and finished water pump station.	$1,900,000		
Water Treatment Plant at Centennial Park and Associated Piping		**$10,400,000**	**2010**	**$6,960,000**
WTP2-1A	Construct 7.0 MGD plant for Well 7 and 4 new wells in SW Woodburn	$6,500,000		
WTP2-1B	Upgrade Well 7 pump and housing	$74,000		
WTP2-2	Install raw water transmission main from well 7, NH Well, and Settlemier Well	$1,925,000		
WT-2	Construct 2.2 MG water tank, and finished water pump station.	$1,900,000		
Westside Supply	**Total**	**$230,000**	**2000**	**$180,000**
WS-1	Install 990 lf of 16-inch dia. pipe.	$227,000		
Fireflow Supply		**$250,000**		**$180,000**
FF-1	Install 60 lf of parallel 10-inch dia. pipe (Boones Ferry Road crossing).	$9,000	**1998**	**$10,000**
FF-2	Install 810 lf of parallel 8-inch dia. pipe.	$93,000	**1998**	**$80,000**
FF-3	Install 850 lf of parallel 10-inch dia. pipe.	$122,000	**2005**	**$70,000**
FF-4	Install 200 lf of parallel 10-inch dia. pipe.	$29,000	**2005**	**$20,000**
Wells	**Total**	**$1,190,000**		**$860,000**
W-NH	Drill well at Church on Newberg Highway plus piping	$275,000	**2000**	**$250,000**
W-CP	Drill well at Centennial Park with new treatment plant	$250,000	**2010**	**$170,000**
W-ST	Drill well at Settlemier/Tout St.	$275,000	**2005**	**$210,000**
W-CR	Drill well at County Rd. 517 plus raw water piping	$390,000	**2015**	**$230,000**
	Totals	**$21,490,000**		**$16,110,000**

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Table 10-9
Woodburn Water Master Plan
Estimated Costs of Three (3) Neighborhood Treatment Plants

Project No.	Project Description	1996 Project Cost	Construction Year	Present Worth
Water Treatment Plant at Well 10 and Associated Piping (WTP-1)		**$9,420,000**	**2002**	**$7,930,000**
WTP1-1A	Construct 4.8 MGD water treatment plant.	$4,956,000		
WTP1-1B	Upgrade existing well pumps in 8, 9, 10, and 11.	$294,000		
WTP1-2	Install raw water transmission main from Wells 8, 9, 10, & 11	$2,270,000		
WT-1	Construct 2.2 MG water tank, and finished water pump station.	$1,900,000		
Water Treatment Plant at Newberg Highway Well and Associated Piping (WTP-2)		**$3,660,000**	**2006**	**$2,750,000**
WTP2-1A	Construct 2.7 MGD water treatment plant at Newberg Highway Well	$3,232,000		
WTP2-1B	Upgrade existing well pump in Well 7	$74,000		
WTP2-2	Install raw water transmission main from Well 7 and Newberg Highway Well	$350,000		
Water Treatment Plant at Centennial Park and Associated Piping (WTP-3)		**$7,040,000**	**2012**	**$4,450,000**
WTP3-1A	Construct 4.3 MGD water treatment plant.	$4,810,000		
WTP3-2	Install raw water transmission main from Well on Settlemier/Trout St.	$325,000		
WT-2	Construct 2.2 MG water tank, and finished water pump station.	$1,900,000		
Westside Supply	**Total**	**$230,000**	**2000**	**$180,000**
WS-1	Install 990 lf of 16-inch dia. pipe.	$227,000		
Fireflow Supply		**$130,000**		**$110,000**
FF-1	Install 60 lf of parallel 10-inch dia. pipe (Boones Ferry Road crossing).	$9,000	**1998**	**$10,000**
FF-2	Install 810 lf of parallel 8-inch dia. pipe.	$93,000	**1998**	**$80,000**
FF-4	Install 200 lf of parallel 10-inch dia. pipe.	$29,000	**2005**	**$20,000**
Wells	**Total**	**$1,190,000**		**$850,000**
W-NH	Drill well at Church on Newberg Highway plus Piping	$275,000	**2000**	**$250,000**
W-CP	Drill well at Centennial Park on new treatment plant site	$250,000	**2012**	**$160,000**
W-ST	Drill well at Settlemier/Tout St.	$275,000	**2005**	**$210,000**
W-CR	Drill well at County Rd. 517 plus raw water piping to Treatment Plant	$390,000	**2015**	**$230,000**
	Totals	**$21,670,000**		**$16,270,000**

Table 10-10

Woodbu Vater Master Plan

Estimated Costs . Wellhead Treatment Plants

Project No.	Project Description		1996 Project Cost	Construction Year	Present Worth
Water Treatment Plant and Tank at Well 10 and Associated Piping		**Total**	**$3,725,000**	**2002**	**$3,137,000**
WTP1-1A	Construct 1.3 MGD water treatment plant.		$1,740,000		
WTP1-1B	Upgrade existing pumps, controls, and housing		$74,000		
WTP1-2	Install raw water transmission main.		$11,000		
WT-1	Construct 2.2 MG water tank, and finished water pump station.		$1,900,000		
Water Treatment Plant at Well 8 and Associated Piping		**Total**	**$1,555,000**	**2002**	**$1,311,000**
WTP2-1A	Construct 1.1 MGD water treatment plant.		$1,470,000		
WTP2-1B	Upgrade existing pumps, controls, and housing		$74,000		
WTP2-2	Install raw water transmission main.		$11,000		
Water Treatment Plant at Well 9 and Associated Piping		**Total**	**$3,547,000**	**2002**	**$2,989,000**
WTP3-1A	Construct 2.4 MGD water treatment plant for Well 9 and 11		$3,220,000		
WTP3-1B	Upgrade existing pumps, controls, and housing		$103,000		
WTP3-2	Install raw water transmission main.		$224,000		
Water Treatment Plant at Church (new well site) and Associated Piping		**Total**	**$3,656,000**	**2005**	**$2,823,000**
WTP4-1A	Construct 2.7 MGD water treatment plant for Well 7 and NH		$3,232,000		
WTP4-1B	Upgrade existing pumps, controls, and housing		$74,000		
WTP4-2	Install raw water transmission main.		$350,000		
Water Treatment Plant at Centennial Park (new well site) and Associated Piping		**Total**	**$5,176,000**	**2012**	**$3,271,000**
WTP5-1A	Construct 4.3 MGD water treatment plant.		$4,810,000		
WTP5-1B	Pump Controls and Telemetry		$41,000		
'WTP5-2	Raw Water Transmission Main from Well on Settlemier		$325,000		
WT-2	Construct 2.2 MG water tank, and finished water pump station.		$1,900,000	**2010**	**$1,269,000**
Fireflow Supply		**Total**	**$220,000**	**1998**	**$205,000**
FF-1	Install 60 lf of parallel 10-inch dia. pipe (Boones Ferry Road crossing).		$9,000		
FF-2	Install 810 lf of parallel 8-inch dia. pipe.		$93,000		
FF-3	Install 850 lf of parallel 10-inch dia. pipe.		$122,000		
Wells		**Total**	**$1,190,000**		**$877,000**
W-NH	Drill well at Church on Newberg Highway plus Piping		$275,000	**2000**	**$246,000**
W-CP	Drill well at Centennial Park on new treatment plant site		$250,000	**2012**	**$158,000**
W-ST	Drill well at Settlemier/Tout St.		$275,000	**2005**	**$212,000**
W-CR	Drill well at County Rd. 517. plus raw water transmission		$390,000	**2010**	**$261,000**
		Totals	**$19,069,000**		**$15,882,000**

DISADVANTAGES of **Three Neighborhood plants** over two neighborhood treatment plants

- More facilities to construct and operate
- Additional facilities required, sites may not be available and public acceptance may be low
- Chemical delivery and handling more complicated
- Telemetry and control system complicated by the additional plant

ADVANTAGES of the **Wellhead plant alternative** over neighborhood treatment:

- Phasing of construction very flexible
- Small localized facilities
- Less raw water transmission mains required
- Lower well pumping costs
- Least impact on system hydraulics

DISADVANTAGES of the **Wellhead plant alternative** over neighborhood treatment:

- Three more facilities to operate and maintain
- May have trouble finding acceptable treatment plant sites for some wells in residential neighborhoods
- Highest individual plant construction cost due to multiple facilities
- Highest operation and maintenance costs due to multiple facilities
- May have to hire additional staff
- Delivery of chemicals complicated by multiple locations
- Telemetry and control system complicated by multiple facilities

Based on the budgetary estimates, the treatment objectives, and the operational characteristics, it is recommended that Woodburn construct neighborhood treatment plants using $KMnO_4$ to oxidize the iron and manganese. It is further recommended that the City evaluate the advantages and disadvantages and the site selection feasibility for the neighborhood treatment alternative in order to determine if two or three neighborhood treatment plants should be constructed. A citizens advisory group should be formed to look at different configurations and sites for the proposed treatment plants in addition to financial issues.

Regardless of the number of plants selected, the first plant would be constructed in the vicinity of Well 10 and have a capacity of 4.8 mgd. It is estimated that it would be operational by the year 2002. Based on current estimates, the plant would not have the capacity to meet the maximum day demands within the system in the year 2002. Untreated water from other wells would have to be pumped into the system on the few days a year that the plant could not keep up with demands. The treatment plant at Well 10 would treat water from Wells 8, 9, 10, and 11.

If the City elects to construct only two neighborhood treatment plants, Well 7 water and the proposed Newberg Highway well water would be treated at the second treatment plant proposed to be constructed in the year 2010 in the Centennial Park area. This plant would have a capacity of 7.0 mgd and would treat the water from 4 new wells and existing Well 7. Total system

treatment capacity would be set at 11.8 mgd. This would meet the maximum day demands through the year 2025 with no redundancy.

If the City elects to construct 3 neighborhood plants, the second plant would have a capacity of 2.7 mgd and would be located at the Newberg Highway well site. This treatment plant would treat water from Well 7 and the Newberg Highway well. It is projected that this plant will be on line in the year 2006 bringing system capacity to 7.5 mgd. This would satisfy maximum day demands through the year 2011.

The third neighborhood plant would be located in the southwest corner of Woodburn in the vicinity of Centennial Park. The treatment plant would have a capacity of 4.3 mgd which would increase the treatment capacity in the system to 11.8 mgd. The plant would treat water from the 3 new wells planned for the Centennial Park area of the city. This plant is scheduled to be on line in the year 2012. A 2.2 million gallon reservoir is proposed for this treatment plant site. The reservoir is scheduled to be completed in the year 2010 to provide the city with needed storage capacity.

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CHAPTER 11
DISTRIBUTION SYSTEM

11.1 HYDRAULIC ANALYSIS

Methodology

The City of Woodburn water system was analyzed using the 1,000 pipe version of the Haestad Methods hydraulic network distribution model, Cybernet. Cybernet is a program that runs in AutoCAD which allows the model to be constructed from AutoCAD drawings or by inputting a database. Pipes lengths and diameters, nodes, velocities, flows, elevations, hydraulic grade, pressures, and elevation and pressure contours can be selected to be shown on water system AutoCAD maps.

The City created a water system map in AutoCAD. This map was converted into the system model. The model contains 890 pipes, 688 nodes, eight wells, and two tanks. To account for all facilities, Wells 2 and 3, and the 60,000 gallon elevated water tank were included in the model. However, because they are not typically being used, they were disconnected from the system. As the system continues to grow beyond a 1,000 pipes, the City will eventually have to upgrade to a larger version of Cybernet.

Nodes were assigned numbers in the 1000's. Pipes were assigned numbers in the 2000's. Wells were modeled as static nodes with a pump on their discharge line. Their number designations correspond to the number the City has given each well. The tanks were also modeled as static nodes and numbered in the 50's.

Data Collection

Water system data which included pipe sizes and lengths, pump curves and depths for each well, tank elevations, ground elevation contours, billing information and other input data was obtained from the Woodburn Water Division. Locations of pipes, tanks, and wells were obtained from the AutoCAD water system map.

Calibration

HDR provided fire hydrant flow test procedures and locations to the City. Utility crews then completed the series of hydrant tests to determine flow, static and residual pressure, and pressure drop in known segments of pipe. This information was utilized to more accurately determine typical pipe roughness coefficients to be input to the model. In the calibration procedure, pipe characteristics were modified until the model more accurately reproduced field obtained data. This procedure resulted in reasonable agreement between the model results and measured pressures.

Existing System Demand

Demands were distributed based on the number and type (residential, commercial, and industrial) of connections within each billing zone. The total average day demands (ADD) and maximum day demands (MDD) for the existing system are 1.8 mgd and 4.1 mgd respectively. The maximum instantaneous demand is approximately 7.0 mgd. Maximum day demands (MDD) were established in the model by multiplying the ADD by 2.3. For the maximum instantaneous demands a multiplier of 3.9 was used. A complete discussion of current and future demands is included in Chapter 4.

Results from the computer analysis indicate that during ADD, typical service pressures range from approximately 50 psi to 60 psi. Depending upon location, MDD and MID maximum pressures were somewhat lower, but still greater than the minimum desired pressure of 40 psi. Low transmission/distribution system pressures do not appear to be a problem during normal operations.

The system pressures are established by the 130-foot-high, 750,000 gallon elevated water reservoir located near Broadway and Front Street. As system demand draws down the reservoir level, wells are turned on to pump into the system and replenish the reservoir supply. If the level in the tank continues to drop after the first well pump has turned on, more pumps will receive signals to turn on and pump into the system until the tank water level begins increasing. The current MID of 7.0 mgd is approximately equal to the total existing pumping capacity of all of the active wells (6.8 mgd).

Future System Demands

By the year 2020, the ADD is expected to increase to approximately 4.2 mgd. The MDD and MID are expected to increase to 9.6 mgd and 16.4 mgd respectively. Future demands were distributed based on the population growth and future areas of development. The multiplying factors used to determine future MDD, and MID were again 2.3, and 3.9 respectively. Results from the computer analysis indicate that with system improvements recommended in the Capital Improvement Plan, the system will be capable of meeting peak day demands and maintain suitable minimum pressures within the system.

Fireflows

The effects of fireflow demands were modeled at five locations throughout the system, including two locations in future developed areas. Table 11-1 lists these locations along with the maximum demand that can be placed at these nodes while maintaining a minimum residual pressure at any point in the system of approximately 20 psi during MDD plus fire events. Depending on the type of land-use and occupancy, fireflow capacity goals ranged from 1,000 gpm for residential up to 5,000 gpm in industrial areas. The rationale for development of minimum desired fireflow capacities is discussed in Chapter 6.

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Table 11-1 Modeled Fireflows 1996-2020 (Approximately 20 psi Residual Pressure)			
		Fireflows (gpm)	
Node	Description	1996	2020
1001	Ten Oaks Ln./Senecal Cr. (res.)	1,480	1,530
1180	French Prairie M.S. (school)	4,200	4,490
1601	Progress Way/Mt. Hood Ave. (ind.)	4,050	5,210
5003	Southwest of W. Hayes/Evergreen (future comm.)	-	5,000
5016	McClaren School	-	5,000

Future fireflow service design for the City of Woodburn should be based on ISO requirements. As areas are developed, transmission lines will have to be extended into those areas. Fireflow delivery capabilities need to be recognized and considered when approving building type and occupancy in all areas of Woodburn. City ordinances should be in place to require commercial and high occupancy development to utilize fire resistant construction, and fire sprinkler systems to reduce fireflow requirements to that which is available from the system. Hydrant tests should be completed to determine actual fire delivery capability prior to approving development plans.

Based on the City's minimum requirements for fireflow, the existing system configuration is able to provide adequate fireflow supply. However, as part of routine system maintenance and prior to final transmission/distribution system design, the actual fireflow delivery capacity should be measured at existing schools and other high occupancy buildings to determine if other special measures should be taken for fire protection. With identified improvements in place, the model analysis indicates that industrial/commercial areas will meet desired fireflow capacities. Proposed improvements include additional supply, transmission, and storage facilities. Proposed improvements are detailed in Chapter 12, Capital Improvement Plan.

Sources of Supply

The existing configuration of six active well sources located throughout the distribution system provides an excellent distribution of sources of supply into the system. As a result, system pressures remain relatively uniform throughout the system and there is less reliance on large transmission and distribution piping to move water to high demand locations.

Future fireflow capability was modeled assuming that the City will construct three additional wells which along with the six existing wells will be pumped to two neighborhood water treatment facilities. Computer model analysis indicated that with the two proposed treatment facilities sources of supply, construction of the recommended raw and finish water piping improvements, and construction of at least one new reservoir, the system will be able to provide the required future fireflows.

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11.2 WATER PIPING REPLACEMENT

Repair History Summary

There is currently approximately 66 miles of transmission and distribution piping ranging from 1-inch to 18- inches in diameter. Approximately four miles are piping with sizes of 4-inches or less. The majority of the system is ductile and cast iron pipe. There is a significant amount of asbestos-cement pipe in the Senior Estates area of Woodburn. This asbestos-cement pipe has not caused any water quality problems, however, the City is replacing sections of it as part of its normal line replacement program. The City routinely repairs and replaces older leaking or undersized pipes as part of an annual maintenance program.

Line Replacement Priorities

Implementing a schedule for the replacement of pipelines could avoid any emergency situations or future capacity problems. This schedule should be spread over a period of years. Following are the priorities for water line replacement:

- Pipes in areas of related frequent customer complaints.
- Leaking pipes.
- Pipes identified by either maintenance or operations as problem pipes.
- Pipes identified by the computer model as having high velocities and head losses.
- Pipes four inches or less in diameter, and are in areas that have the potential for growth.
- Undersized transmission mains.
- Aged asbestos cement pipe.
- Aged steel or cast iron pipe.

An annual budget of $50,000 (1996 dollars) is recommended to fund an ongoing substandard main replacements program.

11.3 TELEMETRY AND CONTROLS

System Summary

The existing telemetry and control system is approximately 30 years old and it utilizes water levels in the elevated reservoir to start and stop the system wells pumps. The control panel located in the maintenance building provides information on which pumps are operating, elapsed pump operating times, high and low elevated tank level alarms, and system pressures. The data is manually recorded by system operators. The on-off sequencing priority of pumps and operating set points are selected by the operator. The telemetry system has no power or system control redundancy.

It is recommended that the City upgrade their telemetry and control system to a non-proprietary solid state digital IBM PC compatible computer based system. The water system module can be designed to "piggy back" onto the planned upgrade of the wastewater treatment plant telemetry and

control system. This updated water system module should be designed to provide significantly enhanced automated control and monitoring functions. System control and performance data such as pumping rates, treatment plant production rates, reservoir levels, and other system conditions can be monitored and stored electronically for recall and insertion into weekly, monthly, and annual reports. This computer based system will allow the two proposed treatment facilities to operate with minimal on-site attention. The treatment plants would be designed to typically operate automatically with daily visits to check on-site systems. The "on-call" operators could also use a laptop computer loaded with the software and a modem to remotely call into the monitoring and control system to check on system operation or to determine the cause of a system alarm.

Compliance with Reporting Requirements

Water Division staff compile and report operating system characteristics manually per current OHD requirements. The staff monitor water quality per state requirements and regularly sample and submit water for bacterial analysis. The staff will routinely flush water mains to maintain water quality in the system. If samples indicate bacterial contamination of the system, crews will flush and disinfect the area to eliminate the problem. Regular reports include the volume of water pumped, sample results, and other maintenance information.

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day demands. Peak hour demands are projected to be approximately 170 percent of the maximum day demand. Multiplying the treatment plant capacities by 1.7 results in corresponding booster pump station capacities of 4.6 mgd (3,200 gpm) and 9.2 mgd (6,400 gpm). Because approximately 15 percent of the system storage should be available in elevated gravity fed storage, the maximum firm capacities of these booster pump stations can be reduced to 2,700 gpm at Well 10 and 5,400 gpm at Parr Road. It is anticipated that the booster pump station operation will be tied to the water level in the elevated tank. The booster pumps will operate, pumping water into the system, to keep the level in the elevated tank at a pre-set elevation.

For emergency service, it is recommended that each booster pump station be capable of providing this rate of flow during a primary source of power failure. This can either provided by a secondary power grid source, diesel engine driven pumps, or an emergency standby generator.

The first storage reservoir and booster pump station system should be constructed with the Well 10 treatment plant and put on line by year 2002. The second storage reservoir and booster pump station should be constructed as part of the Parr Road treatment plant project. If the City decides not to construct water treatment plants in their system, it is still recommended that additional storage reservoirs be added to the system. The proposed storage and pump station projects are listed in Table 12-1 and illustrated in Figure 12-1.

Transmission

The system's primary transmission mains are adequate for the existing system. With the construction of water treatment plants and storage in the northeast, north central and southwest parts of the system, raw water transmission mains will be constructed to pipe water from the wells to the water treatment plants. With this arrangement, the hydraulics of the system will change significantly with all of the water supplied to the system from two locations. Even with this change in the system, no significant changes or improvements to the systems were noted from the computer model of the proposed system.

Possible future transmission/distribution problems could occur when trying to maintain adequate fire flows in currently undeveloped areas. As areas are developed, developers will be required to extend the transmission mains into these areas and make any improvements necessary to the distribution system. The hydraulics of the system will have to be monitored to ensure that as these improvements are phased in and temporary hydraulic problems do not develop because of missing sections of the piping network. For some developments, it may be necessary to upgrade large sections of the system to ensure a high level of service to all of the new areas.

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Distribution

The existing distribution system pressures throughout the system are generally between 50 and 60 psi. The computer model did not identify significant deficiencies during maximum day flows. Modeling fire flow conditions on the maximum day identified several areas that need to be upgraded to meet the required flows while maintaining a minimum pressure of 20 psi throughout the system. The recommended distribution system improvements are listed in Table 12-1 and are

Table 12-1
Woodburn Water Master Plan
Capital Improvement Plan - By Project Type

Project Description	2000 Project Cost	Construction Year	Construction Year Cost
Transmission Improvements			
Install raw water transmission main from National Way treatment plant	$486,000	2003	$521,000
Install raw water transmission main from South Woodburn treatment plant	$384,000	2003	$411,000
Install raw water transmission main from County Club treatment plant	$209,000	2003	$224,000
Pipeline from wells to S. Woodburn treatment plant	$413,000 *	2015	$669,000
Pipeline from wells to West Woodburn treatment plant	$195,000 *	2022	$402,000
Subtotal	**$1,687,000**		**$2,227,000**
Distribution Improvements			
Install 60 lf of parallel 10-inch dia. pipe (Boones Ferry Road crossing).	$10,000	1998	$9,000
Install 810 lf of parallel 8-inch dia. Pipe.	$103,000	1998	$93,000
Install 990 lf of 16-inch dia. pipe.	$251,000	2000	$243,000
Install 850 lf of parallel 10-inch dia. pipe.	$135,000	2005	$155,000
Install 200 lf of parallel 10-inch dia. pipe.	$32,000	2005	$37,000
Subtotal	**$531,000**		**$537,000**
Water Treatment Plant Improvements			
Construct National Way water treatment plant	$3,316,000	2005	$3,805,000
Construct South Woodburn water treatment plant	$3,653,000	2005	$4,192,000
Construct County Club water treatment plant	$3,319,000	2005	$3,809,000
South Woodburn treatment plant expansion	$1,500,000 *	2015	$2,428,000
Construct West Woodburn treatment plant	$1,720,000 *	2022	$3,542,000
Subtotal	**$13,508,000**		**$17,776,000**
Reservoir Improvements			
National Way reservoir and pump station	$2,060,000	2004	$2,284,000
South Woodburn reservoir and pump station	$2,067,000	2004	$2,292,000
Subtotal	**$4,127,000**		**$4,576,000**
Proposed Wells			
Drill 2 wells at South Woodburn site	$680,000	2002	$704,000
Drill 2 wells at S. Woodburn site	$425,000 *	2015	$688,000
Drill 2 wells at West Woodburn site	$335,000 *	2022	$690,000
Subtotal	**$1,440,000**		**$2,082,000**
Total	**$21,293,000**		**$27,198,000**

* Option A of water master plan committee recommendation

CHAPTER 12
CAPITAL IMPROVEMENT PLAN

12.1 SUMMARY OF DEFICIENCIES

Sources of Supply

Currently, the City of Woodburn is meeting maximum day demands with their existing supply and distribution system. The water system is supplied by six wells in the Troutdale Aquifer with a total capacity of 6.8 mgd. To meet future demands, the City plans to drill four new wells in the west and southwest area of the City to increase the total well capacity to approximately 12 mgd. To stay ahead of the projected growth in water demands, the City will need to install these four new wells at an approximate rate of one well every five years. Proposed well projects are listed in Table 12-1 the Capital Improvement Plan. Recommended water system improvements are illustrated in Figure 12-1.

Reservoirs/Storage

Storage is a significant deficiency in the existing Woodburn system. A 750,000 gallon elevated steel tank is the only storage facility currently being used by the City. A second 60,000 gallon elevated steel tank has been taken out of service due to leaks and the need for maintenance. Based existing system demands and supply capacities for 1996, the 750,000 gallon reservoir provides equalizing storage and minimal fire flow reserves but no emergency standby storage.

It is recommended that additional storage be provided for equalizing flow to meet peak hour demands and for the larger of either the required ISO fire flow reserves or a emergency-standby storage. An alternative to providing additional storage in the system is to increase the capacity of the source of supply and treatment. Since it costs on the order of 85-90 cents per gallon for storage and pumping versus more than a $1.25 to $1.50 per gallon to develop additional sources and treatment, it is recommended that storage be utilized to meet peak hour demands and to provide water for fire flow or other emergency conditions.

It is recommended that an additional 4.4 million gallons of new storage capacity be constructed during the next 15 years. This additional storage capacity will increase the total system storage volume to 5.15 million gallons comprised of 2.25 million gallons equalizing and 2.9 million gallons of emergency-standby/fire flow reserve storage. This additional volume of storage will be sufficient for the recommended neighborhood treatment plant configuration to serve the system beyond the year 2020.

It is recommended that the additional storage facilities consist of two each 2.2 million gallon reservoirs. The reservoirs will be located on the proposed treatment plant sites. The northeast treatment and storage site is at the existing Well 10 site at the south end of National Way. This site selected because the City currently owns the property and the area is predominately industrial elopment. The southwest treatment and storage site is at Centennial Park on Parr Road.

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Locating storage in the northeast industrial area and in the southwest residential parts of the system on either side of the centrally located existing elevated reservoir, will serve to improve the hydraulic efficiency and balance of the transmission and distribution systems.

Because of the flat Woodburn topography, storage can either be configured as elevated tanks, standpipes, or at-grade storage. Elevated tanks have the highest per-gallon cost, followed by standpipes, and finally by the least expensive at-grade storage.

An advantage of elevated tanks and standpipes is that water is pumped into storage so that it can flow by gravity out to the system. The capacity of pumps feeding into high tanks can be sized to equal the maximum day demands. Instantaneous peak flows and fire demands are then fed from storage by gravity flow, thereby reducing the size of the pumps required. During power outages, water stored at these higher elevations is still be available to the system by gravity. A major disadvantage to these high tanks, in addition to cost, is that they are visible from long distances and therefore have significant visual and aesthetic impacts to the area.

Standpipes operate in a manner similar to elevated tanks and have the same advantages and disadvantages. Due to their configuration, standpipes have a significant volume of unusable or "dead" storage at the bottom of the tank. This water cannot benefit the system unless booster pumps are provided. Standpipes have significant visual and aesthetic impacts on a neighborhood.

At-grade cylindrical welded steel storage tanks have the lowest per-gallon cost of the reservoir alternatives being considered. Their low profile provide a reduced visual impact to the City. At-grade tanks do have a larger "footprint" and therefore require a larger site than high tanks. In a flat area like Woodburn where locating the tank on a hill is not feasible, their most significant disadvantage is that all of the water from the tank will have to be pumped into the system. This is necessary to increase the pressure of the water being fed into the system to acceptable levels. The combined capacity of these low head booster pump stations will have to equal anticipated peak demands flow rates. Automated auxiliary power should be provided for these "downstream of storage" booster pump stations to insure that stored water is available at system pressures during a power failure to fight fires and provide water service to area customers. Woodburn has the advantage of already having 750,000 gallons of elevated storage which can be available to gravity feed to the system during fire and other emergency conditions. This elevated storage will allow the size of the booster pumps to be reduced.

Based upon discussions with the City staff which identified probable high sensitivity of citizens to tall highly visible water standpipes or elevated tanks in the area, it is recommended that economical at-grade storage be constructed at two of the treatment plant sites. Assuming that forty-foot-high tanks would be acceptable, two equally sized 2.2 million gallon tanks would each be about 100 feet in diameter.

The booster pump stations located at the proposed reservoirs will work in concert with the existing elevated storage to meet typical peak hour demands and provide capacity for emergency and fire flow conditions. The two neighborhood treatment plants that would have storage are 2.7 mgd at Well 10 and 5.4 mgd at Parr Road. The treatment plant capacities are designed to meet maximum

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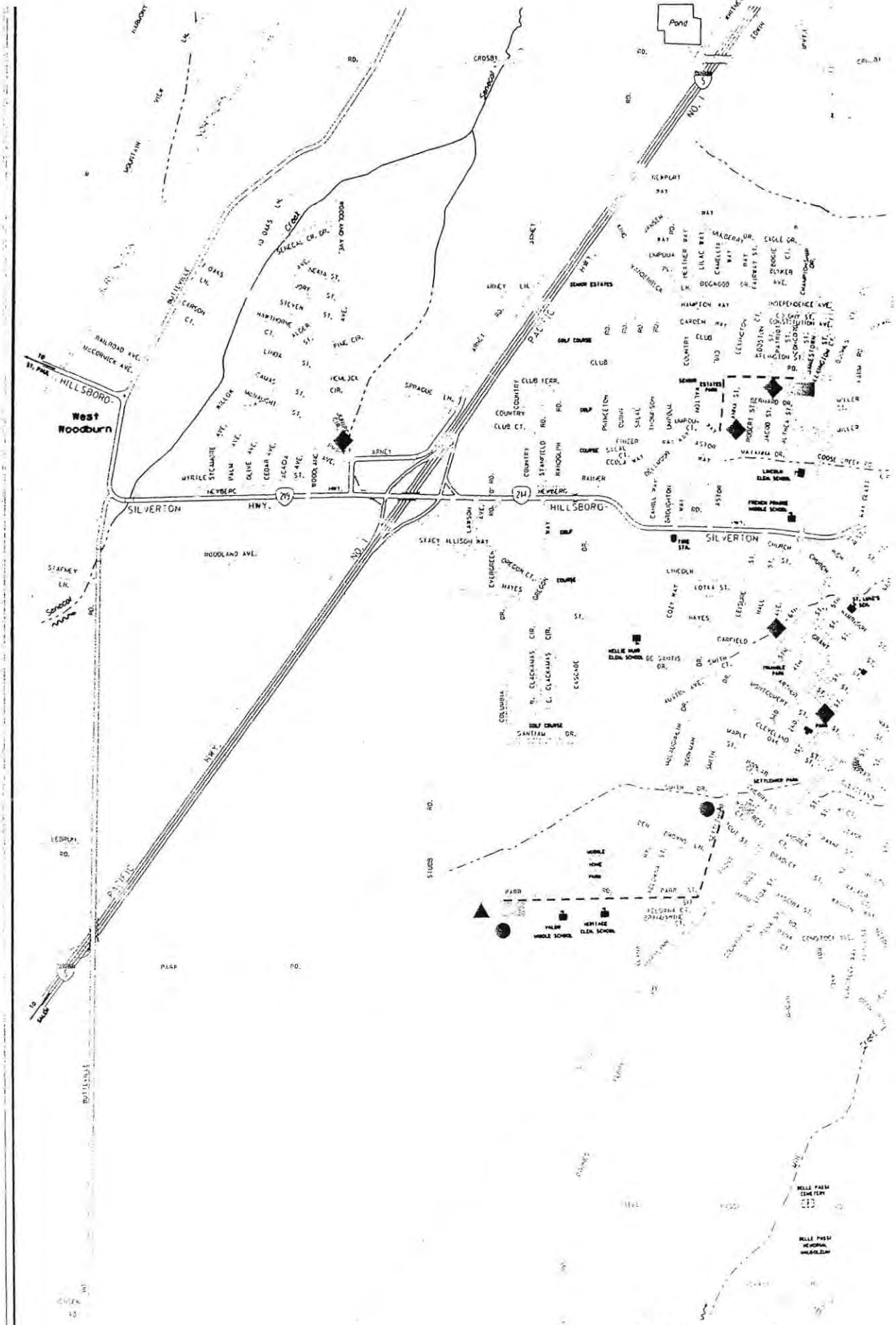

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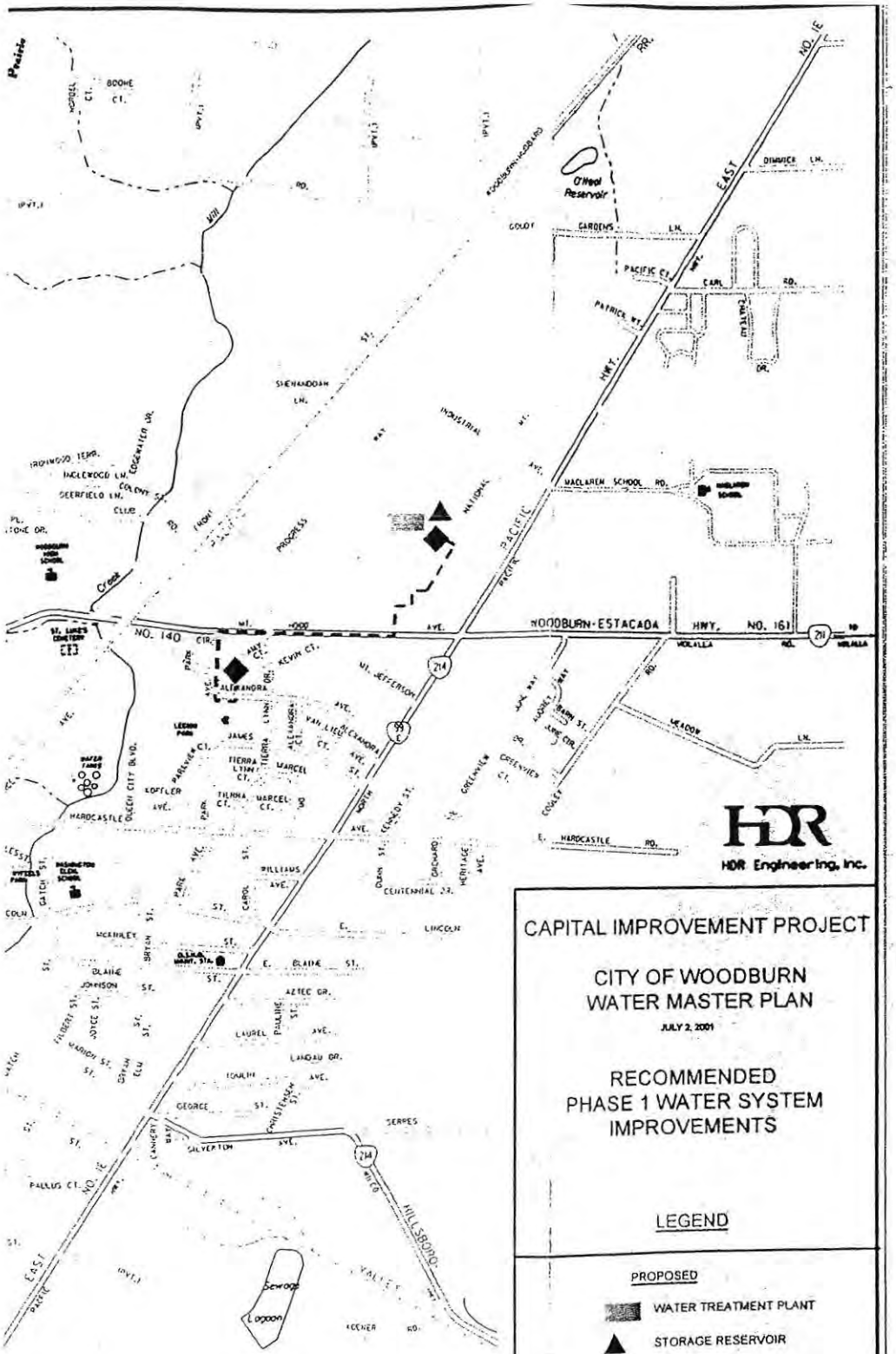

CAPITAL IMPROVEMENT PROJECT

CITY OF WOODBURN
WATER MASTER PLAN

JULY 2, 2001

RECOMMENDED
PHASE 1 WATER SYSTEM
IMPROVEMENTS

LEGEND

PROPOSED

- WATER TREATMENT PLANT
- STORAGE RESERVOIR
- WATER WELL
- RAW WATER PIPING

EXISTING

- WATER TOWER
- WATER WELL

SCALE: 1" = 1200'

FIGURE 12-1

illustrated on the neighborhood treatment system alternative map included in Chapter 10 as part of the treatment alternative analysis. The improvements listed in Table 12-1 are based on the two treatment plant (neighborhood) system. The required improvements are dependent upon the location and the number of treatment plants.

Treatment

Treatment alternatives and budgetary costs were fully developed in Chapter 10. Tables 10-7, 10-8, 10-9, and 10-10 lists the estimated costs for full system treatment to meet the year 2020 water demands for the 4 location scenarios being considered. Based on the estimated costs, operational considerations, and system configuration, it is recommended that the City construct neighborhood treatment plants.

Due to the fact that the construction of treatment plants will concentrate the supply to the distribution system, some piping capacities will have to be increased. A 16-inch parallel pipe would be constructed along Country Club Road and Boones Ferry Road. A 16-inch pipe would be constructed to make the connection from Woodburn Senior High School to Highway 214 and Front Street. This would supply water to the proposed reservoir at Well 10.

Telemetry and Controls

Woodburn is in the process of upgrading their wastewater treatment plant. As a part of this upgrade, a new telemetry and control system will be developed. It is recommended that the City coordinate the installation of this system with the requirements of the water treatment system to upgrade the water system telemetry and controls.

12.2 PROPOSED IMPROVEMENTS

Project alternatives were developed, selected, and prioritized in the following order:

1. Compliance with regulatory/health and safety requirements
2. Transmission, distribution, storage improvements
3. System reliability/repair
4. Sources of supply to meet projected growth
5. Scheduling of project budgets for financing

Budgetary costs for improvement projects were estimated in 2000 dollars. The projects and the estimated costs are listed in Tables 12-1, Table 12-2 and Table 12-3. Table 12-1 lists all of the projects by type of improvement. Table 12-2 lists the projects by year of construction. Table 12-3 groups projects by classification of improvement. Projects were scheduled over a 24 year period. For the first four years, schedules are developed for each year. For the next 20 years, projects are scheduled in five year periods. It is recognized that projects in the final 15 years of the 20 year schedule will be revised as the plan is regularly updated.

The CIP table does not include project costs for distribution improvements in future developed areas. It is not known when and exactly where these facilities will be needed. As areas develop, the

Table 12-2
Woodburn Water Master Plan
Capital Improvement Plan - By Scheduled Year

Project Description	2000 Project Cost	Construction Year	Construction Year Cost
Install 60 lf of parallel 10-inch dia. pipe (Boones Ferry Road crossing).	$10,000	1998	$9,000
Install 810 lf of parallel 8-inch dia. Pipe.	$103,000	1998	$93,000
Install 990 lf of 16-inch dia. pipe.	$251,000	2000	$243,000
Drill 2 wells at South Woodburn site	$680,000	2002	$704,000
Install raw water transmission main from National Way treatment plant	$486,000	2003	$521,000
Install raw water transmission main from South Woodburn treatment plant	$384,000	2003	$411,000
Install raw water transmission main from County Club treatment plant	$209,000	2003	$224,000
National Way reservoir and pump station	$2,060,000	2004	$2,284,000
South Woodburn reservoir and pump station	$2,067,000	2004	$2,292,000
Install 850 lf of parallel 10-inch dia. pipe.	$135,000	2005	$155,000
Install 200 lf of parallel 10-inch dia. pipe.	$32,000	2005	$37,000
Construct National Way water treatment plant	$3,316,000	2005	$3,805,000
Construct South Woodburn water treatment plant	$3,653,000	2005	$4,192,000
Construct County Club water treatment plant	$3,319,000	2005	$3,809,000
Pipeline from wells to S. Woodburn treatment plant	$413,000 *	2015	$669,000
South Woodburn treatment plant expansion	$1,500,000 *	2015	$2,428,000
Drill 2 wells at S. Woodburn site	$425,000 *	2015	$688,000
Pipeline from wells to West Woodburn treatment plant	$195,000 *	2022	$402,000
Construct West Woodburn treatment plant	$1,720,000 *	2022	$3,542,000
Drill 2 wells at West Woodburn site	$335,000 *	2022	$690,000
Total	**$21,293,000**		**$27,198,000**

* Option A of water master plan committee recommendation

Table 12-3 Woodburn Water Master Plan Capital Improvement Plan - By Improvement Classification			
Project Description	2000 Project Cost	Construction Year	Construction Year Cost
Improvements Required to Improve Fire Protection & Correct Deficiencies in the Existing System			
Install 60 lf of parallel 10-inch dia. pipe (Boones Ferry Road crossing).	$10,000	1998	$9,000
Install 810 lf of parallel 8-inch dia. Pipe.	$103,000	1998	$93,000
Install 850 lf of parallel 10-inch dia. pipe.	$135,000	2005	$155,000
Install 200 lf of parallel 10-inch dia. pipe.	$32,000	2005	$37,000
National Way reservoir and pump station	$2,060,000	2004	$2,284,000
Subtotals 11%	**$2,340,000**		**$2,578,000**
Improvements Required to Accommodate Growth			
Install 990 lf of 16-inch dia. pipe.	$251,000	2000	$243,000
Install raw water transmission main from National Way treatment plant	$486,000	2003	$521,000
Install raw water transmission main from South Woodburn treatment plant	$384,000	2003	$411,000
Install raw water transmission main from County Club treatment plant	$209,000	2003	$224,000
South Woodburn reservoir and pump station	$2,067,000	2004	$2,292,000
Drill 2 wells at South Woodburn site	$680,000	2002	$704,000
Drill 2 wells at S. Woodburn site	$425,000 *	2015	$688,000
Drill 2 wells at West Woodburn site	$335,000 *	2022	$690,000
Subtotals 23%	**$4,837,000**		**$5,773,000**
Improvements to Provide Treatment to Remove Iron and Manganese			
Construct National Way water treatment plant	$3,316,000	2005	$3,805,000
Construct South Woodburn water treatment plant	$3,653,000	2005	$4,192,000
Construct County Club water treatment plant	$3,319,000	2005	$3,809,000
Pipeline from wells to S. Woodburn treatment plant	$413,000 *	2015	$669,000
South Woodburn treatment plant expansion	$1,500,000 *	2015	$2,428,000
Pipeline from wells to West Woodburn treatment plant	$195,000 *	2022	$402,000
Construct West Woodburn treatment plant	$1,720,000 *	2022	$3,542,000
Subtotals 66%	**$14,116,000**		**$18,847,000**
Total	**$21,293,000**		**$27,198,000**

* Option A of water master plan committee recommendation

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City will have to determine the exact configuration of the transmission pipe system. The CIP system maps included in Chapter 10 show possible pipe sizes and locations.

Water Master Plan Committee Recommendations and Capital Improvement Summary

The City Council appointed a Citizen Water Master Plan Committee to develop preferred alternatives for treatment and storage improvements. The committee evaluated the water system improvements program, and recommended that a potassium permanganate pressure filtration process be used for water treatment. The committee also recommended that improvements be implemented in three phases. During Phase 1, three treatment plants each with a capacity of 2.7 MGD would be constructed along with two 2.2 MG storage tanks and two pump stations, two new wells, and three raw water transmission lines. Recommendations for improvements in phases 2 and 3 are split into two different alternatives that achieve the same goals. Both alternatives provide for growth needs, and the only difference is the schedule for construction of the fourth treatment plant in the west Woodburn area. Recommended improvements for phases 2 and 3 include expanding the South Woodburn treatment plant from 2.7 to 5.4 MGD, adding a 2.7 MGD treatment plant in west Woodburn, drilling 4 new wells, and constructing raw water transmission lines from the new wells to the treatment plants. Only three new wells may be required if existing Well #7 (Nazarene Well) is able to be upgraded and utilized. Construction of improvements for phases 1, 2, and 3 would begin in 2003, 2015, and 2022, respectively.

Approximately $25.7 million (2000 dollars) in improvement projects have been identified and detailed for the next 24 years. These improvements will provide needed treatment, storage, supply, and distribution improvements for the Woodburn system. Completing these capital improvements will allow the City of Woodburn to continue to provide City residents with a high quality water service well into the 21st century. Improvement projects are shown in Figure 12-1

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CHAPTER 13
FINANCIAL PLAN

13.1 INTRODUCTION

Over the next decade, the Woodburn Water System will be faced with number of significant capital expenditures. The main project will include the installation of water treatment facilities for iron/manganese removal and possibly disinfection, and the installation of four additional wells to meet the future water demand. A sound financial plan is essential for the successful completion of these projects. This chapter reviews the financial status of the Woodburn Water System during the last five years. From the annual net available income which was available for capital expenditures during that time period, the amount of financing currently available to the water system is estimated. The available funds are compared with the required funds for the water projects. Recommendations for financing the planned facilities are made.

13.2 FINANCIAL STATUS

Table 13-1 summarizes the last five years (1991 through 1995) of financial audits for the City's water system. The City allocates its budget into six funds: Water Fund, Water Capital Improvement Fund, Water Well Construction Fund, Water Equipment Replacement Reserve Fund, and the Water System Development Trust Fund. The available sources of revenues come from water user fees, connection and service fees, interest revenues, and miscellaneous revenues.

The Cities' financial audits indicate that during the last five years, the following ranges of revenues and expenditures were experienced:

- Revenues (excluding interest): $863,000 to $1,190,000
- Total expenditures: $598,000 to $1,000,400
- Net income (excluding interest): $185,000 to $382,000
- Net income (excluding interest) and eliminating capital expenditures: $265,000 to $450,000, with an average of approximately $372,000

13.3 WATER RATE HISTORY

Table 13-2 summarizes the water rate history over the last 25 years. The last rate increase, which was about 15%, occurred in 1992. The majority of the residential meters are 3/4-inch. The monthly flat rate for the 3/4-inch meters is currently $7.45 for 400 cubic feet. For consumption over the basic quantity, a rate of $0.70 per 100 cubic feet is charged for up to 3,200 cubic feet. Above 3,200 cubic feet, there is a charge of $0.85 per 100 cubic feet.

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13.4 FUNDS AVAILABLE FOR CAPITAL IMPROVEMENTS

The amount of money currently available for financing the proposed capital improvements was calculated based on the historical financial status of the water system. The following assumptions were made:

- It is assumed that 80% of the average net income of approximately $372,000 is available each year for the capital expenditures, which amounts to approximately $298,000.
- The projects will be funded with 20-year bonds purchased at 6 % interest.
- It is assumed that for expenditures and revenues are affected about the same by inflation, as such inflation is disregarded.

Based on these assumption, the City could raise bonds to a total of about $3,200,000, with no rate increase.

13.5 COMPARISON OF AVAILABLE FUNDS WITH CAPITAL IMPROVEMENTS

The capital improvement plan in Chapter 12 estimated approximately **$ 21.3 million** in recommended improvements (2000 dollars), but the current rate structure is not adequate to fund the recommended projects. A study of the City's rate structure was performed to find additional sources of funding so that the City could go forward with these projects.

Financial Consulting Solutions Group, Inc. performed a water rate and system development charge (SDC) study in April 2001. The study concluded that rate increases should begin in October, 2001, and continue through 2006. The water bill for an average single family residence (SFR) would increase by 27 percent each year in 2002 and 2003, then by 20 percent each year in 2004 and 2005. Rate adjustments would end with with an 8% increase in 2006. A typical bill for a SFR (1000 cf usage) would increase from $11.65 in 2001 to $29.24 in 2006. These rate increases would provide enough revenue for the proposed projects.

ble 13-1

Woodburn Financial Summary 1991 - 1995

Description	1991	1992	1993	1994	1995
		Last Rate Increase			
SUMMARY					
Revenues					
Charges for Services	822,447	1,070,719	1,054,444	1,162,802	1,120,147
Miscellaneous Revenues	40,546	2,257	5,845	26,509	12,849
Interest Revenues	43,252	36,713	31,425	31,190	49,055
TOTAL REVENUES	906,245	1,109,689	1,091,714	1,220,501	1,182,051
Total Revenues Minus Interest Revenues	862,993	1,072,976	1,060,289	1,189,311	1,132,996
Expenditures					
Admin., Dist., & Transmission	479,659	533,044	575,458	598,964	621,971
Meter Read, Accounting, Collect	96,213	102,535	110,129	112,857	113,486
Misc. Water Accounts	15,027	14,656	17,909	14,526	14,658
Materials and Services	7,368	1,300	16,596	12,155	995
Capital Outlay	-	39,877	53,612	265,940	67,942
TOTAL EXPENDITURES	598,267	691,412	773,704	1,004,442	819,052
Revenues (excluding interest) Over Expenditures	264,726	381,564	286,585	184,869	313,944
Rev. (exc. interest) Over Expenditures (exc. capital outlay)	264,726	421,441	340,197	450,809	381,886
WATER FUND					
Revenues					
Charges for Services	729,310	883,060	941,216	980,752	1,002,102
Miscellaneous Revenues	3,483	2,207	5,178	4,134	12,849
Interest Revenues	18,221	7,704	7,113	5,655	8,167
TOTAL REVENUES	$ 751,014	$ 892,971	$ 953,507	$ 990,541	$ 1,023,118
Expenditures					
Admin., Dist., & Transmission	479,659	533,044	575,458	598,964	621,971
Meter Read, Accounting, Collect	96,213	102,535	110,129	112,857	113,486
Misc. Water Accounts	15,027	14,656	17,909	14,526	14,658
TOTAL EXPENDITURES	$ 590,899	$ 650,235	$ 703,496	$ 726,347	$ 750,115
Excess (Deficiency) of Revenues Over Expenditures	160,115	242,736	250,011	264,194	273,003
Other Financing Sources (Uses)					
Operating Transfers In	36,500	37,000	39,000	39,000	40,000
Operating Transfers Out	(216,268)	(255,503)	(214,000)	(357,500)	(273,130)
TOTAL OTHER FINANCING SOURCES (USES)	$ (179,768)	$ (218,503)	$ (175,000)	$ (318,500)	$ (233,130)
Excess (Deficiency) of Revenues Over Expenditures and Other Sources (Uses)	(19,653)	24,233	75,011	(54,306)	39,873
Fund Balances at Beginning of Year	118,662	99,008	123,241	198,283	143,977
Fund Balances at End of Year	$ 99,009	$ 123,241	$ 198,252	$ 143,977	$ 183,850

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Table 13-1

Woodburn Financial Summary 1991 - 1995

Description	1991	1992 Last Rate Increase	1993	1994	1995
WATER CAPITAL IMPROVEMENTS FUND					
Revenues					
Charges for Services	93,137	187,659	113,228	144,785	(991)
Miscellaneous Revenues	37,063	50	667	22,375	-
Interest Revenues	14,669	17,921	14,498	16,711	18,347
TOTAL REVENUES	$ 144,869	$ 205,630	$ 128,393	$ 183,871	$ 17,356
Expenditures					
Materials and Services	7,368	1,300	500	-	-
Capital Outlay	-	14,747	24,071	37,133	37,689
TOTAL EXPENDITURES	$ 7,368	$ 16,047	$ 24,571	$ 37,133	$ 37,689
Excess (Deficiency) of Revenues Over Expenditures	137,501	189,583	103,822	146,738	(20,333)
Other Financing Sources (Uses)					
Operating Transfers Out	(21,503)	(70,000)	(54,074)	(29,074)	(252,396)
TOTAL OTHER FINANCING SOURCES (USES)	$ (21,503)	$ (70,000)	$ (54,074)	$ (29,074)	$ (252,396)
Excess (Deficiency) of Revenues Over Expenditures and Other Sources (Uses)	115,998	119,583	49,748	117,664	(272,729)
Fund Balances at Beginning of Year	80,418	196,416	315,999	365,747	483,411
Fund Balances at End of Year	$ 196,416	$ 315,999	$ 365,747	$ 483,411	$ 210,682
WATER WELL CONSTRUCTION FUND					
Revenues					
Interest Revenues	3,377	5,749	6,206	6,166	4,979
TOTAL REVENUES	$ 3,377	$ 5,749	$ 6,206	$ 6,166	$ 4,979
Expenditures					
Materials and Services		-	16,096	12,155	995
Capital Outlay	-	-	-	172,078	5,573
TOTAL EXPENDITURES	$ -	$ -	$ 16,096	$ 184,233	$ 6,568
Excess (Deficiency) of Revenues Over Expenditures	3,377	5,749	(9,890)	(178,067)	(1,589)
Other Financing Sources (Uses)					
Operating Transfers In	20,000	85,000	20,000	95,000	43,335
TOTAL OTHER FINANCING SOURCES (USES)	$ 20,000	$ 85,000	$ 20,000	$ 95,000	$ 43,335
Excess (Deficiency) of Revenues Over Expenditures and Other Sources (Uses)	23,377	90,749	10,110	(83,067)	41,746
Fund Balances at Beginning of Year	27,720	51,097	141,846	151,957	68,890
Fund Balances at End of Year	$ 51,097	$ 141,846	$ 151,956	$ 68,890	$ 110,636

ble 13-1

Woodburn Fin...ial Summary 1991 - 1995

Description	1991	1992	1993	1994	1995
		Last Rate Increase			
WATER EQUIPMENT REPLACEMENT RESERVE FUND					
Revenues					
Interest Revenues	6,985	5,339	3,608	2,330	3,723
TOTAL REVENUES	$ 6,985	$ 5,339	$ 3,608	$ 2,330	$ 3,723
Expenditures					
Capital Outlay		25,130	29,541	56,729	24,680
TOTAL EXPENDITURES	$ -	$ 25,130	$ 29,541	$ 56,729	$ 24,680
Excess (Deficiency) of Revenues Over Expenditures	6,985	(19,791)	(25,933)	(54,399)	(20,957)
Other Financing Sources (Uses)					
Operating Transfers In	15,000	15,000	15,000	45,000	30,000
TOTAL OTHER FINANCING SOURCES (USES)	$ 15,000	$ 15,000	$ 15,000	$ 45,000	$ 30,000
Excess (Deficiency) of Revenues Over Expenditures and Other Sources (Uses)	21,985	(4,791)	(10,933)	(9,399)	9,043
Fund Balances at Beginning of Year	60,847	82,832	78,041	67,108	57,709
Fund Balances at End of Year	$ 82,832	$ 78,041	$ 67,108	$ 57,709	$ 66,752
WATER SYSTEM DEVELOPMENT TRUST FUND					
Revenues					
Charges for Services				37,265	119,036
Interest Revenues				328	13,839
TOTAL REVENUES				$ 37,593	$ 132,875
Expenditures					
Capital Outlay					
TOTAL EXPENDITURES				$ -	$ -
Excess (Deficiency) of Revenues Over Expenditures				37,593	132,875
Other Financing Sources (Uses)		New fund in 1994			
Operating Transfers In				-	204,061
TOTAL OTHER FINANCING SOURCES (USES)	$ -	$ -	$ -	$ -	$ 204,061
Excess (Deficiency) of Revenues Over Expenditures and Other Sources (Uses)				37,593	336,936
Fund Balances at Beginning of Year					37,593
Fund Balances at End of Year				$ 37,593	$ 374,529
TOTAL BALANCES AT END OF YEAR FOR ALL FUNDS	$ 429,354	$ 659,127	$ 783,063	$ 791,580	$ 946,449

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Table 13-2

Woodburn Rate Structure History

Meter Size	Quantity (cu ft)	Basic Rate ($)												
		May-81	Nov-81	May-82	Nov-82	Nov-83	Nov-84	Nov-85	Jan-87	Jan-88	Jan-89	Feb-90	Jan-91	Jan-92
3/4"	400	3.50	3.90	4.05	4.25	4.50	4.75	5.00	5.25	5.25	5.25	5.85	6.45	7.45
1"	800	5.30	5.78	6.14	6.45	6.80	7.20	7.60	8.00	8.00	8.00	7.85	8.45	9.75
1-1/2"	1,800	9.50	10.50	11.00	11.55	12.20	12.90	13.60	14.35	14.35	14.35	16.00	17.65	20.40
2"	3,200	15.50	16.80	17.94	18.90	19.95	21.05	22.20	23.40	23.40	23.40	26.00	28.65	33.10
3"	7,500	32.50	35.70	37.62	39.40	41.55	43.85	46.25	48.80	48.80	48.80	54.50	60.10	69.40
4"	15,000	64.50	71.40	74.67	78.75	83.10	87.70	92.50	97.60	97.60	97.60	108.90	119.95	138.55
6"	32,000	132.50	147.00	153.39	162.75	171.70	181.15	191.10	201.60	201.60	201.60	224.20	247.20	285.55
8"	57,000	230.50	254.10	266.83	283.50	299.10	315.55	332.90	351.20	351.20	351.20	390.20	430.20	496.90

Meter Size	Quantity (cu ft)	Percent Increase Over Previous Year												
		May-81	Nov-81	May-82	Nov-82	Nov-83	Nov-84	Nov-85	Jan-87	Jan-88	Jan-89	Feb-90	Jan-91	Jan-92
3/4"	400	-	11.4	3.8	4.9	5.9	5.6	5.3	5.0	0.0	0.0	11.4	10.3	15.5
1"	800	-	9.1	6.2	5.0	5.4	5.9	5.6	5.3	0.0	0.0	-1.9	7.6	15.4
1-1/2"	1,800	-	10.5	4.8	5.0	5.6	5.7	5.4	5.5	0.0	0.0	11.5	10.3	15.6
2"	3,200	-	8.4	6.8	5.4	5.6	5.5	5.5	5.4	0.0	0.0	11.1	10.2	15.5
3"	7,500	-	9.8	5.4	4.7	5.5	5.5	5.5	5.5	0.0	0.0	11.7	10.3	15.5
4"	15,000	-	10.7	4.6	5.5	5.5	5.5	5.5	5.5	0.0	0.0	11.6	10.1	15.5
6"	32,000	-	10.9	4.3	6.1	5.5	5.5	5.5	5.5	0.0	0.0	11.2	10.3	15.5
8"	57,000	-	10.2	5.0	6.2	5.5	5.5	5.5	5.5	0.0	0.0	11.1	10.3	15.5

LAST RATE INCREASE 1992

CHAPTER 14
OPERATIONS PLAN

14.1 INTRODUCTION

Currently the Woodburn Water Division does not have a detailed Operations Plan. This chapter presents elements of the operation based on current procedures. The operations plan described here consists of four elements:

- Key Personnel
- System Operation and Control
- Water Quality Monitoring and Reporting
- Emergency Response

14.2 KEY PERSONNEL

The Woodburn Water Division operates within the Public Works Department, under the public works director, Frank Tiwari. The Program Manager for water and transportation is Randy Rohman. Within the water division there are currently eight staff positions, including four certified personnel. Five additional positions are planned within 10 years, including two water treatment operator positions. Key personnel within the Water Division are listed in Table 14-1, along with planned positions. The Public Works Department organizational chart is presented in the Appendix.

Table 14-1
Water Division Key Personnel
City of Woodburn

Name	Job Title	Certification
Randy Rohman	Public Works Program Manager	
Frank Sutter	Superintendent	WD III # 1526
Kevin Mills	Foreman	WD III # 5048
Dennis Samson	Water Tech I	WD I # 1467
Floyd Barth	Water Tech I	WD I # 1029
Future Position	Water Treatment Lead Operator	
Future Position	Water Treatment Operator	
Future Position	Asst. Superintendent	
Future position	Cross Connection Inspector	

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14.3 SYSTEM OPERATION AND CONTROL

Components

The Woodburn water system includes six active wells, six inactive wells, approximately 66 miles of water pipe varying in size from 4 inches to 24 inches in diameter, one operating water storage reservoir and one elevated water reservoir which is currently out of service. The distribution system operates under a single pressure zone. System pressures are generally 45 psi to 60 psi. A more complete description of the facilities is presented in Chapter 5, *Existing System Inventory/Review.*

Normal Operation

The wells pump directly into the distribution system. The pumps are controlled by an Autocon telemetry system based on the water level in the water reservoir. The order in which the individual pumps come on-line is set by the operator, and is based on which well produces the highest water quality. Currently, Well No. 7 is the most frequently used well.

Telemetry and Controls

The central control panel for the Autocon telemetry system is located near the elevated storage tank. The central panel contains the following information:

- Indication lights for current status information
- Elevated tank level indicator and recorder
- System pressure indicator and recorder
- HAND/OFF/AUTO switches for well pump control
- Elapsed pump operating time
- High and low elevated tank level alarms

Field data are telemetered to the central panel using leased telephone lines. The high and low tank level alarm signals are sent to a monitoring service which relays the alarm to the Woodburn police station. There are no operating or intrusion alarms at the wells. The telemetry system has no battery backup and is approximately 30 years old.

Maintenance and Repair Program

The City has an ongoing program of repair of their system, which is done by the City staff. The preventive maintenance program is summarized in Table 14-2.

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Table 14-2 Maintenance Program City of Woodburn		
Item	**Maintenance**	**Frequency**
Reservoir	Drain, clean and internally inspect to ensure water quality and structural integrity; Remove silt build-up on the bottom and algae growth off of interior walls	Every three years
Valves	Operate full open/closed; check for water tightness; uncover where buried; clean out valve boxes	Annually
Water Mains	Flush lines	Semi-Annually
Water Mains	Inspection and service line repairs	Annually and As Needed
Hydrants	Inspection and Repair Operate; check drain rate; lubricate as necessary; measure pressure; paint as necessary	Annually
Pressure Regulating Valves	Testing and Repair	Annually
Pumps	Brief Inspection. Log and record motor current draw, check packing, log and record gallons delivered and pump motor hours; check motor oil level; measure and record static or pumping water level; check motor noise, temperature; and vibration	Daily
Pumps	Detailed inspection. Change oil, perform maintenance required by manufacture	Annually
Meters	Inspection and Repair	Annually
Equipment: Backhoe, trucks	Check all fluid levels and lights, and other safety related items.	Daily
	Replace fluids and filters in accordance with manufacturers recommendations	As needed
Tools	Clean after each use; lubricate as necessary	As needed

Cross Connection Control

The City conducts an active program for systematically identifying and controlling cross connections. The program includes a careful review of all proposed construction for potential cross connections. During construction, the City ensures proper compliance by inspection according to code requirements. All backflow preventers are inspected annually to ensure proper

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function. The City maintains records of cross connection control and backflow prevention device testing. The City plans to bring a cross connection inspector on staff.

Equipment and Supplies Tracking

The City maintains a stockpile of all critical repair parts, tools, and equipment. The City maintains a complete inventory of all repair parts. As repair parts are used, they are reordered to keep supplies current. The City maintains an adequate supply of chlorine for superchlorinating lines as necessary.

Response to Water Quality Complaints

Every customer complaint concerning water quality is received and investigated promptly. The City maintains records of customer complaints pertaining to water quality and the follow-up action undertaken.

14.4 WATER QUALITY MONITORING AND REPORTING

Monitoring

The City routinely collects and submits water samples for laboratory analyses at the frequencies prescribed by OAR 333-061-0036. The water quality monitoring program is summarized in Chapter 9, Water Quality Assessment. The City monitors for the following parameters:

- Coliform
- Lead and Copper
- Inorganic Chemicals (IOCs) (Phase II and V)
- Volatile Organic Compounds (VOCs) (Phase II and V)
- Synthetic Organic Compounds (SOCs)
- Gross alpha activity
- Sulfate
- Arsenic

Reporting, Public Notification, and Record Keeping

Reporting requirement are described in Chapter 9 for the individual contaminants. The City maintains records of all raw water quality, both chemical and microbiological, as well as current records relating to the sampling and analysis undertaken to assure compliance with the maximum contaminant levels.

The City has established procedures in conformance with ORD 333-061-0042 Public Notice for cases when the system violates a primary water quality standard; or they fail to meet monitoring, and analytical testing requirements. Standard notices provide a clear explanation of the violation, adverse health effect, remedial action being taken, and steps the consumer should take to minimize risk. **Volume** 1
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The procedures call for notices by publication in a daily newspaper within 14 days after the violation and by direct mail or hand delivery within 45 days after the violation. The OHD may waive the mail or hand delivery requirement if the violation is corrected within 45 days. For an acute violation, including acute coliform, nitrate, and a water borne disease outbreak, a copy of the notice is to be furnished to the radio and television stations serving Woodburn within 72 hours after the violation.

14.5 EMERGENCY RESPONSE PROGRAM

The City has an Emergency Response Plan which includes:

- Vulnerability Assessment
- Contingency Procedures
- Emergency Response Procedures

The City has taken appropriate measures to develop a reliable system. The City's six active wells provide a multiple water source. In the event of pump failure, all areas within the distribution system may be served by the remaining wells. In the event of electrical power outage, all pumps are connected with diesel-driven engines.

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Memo

To: Frank Tawari, Jim Mulder; Dave Torgeson; Bob Shields

From: Deniece Won

Date: 11/5/2003

Re: Adopting Storm Water Master Plan

I have talked with each of you about the issue of adopting the Storm Drainage Master Plan to replace the plan adopted in 1989. As you know, the decision is complicated by the fact that the storm water plan is one of three facility plan items in one work task of our periodic review work program. Consequently, our decision needs to satisfy both that work task and Goal 11, which is implemented by the public facilities planning rule.

This memorandum is intended to help you to decide what work remains to be done and in what order. I suggest we have a short meeting next week to discuss this.

In summary, I have identified the following tasks to be completed:

Storm Drainage Master Plan

1. Amend storm water master plan to delete population projections.
2. Include the following in the storm water master plan.
   a. List of needed long term projects
   b. Rough cost estimates by project
   c. Discuss funding
3. Identify any comprehensive plan amendments needed due to storm water master plan
4. Identify any implementing regulation(s) needed due to storm water master plan and prepare for adoption

Water Master Plan

5. Water plan population projection alternatives
   a. Amend to be consistent with interim population of 34,919
   b. Develop explanation that water plan is consistent with Goal 11
6. Amend water plan to include the following:
   a. Sensitive aquifers inventory

b. Wellhead protection Plan

c. Hazard substance cleanup site inventory

d. Water rights review

7. Identify any comprehensive plan amendments needed due to water master plan

   a. Promotion of water conservation by low water demand landscaping for retail customers

8. Identify any implementing regulation(s) needed due to water master plan and prepare for adoption

   a. Promotion of water conservation by low water demand landscaping for retail customers

Sanitary Sewer Plan

9. Review sanitary sewer plans; provide appropriate updated inventory, needed projects, etc.

10. Adopt any necessary sanitary sewer plan amendments and implementing ordinances

Water, Storm Water and Sanitary Plans

11. Adopt water and storm water master plans and any associated comprehensive plan amendments and implementing regulations

Periodic Review Work Task. Our periodic review work program includes a requirement that we adopt a storm water master plan. In addition, the work task requires us to complete a water plan and to review and submit a wastewater plan. All three facility plans are part of one periodic review work task. That work task is set out in Exhibit A. In answering the question concerning adoption of the storm water master plan I have also taken into account our obligations for completing work task 3.a., including the water and sanitary sewer master plans.

The work task requires that it be consistent with growth management approaches developed in Task 1. Task 1 requires a buildable lands inventory, documentation of growth trends, analysis of housing demand, and preparation of a growth management ordinance.

Goal 11. When a city makes a decision to adopt or amend a comprehensive plan, the decision must be consistent with applicable goals. Goal 11, implemented through the public facilities planning rule, applies in the situation of adopting a facility plan. The Goal 11 rule requirements are summarized in Exhibit B.

The City could satisfy the LCDC requirements by adopting each entire master plan as a supporting document to the comprehensive plan. When the city addresses matters not required to be addressed by the rule, LCDC may not review them. OAR 660-011-0010(2). However, by adopting the additional matters (such as location of lateral lines) as a land use decision and as a comprehensive plan, the city is bound to make future decisions in compliance with that plan. Flexibility in future decisions in implementing the master plan could be unnecessarily restricted if the entire master plans were adopted as a supporting

document to the comprehensive plan. Desired flexibility may be retained if the plan is clear about what is mandatory and what is discretionary. Dave may want to consider whether there are provisions in either the water or the storm drainage plans that would be mandatory if we adopted the whole plan for which we prefer to reserve flexibility. An alternative to adopting the whole plans would be to adopt a separate a "public facility plan" that includes the things required by Goal 11.

Preliminarily, it is your preference to adopt by ordinance only those portions of the master plans that are required for Goal 11 compliance. It appears feasible to assemble into one document, a "public facilities plan" element that will become part of the City's Comprehensive Plan, but that does not include information not required by the Goal.

Summary of Issues.

Population Projections. Work task 3A requires that the City use the "Marion County coordinated 20-year population projection" to determine demand for facilities, which is 26,290. Marion County and LCDC have subsequently agreed the City may use the number of 34,919 for interim planning purposes. The plans were prepared for a projected population greater than LCDC has agreed the City may use. All three facility plans rely on the population projection decision made in the 1995 sanitary sewer master plan that the City will have a 3.4 percent annual growth rate. That growth rate results in a year 2020 permanent population of 38,586, with a seasonal population of 4,099 (for a total of 42,685).

The adopted comprehensive plan projected a year 2014 population of 28,000. The City is currently studying its future growth needs. The most recent (unadopted) study by EcoNorthwest projects a low population forecast of 31,674 and a high forecast of 38,477 for the year 2020.

The sanitary sewer and storm sewer plans consider the population equivalent of full buildout of the city under current zoning at maximum density. That number is 125,000 people. Although this may be a very long term projection, considerably beyond the 20-year planning period, the number would likely alarm DLCD on reviewing our facility plans.

The water master plan uses the figure 38,586 (permanent residents only) – this is only 2,667 more people than the agreed upon interim planning number. The plan projects that the City will need to produce (demand plus water lose) 4.47 mgd per day on an average day and 10.28 on a maximum demand day. The city consumes 97 gpd per capita. The extra 2,667 projected population thus accounts for 6 percent of projected average day demand, 3 percent of projected maximum day demand, and 5 percent of total required storage projected for year 2020. Because the capacity of water systems is designed to satisfy fire and emergency flows which exceed the requirements of user consumption, the fact that the numbers are a little off may have no consequence on the planned infrastructure. That is, we may adopt the plan as is if we are able to explain that the discrepancy is of no consequence. I believe an alternative would be to slightly adjust the per capita consumption from 92 to about 100 gallons, which is a normal average consumption. Such an adjustment in consumption would justify the planned facilities if the population figure were reduced.

The Storm Drainage Master Plan discusses projected population and is consistent with the water and sanitary plans. However, the population projection appears to have no relevance to the infrastructure planned in the master plan. Change in storm water runoff volume and rate is a function of impervious surface, not population growth. The consultant did not

consider population growth when arriving at increases in impervious surface over the planning period. Rather, the impervious surface existing in 1994 was determined from aerial photos. Future impervious surface was determined by assuming an annual growth rate of 3.4% and considering the maximum development allowable under existing comprehensive plan designations. It appears to me that the Storm Drainage Master Plan could be amended to remove the growth projections without affecting anything in it.

Water Plan Work Task Item. The periodic review work task contains four items that we agreed to complete for the water plan. I understand that the work on those items is complete. That work could be incorporated into the Water Master Plan, or included in the Goal 11 public facilities plan.

Storm Drainage Master Plan Lacks Some Requirements of Goal 11. As outlined in Exhibit B, the Goal 11 rule requires a list of needed projects, rough cost estimates by project, identification of project location or service area, and a general estimate of when long term projects will be needed. The Storm Drainage Plan does not satisfy these requirements. A goal 11 rule requirement is that public facility plans contain a funding discussion. The Storm Drainage Master Plan lacks a discussion of funding for the operation and maintenance of storm water facilities.

What Form Should the Public Facilities Plan Take? The public facilities plan is required to address four subjects: sanitary sewers, water, storm sewers and transportation. The City council has already adopted and obtained acknowledgement of the Wastewater Facilities Plan and the Transportation System Plan in their entirety. As noted, maintaining maximum administrative flexibility may be a reason not to adopt the water or storm water plans in their entirety. If there are items included within the water or the storm water plan that could be considered mandatory requirements the plans could be amended to specify what is mandatory and what is a guiding principle subject to the City Engineer's discretion. Alternatively, we could create and adopt a different document, a "public facilities plan," from parts of the plans and submit that to LCDC for period review compliance. As noted above, I understand you may prefer to adopt a separate Goal 11 "facilities plan" specifically for LCDC approval that is an element of the comprehensive plan and separately adopt the entire water and storm master plans, so that the entire plans are not land use plans.

How Should the Plans be Adopted? The transportation plan was adopted by Ordinance and incorporated into the City's Comprehensive Plan. The Wastewater Facilities Plan was adopted by resolution. A facility plan has the character of making general policy for the city and thus should be adopted by ordinance. The ordinance adopting the storm water plan should amend the flood plain ordinance to repeal the Storm Water Management Plan and replace it with the Storm Drainage Master Plan.

The Public Facilities Rule defines a "public facility plan" as "a support document or documents to a comprehensive plan," that describes the facilities that support the land uses designated in the comprehensive plan. By defining the facilities plan as a "support document to" a comprehensive plan, not as a part of a comprehensive plan, the rule does not require that the facilities plan actually be part of the comprehensive plan (which needs to be adopted by ordinance). Consequently, the City is not necessarily amending its comprehensive plan when it adopts a facility plan.

A decision adopting a Water Master Plan would be a "land use decision" because the comprehensive plan contains storm drainage policies with which the storm master plan

needs to be consistent and because the Goal 11 Administrative Rule requires the city to adopt certain portions of the storm water master plan as part of the comprehensive plan. Because a decision to adopt a facility plan is a land use decision, and is not a quasi-judicial decision, these plans should be processed as a Type V land use decision under the Woodburn Development Ordinance.

<u>.t Comprehensive Plan Amendments are Necessary Due to Water and Storm Water Plans?</u> The policies in the storm water and water plans need to be compared with those in the current comprehensive plan, which may need to be amended to include storm and water policy choices made in the master plans. Consider incorporating the objectives of the storm water plan, pages 1-2 through 1-3 into the comprehensive plan.

The storm water management goals on page 11-3, could be included in the Comprehensive Plan.

<u>What Implementing Ordinances are Necessary.</u>

The "policy provisions" pages 11-4 through 11-19 appear regulatory in nature. We should consider revising these in ordinance form. Concerning these policy provisions, I preliminarily note the following.

1. These provisions contain "reimbursement" provisions. The City has a reimbursement district ordinance (No 2237). That ordinance contains procedures for creating a district, calculating an equitable allocation of cost to benefited properties, collecting and distributing the revenues. The purpose of the policies in the storm drain plan is to provide a developer an opportunity to request that the City participate in the costs of a storm sewer when the City wants the sewer to be oversized to meet future needs. Use of the term "reimbursement" is somewhat confusing.

   Our sanitary and storm sewer ordinance allows a person who oversizes a facility to request the Council to form a reimbursement district to receive payment from benefited properties. The plan should be clear about the two different procedures.

2. The provisions allow fill in the floodway fringe, but not the floodway, of primary drainageways, pursuant to the city's Floodplain Ordinance without qualification. Land in the floodway fringe may be wetlands and subject to Army Corps of Engineers and Division of State Lands removal and fill requirements. The outright allowance to fill floodway fringe areas should be qualified to fill of not more than 50 cubic feet or with DSL approval. Because fill is specifically allowed in the 100 year floodplain of primary drainageways it impliedly is not allowed in secondary and local drainageways. I assume that the intention is to allow fill in all floodplains outside of floodways.

3. The fill provisions appear inconsistent with the floodplain ordinance. I leave checking that to your expertise.

4. The definitions of primary, secondary and local drainageways encompass the entire drainage system within the applicable basins. The regulations on closed and open conveyances consequently apply to the entire basin not just the channel of the receiving stream or tributary. I assume that the intent is that streams should be open channels and uplands should have closed

conveyances (except detention facilities). Also, all the tributaries are "waters of the state" and would require a fill permit from DSL to convert them to closed conveyances. As our experience in attempting go enclose Goose Creek shows, permits are unlikely. The plan should clarify that all streams, including intermittent tributaries that receive stormwater from uplands should be remain open channels.

The following ordinances (or operating guidelines) may be necessary or desirable to implement the Water Master Plan. This list is offered only for discussion purposes.

1. Best Management Practices for Industries within the influence zone of the City's wells
2. Water Conservation Requirements
   a. Promotion of conservation for nurseries and park department facilities
   b. Low water demand landscaping in all retail customer classes.
3. Water system standards

The following ordinances (or operating guidelines) may be necessary or desirable to implement the Storm Drainage Master Plan. This list is offered only for discussion purposes.

1. Erosion and sediment control standards for construction activities that disturb land (e.g., silt fences, temporary storm water detention ponds) – Alternatively, just rely on EPA's NPDES permit requirements that regulate all construction on parcels of one or more acres, adopting no local regulations.
2. Drainage regulations for new development and redevelopment (e.g., protecting wetlands, use of best management practices such as grassed swales or porous pavement).
3. On-site Detention facility standards. The policy provisions contain mandatory detention requirements for nonresidential developments with more than 2.5 acres impervious surface and residential developments with more than 5 gross acres. The provisions contain construction standards and require the owner to maintain. They do not address issues of aesthetics or safety. For subdivisions, maintenance responsibility may be an issue. A homeowners association may not be an adequate body for ongoing maintenance if a detention facility is the only reason for their existence. Detention facilities serve a pollution control function as well as a flood control function, should pollution control considerations be included? What about locational guidelines for detention facilities – (wouldn't some locations be easier to maintain than others, safer or more attractive?)
4. Public detention facility operations and maintenance program
5. Financing mechanism for operating and maintaining detention facilities

Timing of Urban Growth Boundary Expansion and Public Facility Plan Adoption. A major city effort is underway to submit an urban growth boundary expansion proposal. Among the considerations in proposing a UGB amendment are the service abilities and costs of various possible locations of expanding. Should the facility plans be amended to address the UGB proposal at the same time as the storm water and water plans are adopted?

Managing all the studies and amendments at once may be difficult. An alternative approach would be to adopt the facility plans soon for the existing UGB. Later, after the need for the UGB amendment and its location is justified, we could prepare an amendment to all the facility plans (sanitary sewer and transportation, water and storm water) to demonstrate adequate facilities to serve the proposed UGB amendment.

IEW OF PLANS FOR COMPLIANCE WITH OAR

Sanitary Sewer Plans.

The sewage treatment plant plan and the collection facilities plan were prepared by a consultant in 1995 to meet the city's projected needs through the year 2020. The plan results required changes in the comprehensive plan. In 1996 the City completed a draft water facilities master plan. A substantial goal of the city was to improve the aesthetic quality of the water. The water plan too, was prepared to meet the city's projected needs through the year 2020. Both plans included the area within the present UGB (except for one UGB amendment for Davidson Farms, Ord. 2146).

The sanitary sewer treatment plant plan is based on a projected total summer population equivalent (residential flows and an equivalent for commercial and industrial flows), of 61,430 (increased from the 1993 population equivalent of 29,085. Residential flow was 60.9 percent, industrial flow is 26.8 percent and commercial is 12.3 percent. The plan assumed the growth in population would be 3.4 percent, from 17,707 in 1993 to 43,659 in 2020. It also assumed an increase of flow from industrial users and commercial users would be 1.0 and 3.4 percent respectively, over the 25-year planning period.

The sanitary sewer collection facilities plan included land within the UGB plus additional land to the west and the east of the UGB. The collection facilities plan addressed two planning periods, 5-years (1997) and full buildout. (It does not specifically plan collection facilities a 20-year planning period). Buildout development levels assumed residential land would develop at the maximum density allowable under the comprehensive plan. At full buildout t an projected 38,225 low density residential units and 8,175 high density residential units (a total of 46,400 residences). The plan assumed 2.7 persons per unit. Thus, the plan projected 125,280 people at full buildout. It assumed residential uses would generate flows of 100 gallons per capita per day and commercial and industrial uses would generate 3,000 gallons per acre per day.

The wastewater facilities plan (all three volumes) was adopted in July 1995. (Res. 1308).

On September 16, 1997, the City adopted amendments to the comprehensive plan text (Ordinance No.2201) called for in by the sanitary sewer and water plans. Those amendments made the following changes:

1. Described the City's watersheds
2. Described water quality requirements for treatment plant outfall and status of STP construction
3. Described storm water drainage basins
4. Adopted storm drainage policies
5. Adopted wastewater goals and policies
6. Adopted water goals and policies

DLCD was given notice of the plan amendment, and a copy of all three volumes of the sanitary sewer plan, pursuant to the post-acknowledgement procedures. This decision, to implement the 1995 sanitary sewer and 1996 water master plans occurred two-months after the date of the adoption of the City's periodic review work program. Apparently, that decision was not made in response to the periodic review work program to satisfy its requirements.

Water Master Plan

Woodburn prepared a water master plan in 1996 and updated it in 2001. The water master plan was prepared for all the land within the City's acknowledged UGB.

I have found no evidence that the water master plan document has been adopted by City Council. Therefore, no adopted plan addresses water sources, treatment systems, pumping system; or primary distribution system. Consequently, the comprehensive plan does not satisfy Goal 11 public facilities rule requirements.

However, the water master plan satisfies the public facilities rule requirements. The water master plan addresses the City's water source, storage and distribution systems. It considers the City's water facility needs for the year 2020 and beyond to 2040. Its year 2020 planning period is based on a projected permanent population of 38,586 (plus a seasonal population of 4,099 for a total of 42,685).

The plan contains a map of the inventory of wells, reservoirs, and distribution facilities by size. It contains a capital improvements list (Table 12-1) through the year 2022. Needed projects are listed and the projected construction year is identified for each project, along with the estimated project cost expressed in year 2000 dollars. The projects and the estimated costs are listed in Tables 12-1, Table 12-2 and Table 12-3. Table 12-1 lists all of the projects by classification of improvement. Table 12-2 lists the projects by year of construction. Table 12-3 groups projects by classification of improvement. Projects were scheduled over a 24-year period. For the first four years, schedules are developed for each year. For the next 20 years, projects are scheduled in five year periods. Chapter 13 contains a financial plan.

To analyze the capacity of the system and identify deficiencies that may exist, the plan assumes a number of standards (see pages 7-3 to 7-4). These standards should be adopted by public works as operating standards. None of these standards has characteristics of land use regulations and should not be adopted as amendments to the comprehensive plan nor as an ordinance implementing the comprehensive plan.

The water sources, storage and distribution system are adequate to meet existing needs. Replacement over a period of years is desirable for small and aged lines. To meet projected growth the City needs new wells and storage (these are currently in progress). The biggest deficiency in the water system identified was the aesthetic quality of the water. To solve this problem, treatment facilities were proposed to be added to the system (this is currently in progress). These new facilities are expected also to satisfy expected future safe drinking water act standards. The plan also identified a need for additional storage for emergencies and fire flows. No deficiencies were identified in the transmission system, except to connect new wells and treatment facilities.

Only one recommendation of the plan potentially has an effect on the contents of the City's comprehensive plan or zoning ordinance. That recommendation is to promote water conservation by low water demand landscaping for retail customers.

Storm Water Master Plan

orm Water Management Plan was adopted in 1989, and is still in force. That plan was adopted by reference in the Flood Plain Ordinance. A new Storm Drainage Master Plan was developed between 1996 and 2001. General information and proposed recommendations were updated for the year 2001. The hydrologic and hydraulic modeling is based primarily on data and assumptions made for conditions existing in 1996.

The Storm Water Master Plan used the Woodburn Comprehensive plan as the basis for projecting future conditions in the areas that are currently unserved. Plan. Pg. 2-6.

> "Woodburn's population in 2000 was about 21,500 people. Projections made in production of the Wastewater Facilities Plan, (CH2M HILL, 1995) indicate that the City can expect the population to increase to 125,000 people by the time complete buildout of the Urban Growth Boundary is complete. The development that occurs with population growth will typically produce increases in stormwater runoff rates due to increases in the impervious area caused by new roads, roofs and hard surfaces." Plan pg. 2-7

The 125,000 population is vastly in excess of any population projections for a 20-year planning period. The storm water plan does not use population in calculating storm water system capacity requirements. It uses impervious surface projected for the planning period based on an assumption that new development will occur at maximum allowable density under the acknowledged plan and zoning designations. Consequently, it is not necessary to discuss population projections at all in this plan.

Improvements identified as needed are of two types. One is to solve existing problems, the ot is to serve growth needs.

Projects to solve existing problems are included within the 5-year capital improvements program, except those that pose a lower level of risk and that will increase due to future development. All but two of the 5-year improvements involves a street. Those two involve detention facilities, both use an existing park as a temporary storage area, although one proposes to also use land currently privately owned.

Projects needed to serve new growth either involve onsite facilities to store and delay release of storm water or involve increasing capacity in existing conveyances. The Storm Drainage Master Plan distinguishes development on large parcels from development on small parcels. For large parcel development construction of onsite storm drainage facilities is the responsibility of the developer. The plan provides a computer model for use in determining the impact of water from a development site on the downstream conveyance system.

The plan does not include a list of long term projects nor does it contain any discussion on cost estimates or the funding for developing needed facilities. All of these are required by Goal 11. The funding discussion needs to include existing funding mechanisms, possible alternative mechanisms, and the ability of the existing and alternative mechanisms to fund the needed projects. The funding mechanism discussion may be described in terms of general guidelines or local policies.

Because Woodburn has not had a source of revenue dedicated to storm water facilities, the City's past involvement in operating and maintaining storm water facilities primarily has been limited to those facilities associated with streets, which are gas tax eligible expenditures. The plan does not include a discussion of funding for the operation and maintenance of detention facilities that developers may dedicate to the City. The plan is a logical place for a discussion of the existing and future O&M costs and funding sources, alternatives, how storm water master plan policy choices may affect the costs and financing, and provide a strategy for the City to address its funding needs.

PERIODIC REVIEW PROCEDURE

The decision to adopt all or part of the storm water master plan as part of the comprehensive plan would be a legislative land use decision, and processed pursuant to the Type V procedures in the zoning ordinance.

Completed work tasks are to be submitted to DLCD, after a final decision by the City, along with a list of persons who requested notice of the decision. DLCD first determines whether the submittal is complete because it contains all required elements identified for that task in the work program. DLCD may review an incomplete submittal and require further work on the missing material. OAR 660-025-0140 contains specific requirements for the content of the notice.

PERIODIC REVIEW WORK TASK 3.A.

City of Woodburn's periodic review program work task 3a provides as follows:

Update Public Facilities Plan:

The public facilities plan will be coordinated and updated and incorporate revised policies that are consistent in serving growth management approaches developed in Task 1.

1. Prepare detailed work program for subtask 3.a.
2. Use Marion County coordinated 20-year population projection to determine the potential demand for critical public facilities and services.
3. Use Marion County coordinated 20year population projection to determine the potential demand for public facilities and services, i.e., parks/open space/schools.
4. Review/submit wastewater plan.
5. Complete water plan:
   a. Sensitive aquifers inventory;
   b. Wellhead protection plan;
      1) identify and describe the resource and conflicting use;
      2) analyze dat[a];
      3) prepare technical paper;
      4) evaluate impacts on buildable land inventory;
   c. hazard substance cleanup site inventory; and,
   d. look at water rights.
6. Complete storm water plan.
7. Incorporate findings into a public facilities plan
8. Recommend amendments to the comprehensive plan text and map and to the city's implementing ordinance, consistent with the findings of the study.

OAR 660 Division 11 – Public Facilities Planning Rule

Facilities Required to Be Addressed. The Public Facilities Planning Rule requires cities to adopt certain elements of water sewer and transportation plans as elements of their comprehensive plans. The facilities systems required to be addressed in the comprehensive plan (excluding transportation facilities), are limited to the following:

(a) Water:

(A) Sources of water;

(B) Treatment system;

(C) Storage system;

(D) Pumping system;

(E) Primary distribution system.

(b) Sanitary sewer:

(A) Treatment facilities system;

(B) Primary collection system.

(c) Storm sewer:

(A) Major drainageways (major trunk lines, streams, ditches, pump stations and retention basins);

(B) Outfall locations.

The city may include in their facilities plans matters beyond those minimally required as listed above.

The rule requires that a public facility plan contain the following items:

1. Inventory. An inventory and general assessment of the condition of all the significant public facility systems which support the land uses designated in the acknowledged comprehensive plan; The required public facility system inventory may be incorporated by reference if the inventory is included in another document. The inventory is required to include the following:

   a. Mapped location of the facility or service area;

   b. Facility capacity or size; and

   c. General assessment of condition of the facility (e.g., very good, good, fair, poor, very poor).

2. List of Needed Projects. The City is required to include in the public facility plan significant public facility projects that are needed to support the land uses designated in the acknowledged comprehensive plan:

   b. Listed by title of the project and, and

   c. Describing each project in terms of the

      (1) Type of facility

      (2) Service area, and

      (3) Facility capacity.

3. Rough Cost Estimates By Project. The City is required to include rough cost estimates for the projects identified in the facility plan and a discussion of the existing funding mechanisms and the ability of these and possible new mechanisms to fund the development of each public facility project or system. These funding mechanisms may be described in terms of general guidelines or local policies.

4. Identify Project Location or Service Area. A map or written description of each public facility project's general location or service area; The city is required to identify, in specificity appropriate for the facility, the general location of the project. Locations of projects anticipated to be carried out in the short term can be specified more precisely than the locations of projects anticipated for development in the long term.

5. Identify Provider. The rule requires each public facility plan to include the policy(ies) or urban growth management agreement designating the provider of each public facility system.

6. Identify Project Timing. The City is required to include a general estimate of the timing for the planned public facility projects. The city needs to group the projects as short term (year one through year five of the facility plan) or long term (year 6 though term of the planning period).

   a. Short Term Projects. For short term projects, the city is required to identify an approximate year for development.

   b. Long Term Projects. For long term projects, the city is required to provide a general estimate of when the project will be needed for project development would exist. That estimate need not be by year, but may be by population level, service level standards, for examples.

   Timing provisions for public facility projects are required to be consistent with the acknowledged comprehensive plan's projected growth estimates, and consider the relationships between facilities in providing for development.

7. Discuss Funding. The facilities plan needs to include a discussion of existing funding mechanisms and the ability of these and possible new mechanisms to fund the development of each public facility project or system.

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PUBLIC FACILITIES PLANNING RULE REQUIREMENTS

OAR REQUIREMENT	WATER PLAN	SANITARY SEWER PLAN	STORM WATER PLAN
INVENTORY			
Mapped location		1992 conditions pages 19-23 Vol II	Appendix A
Facility capacity or size			Appendix A
Assessment of condition		Just completed inventory, including size of lines	Yes – deficiencies identified
NEEDED PROJECT LIST			
Type of facility			Yes - Chapter 9
Service area			
Facility Capacity or size			
ROUGH COST ESTIMATES			Table 9-1 (deficiencies) Everything else is needed because of growth – a nd will be funded by developer or SDC
PROJECT LOCATION IDENTIFIED			Plan Map
PROVIDER IDENTIFIED			Stormwater plan Pg. 2-1
PROJECT TIMING			
Short Term Projects (5 years)	5-year list is in CIP	5-year list is in CIP	Chapter 8 5-year list is in CIP
Long Term Projects (years 6 – 20)			
FUNDING DISCUSSED		Vol III Rate & SDC study (1996)	11-1

PERIODIC REVIEW REQUIREMENTS

WORK TASK	STATUS / COMMENTS
3.a - Update Public Facilities Plan	
Prepare detailed work program for subtask 3.a.	
Use Marion County coordinated 20-year population projection to determine the potential demand for critical public facilities and services. Use Marion County coordinated 20year population projection to determine the potential demand for public facilities and services, i.e., parks/open space/schools	County adopted 20-year forecasts in 1998. For Woodburn the official population number is 26,290 Woodburn, Marion County and LCDC have agreed Woodburn can use 34,919 for planning purposes Water Plan – year 2020 38,586 - permanent 4,099 – seasonal total 42,685 (derived from wastewater facilities plan)
Review/submit wastewater plan	The periodic review work program is dated 7/30/77. The sanitary sewer plans (treatment plant and collection system) were prepared in 1995. Sanitary sewer plan adopted 7/6/95 by resolution #1308 [CB 1647]) – submitted to LCDC (all three documents) as post-acknowledgement decision (not periodic review) Comp plan amended to reflect plan 9/16/97 (Ord. # 2201) **1 Review Work Done Since 1995** **2 adopt as update to public facilities plan** **3 adopt any necessary comp plan amendments** **4 adopt any necessary ordinance[s].**
Complete water plan:	
Sensitive aquifers inventory	None of these topics are required by the public facilities planning rule. LCDC is prohibited by the rule from considering
Wellhead protection plan	
hazard substance cleanup site inventory	

look at water rights	prohibited by the rule from considering them, even if we did include them in a plan. Dave Torgeson says these tasks are completed 1. **Review Work Done Since 1995,** 2. **adopt as update to public facilities plan** 3. **adopt any necessary comp plan amendments.** 4. **adopt any necessary ordinances**
Complete storm water plan	Storm Water Plan completed Satisfies Public Facilities Rule Issues: 1. Population forecast is 125,000 - way over the 20-year projection 2. How to adopt the policies in last chapter – ordinance or operation procedures?
Recommend amendments to the: comprehensive plan text comprehensive plan map implementing ordinance	9/16/1997 – comprehensive plan amendments adopted regarding water wastewater stormwater Including adding an "abstract" of the sanitary sewer system water system [Ord. 2201] The 1997 amendments were not done through periodic review and were done right after the period review work program was finalized. **Review work done since 1997 to see if there are needed amendments.**
1.a – B uildable Lands Inventory	

Prepare detailed work program for subtask 1.a	
Coordinate with Marion County to develop a 20-year population projection to determine the potential demand for residential land	Woodburn, Marion County and LCDC have agreed Woodburn can use 34,919 for planning purposes
Document recent demographic, economic and transportation trends impacting residential land.	
Analyze demand for residential land/prepare housing needs analysis, pursuant to Goal 10, coordinate with surrounding jurisdictions to address low income housing needs.	IN PROCESS
Analyze comprehensive plan policies/map and inventory related to buildable land supply, Goals 10 and 14.	
Compare supply and demand in light of policies.	
Incorporate findings from public facilities plan that will affect availability of residential development.	There are no public facility constraints that will affect residential development
Coordinate proposed comprehensive plan map changes with findings and recommendations from commercial and industrial land study.	Commercial and industrial land study is in process
Adopt approved SMART development recommendation, research overlay district/infill strategies.	
Analyze growth management measure/public facilities strategy and develop[] necessary ordinances	
Recommend amendment to comprehensive plan text land use map implementing ordinances	

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Chapter 1

OBJECTIVES OF THE STUDY

INTRODUCTION

This section of the Study presents the objectives and goals of the Woodburn Storm Drainage Study including issues pertinent to the City and its managers and decision-makers. This Study is to be used in context with the land use and planning decisions and documents in effect at the time of the Study's creation. As development and environmental conditions in the study area change and objectives concerning growth patterns and land use change, the recommendations of this Study should be revisited and either confirmed or modified to reflect the new situation. This Study was developed between 1996 and 2001. While the general information and proposed recommendations for this Study have been updated for the year 2001, the hydrologic and hydraulic modeling is based primarily on data and assumptions made for the existing conditions in 1996. Specific information about the storm water system can be obtained through the City Public Works Department including results of a storm system inventory conducted in 1999.

REPORT FORMAT

This study outlines the storm drainage system capital projects that the City of Woodburn will need to implement soon. It also identifies capital projects that should be incorporated into the City's Capital Improvements Program (CIP) as development and growth require their implementation. All of these projects are needed to maintain a high level of runoff control while protecting public and private structures and overall public health. Since the City is served by two natural drainageways, Senecal Creek and Mill Creek and the two drainages have separate contributing areas, many of the report sections are formatted to discuss each drainage separately. A review of the detail of the table of contents will assist the reader in finding specific information about

drainage facilities, runoff quantities and recommendations in each basin.

OBJECTIVES OF THE STUDY

The following objectives outline the basis for this Study and are used to guide the analysis and decision process in arriving at the recommendations for drainage system modifications and improvements.

1. To provide a methodical and documented guide for development of storm drainage facilities in the City

a. by identifying problem areas that currently exist in the major drainage facilities.

b. by identifying potential problem areas that will become worse with development pressures.

c. by providing guidelines for future development and supporting storm drainage facilities.

2. To protect public and private property from flood risk

a. by identification of areas which frequently flood

b. by proposing system improvements to mitigate conditions which contribute to flooding conditions.

c. by selection of facilities which will convey storm water quantities deemed by the Study to be beyond the reasonable risk.

3. To minimize the public and private costs of drainage facilities

a. by optimizing use and conveyance capacity of existing facilities

b. by routing storm flows through natural channels, taking advantage of the capacities of those facilities.

c. by making recommendations that will provide maximum benefit to the public while minimizing cost.

d. by retaining natural drainageways in lieu of constructing structural systems in their place.

4. To make optimum use of the existing drainage facilities

a. by identifying natural flood storage areas and preserving and enhancing the capacity of those areas for similar use in the future.

b. by routing storm flow in a manner that takes advantage of the natural carrying capacity of existing drainageways.

c. by identifying critical elements of the existing manmade system and allowing for their continued preservation and maintenance.

5. To create a system of drainage facilities that will convey design storm runoff safely

a. by creation of a hydraulic model of the drainage system

b. by identifying those areas where storm runoff detention can safely be routed and stored during periods of high storm runoff.

6. To create a drainage system that will minimize maintenance and repair costs

a. by identifying opportunities to maximize the use of public rights-of-way for drainage routes.

b. by recommending drainage facilities that lend themselves to ease of maintenance and repair.

7. To provide a sound planning document in the form of a Detention Policy to guide future development within the drainage area

a. by creating a document for public review which will guide development of drainage facilities as the City grows and expands its service area.

8. To provide flow and water surface elevations and related data for Senecal Creek and Mill Creek for the 25- and 100-year flood conditions

a. by modeling the hydrologic conditions in each drainage way under estimated peak runoff conditions in each drainage watershed.

DEFINITIONS

Build-out Impervious Area - The estimated impervious area associated with full and complete development of the parcel in question when the land is developed as permitted in the City's Comprehensive Planning Document. Parcels considered may be undeveloped or under-developed parcels of land or acreage within Urban Growth Boundary.

City - City of Woodburn, Oregon

Concentration of Flow - The natural or created diversion of overland flow into a pipe, ditch, channel or other stormwater conveyance.

Datum – All references to flood elevations are based on the National Geodetic Vertical Datum of 1929 (NGVD29). Use of other datum should be adjusted to the NGVD 29 base.

Drainageways – are located on public or private property and specifically classified as follows:

Primary - A major drainage system serving an upstream area of 150 acres or greater, some or all of which are located within the City's Urban Growth Boundary. Specifically, Primary Drainageways include Mill Creek, the Stubb Road Tributary of Mill Creek, Senecal Creek and the East Tributary of Senecal Creek and other major drainageways as may be determined by the City.

Secondary - A natural, or manmade, stormwater conveyance system which collects stormwater from a land area of between 50 acres and 150 acres including all upstream

areas. Typically, secondary drainageways are small tributaries to Mill Creek and Senecal Creek or their Primary Drainageways.

Local - All other water routes not classified as Primary or Secondary Drainageways which carry stormwater or natural runoff. Typically, these include culverts, storm drains, ditches and other facilities which carry flows originating in an area of 50 acres or less.

Floodplain - The area within and adjacent to the City's primary drainageways, which is inundated by the 100-year runoff event, also, referred to as "Special Flood Hazard Area".

Floodway - See City of Woodburn, Ordinance No. 2018, Section 2 and Section 3, dated March 27, 1989. (Ordinance No. 2018 can be found in Appendix 'B' of this Study.)

Floodway Fringe – The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe encompasses the portion of the flood plain that could be completely obstructed without increasing the water surface elevation of the 100-year flood by more than 1.0 foot at any point.

Natural Drainageway - Any well-defined conveyance of stormwater which is not manmade. Alteration of any natural drainageways by diverting, culverting, armoring, deepening, or other similar activity does not change the category of such features, unless all, or nearly all, natural characteristics have been replaced with constructed facilities.

Overland Flow - Stormwater runoff which flows across sloping land in a diffused, non-concentrated manner.

Pre-Development - The existing, natural hydrologic condition of a site immediately prior to development or improvements.

Private Stormwater Facilities - Any stormwater facility which is not owned, maintained or operated by the City of Woodburn or any other public agency.

Post-Development - The hydrologic conditions of a site following development or improvements, including any new street or sidewalk construction.

Public Stormwater Facilities - All natural drainageways; also any stormwater facility which is owned by the City or located within a public utility easement, or public storm drainage easement that is granted to the City, but excluding any storm drainage pipe which crosses such easement for the specific purpose of serving private property or properties.

Stormwater Facility - Any man-made stormwater collection, conveyance or detention facility, including culverts, storm drains, manholes, catch basins, inlets, detention pipes and ponds, ditches, channels and swales, ownership of which may be public, private or shared.

Storm Return Frequency - The frequency that a storm of a given magnitude is statistically likely to occur, e.g., a 25-year storm event is a storm of such magnitude that has a statistical chance of .04 of occurring during a particular year.

System Development Charge – System Development Charges (SDC's) are fees charged in accordance with state law as implemented through Council-approved ordinances. Charges and fees are levied on new development in proportion to the impact on public facilities created by the development.

SUPPORTING DOCUMENTS

Documents used as reference in the preparation of this Study include the following:

- Comprehensive Planning Document, City of Woodburn, latest revision
- Zoning and Land Use Maps, City of Woodburn, latest revision
- Storm Water Management Plan, City of Woodburn, Robert E. Meyer Consulting Engineers; October, 1978
- City of Woodburn Flood Insurance Study (FIS), Federal Emergency Management Agency (FEMA), 1974
- Storm Drain Inventory, June 1999, Crane & Merseth Engineering/Surveying (Appendix A)
- City of Woodburn, Ordinance No. 2018, Council Bill No. 1138, dated March 27th 1989 (Appendix B)
- City of Woodburn, Senecal Creek East Tributary Capacity Analysis, Oakley Engineering, Inc., March 1994 (Appendix C)
- Elevation and Cross Section Surveys along Mill & Senecal Creeks, DaHaas & Associates, various dates

Chapter 2

WATERSHED DEFINITION

INTRODUCTION

Woodburn is situated primarily in the drainageway of Mill Creek and Senecal Creek. A very small portion of the City drains to the Pudding River, however, this portion is so small that the characteristics of the Pudding River watershed do not impact the analysis or findings of this Study. This section of the report describes the general characteristics of the watershed that contributes storm runoff to the Mill Creek and Senecal Creek drainageways as they cross the City's service area. It also includes areas within the City that contribute storm runoff directly to the two streams.

The City of Woodburn is the municipal agency with direct responsibility for storm water control and planning within the City's legally defined limits. The City of Woodburn does not have jurisdiction over all the lands located within the watersheds of the two major streams or that impact the drainage facilities within the City's control. The areas of the Senecal Creek and Mill Creek watersheds south of the Woodburn city limits are located within Marion County which has land use jurisdiction in the watershed.

Characteristics to be described include definition of the study area, annual and seasonal rainfall, topography, major natural features, soils conditions, current and projected land uses, and a description of the drainage facilities that serve the study area.

STUDY AREA DEFINITION

The study area for the Storm Drain Master Plan is comprised of the area within the city limits, the Urban Growth Boundary and those areas immediately surrounding the City which contribute

runoff flows to Mill Creek and Senecal Creek upstream of the City. This comprises approximately 9447 acres.

Location

Woodburn is located in the French Prairie area of the north Willamette Valley approximately 25 miles south of the Portland metropolitan area and 12 miles north of the City of Salem. Two major highways traverse the City; Interstate 5 along the west side of the City and 99E along the east side of the City. Both routes run generally north-south through Woodburn. Oregon highway 214 is an east-west route through the City, separating the northerly third of the City from the south areas.

In addition, the City is bisected by the Southern Pacific Railroad main line. The railroad extends north-south through Woodburn and parallels Front Street through the City. These major transportation routes create a significant barrier to surface water flows.

The study area used to develop this Master Plan is shown on Figure 1, Senecal & Mill Creek Drainage Basin Boundaries. The major features mentioned above are noted on this figure.

Natural Drainageways

Two natural drainageways cross the Woodburn study area from south to north. These are Senecal Creek along the west side of the study area and Mill Creek which bisects the City. The most easterly side of the City can be considered in the Pudding River watershed as small portions of the City generally (east of highway 99E) naturally drain to that watercourse. A few storm drainage facilities constructed and maintained by the City are routed to the Pudding River. These are small systems and are located so as to have little to no impact on the remaining natural and man-made drainageways located in the City.

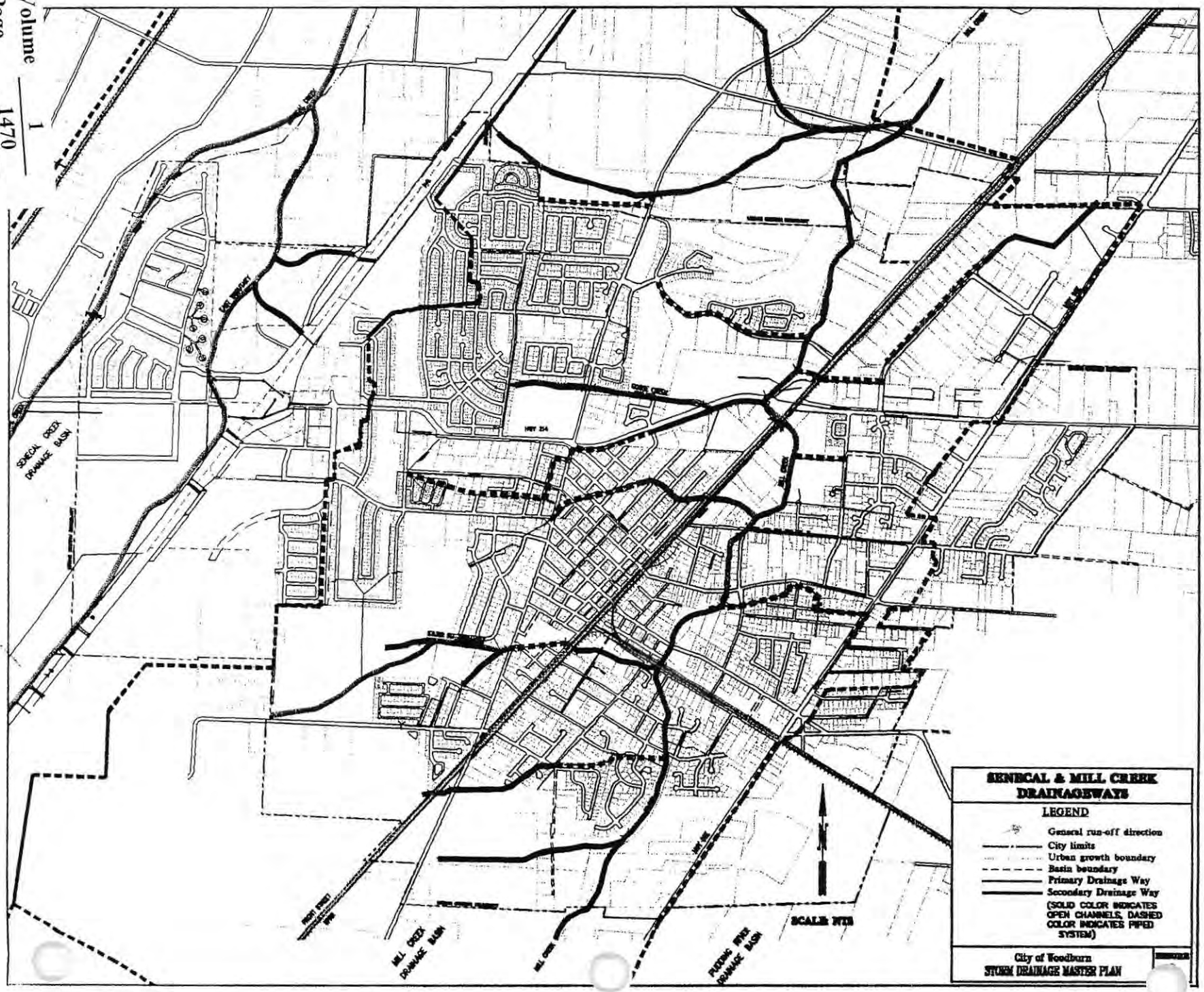
Each of the major drainageways, Senecal Creek and Mill Creek, has tributaries that originate within or just outside the study area. Figure 2, Senecal & Mill Creek Drainageways, displays the primary and secondary drainageways within the City boundaries. Some of these are named; others are small enough that no common name is associated with them. Senecal Creek and Mill Creek have their confluence north of Aurora approximately 4 miles north of Woodburn. Mill Creek continues to the Pudding River northeast of Aurora and the Pudding River joins the Molalla River near its confluence with the Willamette River. The gradient of both Senecal Creek and Mill Creek is steep enough that it is not necessary to model the drainageways to the north of a line approximately one mile north of Crosby Road.

The Corps of Engineers conducted a flood study for the Federal Emergency Management Agency (FEMA) in 1973. This Study provided a forecast of potential flood conditions along both Senecal Creek and Mill Creek outside the Woodburn city limits. Portions of this Study were used in preparation of this Master Plan.

Mill Creek Watershed Area

Mill Creek originates in a broad area south of Woodburn, west and north of the City of Gervais. Most of the area upstream from Woodburn is in agricultural use and has been terraced for this use. The Mill Creek drainage area within the Study area is approximately 5017 acres. Mill Creek flows northerly to its confluence with the Pudding River near the town of Aurora. In addition to Senecal Creek, several small, unnamed tributaries contribute to the Mill Creek flows.

Near Cleveland Street in the south part of Woodburn, Mill Creek divides into two main branches. One drains the areas to the southwest, generally east of I-5; the other continues south toward Gervais where it collects drainage and runoff from farmlands between the two cities.


SENECAL & MILL CREEK
DRAINAGEWAYS
LEGEND
General run-off direction
City limits
Urban growth boundary
Basin boundary
Primary Drainage Way
Secondary Drainage Way
(SOLID COLOR INDICATES OPEN CHANNELS, DASHED COLOR INDICATES PIPED SYSTEM)
City of Woodburn
STORM DRAINAGE MASTER PLAN
SCALE: NTS
SENECAL CREEK DRAINAGE BASIN
MILL CREEK DRAINAGE BASIN
PUDDING RIVER DRAINAGE BASIN
HWY 214
HWY 99E

Senecal Creek Watershed Area

Senecal Creek is a tributary of Mill Creek and originates in the area west of the Mill Creek drainage. A relatively small watershed of approximately 4430 acres within the Study area Senecal Creek flows from south to north and abuts the Woodburn city limits near the Butteville Road intersection with Highway 214 west of I-5. It serves as a drainageway for area both within and outside the city limits. The main stem of Senecal Creek enters the City passing under a bridge under Highway 214 just east of the Butteville Road intersection and extends from there along the west side of the West Woodburn development area (the former Nazerene Estates). From there the stream flows north, in open water crossing an abandoned railroad embankment through a 48" culvert. Near the north end of West Woodburn, it passes under a new bridge structure entering Senecal Creek Estates. North of that point, it exits the City and continues in a northerly direction.

A small tributary of Senecal Creek termed the East Tributary in this Study provides a drainageway for the areas east of West Woodburn, most of the I-5 runoff and a portion of Woodburn proper east of I-5 and south of Highway 214. This tributary serves an area of 883 acres inside the City including properties both east and west of I-5.

Major Topographic Features

The storm drainage study area is located on a reasonably flat, terraced area crossed by the two major drainageways described above. These two streams provide the greatest vertical relief in the study area itself, however south of the study area each becomes rather poorly defined and ends in a broad reach of agricultural land extending from highway 99E to I-5 and south from Parr Road to the City of Gervais. At the upper end of the two streams, the drainageway is poorly defined.

Soils

Soils and their characteristics to either retain or absorb precipitation is a prime factor affecting runoff and subsequent water levels in the streams receiving runoff flows. Soils in the Woodburn area have been classified by the Soils Conservation Service (SCS) in a report titled, "Soil Survey of Marion County Area, Oregon." This report indicates that Woodburn and the surrounding areas are located in what is termed a "Young, silty terrace alluvium." This material was deposited on flood plains probably in the late Pleistocene epoch.

The SCS classifies the runoff characteristics of a soil as belonging to one of four hydrologic groups. These groups, classified as A, B, C and D are used to set the characteristics of the hydrologic model. Group A soils are typically sands and gravels, having a well-drained profile, high infiltration and result in low runoff rates. Conversely, Group D soils are very poorly drained, and have low infiltration rates, resulting in high runoff rates. In areas immediately adjacent to the streams in the area, other soil types such as the Concord (Group D) and Dayton (Group D) are found. These make up such a small portion of the soils in the area that their effect can be ignored for purposes of creating an accurate model.

The predominant soil series found in the drainage areas of Mill Creek and Senecal Creek are the Amity Series and the Woodburn Series. The Amity and Woodburn soils are described as silt loam and silty clay loam and are classified by the SCS as Group 'C' soils. These two series are moderately well drained and moderately fine textured. Like other soils found in the area, the Amity and Woodburn soils are usually moist but may be dry for more than 60 consecutive days following the summer solstice. These two soil types make up over 20 percent of soil classifications found in the northern Willamette Valley.

Climate

The climate in the study area is a modified marine climate, typical of the northern Willamette Valley. The Pacific Ocean, the Coast Range and the Cascade Mountains have a substantial influence on the climate in the Woodburn vicinity as air masses move inland from the Pacific Ocean. Usually, the air is moist and near the ocean temperature. The coastal range serves as a buffer, moderating the most severe weather during the winter months.

On the floor of the Willamette Valley, those elevations between 100 and 500 feet, rainfall averages about 41 inches per year and one year in ten will exceed 51 inches in precipitation. The wettest months are usually November, December and January with almost 20 inches of rainfall occurring during that time. Lingering snowfall on the floor of the valley in Woodburn is unusual and contributes little to runoff and stream flows.

EXISTING AND FUTURE LAND USE

The Woodburn Urban Growth Boundary (UGB) encompasses the land within and immediately surrounding the existing city limits which has been designated within the jurisdiction of the City for the purposes of providing future planning. Within the UGB, the City has created and adopted a Comprehensive Land Use Plan which delineates the general future land uses and the average density of development within each land use area. The Comprehensive Land Use Plan is indicated in Figure 3, Woodburn Comprehensive Plan. This Plan has been used as the basis for projecting future conditions in the areas that are currently unserved.

In Woodburn the remaining undeveloped acres will be developed as economic and social conditions dictate and regulation allows. Woodburn's location on Interstate 5, located midway between the urban areas of Salem and Portland make it a desirable area for both residential and

COMPREHENSIVE
LAND USE PLAN
LEGEND
RESIDENTIAL
< 12 UNITS PER ACRE
RESIDENTIAL
> 12 UNITS PER ACRE
COMMERCIAL
INDUSTRIAL
OPEN SPACE AND PARKS
PUBLIC USE

FIGURE 3

commercial development. Woodburn has shown reasonably consistent growth over the past 10 years and is expected to continue that growth into the future.

Growth in Woodburn is expected to closely match historic growth in terms of the type and density.

Future Increases in Impervious Areas

The quantity of stormwater that reaches public waterways is a direct function of the location, amount and type of impervious areas in the drainage basin. Impervious areas are those surfaces such as rooftops, parking areas, streets, sidewalks which minimize and even prevent percolation of stormwater into the soil. Impervious areas may be in the City or outside the UGB and may be publicly or privately owned. It is important therefore, to estimate the location, type and runoff parameters of impervious areas in the drainage basins and base future hydraulic capacities on these projections.

Based on the 1996 Comprehensive Plan the estimated increase in development to achieve full build out is 617 acres of new development. In preparing the estimate of future impervious areas, the following assumptions were made:

A. Open Space and Natural Areas - Areas within the study area which are currently designated as Open Space or Natural Areas are assumed to remain as natural areas and are excluded from the impervious area calculations. Examples include public parks and designated wetlands.

B. Public Areas - Areas which are in public ownership and used as public facilities or set aside for future use as a public facility. Impervious area calculations will consider these parcels based on their current or intended use and assume runoff

based on that use. For example, a future public park will have a negligible amount of impervious area while a school site will have an amount similar to a light industrial site.

C. Private Developable Areas – Privately held lands planned for residential (single or multifamily), light and heavy commercial and industrial uses were assumed to develop to the fullest extent allowed by the Comprehensive Plan. Areas not fully built as of 1996 were assumed to have the same percentage of impervious area as fully built areas with similar zoning.

D. Land Available for Development - Private lands planned for eventual development were assumed to have a full compliment of public streets, sidewalks and other amenities as required by development regulations. These impervious areas are assumed to be developed to the fullest extent allowed by the Plan.

E. Development Efficiency - Each category of land use was assumed to develop to 100 percent of the density allowed by the Comprehensive Plan. This is a conservative assumption as there will usually be parcels that, for a variety of reasons, are not developed at all or develop to densities less than that allowed by the Plan.

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Chapter 3

STUDY METHODOLOGY

INTRODUCTION

This section of the report outlines the approach and technical methods used to create the Storm Drainage Master Plan, analyze drainage system features and forecast the future needs of the system. Hydraulic and hydrologic calculations for this Study are based on 1996 land use and system layout. This Study includes both major drainageways that serve the City of Woodburn, Senecal Creek and its tributaries and Mill Creek and its tributaries. A part of Woodburn's jurisdiction is located east of Highway 99E and properties in this area generally drain to the Pudding River. These properties are relatively small and located at the fringe of the Pudding River catchment area. Consequently, these properties are not included in this Study as any analysis of this area would not provide a suitable basis for decisions about drainage system development within the City's Urban Growth Boundary in the area in question.

In order that the Study accurately reflect the existing system and hydraulic conditions in the Senecal Creek and Mill Creek drainage systems and to set the basis for conditions not easily measured, several assumptions were made and are outlined here. This section also presents the basis of the computer model used to calculate runoff quantities (hydrologic elements) and flow rates and conditions in the existing drainageway (hydraulic elements).

ASSUMPTIONS USED IN THE ANALYSIS

The following assumptions were made in performing the hydrologic and hydraulic analysis:

1. Land uses for calculation of future development types and densities were based on the Woodburn Comprehensive Plan Land Use Map, dated 1996. See Figure 3, Woodburn

Comprehensive Plan, for the land use plan as of June 2001.

2. Rainfall is assumed to be constant throughout the watershed for the design storm used in the calculations.

3. Existing impervious areas were computed from aerial photos of the Woodburn area taken in 1994. Estimates of future impervious areas are based on these aerial photos where similar land uses and full buildout of areas existed. (Note: More current aerial photos were taken in April, 2001 and are available at the City of Woodburn, Public Works Dept.)

4. Model parameters such as soil types within each basin and subbasin are taken from the relevant publications prepared by federal and state agencies.

5. The design storm used in this analysis is the 24-hour storm with recurrence intervals of 2-, 5-, 25- and 100-years. Recurrence interval or annual probabilities of storm occurrence is as follws:

Recurrence Interval (Frequency) (years)	Annual Probability of Occurrence
2	0.50
5	0.20
25	0.04
100	0.01

It is apparent that the annual probability is the reciprocal of the recurrence interval indicating that large storms occur with less frequency than do smaller storms. A key assumption in development of the hydraulic analysis is the degree of protection from floodwaters that the community wishes to assure balanced against the ability of the community to pay for that added protection. It is also prudent, from a public works management point-of-view, to plan for

maximum return on investment knowing that the community cannot practically afford to protect its property against all conceivable storm events.

Years of experience by communities like Woodburn has shown that planning drainageway facilities to convey storm runoff with a recurrence interval of 25 years is an affordable goal while providing reasonable flood protection.

MODELING AND ANALYSIS BASIS AND ASSUMPTIONS

Figure 1, Senecal & Mill Creek Drainage Basin Boundaries, shows the entire study area including the portions of Senecal Creek and Mill Creek that flow through the City of Woodburn. The study area boundary is set by topographical features. Since one of the stated purposes of this Study is to determine the existing flow and water surface elevations in each stream during specified runoff conditions and, from that create a plan, definition of the study area itself is very important.

The most current hydraulic information currently available for Senecal and Mill Creeks includes the following reports:

1) "City of Woodburn Flood Insurance Study (FIS)", Federal Emergency Management Agency (FEMA), 1978.

2) "City of Woodburn Storm Water Management Plan", Robert E. Meyer Consultants, October, 1978.

Since publication of these two studies, several significant changes have occurred which affect hydrologic and hydraulic conditions in Senecal Creek and Mill Creek. The primary factors which account for differences between this Study and previous flow and flood profile information published for these streams are:

1. **Impervious area increases:** Flows calculated in this Study account for increases in impervious areas due to development which has occurred between 1978, when the previous drainage master plan was developed, and 1996.

2. **Additional downstream flow constrictions:** A privately-owned agricultural structure on Senecal Creek located about one mile north of Crosby Road restricts flows and causes water to back up into the city limits. Neither previous study calculated the impacts on upstream water levels resulting from this structure.

3. **Modifications to the Oregon Electric Railroad embankment:** Flood level calculations on Senecal Creek assumed there to be no breaks in the top of the berm at this abandoned crossing structure. Field observations indicate that a 60-foot wide portion of the earthen structure crossing Senecal Creek has been excavated to create a high water overflow channel at the eastern end of the structure.

4. **Senecal Drive Crossing at Senecal Creek Estates:** This culverted road embankment across Senecal Creek was not present during the time of the earlier studies.

5. **Field survey data:** In 1995 survey data was obtained at all road crossings and at a number of selected cross-sections for both Senecal Creek and Mill Creek for this Study. This information was obtained by DeHaas & Associates, Inc. using Global Positioning Systems methods and represents a higher standard of accuracy than that required by FEMA for the earlier studies. Modeled cross-sections were field surveyed to obtain more accurate data and elevations.

HYDROLOGIC ANALYSIS METHODOLOGY

A hydrologic analysis was conducted to estimate peak flows and runoff volumes impacting drainage facilities within the study area. Computer models using the US Army Corps of Engineers HEC-1 methods were developed to compute flow hydrographs for existing and full buildout levels of development for each subbasin in the study area.

The HEC (Hydrographic Engineering Center) models are designed to simulate the surface runoff (HEC-1) and the hydraulic response (HEC-2) of a basin to that runoff. A design storm rainfall distribution is translated into a runoff hyetograph and this is used to develop the stream hydrograph for each subbasin and the main stem of the stream. Effective rainfall is computed by abstracting infiltration and surface storage using an infiltration function. Within each subbasin, rainfall and infiltration rates are assumed to be uniformly distributed across the subbasin. Flows from each subbasin are routed by the model to the point of confluence with other subbasins. When combined with the hydrograph from another subbasin, a composite hydrograph is computed by the model which accounts for any differences in the timing of the occurrence of the peak flow between the two hydrographs.

The processes used in the HEC-1 model are precipitation, interception/infiltration, transformation of effective precipitation into runoff, addition of base flows and flood hydrograph routing in the stream channels including reservoirs where they are present.

The HEC-1 and HEC-2 models use the following input parameters:

- Subbasin Area (acres)

  Subbasin area is the surficial watershed within which runoff can be assumed to flow to a single discharge point.

- Design Precipitation Hyetograph

The design hyetograph for the appropriate return interval is the bell-shaped relationship between precipitation intensity and time as the storm begins, then reaches peak intensity, then recedes. The SCS Type 1A 24-hour design storm distribution was used.

- Soil Conservation Service's (SCS) Runoff Curve Number

  The SCS runoff curve number is used to calculate the amount of rainfall that is absorbed by vegetation or the underlying soils. For impervious areas, a standard curve number of 98 was used. For grassed and wooded areas curve numbers were calculated based on the composite hydrologic group of the soils within each subbasin.

- Percent Impervious Area

  The percent impervious area is the percentage of the watershed surface over which no infiltration and only minor rainfall losses occur. Percent impervious for existing conditions was obtained from aerial photography taken in 1994. Percent impervious for future development conditions was computed based on typical percentages of impervious areas for the land use(s) planned for the subbasin.

- Percent Grass

  The percent grass parameter is used to represent the percentage of the basin for which runoff can be calculated using an SCS curve number typical of grass or pasture ground cover. For future full buildout conditions, pervious surfaces in fully developed areas were assumed to be primarily grass.

- Percent Woods

  The percent woods parameter is used to represent the percentage of the basin for which runoff can be calculated using an SCS curve number typical of wooded ground cover.

- Time of Concentration (Minutes)

  Time of concentration is the time lag between when the storm begins and when runoff

from the most distant portions of the subbasin reach the discharge point. Time of concentration was estimated by calculating the time of travel from the most distant point in the subbasin to the subbasin discharge point, or node.

The result of the hydrologic modeling process is the computation of subbasin runoff hydrographs (runoff from each individual subbasin vs. time) and stream flow hydrographs (stream flow rates from all upstream subbasins vs. time). Peak flows at desired locations in the drainageways were estimated for both existing and full-buildout development conditions. Existing and future peak flows from individual subbasins were calculated for the 2-, 5-, 10-, 25- and 100-year events. Composite in-stream peak flows were calculated for the 5-, 10-, 25- and 100-year events.

Estimated peak flows are used in the hydraulic models described below to evaluate existing and future drainage facility capacities. The hydrologic model estimates "how much" flow is occurring and the hydraulic models estimate "how deep" the flow will get in the various types of conveyance structures.

HYDRAULIC ANALYSIS

Hydraulic analysis involves calculating the water surface profile under existing and ultimate land use conditions based on the estimated peak flows generated from the hydrologic analysis. Hydraulic modeling was conducted to determine the maximum capacity of existing and future drainage facilities and to determine improvements required to meet existing and future drainage needs.

In-house hydraulic models were used to calculate hydraulic capacities for a majority of the piped, culverted and open channel drainage segments in the study area. These models implement Manning's equation for normal depth flow in pipes and open channels and the Federal Highway Administration (FHA) culvert equations for inlet control and submerged culvert conditions. For complex culvert configurations, the FHA utility program HY-8 was used. The Corps of

Engineer's HEC-2 hydraulic profile model was used to calculate hydraulic profiles along Senecal and Mill Creeks.

The HEC-2 and HY-8 models are described below:

HEC-2

The HEC-2 model computes water surface profile using several input parameters: (1) peak flows from the hydrologic analysis, (2) cross-sectional areas at regular intervals along the channel, (3) Manning's "n" friction coefficient, and (3) starting water surface elevations.

The HEC-2 model only models subcritical flow. Generally, subcritical flow is deep, slow flow, while super-critical flow is shallow, rapid flow. Starting at the water surface elevation at the outfall of the waterway, HEC-2 calculates water surface elevation at the next selected upstream point. The program then calculates the energy loss due to slope and friction between the points. Energy loss, or head loss, is expressed as loss in water surface elevation (relative to the streambed). This procedure is repeated for the length of waterway, resulting in a water surface profile. Water surface profiles were developed for flows anticipated under existing and future development conditions.

HY8

The Federal Highway Culvert Program HY8 model is a utility program which was used to supplement HEC-2's limited multiple culvert modeling capabilities. The HY8 program effectively models changes in the water surface profile due to multiple culverts and combination culvert/weir flow. The methodology of HY8 is identical to HEC-2, except that it requires the physical dimensions of the culvert/weir.

ANALYSIS OF THE MODEL RESULTS

The primary objective of the analysis was to evaluate the adequacy of existing drainage facilities

to accommodate both existing and future flows and to develop a phased capital improvements plan to upgrade inadequate facilities. The approach involved problem identification, identification of improvement alternatives, and selection of the appropriate system improvements. This approach was used first to analyze the drainage system's response to existing peak flows, and then its response to future peak flows.

Major drainage basins were defined for the major tributary creeks. Drainage subbasins were delineated by identifying areas which could be characterized as draining to one discharge point and which were relatively uniform as to slope and land use. Subbasins were delineated into relatively small areas (15-60 acres) within the City of Woodburn study area. Larger basin areas were used to calculate flows for portions of the watershed outside the Woodburn UGB and within Marion County. For each subbasin, hydrologic input parameters were estimated. (See Chapter 4, Model Definition and Basin Delineation.)

The design rainfall event for input into the hydrologic models was determined using the NOAA Atlas and the SCS Type 1A storm distribution. See Chapter 5, Analysis of Rainfall Runoff, for a more complete description of these runoff parameters.

The Santa Barbara Urban Hydrograph Method was used to compute individual flow hydrographs for each subbasin area. Peak undetained subbasin flows were determined for existing and future conditions.

In order to calculate peak in-stream flows for existing and future, unimproved conditions, hydrologic computer routing models were constructed using the branching configurations of the subbasins. The subbasin hydrographs were routed and combined using the "Hydrograph lag" and "Muskingum" routing methods described previously to determine "free-flowing" peak in-stream flows for the main open-channel drainageways. Locations where significant reduction in flow occurs due to existing culvert constrictions and storage of excess flows were identified and modeled separately using detailed storage routing computer spreadsheet models. The outflow

hydrographs obtained from the storage routing models were then input back into the "free-flowing" models to obtain peak in-stream flows which account for storage. At key storage locations, existing culvert and storage-elevation curves were assumed for both existing and future, unimproved flow calculations.

Peak undetained subbasin flows and peak in-stream drainageway flows are calculated in Chapter 5, Analysis of Rainfall Runoff.

In-house hydraulic spreadsheet models were used to calculate the flow capacity of each significant drainage facility in the City. Drainage facilities evaluated include the major creeks and tributaries, piped segments 12 inches or larger in diameter and open channel drainage ditches which convey more than just local runoff from adjacent properties. For Senecal Creek and Mill Creek facilities, in-house models were used to estimate the individual capacity of the culvert and bridge crossings, while HEC-2 models previously developed by the Corps of Engineers were used to evaluate the capacity of the creek as a whole.

The capacity of each facility evaluated was compared to the calculated peak in-stream flows to determine the largest frequency event that could be conveyed by the existing facilities for existing and future flows. The frequency of excedence was then compared to the approximate risk to adjacent development. For example, if a parking lot were inundated every 5 years it would probably be considered tolerable. If a residential dwelling were at risk even at a 25-year frequency, it would probably be considered intolerable. If the frequency of system excedence was considered to be intolerable based on discussions with City staff, the segment would be identified for correction. The severity of each identified problem area was evaluated based on the extent of flooding hazards, such as inconvenience or property damage. The timing of improvements to correct an identified problem was dependent on the severity of risk associated with system excedence and the rate of upstream growth that could further aggravate the situation.

After the problem areas were identified, improvement alternatives for alleviating flooding were

developed. The following alternatives were considered in this approximate order:

(1) Surcharge - Consider allowing pipes to be surcharged if the hydraulic grade line does not rise above the ground surface.

(2) Design Storm - Consider allowing a lesser design storm standard such as a 2 year or 5 year standard where the risk of damage is minimal or low.

(3) Bypass - Re-route the flow around or away from the problem area without further aggravating other areas.

(4) Detention - Consider the construction of detention facilities upstream of the problem area to hold back peak flows upstream in order to moderate downstream flows.

(5) Replacement - Replace the conduit with a larger diameter pipe and/or increase the slope of the pipe.

The effects of these alternatives were evaluated using the HEC-2 model for Senecal Creek and Mill Creek and in-house hydraulic spreadsheet models for other drainage systems. The alternative that minimized costs without compromising safety was the alternative recommended. (See Chapter 7, Recommendations for Drainage Improvements.)

When analyzing future system improvements, it was assumed that improvements required for the existing development conditions were in place. Costs were estimated for the recommended improvements. The costs, scope of improvement, and suggested phasing are summarized in Chapter 9, Recommended Capital Improvement Projects.

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Chapter 4

MODEL DEFINITION AND BASIN DELINEATION

INTRODUCTION

The Study area watershed and major drainage basins within that area were delineated in Chapter 2, Watershed Definition. The major drainage basins delineated in Chapter 2, Watershed Definition, represent the overall basin areas draining to the two principle drainageways in the Study area, Senecal Creek and Mill Creek (See Figure 1, Senecal & Mill Creek Drainage Basin Boundaries). In this chapter, the major drainage basins are further divided into subbasins for the purpose of modeling drainage flows within the storm drainage system. This chapter describes the process used to delineate the subbasins and explains the conventions used for referencing the subbasins. The following sections describe and then quantify the hydrologic parameters for each subbasin used in the runoff calculation models. Chapter 3, Study Methodology, of the report describes the hydrologic runoff models used in this analysis and the input parameters required to adapt these models to the two major drainage basins and their subbasins.

SUBBASIN DELINEATION METHODOLOGY

Using the criteria outlined below, for the Senecal Creek basin delineation process resulted in 5 major basins, (S-1 to S-5). The East Tributary of Senecal Creek lies within major basin S-4. In the East Tributary of Senecal Creek basin 13 subbasins (A-L) were delineated within 4 management zones (ES-1 to ES-4). Areas of the Senecal Creek basin outside the East Tributary area were not further divided into subbasins. In the Mill Creek drainage basin 12 major basins (M-1 to M-12) and 51 subbasins were identified. Subbasins generally range in size from 15 to

100 acres with larger subbasins located at the extreme north and south ends of the Study area. The location of these subbasins are shown in Figures 4 and 5, Drainage Subbasins, for Senecal Creek and Mill Creek, respectively. The coding and drainage parameters of these subbasins are described below.

To refine the modeling analysis and facilitate identification of potential drainage problems and improvements, each primary basin delineated in Chapter 2, Watershed Definition, was further delineated into major basins and subbasins. The factors considered for each basin delineation include:

- Size between 20 and 120 acres - Subbasin areas within this range increase the modeling accuracy of peak flow analysis and are typically used in drainage master planning. Some subbasins smaller than 20 acres were necessary to account for highly varied land uses or topography, or to facilitate calculating flows at a specific key point of interest. Subbasins larger than 120 acres were used for large undeveloped areas with uniform basin characteristics and minimal existing drainage facilities.

- Similar existing and/or future land uses within subbasin - Since runoff rates and amounts are significantly impacted by impervious surface areas and since the amount of impervious surfaces is largely a function of land use intensity, delineating subbasins with relatively uniform land uses allows more meaningful runoff parameters to be estimated.

- Consistent topography - Since the time for runoff to reach the outfall of a subbasin from the furthest reaches of the subbasin is an important factor in the determination of peak flows and since flow time is related directly to slope, accuracy is improved if the subbasin is drawn to include areas of relatively uniform topography.

- Consistent soil type - Since runoff is that portion of precipitation that is not absorbed by the soil or otherwise retained and since the type of soil is directly related to how much water

infiltrates through the soil, the estimation of subbasin flows is more realistic if the subbasins are drawn to include areas of relatively uniform soils.

- Common Outfall - Generally, the subbasin should be drawn so that all flow from the subbasin discharges at one point, i.e., one storm drain outfall or a creek. For those subbasins which lie along major waterways, discharges into the waterway are often numerous and sometimes indistinct. However, these subbasins which discharge along drainageways can generally be considered as if they discharged at a single outfall into the waterway.

- Jurisdictional Boundaries - Where possible, subbasin boundaries were delineated to coincide with jurisdictional boundaries. This convention allows the Drainage Master Plan to more easily identify runoff impacts due to lands within other jurisdictions.

SUBBASIN CODING

Subbasin coding is required as a means of referencing the branching relationships of the drainageways modeled in the hydrologic computer models. To facilitate subbasin coding and model identification, each of the major drainage basins in the Study area watershed was assigned a letter prefix. In this report, subbasins in the Senecal Creek drainage basin begin with an "S", an "ES" for the East Tributary of Senecal Creek and those located in the Mill Creek basin begin with an "M".

Portions of both stream basins are located outside the City's area of influence (the UGB). Runoff from these areas is simulated through use of a flow hydrograph located at the upper (south) segment of either Mill Creek or Senecal Creek where the two streams enter the Woodburn service area. On Mill Creek, an additional basin (M - 1) is located immediately north of the UGB and, while it has a minor impact on flood levels in Mill Creek, it does not have a direct

effect on any of the tributary stream water levels or any piped system in the City. Subbasin M - 1 joins the main stem of Mill Creek just south of Crosby Road and because of this, subbasin M - 1 is included in the model calculations.

Within major basins of Mill Creek and Senecal Creek, smaller subbasins are identified and given discrete alphanumeric names. Each subbasin delineated has one node (defined as the subbasin discharge point) where the runoff collected within the subbasin is discharged into the next downstream subbasin. The downstream node number and the subbasin designation are the same. These smaller subbasins within the Mill Creek and Senecal Creek drainage basin were numbered, beginning with the furthest downstream node point. Moving upstream along the basin's main waterway, each node is numbered sequentially. For example, on Mill Creek, subbasins along the main creek are numbered M-1, M-2, M-3, M-4, etc.

In some cases, subbasins are further subdivided into smaller areas and these are numbered using a lower case letter following the major basin number. For example, the Mill Creek subbasin M - 7 has additional subbasins further away from the stream and these are designated M - 7a, M - 7b, etc. This convention was used where a subbasin was located on either side of the modeled stream or where the smaller areas within a subbasin have distinctly different characteristics and were modeled individually. Usually, the major subbasin designation (M-1, M-2, etc) were used to show the accumulated runoff in a defined tributary of either Mill Creek or Senecal Creek.

HYDROLOGIC PARAMETERS

Chapter 3, Study Methodology, gives a brief overview of the hydrologic modeling process and the input parameters required to calculate peak drainageway flows. These required hydrologic input parameters were developed for each subbasin delineated in the Study area watershed and are discussed below. Table 4-1 and 4-2, Subbasin Runoff Parameters, for Mill Creek and the East Tributary of Senecal Creek respectively, summarizes the runoff parameters selected for use

Table 4 - 1
Subbasin Runoff Parameters
Mill Creek

			Soils / Infiltration			1996 Level of Buildout			Full Buildout Conditions		
Sub-basin	Area (Acres)	Area (Sq. Miles)	% Class C Soils	% Class D Soils	Existing Use Curve No.	Mapped Impervious Area	Modelled / Effective Imperv. Area	Time of Conc. (Min)	Mapped Impervious Area	Modelled / Effective Imperv. Area	Time of Conc. (Min)
M-1	359	0.561	80%	20%	80.9	5%	0%	195	0%	0%	195
M-1A	390	0.610	90%	10%	80.0	5%	0%	70	0%	0%	70
M-1B	71	0.112	90%	10%	80.5	5%	0%	64	45%	39%	28
M-1C	53	0.083	65%	35%	76.1	39%	24%	26	39%	24%	26
M-2	109	0.170	90%	10%	78.2	8%	2%	74	72%	68%	26
M-3	76	0.119	92%	8%	74.5	5%	0%	73	0%	0%	73
M-3A	96	0.150	100%	0%	74.0	5%	0%	73	40%	34%	29
M-4	40	0.062	90%	10%	74.4	25%	19%	26	37%	30%	26
M-4A1	42	0.066	60%	40%	77.6	45%	39%	26	79%	75%	21
M-4A2	16	0.025	40%	60%	77.6	56%	50%	15	56%	50%	15
M-4A3	18	0.028	100%	0%	78.0	40%	33%	20	74%	69%	15
M-5	59	0.092	90%	10%	74.4	30%	24%	25	55%	49%	20
M-5A1	69	0.107	90%	10%	78.2	10%	3%	45	34%	28%	37
M-5A2	65	0.102	75%	25%	77.0	15%	6%	60	46%	39%	27
M-5A3	97	0.151	60%	40%	76.4	43%	28%	30	43%	28%	30
M-5A4	30	0.047	50%	50%	74.5	23%	11%	30	23%	11%	30
M-5B1	53	0.083	80%	25%	76.3	51%	36%	29	51%	36%	29
M-5B2	37	0.058	60%	40%	76.4	35%	29%	35	56%	50%	20
M-5B3	55	0.086	60%	40%	76.4	37%	23%	35	41%	26%	35
M-6	42	0.066	90%	10%	71.7	0%	0%	70	0%	0%	70
M-6A	65	0.102	95%	5%	74.3	40%	25%	25	46%	32%	20
M-6A2	69	0.108	95%	5%	74.3	33%	19%	40	66%	61%	30
M-6B	23	0.036	90%	10%	74.6	25%	13%	25	73%	69%	15
M-7	99	0.154	95%	5%	74.3	40%	25%	35	55%	41%	35
M-7A	24	0.038	100%	0%	74.0	40%	25%	18	68%	55%	18
M-7B1	49	0.076	90%	10%	74.6	25%	13%	24	39%	25%	24
M-8	36	0.056	90%	10%	74.4	39%	25%	25	49%	43%	21
M-9	31	0.049	85%	15%	74.7	15%	6%	40	33%	27%	28
M-9A1	92	0.144	95%	5%	74.3	45%	30%	35	52%	37%	35
M-9A3	57	0.089	100%	0%	76.0	50%	44%	30	68%	63%	25
M-9B	33	0.052	100%	0%	76.0	56%	50%	13	70%	65%	13
M-10	100	0.157	90%	10%	74.5	38%	24%	27	43%	28%	27
M-11	78	0.121	90%	10%	74.6	19%	8%	34	51%	45%	26
M-11A	43	0.067	90%	10%	74.6	30%	16%	25	41%	35%	20
M-11B1	69	0.108	95%	5%	74.3	27%	14%	30	43%	28%	30
M-11B2	28	0.044	90%	10%	78.0	0%	0%	63	39%	32%	38
M-11C	34	0.053	95%	5%	78.2	0%	0%	63	46%	40%	26
M-11C2	39	0.060	60%	40%	79.6	5%	0%	75	45%	39%	23
M-11D1	88	0.138	90%	10%	78.4	0%	0%	62	32%	25%	25
M-11D2	48	0.075	60%	40%	76.4	49%	34%	25	49%	34%	25
M-11E1	57	0.088	90%	10%	78.4	0%	0%	69	18%	13%	25
M-11E2	77	0.120	90%	10%	78.4	0%	0%	69	45%	39%	25
M-11E3	61	0.095	100%	0%	78.0	0%	0%	90	0%	0%	90
M-11F	161	0.252	50%	50%	80.0	0%	0%	180	0%	0%	180
M-12	62	0.097	60%	40%	75.6	25%	19%	27	36%	29%	27
M-12A1	23	0.036	95%	5%	72.0	5%	0%	75	45%	39%	26
M-12A2	70	0.109	95%	5%	78.0	2%	0%	110	45%	39%	36
M-12A3	12	0.018	90%	10%	78.0	0%	0%	45	45%	39%	20
M-12B	68	0.106	95%	5%	78.0	20%	9%	40	65%	60%	23
M-12C	134	0.209	95%	5%	78.0	2%	0%	120	45%	39%	36
M-13	955	1.493	90%	10%	78.2	1%	0%	200	1%	0%	200

TABLE 4 - 2

East Tributary of Senecal Creek

Subbasin Runoff Parameters

Sub-basin	Area (Acres)	Area (Sq. Miles)	% Impervious MIA	% Impervious EIA	SCS Curve #, Pervious Areas	Time of Conc. (Minutes)	Lag Time (Hours)
1993 Conditions							
A	124.5	0.195	8.0%	1.0%	78	102	1.02
B-1	60.3	0.094	60.0%	46.5%	74	60	0.60
B-2	49.4	0.077	2.0%	0.5%	74	31	0.31
C	49.0	0.077	38.0%	23.4%	74	19	0.19
D	78.3	0.122	3.0%	0.5%	80	35	0.35
E	50.2	0.078	22.0%	10.3%	80	28	0.28
F	30.0	0.047	35.0%	20.7%	80	20	0.20
G	76.6	0.120	5.0%	0.5%	80	127	1.27
H	26.7	0.042	60.0%	54.4%	77	20	0.20
I	33.6	0.053	57.0%	51.2%	77	20	0.20
J	40.6	0.063	2.0%	0.5%	80	130	1.30
K	83.1	0.130	5.0%	0.5%	80	160	1.60
L	121.0	0.189	3.0%	0.5%	81	190	1.90
Full Buildout Development Conditions							
A	124.5	0.195	8.0%	1.0%	78	102	1.02
B-1	60.3	0.094	60.0%	46.5%	74	60	0.60
B-2	49.4	0.077	2.0%	0.5%	74	31	0.31
C	49.0	0.077	45.0%	30.2%	74	19	0.19
D	78.3	0.122	70.0%	65.5%	77	22	0.22
E	50.2	0.078	67.0%	62.1%	77	16	0.16
F	30.0	0.047	66.0%	61.0%	77	18	0.16
G	76.6	0.120	72.5%	68.3%	77	37	0.37
H	26.7	0.042	68.0%	63.3%	77	16	0.16
I	33.6	0.053	72.0%	67.5%	77	14	0.14
J	40.6	0.063	75.0%	71.1%	77	18	0.18
K	83.1	0.130	45.0%	38.5%	77	24	0.24
L	121.0	0.189	3.0%	0.5%	81	190	1.90
New Development Areas to Be Routed (Full Buildout) *							
M-C	24.7	0.039	75.0%	71.1%	77	15	0.15
S-I	17.0	0.027	85.0%	82.7%	77	13	0.13
M-HDR	30.3	0.047	65.0%	59.5%	77	15	0.15
M-LDR	42.9	0.067	45.0%	38.5%	74	24	0.24

* NOTE: M denotes basins currently draining to Mill Creek.
S denotes basins currently draining to Main Senecal Creek.

in the hydraulic model. Parameters include size, percentage of various soils classes, mapped impervious and modeled impervious area for both existing and future conditions, and the time of concentration for both existing and future conditions. Descriptions and explanations of the key parameters follow.

EFFECTIVE IMPERVIOUS AREA

The amount of runoff is increased substantially by increased impervious areas within the subbasins. Impervious areas, such as streets, parking lots, rooftops, sidewalks, and loading areas, increase the volume by preventing infiltration. Further, these impervious areas tend to concentrate the runoff into storm drains or ditches which more rapidly convey the runoff to the receiving stream. This decreased time of conveyance decreases the time of concentration and generally increases peak rates of runoff downstream. Transformation of agricultural lands to highly urbanized lands can increase the rates and volumes of storm runoff by a factor of 2 to 4 times. Impervious area is a very significant factor in the analysis of storm drainage systems.

Percent impervious areas for this Study were determined using aerial photography taken in 1994 supplemented with zoning maps. Using the aerial photographs, developed areas were delineated and categorized by the type of land use. Using zoning maps in conjunction with the aerial photographs, the approximate density and land use of each developed area were determined. For each developed area having a similar land use and density, a percent impervious area representative of existing conditions was computed. Within each subbasin, the ratio of impervious area was multiplied by the percent developed for each land use to determine a total impervious area for the subbasin.

The "mapped" impervious areas determined above were adjusted to an "effective" impervious area for input into the hydrologic models. For fully storm sewered basins, where a majority of the impervious surfaces drain directly to a storm drain system, the effective impervious area is equivalent to the mapped impervious area. In older areas of town, however, many of the streets

do not have curb and gutter systems, roof drains may drain to individual drywells and many impervious surfaces may drain across pervious areas before runoff is collected by the storm system. In these cases, the mapped impervious area was adjusted to an effective impervious area in order to account for the additional rainfall losses which occur.

The following equation, which is based on regression analysis results published by OTAK, Inc. (1988), was used to estimate the effective impervious area (EIA) for use in the hydrologic models, given the mapped impervious (MIA) area determined from the aerial photographs:

$$EIA = 0.1 \times (MIA)^{1.5}$$

Future percent impervious areas were estimated using the Comprehensive Plan land use map and the Zoning Map for Woodburn. Lands which are currently undeveloped are assumed to be developed according to their Comprehensive Land Use designations. Developed, nonconforming parcels (different from what is specified in the Comprehensive Plan) are assumed to be re-developed and eventually reach the land use and density specified in the Comprehensive Land Use Plan.

Future developed areas are assumed to be fully served by a public storm sewer system, and have an effective impervious area equivalent to the mapped impervious area estimated from the land use maps. The final effective impervious areas for the Mill Creek basin used in the hydrologic models are summarized in Table 4-1, Subbasin Runoff Parameters, for existing and buildout conditions.

SOIL LOSS PARAMETER

The reduction in runoff from pervious areas which occurs due to infiltration and evapotranspiration is estimated in the hydrologic models using a soil loss parameter developed

by the Soils Conservation Service (SCS). This parameter, the Runoff Curve Number, depends on the soil type, ground cover and antecedent (pre-design storm) moisture of the watershed.

Chapter 2, Watershed Definition, discusses the infiltration characteristics of the surface soils found throughout the Study area watershed. In that chapter, soils were designated as belonging to Hydrologic Group A, B, C, or D as defined by the Soils Conservation Service (SCS). Hydrologic Group "A" soils typically include highly pervious soils with low potential for runoff, such as sands. Hydrologic Group "D" soils typically include fine grained impervious soils with high runoff potential such as clays. Table 4 - 1, Subbasin Runoff Parameters (Mill Creek), shows the distribution of surface soils in each Hydrologic Group throughout the Mill Creek Drainage area and Table 4 - 2 shows similar data for the East Tributary of Senecal Creek.

Given the hydrologic classification of the soil, a Runoff Curve Number can be determined using tables developed by the SCS. The SCS tables (published in SCS TR-55, "Urban Hydrology for Small Watersheds) list Runoff Curve Numbers for each Hydrologic Group for a variety of ground cover conditions. Values listed in the table are for average antecedent moisture conditions. Average antecedent moisture conditions, as defined by the SCS, apply to the Study area watershed and no adjustment to these values is necessary.

The hydrologic models require SCS Runoff Curve Numbers for two ground cover conditions. For this Study, pervious areas were classified as woods or grass/pasture. For existing conditions, the percentage of a subbasin classified as woods was determined by identifying undeveloped wooded areas using aerial photography. All other open areas were assumed to be grass/pasture. For future conditions, wooded areas were assumed to occur only in environmentally protected areas where development is not anticipated.

The SCS tables were used to determine Runoff Curve Numbers for grass/pasture and wooded ground cover conditions. The Runoff Curve Numbers selected for wooded areas are applicable to natural wooded areas with thick underbrush. Values selected for grass/pasture areas assume a

Table 4 - 3

Time of Concentration Assumptions

1. Channel, Gutter and Swale Velocity Assumptions

Slope	Velocities in Feet per Second Channel/Pipe	Gutter	Swale
.002 - .005	2.0	1.0	0.5
.005 - .010	3.0	1.5	1.0
.010 - .015	4.0	2.0	1.5
.015 - .020	5.0	2.5	2.0
.020 - .030	6.0	3.0	2.5
.030 - .060	7.0	4.0	3.0
.060 +	8.0	4.5	3.5

2. Manning's "n" for Overland Flow (OF)

Surface	Manning's "n"
Paved or gravel with slope >2%	0.02
Lawns, natural grass areas, uncultivated fields	0.24
Cultivated fields	0.18
Trees with light underbrush	0.40
Trees with heavy underbrush	0.70

3. Assumptions for Estimating Time of Concentration for Future Development

A. Single Family Residential

Length of Overland Flow (OF)	75 feet
Manning's "n" for OF	0.13 (mix of lawn and pavement)
Slope for OF	Existing Grade
Length of Gutter	250 feet
Channel/Gutter Slope	Existing Grade

B. Multi-family Residential

Length of Overland Flow (OF)	100 feet
Manning's "n" for OF	0.06 (primarily pavement)
Slope for OF	0.005 - 0.02
Length of Gutter	250 feet
Channel/Gutter Slope	Existing Grade

C. Commercial/Industrial

Length of Overland Flow	150 feet
Manning's "n" for OF	0.02 (paved)
Slope of OF	0.005 - 0.03 (depending on exst. grade)
Channel Slope	Existing Grade
Gutter Flow	None

Table 4 - 4

Time of Concentration Equations

OVERLAND FLOW (Length < 300 feet)

$$Tc = \frac{.007\,(nL)^{0.8}}{(P_2)^{0.5}\,(S)^{0.4}}, \quad \text{where}$$

Tc = time of concentration in hours
n = roughness coefficient (dimentionless)
L = length of flow (feet)
S = slope (ft/ft)
P_2 = 2 year, 24 hour precipitation (inches)

GUTTER, CHANNEL AND GRAVITY PIPE FLOWS

$$Tc = \frac{L}{3600\,(V)}, \quad \text{where}$$

Tc = time of concentration in hours
L = length of flow (feet)
V = velocity (feet/sec)

US Soil Conservation Service - Technical Release No. TR-55, "Urban Hydrology for Small Watersheds" (January, 1975)

ground cover of only 50% to 75% to account for other landscape uses that may not have 100% ground cover.

The numeric Curve Number values for each ground cover were applied to the areas of mapped soil types within each subbasin and a composite weighted average (by area) for soil type within each subbasin was developed.

TIME OF CONCENTRATION

The time of concentration is the travel time from the most hydraulically remote point in the subbasin to the subbasin outlet. These times of concentration are determined according to the specific type flow for that subbasin, i.e., overland flow, shallow concentrated flow, gutter flow, channel flow, or pipe flow.

The time of concentration was calculated for each subbasin for existing and future land use and building conditions. For existing conditions, overland flow, swale flow and channel flow conditions were estimated using aerial photography and existing topographic mapping. For future conditions, time of concentration parameters were estimated, based on typical values for each land use designated in the City's Comprehensive Land Use Plan (Figure 2).

Table 4 - 3, Time of Concentration Assumptions, lists the assumptions used to calculate the time of concentration for existing and future conditions. Table 4 - 4, Time of Concentration Equations, presents the equations used in the calculations.

Chapter 5

ANALYSIS OF RAINFALL RUNOFF

INTRODUCTION

Runoff from each of the subbasins identified in the study area was calculated using hydrologic models running on a PC computer model. This model requires input data in the form of a design storm rainfall distribution, commonly called a rainfall hyetograph. Earlier work for the City provided an Intensity-Duration-Frequency (IDF) chart which was based on data gathered from nearby rain gauge stations. Subsequent rainfall and runoff calculations were based on the IDF analysis figures.

This chapter of the report outlines the 24-hour precipitation figures that will be used to calculate the runoff flows in the drainage basins within the study area watershed. Rainfall hyetographs were calculated for the 2-, 5-, 10-, 25-, and 100-year storm events. These projections of storm events are typically referred to as the "return frequency" for a storm of a given magnitude. The resulting design storm hyetographs are then used in conjunction with the subbasin parameters. The combination of the subbasin parameters and the design hyetographs provides an estimate of the undetained, peak flow runoff hydrographs at specific points in the drainage system. Estimates of runoff rates and volumes can be calculated for both undeveloped and developed areas within the study area.

DESIGN STORM PARAMETERS

In developing runoff rates for the subbasins in the study area, a design-storm duration of 24 hours was used. This design storm duration has been found to produce the greatest peak flows for basins with characteristics similar to those found in Woodburn. Shorter durations may be used

where basins are smaller, have highly impervious areas or are much more steeply sloped than those found in Woodburn and the surrounding areas. At the other extreme, longer design storms would be used to produce peak runoff rates when the basins are much larger and have highly pervious surfaces.

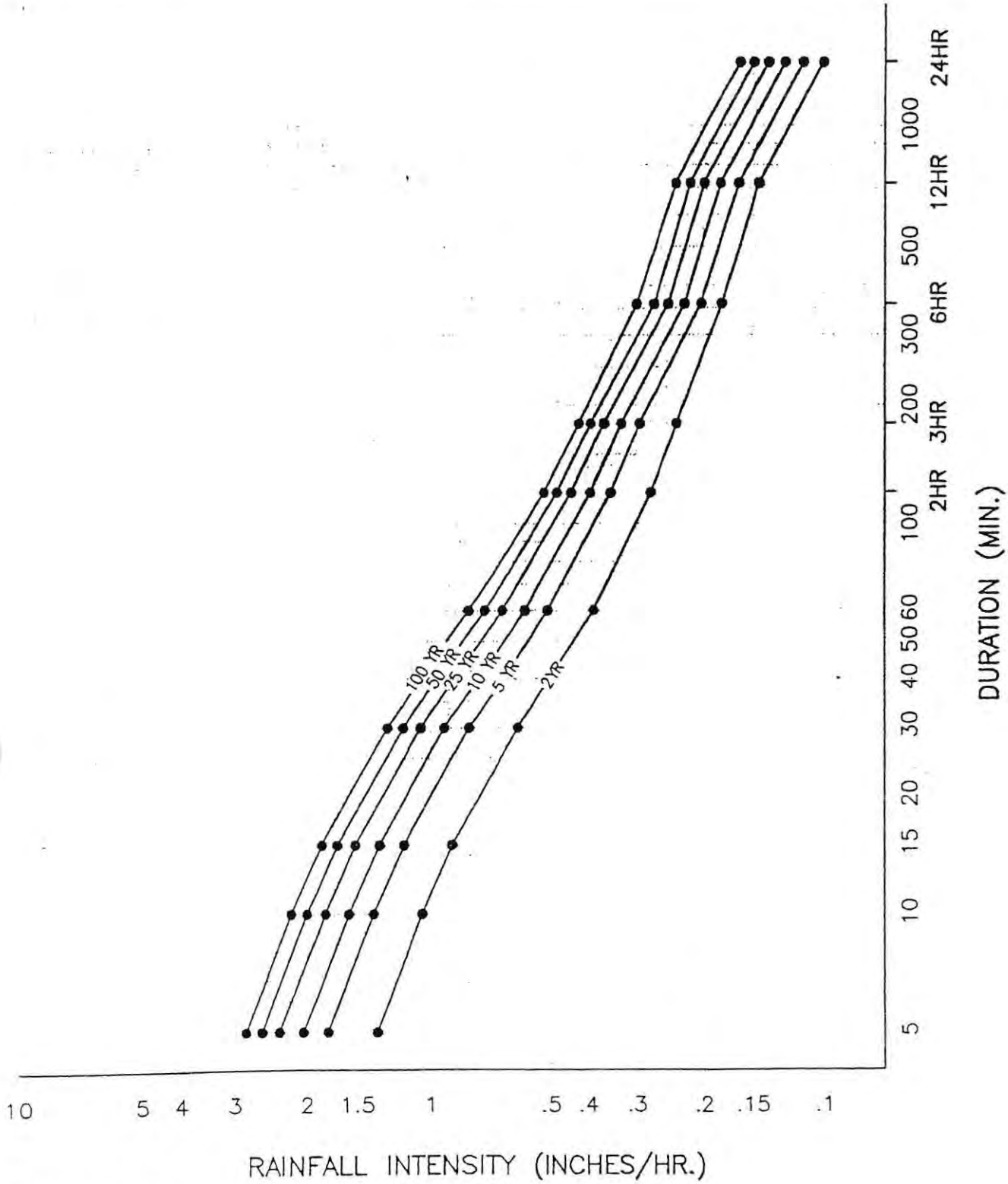
Total 24-hour rainfall depths for the 2-, 5-, 10-, 25-, and 100-year storm events were determined from isopluvial maps published by NOAA in the Precipitation-Frequency Atlas of the Western United States, Volume X - Oregon, 1973. These values were applied to the standard Soils Conservation Service (SCS) Type IA Rainfall Distribution to develop design storm rainfall hyetographs. The SCS has developed rainfall distribution curves to represent the depth vs. time relationship observed for large storms in various regions of the country. The Type IA distribution is typical of large storm events in Western Oregon.

The IDF curves are used to determine the rainfall intensity in inches-per-hour when associated with a storm event of a particular frequency and duration. This information is critical when using the Rational Method of predicting rainfall runoff. This method may be used by designers when estimating runoff for very small parcels in the study area. It is not typically used, and can become overly conservative when used to predict runoff for parcels exceeding 10 acres.

The IDF curves computed for this study are shown in Figure 6, Intensity, Duration and Frequency Curves. In addition, Figures 7 and 8, the SCS Type IA Rainfall Distribution Curve and SCS Type IA Rainfall Hyetograph are shown for reference.

PEAK SUBBASIN FLOWS

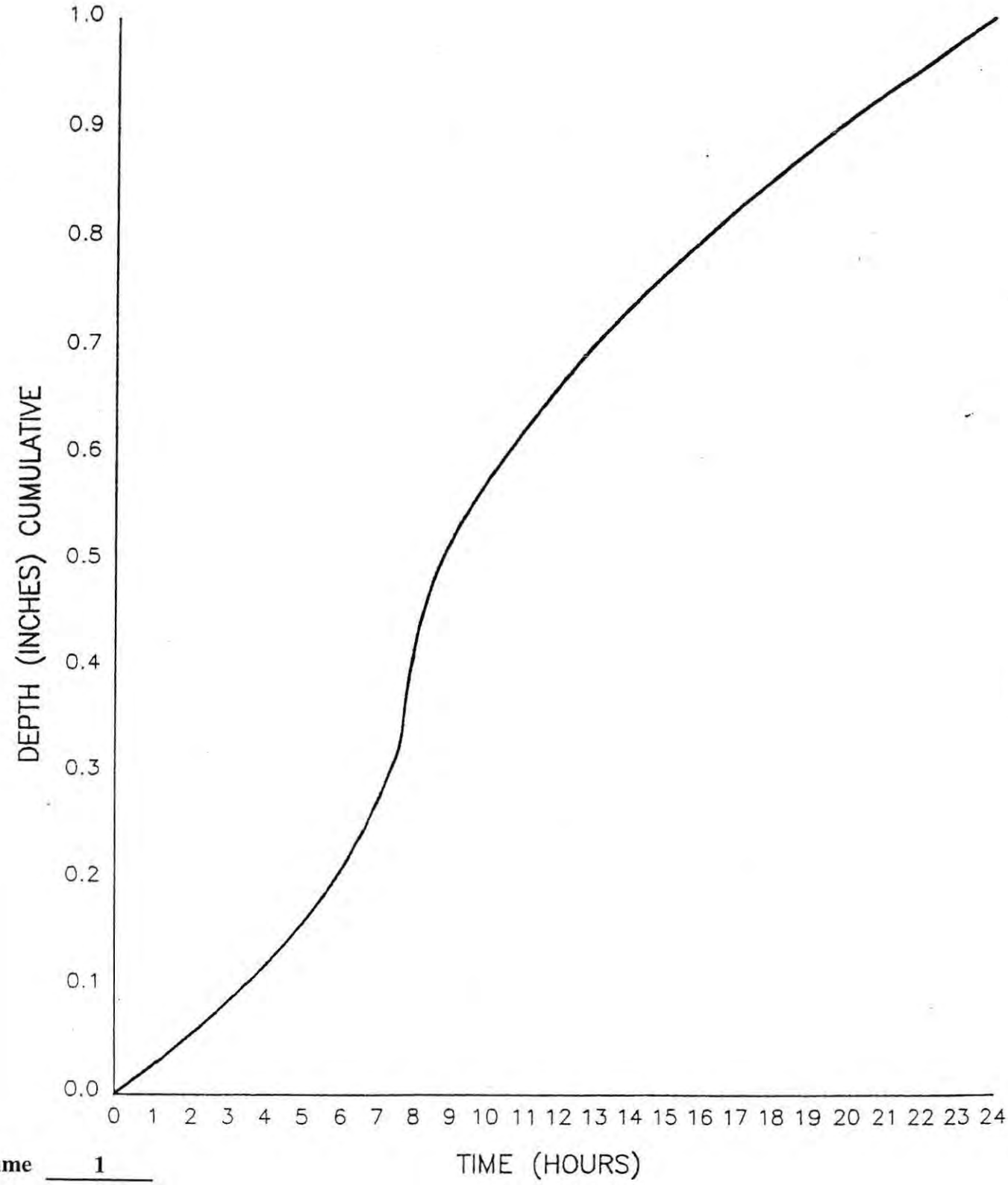
Flow hydrographs for each of the subbasins in the study area were computed for the 2-, 5-, 10-, 25-, and 100-year storm events. The results of these calculations are shown in Tables 5-1 and 5-2, Undetained Individual Subbasin Flows, for Mill Creek and the East Tributary of Senecal Creek



DECEMBER, 1992

DATE			FIGURE
July	CRANE & MERSETH Engineering/Surveying 6566 SE LAKE Rd., SUITE D MILWAUKIE, OREGON 97222 BUS: (503) 654-2005 FAX: (503) 654-2575	INTENSITY DURATION AND FREQUENCY CURVE City of Woodburn STORM DRAINAGE MASTER PLAN	6

K/cad/112-005c/dwg/112-f6.dwg



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DATE
July 2001

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Engineering/Surveying
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MILWAUKIE, OREGON 97222
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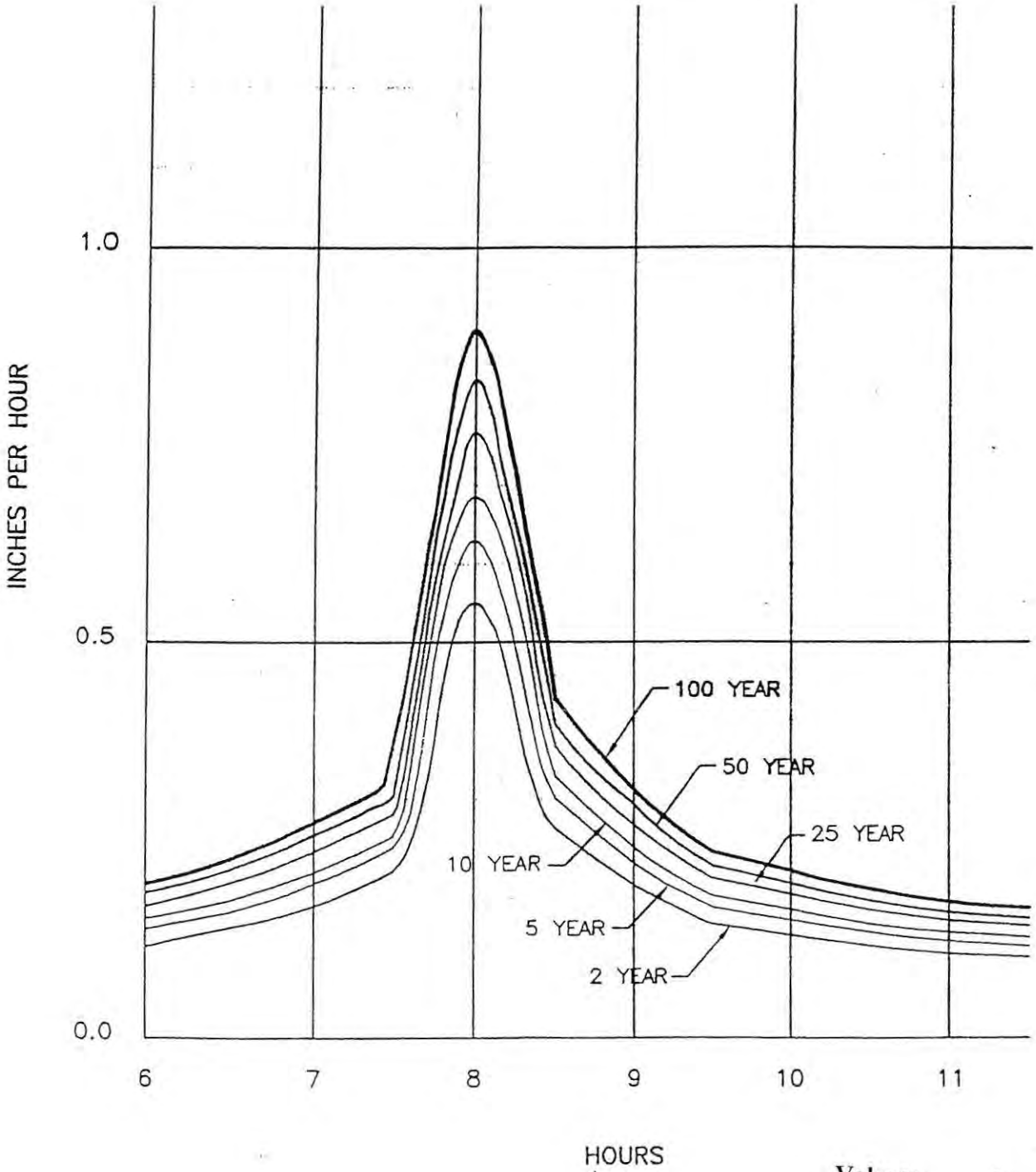
FAX: (503) 654-2575

SCS TYPE 1A RAINFALL DISTRIBUTION CURVE

City of Woodburn
STORM DRAINAGE MASTER PLAN

FIGURE 7

K:/coc/112-005c/dwg/112-F7.dwg



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DATE			FIGURE
y 2001	CRANE & MERSETH Engineering/Surveying 6566 SE LAKE Rd., SUITE D MILWAUKIE, OREGON 97222 BUS: (503) 654-2005 FAX: (503) 654-2575	SCS TYPE 1A 24 HOUR RAINFALL HYETOGRAPH City of Woodburn STORM DRAINAGE MASTER PLAN	8

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Table 5 - 1
Undetained Individual Subbasin Flows (CFS)
Mill Creek

Sub-basin	Area	Existing Conditions						Full Buildout					
Name	(Ac)	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR
M-1	359	26	36	43	53	63	71	26	35	43	53	63	71
M-1A	390	37	52	64	81	96	110	37	52	64	81	96	110
M-1B	71	12	15	18	22	25	28	16	19	22	26	30	33
M-1C	53	9	12	14	17	19	22	9	12	14	17	19	22
M-2	109	9	13	16	20	24	28	13	19	23	29	34	39
M-3	76	4	6	8	10	13	15	4	6	8	10	13	15
M-3A	96	4	7	9	12	15	18	19	24	27	33	37	42
M-4	40	5	7	9	11	13	14	7	9	11	13	15	17
M-4A1	42	10	13	15	17	19	21	17	20	22	25	28	30
M-4A2	16	5	6	7	8	9	10	5	6	7	8	9	10
M-4A3	18	4	5	6	7	8	9	7	8	9	11	12	13
M-5	59	9	12	14	18	20	23	16	20	23	26	29	32
M-5A1	69	7	10	12	15	18	21	13	16	19	23	26	29
M-5A2	65	6	8	10	13	15	18	15	18	21	25	28	31
M-5A3	97	18	23	27	32	37	41	18	23	27	32	37	41
M-5A4	30	3	4	5	7	8	9	3	4	5	7	8	9
M-5B1	53	12	14	17	20	22	25	12	14	17	20	22	25
M-5B2	37	7	9	10	12	14	15	11	13	15	17	19	21
M-5B3	55	9	11	13	16	19	21	11	13	16	19	21	24
M-6	42	1	2	3	4	6	7	1	2	3	4	6	7
M-6A	65	10	14	16	20	23	26	13	17	19	23	26	30
M-6A2	65	3	5	7	10	12	14	18	22	24	28	31	34
M-6B	23	3	4	4	6	7	8	9	11	12	14	15	16
M-7	99	15	19	23	28	32	36	21	26	30	35	40	44
M-7A	24	4	5	6	8	9	10	7	9	10	12	13	14
M-7B1	49	4	6	7	9	10	12	7	8	10	12	14	15
M-8	36	6	8	10	12	14	16	11	13	15	18	20	22
M-9	31	2	4	5	6	7	8	5	7	8	10	11	13
M-9A1	92	13	17	20	24	28	31	16	20	22	27	30	34
M-9A3	82	20	25	28	33	37	41	29	34	38	43	48	52
M-9B	33	10	12	14	16	18	20	13	15	17	19	21	23
M-10	100	16	21	24	30	34	39	17	22	26	32	36	41
M-11	78	7	10	12	16	19	22	19	24	27	31	35	39
M-11A	43	5	7	9	11	13	15	9	12	13	16	18	20
M-11B1	69	8	11	13	17	20	22	12	15	18	21	24	27
M-11B2	28	2	3	4	5	6	7	5	6	7	8	10	11
M-11C	34	3	4	5	6	8	9	8	9	11	13	14	16
M-11C2	39	5	7	8	10	12	14	13	16	18	21	24	26
M-11D1	88	7	11	13	17	20	24	14	19	22	27	31	35
M-11D2	48	12	15	17	20	22	25	10	13	15	18	20	23
M-11E1	57	4	7	8	10	13	15	6	9	11	14	16	19
M-11E2	77	6	9	11	14	17	20	17	21	24	29	33	36
M-11E3	61	4	6	8	10	12	14	4	6	8	10	12	14
M-11F	161	11	15	19	23	28	32	11	15	19	23	28	32
M-12	62	9	12	14	18	21	23	12	15	17	21	24	26

Table 5 - 1
Undetained Individual Subbasin Flows (CFS)
Mill Creek

Sub-basin	Area	Existing Conditions						Full Buildout					
Name	(Ac)	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR
M-12A1	23	1	1	2	2	3	4	5	6	7	9	10	11
M-12A2	70	5	7	8	11	13	15	14	18	20	24	27	30
M-12A3	12	1	2	2	2	3	3	3	3	4	5	5	6
M-12B	68	6	8	10	13	16	19	22	26	29	33	37	40
M-12C	134	9	12	15	20	24	28	27	34	39	46	52	58
M-13	955	52	75	92	118	140	161	52	75	92	118	140	161

TABLE 5 - 2
East Tributary of Senecal Creek
Undetained Individual Subbasin Flows

Sub-basin	Area (Acres)	Area (Sq. Miles)	Existing 25 YR (CFS)	Existing 100 YR (CFS)	Full Buildout 25 YR (CFS)	Full Buildout 100 YR (CFS)
Natural Watershed						
A	124.5	0.195	20	28	20	28
B-1	60.3	0.094	24	29	24	29
B-2	49.4	0.077	7	10	7	10
C	49.0	0.077	15	20	17	22
D	78.3	0.122	20	27	42	50
E	42.7	0.067	16	20	28	33
F	31.1	0.049	11	15	17	20
G	76.6	0.120	13	17	38	45
H	26.7	0.042	13	16	15	18
I	33.6	0.053	16	20	20	24
J	40.6	0.063	7	9	24	28
K	83.1	0.130	13	17	33	41
L	121.0	0.189	18	24	18	24
Potential Re-routing of Future Development						
M-C	24.7	0.039	-	-	15	18
S-I	17.0	0.027	-	-	12	14
M-HDR	30.3	0.047	-	-	16	19
M-LDR	42.9	0.067	-	-	11	14

* NOTE: M denotes basins currently draining to Mill Creek.
S denotes basins currently draining to Main Senecal Cree

Table 5 - 3
Peak In-Stream Flows at Key Points
Mill Creek

Node	Description	Upstream Drainage Area: Incremental (Acres)	Upstream Drainage Area: Cumulative Upstream (Acres)	Upstream Drainage Area: Cumulative Upstream (Sq. Miles)	Peak In-stream Flows (CFS): 1996 Conditions 10 YR	1996 Conditions 25 YR	1996 Conditions 100 YR	Full Buildout 10 YR	Full Buildout 25 YR	Full Buildout 100 YR
M-1	Mill Cr. @ Crosby Rd.	874	4,567	7.14	390	447	542	445	565	640
M-2	Mill Cr., downstream of M-2	109	3,693	5.77	289	340	418	370	476	519
M-3	Mill Creek @ Private Drive	172	3,584	5.60	280	331	400	369	460	500
M-4	Mill Creek @ Hazlenut Dr.	580	3,412	5.33	280	331	400	369	453	490
M-5	Goose Creek, Outlet	59	465	0.73	100	122	161	131	156	198
M-5A	Goose Cr. Trib. A @ Hwy 214	260	260	0.41	51	64	86	69	83	107
M-5B	Goose Cr. Trib. B below Hwy 214	146	146	0.23	37	45	58	42	52	66
M-6	Mill Cr. @ Front St. / RR	341	2,832	4.42	217	248	292	241	276	318
M-7	Side tributary @ Front St.	210	210	0.33	30	33	37	65	76	96
M-8	Mill Cr. @ Gatch / Hardcastle	43	2,491	3.89	199	230	272	218	252	290
M-9	Mill Cr. @ Lincoln St.	282	2,448	3.83	196	226	268	218	252	290
M-9A1	99E tributary @ outfall to Mill Cr.	218	218	0.34	53	65	84	82	95	117
M-10/11	Mill Cr. @ Cleveland St., downstream	754	2,166	3.39	180	213	271	194	262	288
M-10	Mill Cr. @ Cleveland St., upstream	100	1,412	2.21	116	140	182	123	149	194
M-11	Stubb Rd. Tributary @ Brown St.	78	754	1.18	65	75	89	83	96	113
M-11A	Stubb Rd. @ Front St.	43	677	1.06	60	69	81	66	74	84
M-11B	Stubb Rd. @ Settlemeir	634	634	0.99	57	65	77	62	70	79
M-12	Mill Cr. @ Wilson St.	155	1,312	2.05	111	140	176	116	141	184
M-12A	Brown Street Tributary "12A"	93	93	0.15	10	13	18	27	32	41

respectively. These flows represent the runoff flows from each subbasin and its specific natural parameters as identified earlier.

PEAK CUMULATIVE FLOWS

Hydrographs from each subbasin were routed and flows combined using the routing methods described in Chapter 3, Study Methodology. The models take relative timing of flow patterns into account when peak flows from tributary subbasins arrive at a specific node at different times and allows for the attenuation of the peak flows when storage occurs in the runoff channels and flood ways of Senecal Creek and Mill Creek.

Storage locations exist throughout both areas and are not specifically identified in this report. However, Senecal Creek exhibits significant storage in the area north of Highway 214 and south of the new crossing at Senecal Estates. No areas of unusual storage were identified along the East Senecal Creek Tributary except for the small natural detention area located in the southwest quadrant of the intersection of Interstate 5 and Highway 214.

Along Mill Creek several areas of natural storage exist between the major crossings. These provide storage during high flow events and extend from the man-made pond near the south city limit on the main stem of Mill Creek to the large area south of the Front Street/SPRR crossing near Highway 214. Storage also exists along the west tributary of Mill Creek that extends from the Cleveland Street crossing west to Settlemier Avenue.

Peak instream undetained flows for the main stem of Mill Creek are shown on Table 5-3, Peak In-stream Flows at Key Points.

Table 5 - 3
Peak In-Stream Flows at Key Points
Mill Creek

Node	Description	*Upstream Drainage Area*			*Peak In-stream Flows (CFS)*					
		Incremental	Cumulative Upstream		**1996 Conditions**			**Full Buildout**		
		(Acres)	(Acres)	Sq. Miles)	10 YR	25 YR	100 YR	10 YR	25 YR	100 YR
M-12B	Mill Cr. @ Deer Run	202	1,157	1.81	109	140	176	112	142	192
M-13	Mill Cr. @ UGB	955	955	1.49	92	118	161	92	118	161

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Chapter 6

EXISTING SYSTEM DESCRIPTION

INTRODUCTION

This chapter presents a description and partial inventory of the existing public storm water systems found in the Mill Creek and Senecal Creek drainages as these drainageways traverse the City of Woodburn. These descriptions do not encompass the smaller portions of the systems such as catch basins, inlets and pipelines less than 12 inches in diameter. Likewise, small ditches and culverts that convey storm water across private lands are not included in this description and inventory.

MILL CREEK

Mill Creek is the major natural drainage route serving most of the incorporated area of Woodburn, extending from north to south through the center of the City. Its drainage area within the Study area as indicated on Figure 1, Senecal & Mill Creek Drainage Basin Boundaries, contains about 5017 acres (7.84 square miles). The drainage system that has been constructed over time generally follows the natural topography with open channels branching into a number of areas of the City, supplemented by constructed drainage facilities using storm sewer systems serving residential and commercial areas, major culverts and bridges crossing the main stem of Mill Creek and some of the more major tributaries. Figure 9, Mill Creek Drainage, Existing Facilities, shows the existing storm water facilities in the Mill Creek basin within Woodburn.

Several major tributaries flow to the main stem of Mill Creek. In the urbanized areas of the City, many of these tributaries have been converted to piped systems and now carry much of the storm

runoff. Several tributaries still convey storm flows via open channel. Most of these tributaries are unnamed and will be referred to by their subbasin designation.

At the north city limit, a shallow tributary extends west from Mill Creek near its crossing of Crosby Road. This tributary extends through subbasin M-1 and collects runoff from that subbasin. It is included in the model to incorporate any backwater effects caused by this system. The tributary primarily serves undeveloped lands including portions of the Tukwila Golf Course and a small, developed area labeled M-1a.

A tributary to the east serves the M-4 system of subbasins. This tributary is now entirely piped and discharges through two major storm drain lines; one along Highway 214, the other just north of the highway which serves the light industrial areas in the Woodburn Industrial Park. These lines, an older, 24-inch diameter system along the south right-of-way of Highway 214 and a newer 30-inch line serving the industrial properties convey all storm water to Mill Creek. Each system crosses the Southern Pacific Railroad (SPRR) main line.

Goose Creek is a steep channel extending westerly from near the intersection of Mill Creek and Highway 214. It provides drainage to the undeveloped area north of the highway, the high school property and collects piped flows where it crosses Boones Ferry Road. Subbasins M-5 flow through the piped and open channels of Goose Creek. Flows in Goose Creek are increased by drainage collected in a 48-inch diameter line immediately south of and parallel to Highway 214. Stormwater originating in the M-5 subbasins concentrates in either Goose Creek or the 48-inch line before discharging to Mill Creek. This sizeable system of subbasins extend to the Senecal Creek drainage and includes much of Senior Estates and all the commercial areas along Highway 214. A large undeveloped area north of Highway 214 and east of Boones Ferry Road contains the last remaining large parcels that are in the process of being developed in the these subbasins

Subbasins titled M-6a and M-6c are collected in 21- and 30-inch lines respectively. The larger

line is aligned along Hardcastle Avenue and provides service to the residential areas both north and south of this major street and extends to the commercial areas along Highway 99E. The 21-inch line generally provides drainage to residential areas east of Mill Creek.

The oldest storm drainage system in the City serves the M-7 subbasins. This system of lines ranging from 8- to 30-inch lines generally follows an existing low area that meanders through the residential areas west of Front Street and extend to the west to Cascade Drive. Portions of this system are still open channel flow, however most of the system is conveyed in closed conduits. This system is probably the most hydraulically restricted system in the City, contains the oldest pipes and likely cannot be expanded to include any new flows from the remaining undeveloped area east of Senior Estates. Runoff from infill lots will be piped into this system and, with possible expanded capacity in the culverts on 1st and 2nd Streets, overall system capacity should be adequate. A small city park located along the west side of Front Street just north of Hardcastle Avenue serves as a detention facility during high flows.

Storm flows from subbasin M-7a are conveyed through a 16-inch diameter storm line northerly to the area of the city park. At this point, a leaping-weir manhole diverts storm flows to a surface ditch. This surface system conveys storm flows around the park area where they re-enter a storm drain line before crossing Front Street and the SPRR embankment.

Subbasins M-9a1 and M-9a3 generally follow a natural stream channel flowing from east to west, crossing Gatch Street south of Lincoln Street before discharging to Mill Creek. This system is a combination of open channel and closed conduit routes and provides storm runoff service to several residential areas and a number of commercial properties along Highway 99E. Property owners served by this system and located along Gatch Street have reported flooding problems in the past and the City has responded through extension of storm sewers in some areas.

Immediately south of Cleveland Street, Mill Creek divides into two major channels. The smaller of these channels turns west, crossing Brown Street, Front Avenue, the SPRR right-of-way and Settlemier Avenue. It is primarily an open channel system, fed by small lateral storm sewers. In the area of the city park east of Settlemier Avenue, the tributary has been routed through a 48-inch closed conduit storm sewer. This major tributary serves much of the developed and undeveloped property in the southwest quadrant of the Woodburn UGB. Large diameter culverts are used to cross Cleveland Street, Brown Street, Front Street/SPRR and Settlemier Avenue. A privately-owned detention facility is located west of Settlemier Avenue near the west end of Ben Brown Lane and serves the homes in the adjoining subdivision. More detention facilities have been constructed with the largest serving the new school property on Parr Road. Storm flows tributary to this system originate in the M-11 subbasins.

The main channel of Mill Creek crosses Cleveland Street. It progresses upstream through open channels, enclosed only by culverts where it crosses city streets. Portions of Mill Creek are located in City-owned parks between Cleveland Street and the south city limit. A constructed pond is located along the main stem of Mill Creek, east of Hermason Street. Control and maintenance of this pond is currently not a part of the City's responsibilities. The major piped system located in subbasin M-12 is a 48-inch line serving new subdivisions north and south of Warren Way. This line has been sized to serve developing areas west of Mill Creek and will be extended as development dictates. An off-line detention facility has been constructed in this subbasin to serve the Meadow Wood subdivision.

South of the City, Mill Creek progresses upstream into farmland where it terminates before reaching the neighboring town of Gervais.

Table 6-1, Mill Creek Tributary and Subbasin Storm Drain Capacity Inventory, provides an outline of the major tributaries, an inventory of the major storm water facilities in the subbasin including their diameter, type and length and their hydraulic adequacy compared to modeled

Table 6 - 1
Mill Creek Tributary and Sub-basin
Storm Drain Capacity Inventory

(continued)

Pipe/Channel Segment Description	Flow Node/ Subbasin	Size / Diam. (Inches)	Type	Approx. Length (FT)	ADEQUACY Design Event Carried (YR) 1996 Conditions.	Full Build.
SUB-BASIN M-6A2						
Hardcastle Ave. 30" Outfall Line	M-6A2	30"	CSP	2800	100	25
TRIBUTARY M-7 (includes M-11C2)						
SETTLEMEIR TO FRONT ST.						
Front St. Crossing & Leaping Weir	#7	30	CMP	230	100 (Ponded)	2 (Ponded)
Open Channel, 1st to Front	#7		DITCH	250	25, Storage Area	Maintaing as Storage or Convey 100 CFS
1st Street Crossing	#7	30	CMP	150	2	<2
Open Channel, 2nd to 1st	#7		DITCH	200	100, out of bank	Convey 100 CFS
2nd St. Crossing	#7	36	CMP	70	5	2
72", 3rd to 2nd St. Crossing	#7	72	CMP	350	100	100
42" Lincoln to 3rd St.	#7b	42	CMP	1390	100	25
24" Settlemeir to Lincoln	#7b	24	RCP	280	25	<2
HAYES ST. LINE	M-7B1/B2	18	RCP	390	10	(No additional capacity)
AUSTIN CT. /HAYES ST. LINE	M-7B1	18	RCP	750	10	(No additional capacity)
	M-7B1	15	RCP	440	10	(No additional capacity)
	M-7B1	18	RCP	520	10	(No additional capacity)
TRIBUTARY M-9A, McKINLEY / 99E						
HWY 99E TO OUTFALL						
48" CMP Gatch St. Crossing	#9a	48	CMP	375	100	100
Open Channel, Gatch to Bryant	#9a		DITCH	800	100 , Ponded	Convey 75 CFS
48" Outfall @ Bryant	#9a	48	CMP	150	25	25
48" CMP, Bryant to McKinley	#9a	48	CMP	550	50	50
McKinley St. 24", Conf. 48" to 99E	M-9A3	24	CMP	600	<2	<2
SUB-BASIN M-10						
12" Collector, Outfall to Jana Ave.	M-10	12	CMP	470	2	(No additional capacity)
12" Collector, Jana Ave. to Hawley	M-10	12	CMP	650	2	(No additional capacity)
TRIBUTARY M-11						
CLEVELAND ST. OUTFALL TO SETTLEMEIR						
Outfall Culvert, Brown to Cleveland	#11	(2) 42"	RCP		100	5 (Undetained)
Open Channel, Front St. to Brown St.	#11		DITCH		50	2 (Undetained)
Front St. Crossing	#11a	48"	RCP	200	50	2 (Undetained)
Park pipe, Settlemeir to Front	#11b	48"	RCP	1160	50	2 (Undetained)
Settlemeir Crossing	#11b	54"	CMP	50	50	2 (Undetained)
18" A Street Collector	M-11	18"	I	1300	5	<2
SPUR M-11B / PARR ST. TO CONF.						
Open Channel, Brown St. to Conf. Main Trib.	M-11B1/B2		DITCH		100, Backwater Ponding	Convey 30 CFS

flows. Table 6-2, Mill Creek Main Stem Existing Culvert Inventory, shows additional detail on major structures on Mill Creek including surveyed data on overflow elevations and flood elevations.

Figures 10A and 10B, Mill Creek Undetained Flows Structures and Flood Profiles, show the water surface profiles for 1996 conditions for the 25- and 100-year storm events. Figures 11A and 11B, Mill Creek Detained Flows, Structures and Flood Profiles, show future water surface profiles for the 25- and 100-year storm events assuming that detention measures as outlined in this Study are implemented.

TABLE 2

Mill Creek Main Stem
Existing Culvert Inventory

Crossing Description	Flow Node	1995 SURVEY DATA			Top of Road Overflow Elev. (FT)	Target Flood Elev. (FT)	APPROXIMATE CAPACITY		
		Size/ Diameter	Type	Length (FT)			Flow (CFS)	Event (YR) 1996	Event (YR) Buildout
Crosby Road Arch Culvert	M-1	7'x10'	CMP Arch	69	148.4	148.0	340	5	2
Private Drive	M-2	8.3'x7.8' (96")	CMP	26	149.1	149.0	280	2	<2
Hazelnut Ave. Bridge	M-4	Natural Section	NA	80*	157.1	152.0	>500	100	100
High School Entrance Drive	M-4	9.1'x14.0'	CMP Arch	66.8	158.9	153.4	490	100	100
Hwy 214 - Box Culvert	M-5/6	12'X7.7'	Conc. Box	73	154.4	154.0	500	100 (Backwater Flooding)	
Front St. and SPRR Culverts	M-6	96"	CMP	185	180.6(RR)	156.0	430	100	100
Hardcastle Avenue - 72 " CMP	M-8	72" (deformed outlet)	CMP	182	163.6	161.5	250	50	25
Lincoln Street Culvert	M-9	84" (deformed)	CMP	130*	169.3	163.5	290	100	100
Young Street Box Culvert	M-10/11	8'x6'	Conc. Box	100*	174.0	164.3	290	100	100
Cleveland Street Arch Culvert	M-10	9.3'X16.4'	CMP Arch	150*	168 (street)	164.4	210	100	100
Marshall Street Culvert	M-10	48"	RCP	57	165.5	165.5	82	10	5
Stark Street Culverts	M-10	(2) 48"	RCP	62	167.9	167.0	200	100	100
Wilson Street Culverts	M-12	(2) 52"	RCP	74	169.0	169.0	200	100	100

NOTE: * Indicates approximate length only, no field survey data.

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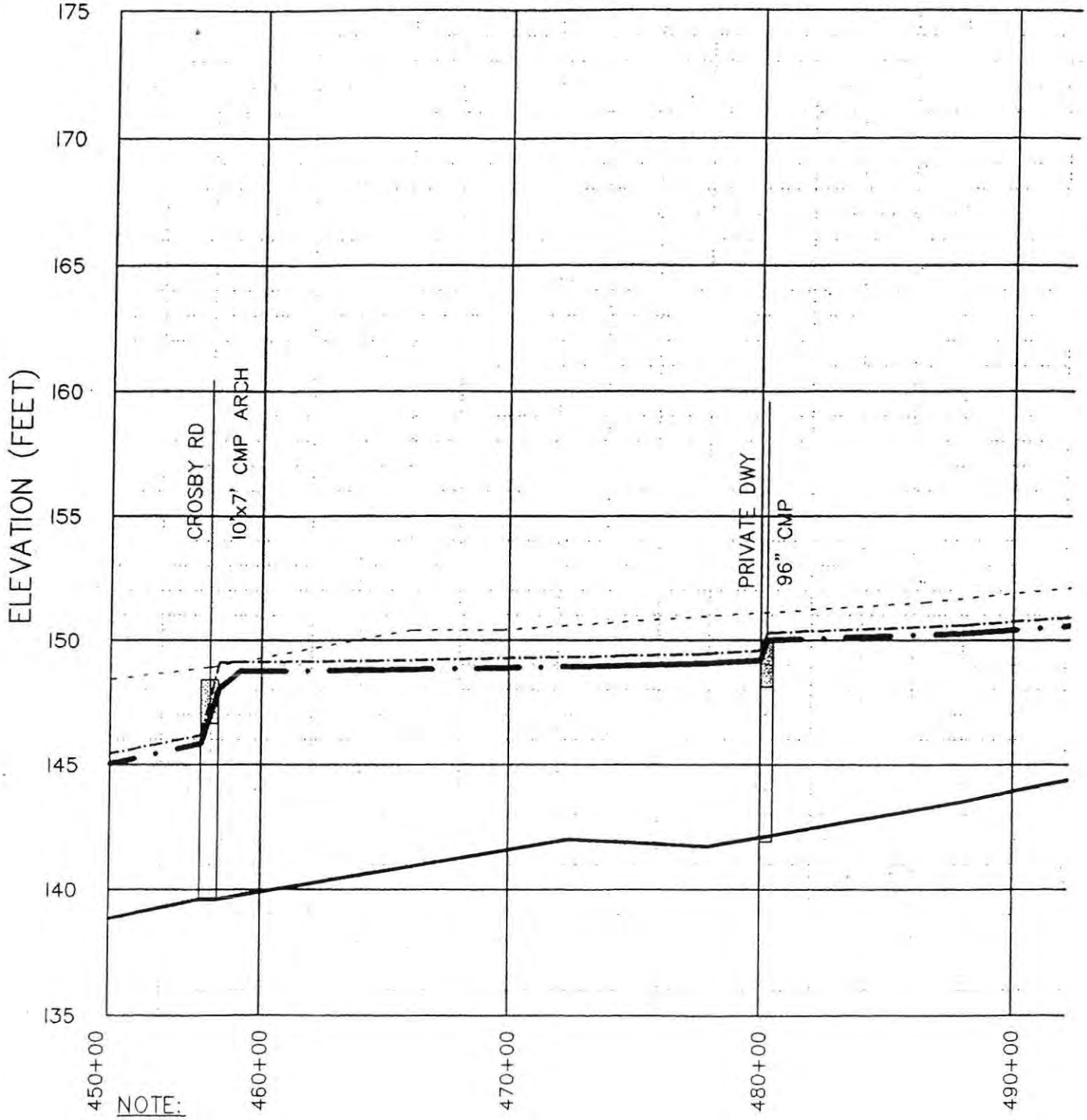

NOTE:
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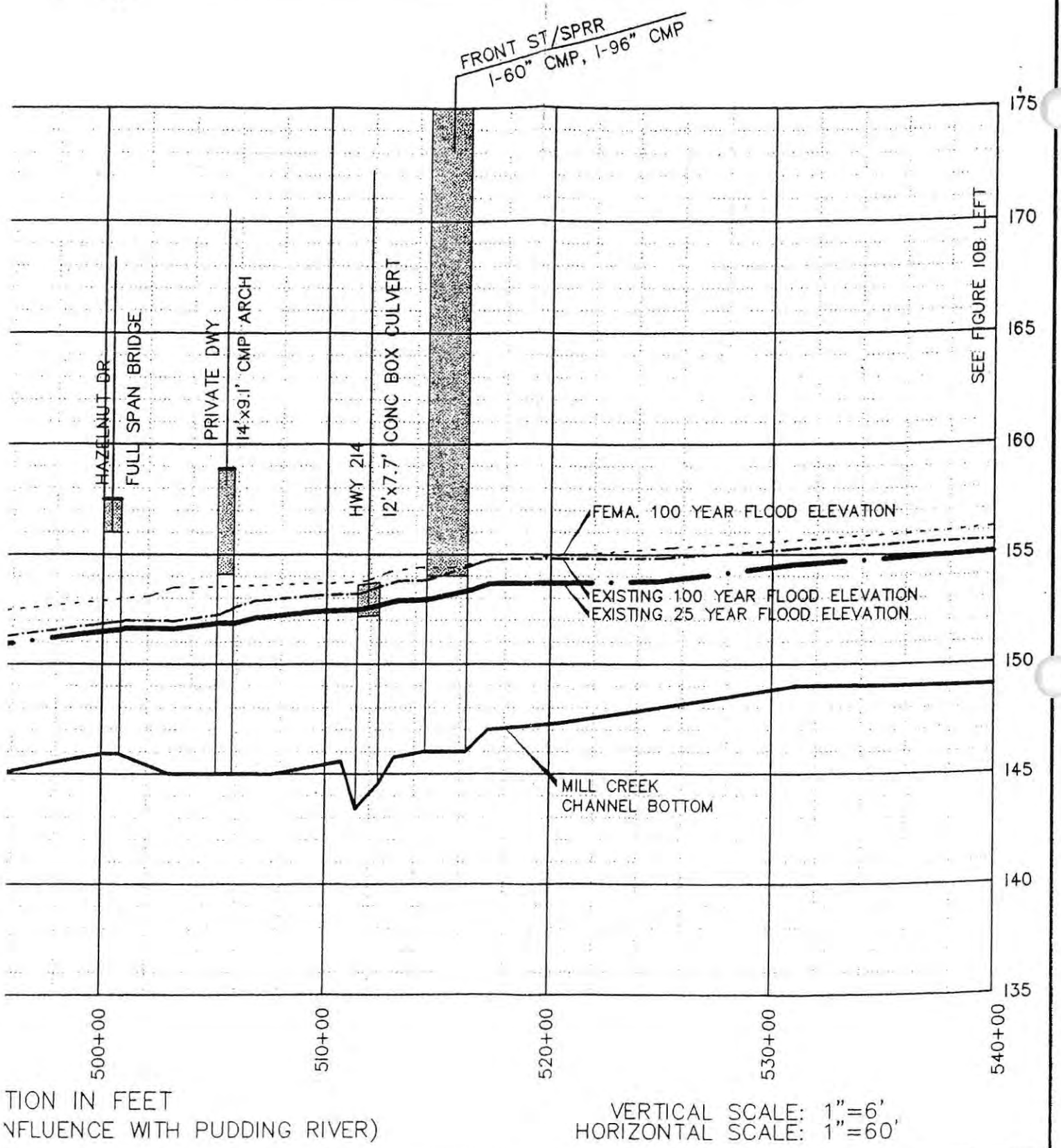

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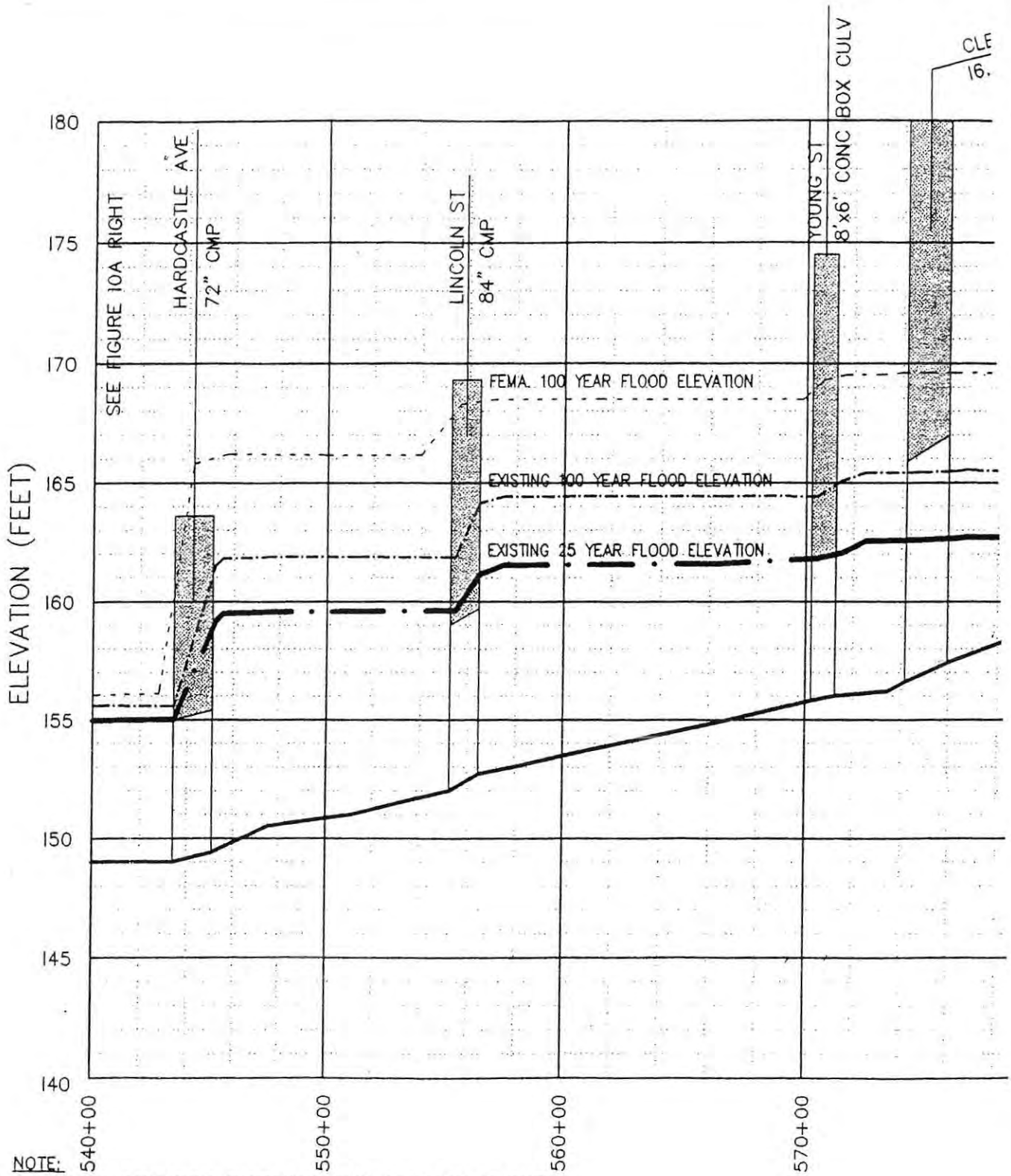
MILL CREEK UNDETAINED FLOWS
STRUCTURES AND FLOOD PROFILES

FIGURE
10A



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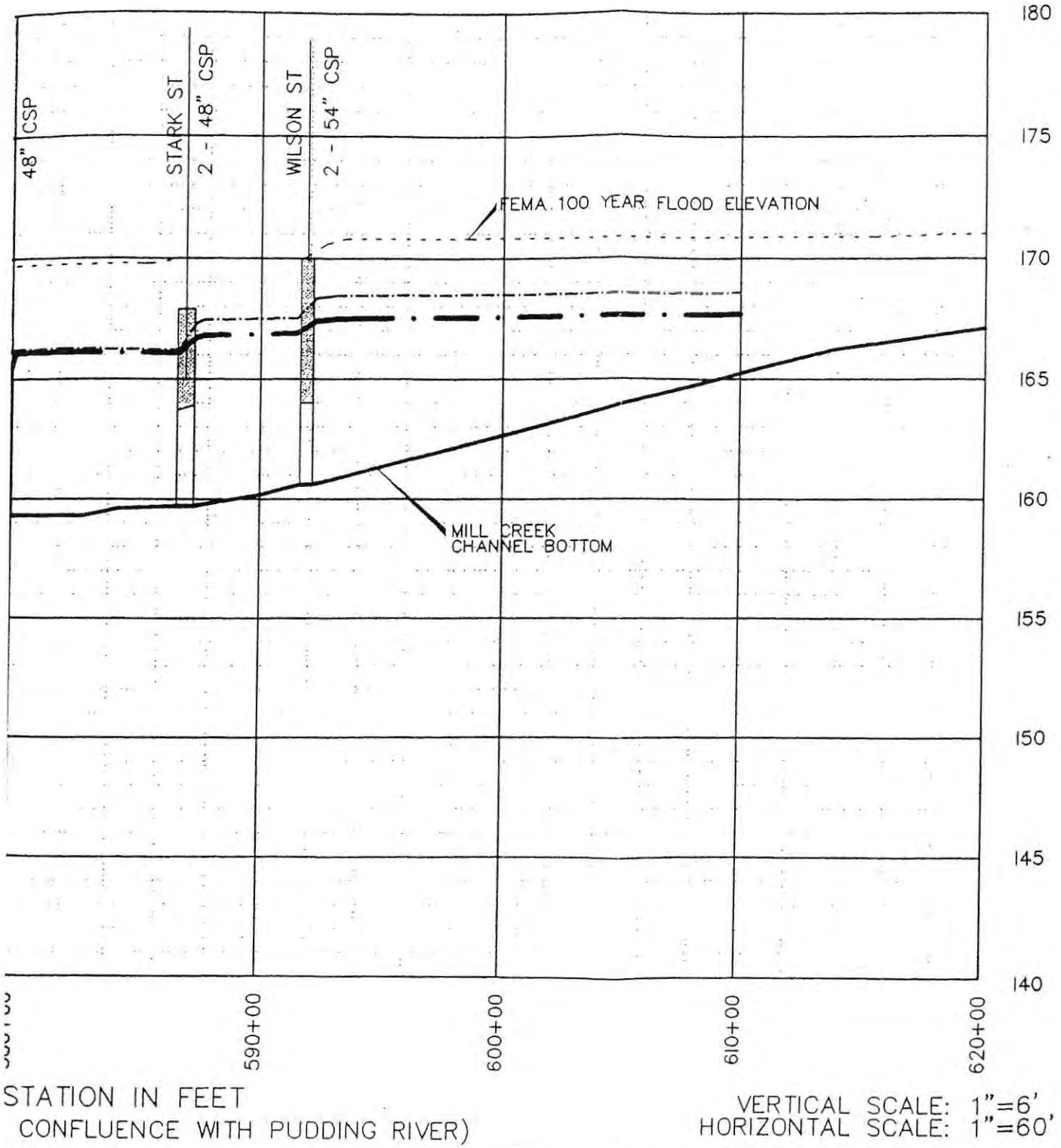

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Woodburn
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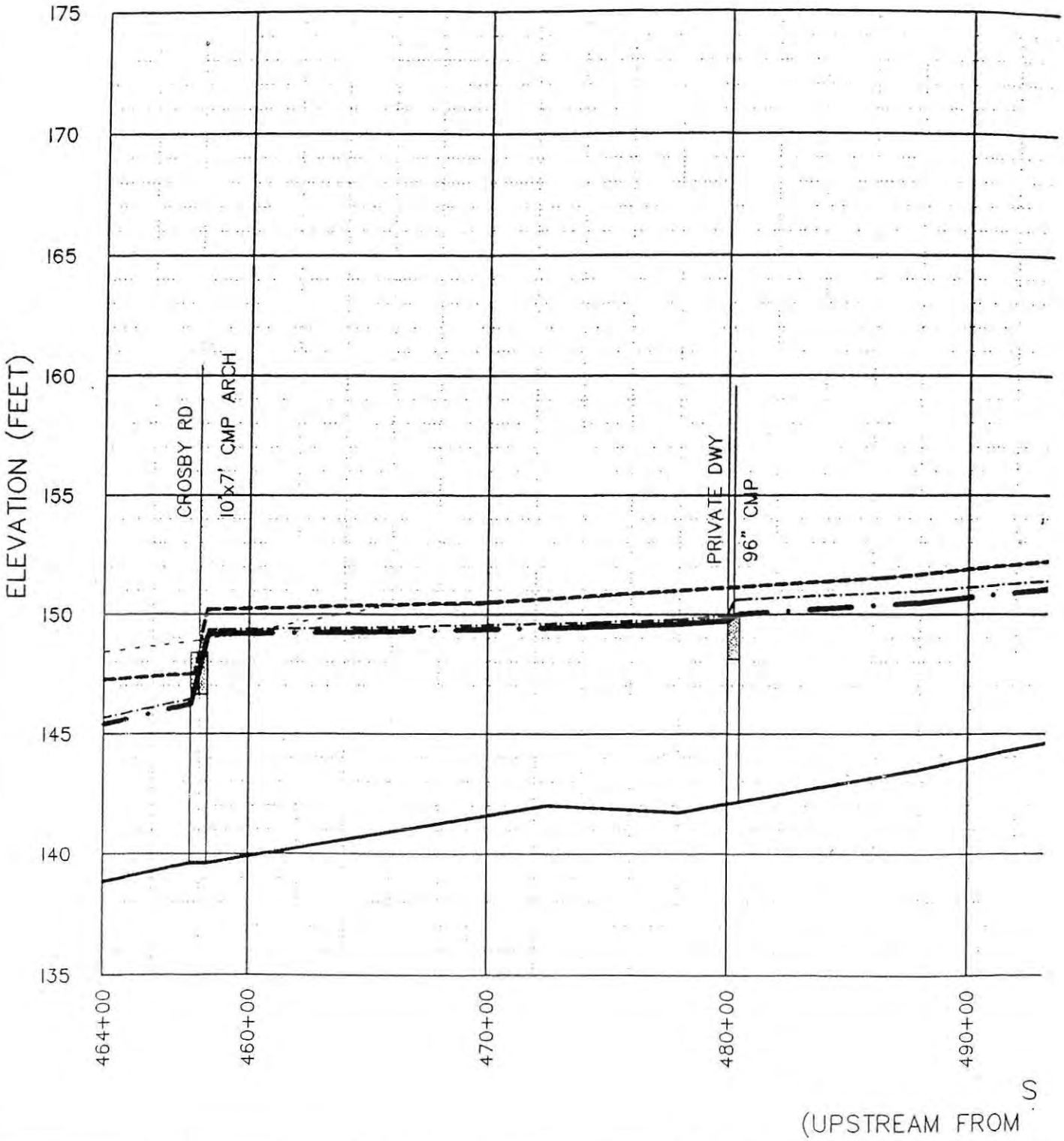
MILL CREEK UNDETAINED FLOWS
STRUCTURES AND FLOOD PROFILES

FIGURE
10B



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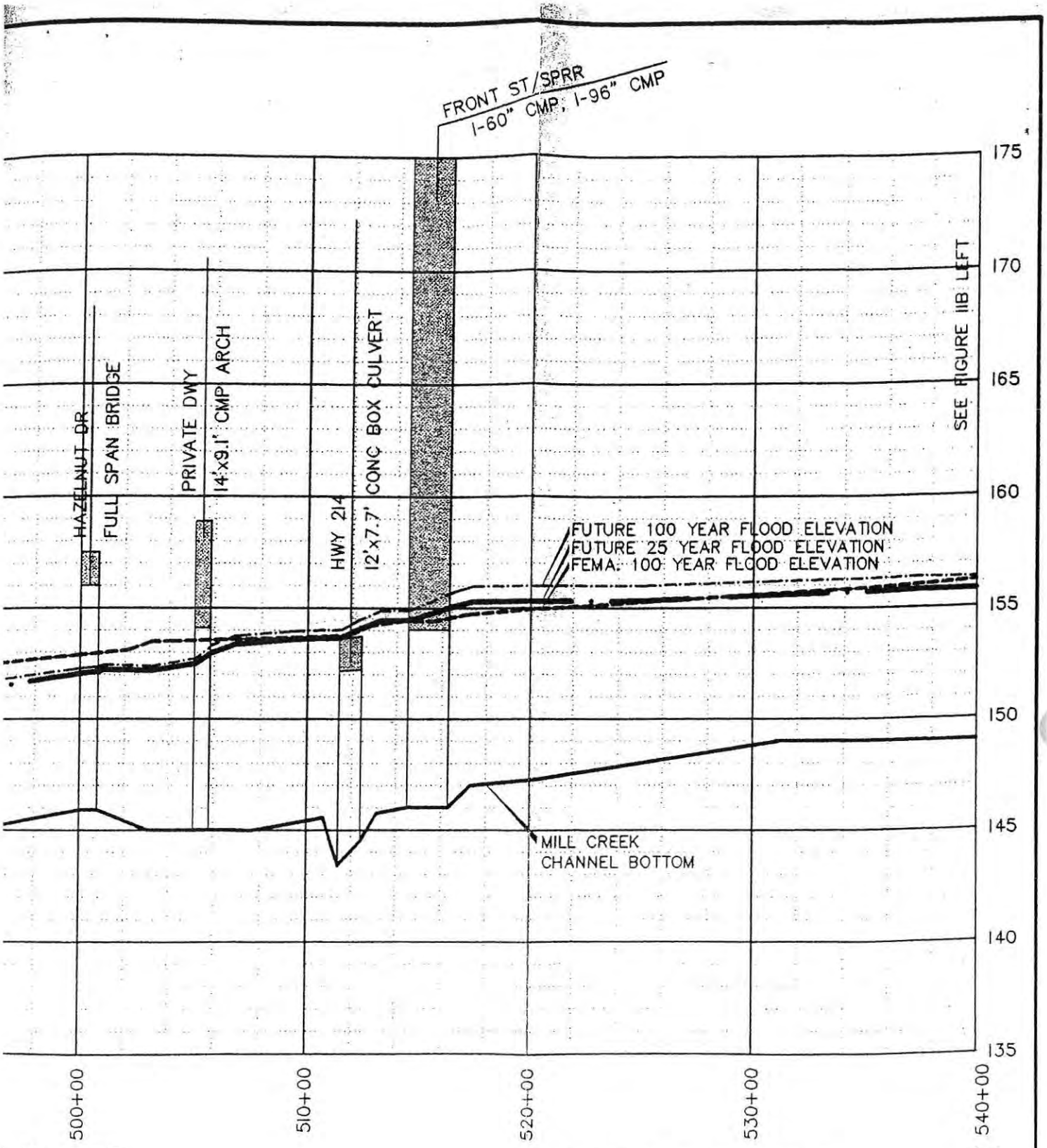

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OBURN
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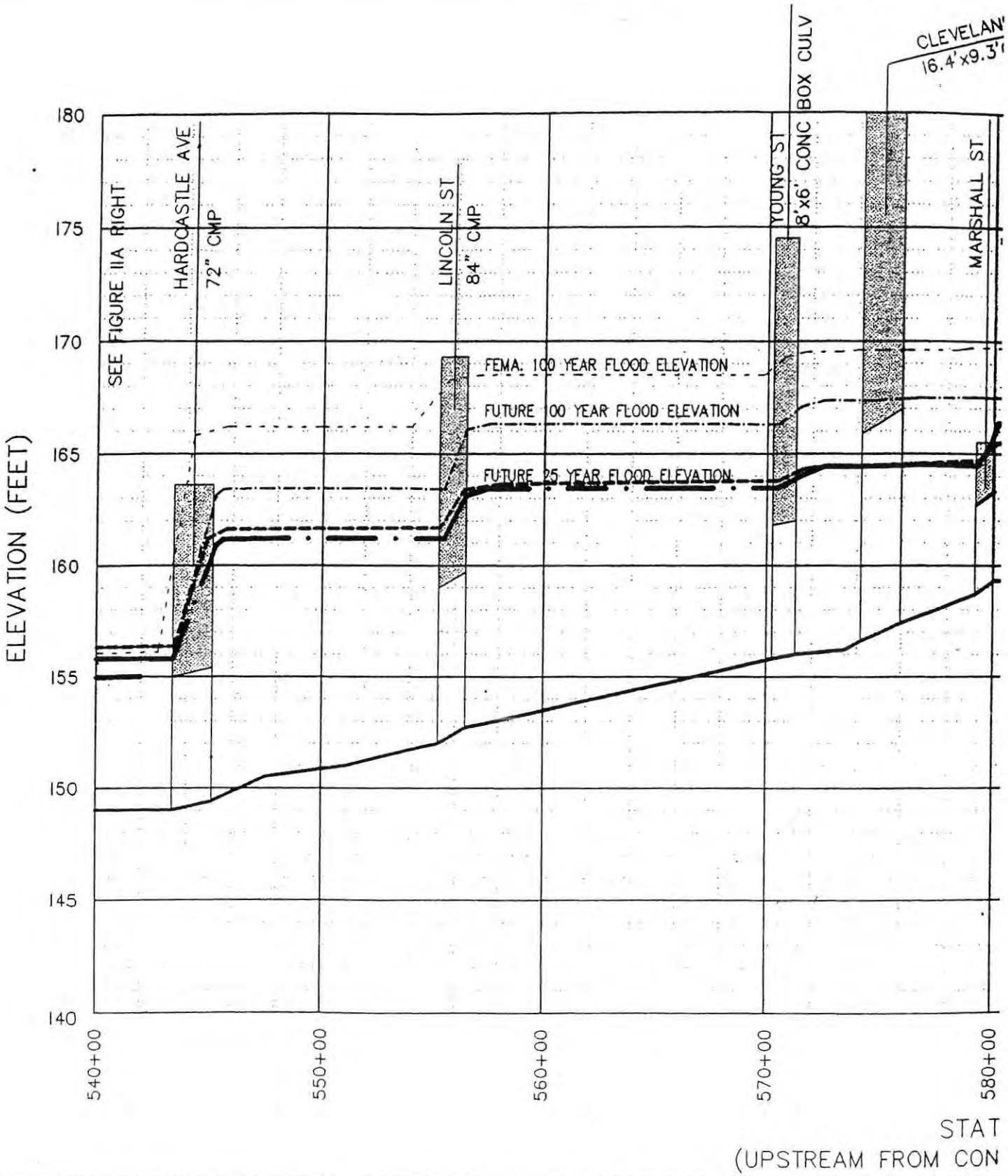
MILL CREEK DETAINED FLOWS
STRUCTURES AND FLOOD PROFILES

FIGURE
11A



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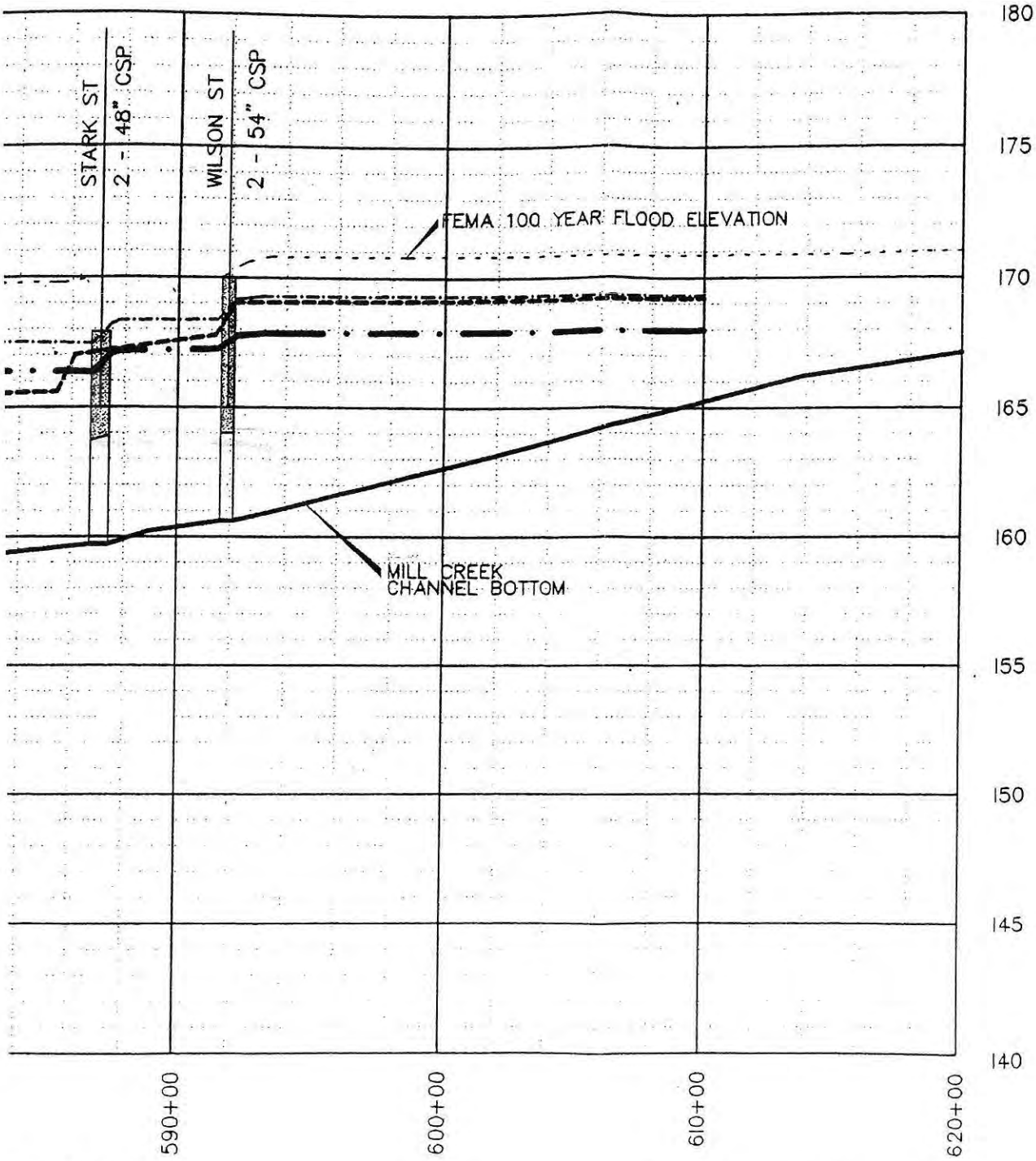

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urn	Volume 1 / Page 1528	MILL CREEK DETAINED FLOWS	FIGURE
STER PLAN		STRUCTURES AND FLOOD PROFILES	11B

SENECAL CREEK

Senecal Creek Main Stem

Senecal Creek is a shallow stream that begins southwest of Woodburn where it provides drainage to farmlands. The total drainage area of Senecal Creek within the Study area as indicated in Figure 1, Senecal & Mill Creek Drainage Basin Boundaries, is approximately 4,430 acres. The main stem of Senecal Creek skirts the western side of the City, paralleling the UGB and west city limit. In the city, Senecal Creek follows a course from the bridge crossing of Highway 214 near Butteville Road, through a wooded area west of West Woodburn, crosses an abandoned railroad embankment and flows through a crossing of the roadway into Senecal Estates. Figure 12, Senecal Creek Undetained Profile, shows the water surface profiles for the 25- and 100-year storm events. It is assumed that no detention facilities will be built along these segments of Senecal Creek. Most of the areas in the City served by Senecal Creek are served by the East Tributary of Senecal Creek. Additional modeling of the East Tributary has been completed and a separate set of recommendations has been compiled for this portion of Senecal Creek.

East Tributary of Senecal Creek

Basin Delineation

The East Tributary of Senecal Creek drains approximately 823 acres along the Interstate 5 route corridor and a large portion of the City's future industrial and commercial development area. Within this watershed, approximately 210 acres of new impervious area is expected to be constructed within the UGB between 1996 and 2016. In addition it is recommended that about 96 acres of developable lands outside the topographical watershed in the upper (southerly) end of the basin be drained to the East Tributary. Figure 13, Senecal Creek Drainage, Existing Facilities, shows the existing facilities in the East Tributary of Senecal Creek basin within Woodburn. Figure 14,

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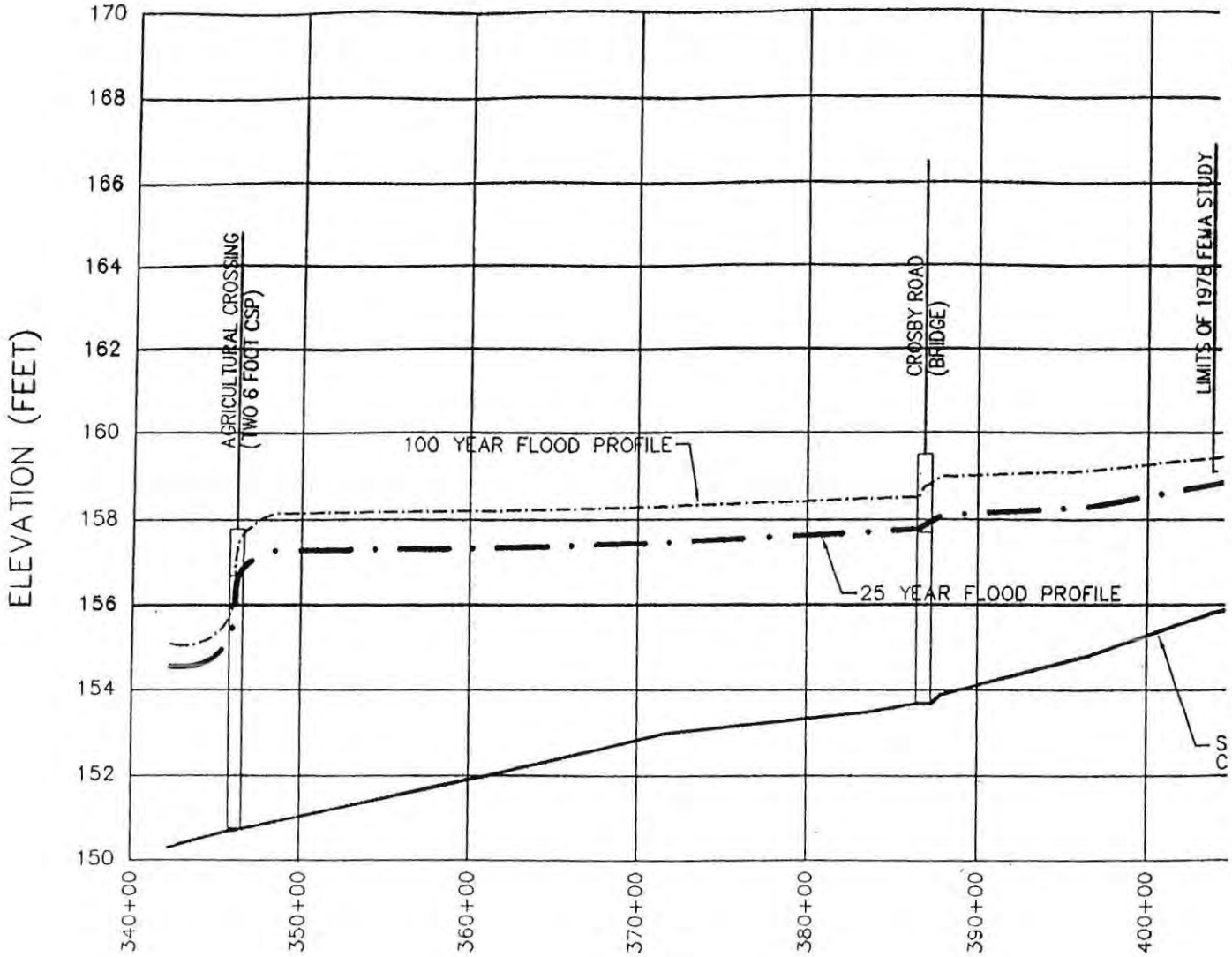

NOTE:

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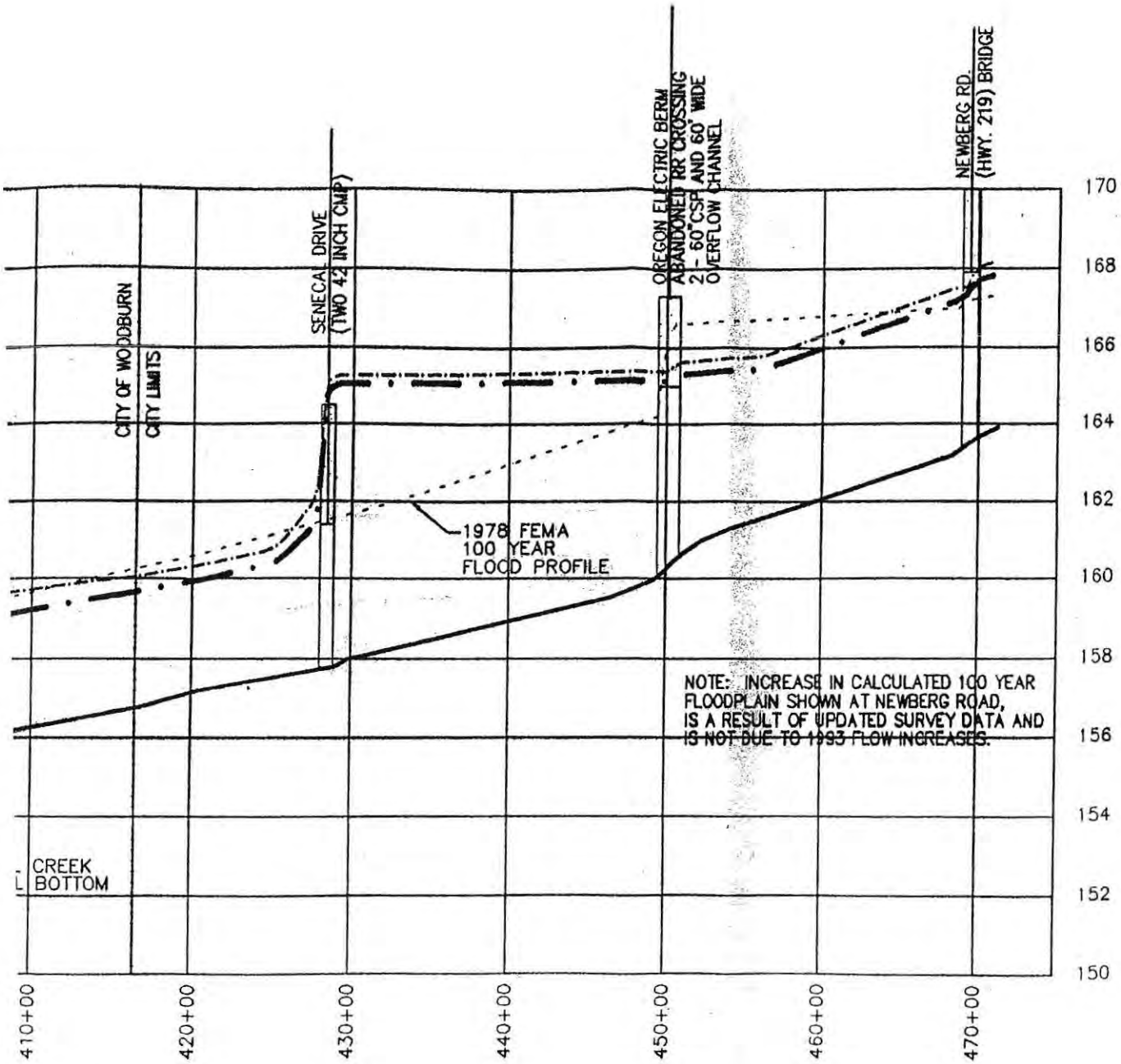

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MASTER PLAN

SENECAL CREEK UNDETAINED FLOWS
STRUCTURES AND FLOOD PROFILES

FIGURE
12

East Tributary of Senecal Creek Structures and Detained Flood Profiles, shows the water surface elevations for the 25- and 100-year storm events.

The "Senecal Creek Capacity Analysis" (1994) evaluated the drainage capacity in terms of the existing channel and drainage structures. The "Senecal Creek Capacity Analysis" is included in Appendix "C" of this Study. In summary, the following key features of the basin were identified:

- The East Tributary provides an essential drainageway for Woodburn's development along I-5.

- Existing agricultural access crossings north (downstream) of Highway 214 will be overtopped by undetained runoff flow from anticipated future upstream development.

- The twin 54-inch culverts crossing Highway 214 immediately west of the I-5 intersection represent a constriction to stormwater flows from future development if no upstream detention is provided.

- There is limited culvert capacity available to convey stormwater from the future development area south of the Walmart complex on the east side of I-5 to the East Tributary on the west side of I-5.

- In the upper (southerly) reaches of the watershed, the topography becomes very flat leaving no well-defined drainageway to transport stormwater into the East Tributary.

In order to provide orderly and cost-effective urban drainage services to Woodburn's East Tributary watershed, the conveyance of increased stormwater flows to the East Tributary must be planned and drainage structures in the stream must be protected using upstream detention facilities or similar alternatives to mitigate stormwater flows. In the absence of such actions,

significant capacity improvements must be made to a series of major culverts conveying the peak flows in the East Tributary in the vicinity of the Highway 214 and Interstate 5 intersection.

The upper (southerly) reaches of the East Tributary basin are so flat that the exact surficial basin boundary may be easily modified, thereby allowing the City to determine which properties should appropriately drain toward the East Tributary and which should drain eastward toward Mill Creek. Figure 4, Senecal Creek Drainage Subbasins, shows the natural basin boundary based on topography and the expanded basin boundary based on parcel limits and land use planning considerations. These expanded basin boundaries were analyzed in the "Senecal Creek East Tributary Capacity Analysis" (February, 1994) and will be assumed to hold throughout the following discussions.

Management Zone Definition

Four management zones are defined for the East Tributary's expanded watershed. The boundaries for these zones are designated as ES-1 through ES-4 as shown on Figure 4, Senecal Creek Drainage Subbasins. The zones are delineated by the four quadrants created by the intersection of Interstate 5 and Highway 214.

Culvert Capacity at Highway 214

The primary existing constraint in the East Tributary drainage system is in the vicinity of the Highway 214 culvert crossing. Water is conveyed through a series of culverts under Highway 214, through the Texaco station and under Arney Road. The two 54-inch diameter corrugated metal pipe culverts crossing Hwy 214 convey approximately 138 cubic feet per second (cfs). The maximum tolerable water surface elevation at the upstream (south) side of Hwy 214 is 174.0'.

This is due to the fact that water levels higher than 174.0' will adversely impact the existing I-5 culverts and other existing public stormwater systems up stream from the Hwy 214 crossing. Therefore, total stormwater flows generated south of Highway 214 should not be allowed to exceed 138 cfs to prevent surcharging of the 54-inch culverts. The following undetained flows are projected to occur using the runoff/routing model of the basin:

EVENT	PEAK FLOW (CFS)
Existing (1993) 100-Year Event	76
Full Development, Undetained 25-Year Event	180
Full Development, Undetained 100-Year Event	220

These future flow rates indicate that significant detention will be required to limit flows at Highway 214 to 138 cfs.

New I -5 Culvert Crossing to serve Zone ES-4

There are about 222 acres of prime future development land located in detention zone ES-4 south of the Walmart facility. Provisions have been made to convey runoff from this acreage across I-5 and into the East Tributary. At the time modeling for this Study was being completed there was no available capacity in the culverts crossing under I-5 into to convey additional runoff flows from ES-4. But, in order to prevent future flow rates above the 138 cfs at the Hwy 214 crossing it was recommended to limit the total flow capacity of the I-5 culverts to 78 cfs for detention zone ES-4. Preliminary analysis of the runoff flows indicated that an additional 42-inch diameter concrete sewer pipe (CSP) was required to convey the future modeled flow of 78 cfs from the east side of I-5 to the west side. In 2000 the 42-inch culvert was installed and presently serves zone ES-4. Approximately 3.0 feet of head loss has been incorporated into the crossing.

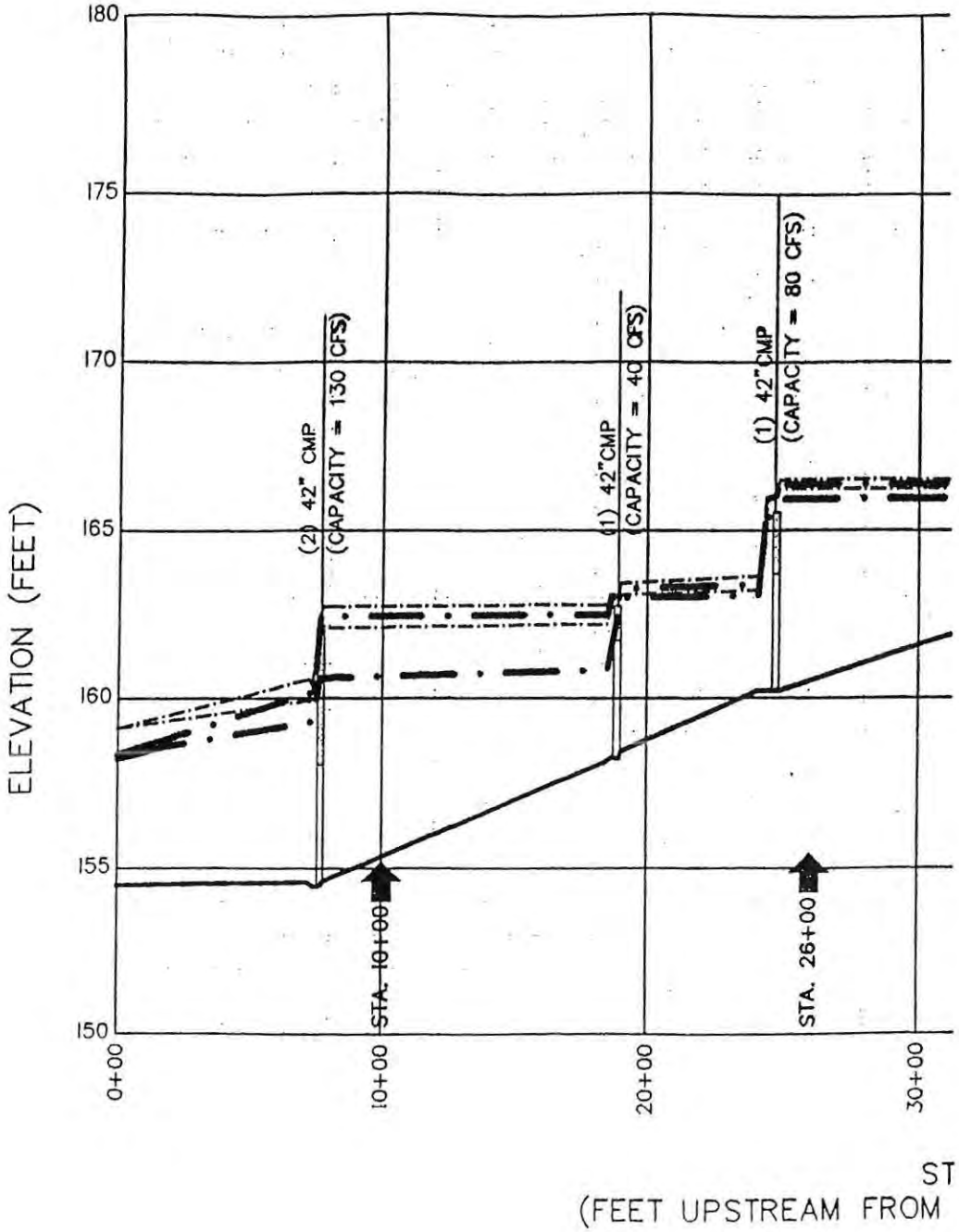
Near the upstream end of the East Tributary at Sta 73+00 as shown on Figure 14, East Tributary of Senecal Creek Structures and Detained Flood Profiles, the ditch bottom elevation is approximately 170.5'. This is the approximate location where existing 24" and 30" culverts that cross I-5 discharge into the East Tributary. At this location if the surface water elevation for the 100-year event in the East Tributary is maintained at 174.5', an upstream water surface elevation below 177.5 feet on the east side of I-5 can be maintained. A maximum 100-year water surface elevation of 177.5 on the upstream side of I-5 will allow sufficient hydraulic head to convey the 78 CFS, while low enough to avoid flooding on the east side of I-5.

In Zone ES-4, the following head losses in the future drainage system can be presumed:

Prevailing ground surface elevation	184.0 feet (MSL)
Less Minimum cover over the storm drain pipeline	2.5 feet
Less Head Loss for 3,600 feet of storm drain pipe	4.0 feet
Resulting water surface at I-5 culvert (upstream)	177.5 feet (MSL)

Detention in Zone ES-4

The undetained flow from future development in Zone ES-4 is 120 CFS. In order to reduce this flow to the capacity of the recommended 42-inch culvert (78 CFS), 7 acre-feet of detention is required on the east side of I-5. As of July 2001, this proposed detention facility is under construction as part of the Montebello Subdivision and is shown on Figure 13, Senecal Creek Drainage Existing Facilities. 7 acre-feet of storage volume will provide sufficient detention capacity in this zone. When combined with the mitigation policies listed above, and construction of the 7 acre-feet detention lagoon, the flow rate at the Hwy 214 crossing resulting from a 100-year event is not expected to exceed the target flow of 138 CFS.



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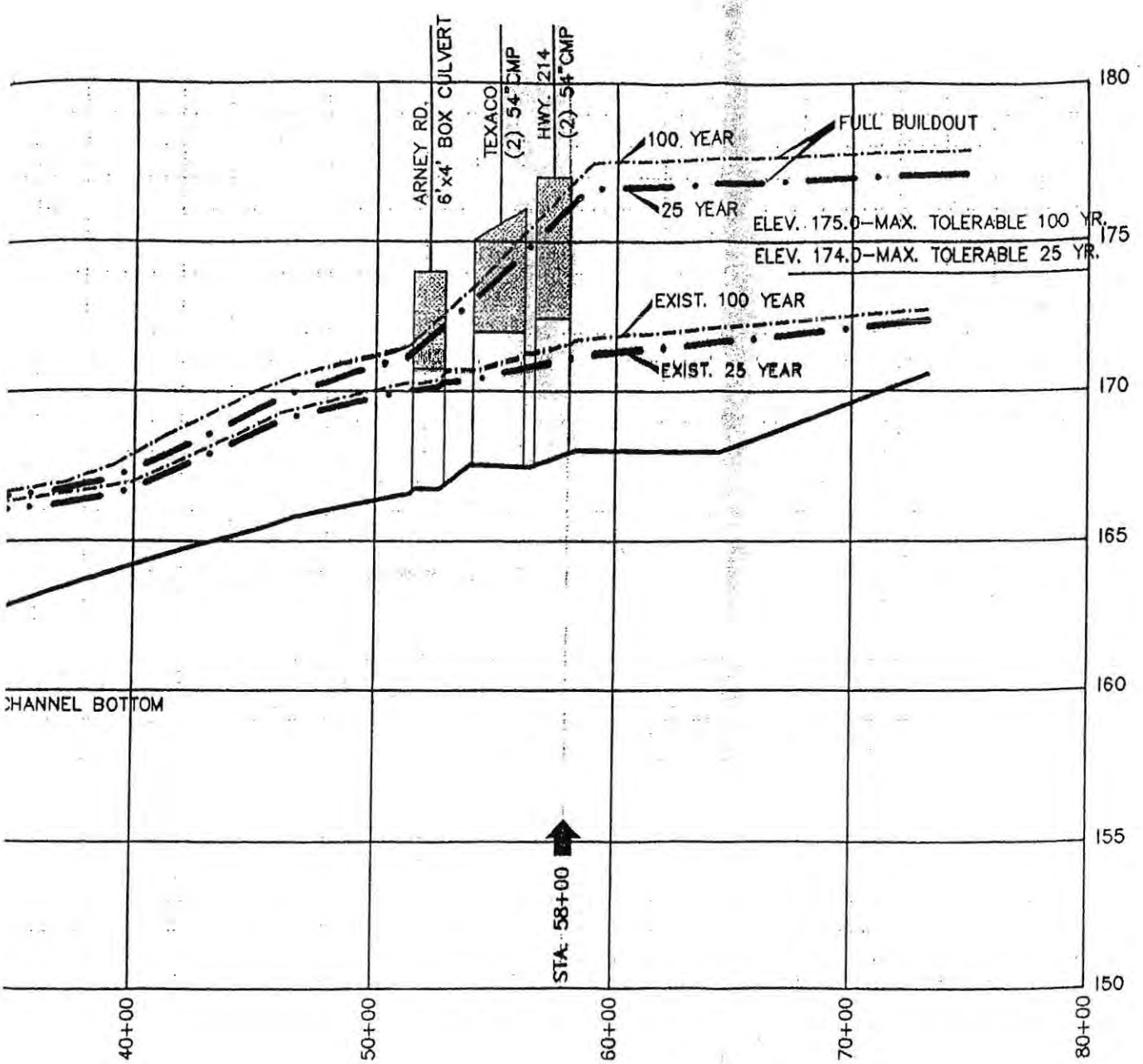

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UNDETAINED FLOWS

INSTREAM FLOWS:	STATION 10+00	STATION 26+00	STATION 58+00
EXIST. 25 YR	115 CFS	85 CFS	58 CFS
EXIST. 100 YR	155 CFS	112 CFS	76 CFS
FUTURE 25 YR*	250 CFS	230 CFS	180 CFS
FUTURE 100 YR*	350 CFS	280 CFS	220 CFS

* EXPANDED AREA

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of Woodburn
INAGE MASTER PLAN

EAST TRIBUTARY OF SENECAL CREEK
STRUCTURES & DETAINED FLOOD PROFILES

F.

14

Chapter 7

RECOMMENDATIONS FOR DRAINAGE IMPROVEMENTS

Continued improvements of the drainage system in Woodburn will rely on a number of activities and attention to the condition of the existing facilities. Specific recommendations for projects are found in Chapter 9, Recommended Capital Improvement Projects, of this report. These projects should be implemented as soon as funds, permitting and the public review process allow. However, these projects will only mitigate current shortcomings in the systems capacity and should not be relied upon to provide a drainage system which will adequately serve the City in the long term. Projects of growth and development patterns made in this study are based on the best understanding available at the time. Experience shows that trends change over time and forecasts of future conditions should be revisited periodically.

In light of this, the following general recommendations are provided to guide the City managers in their planning for future use of the drainage system.

Detention Policy Implementation

A city-wide Stormwater Flow Management Program including policies regarding detention has been developed concurrently with this study. It addresses on-site detention for individual parcels of land and identifies several locations in the City where a public detention facility may be sited. For the past number of years, the city has utilized a guide presented in Table 7-1, "Volumes for Different Intensity Storms for 10-Acre Site". This guide is presented here to document the city's recent position on detention facility sizing. The new guidelines are provided in the Stormwater Flow Management Program document and these should be used for analysis and

Table 7 - 1
VOLUMES FOR DIFFERENT INTENSITY STORMS
FOR 10-ACRE SITE

Storms	Results (Rates)	I (INTENSITIES)	A = 435,600 =10 acres	Developed C = 0.71 (UN)developed C = 0.25	ft³ Sec (cfs)	Volumes ft³ storms / 3600sec sec hrs	hrs storm
100 yr.	1.26" 2.7 hrs	0.467 in hr	435,600 ft² or 10 acres	0.71 0.25	3.313 1.167	32,205 ft³ 11,340 ft³	32,205 ft³ -- 11,340 ft³ 20,865 ft³ storage volume
50 yr.	1.20" 2.76 hrs	0.435 in hr	435,600 ft² or 10 acres	0.71 0.25	3.087 1.087	30,672 ft³ 10,800 ft³	30,672 ft³ -- 10,800 ft³ 19,872 ft³ storage volume
25 yr.	1.14" 2.86 hrs	0.399 in hr	435,600 ft² or 10 acres	0.71 0.25	2.830 0.996	29,138 ft³ 10,255 ft³	29,138 ft³ -- 10,255 ft³ 18,883 ft³ storage volume
10 yr.	1.08" 2.97 hrs	0.364 in hr	435,600 ft² or 10 acres	0.71 0.25	2.582 0.909	27,605 ft³ 9,720 ft³	27,605 ft³ -- 9,720 ft³ 17,885 ft³ storage volume
5 yr.	0.935" 3.28 hrs	0.285 in hr	435,600 ft² or 10 acres	0.71 0.25	2.024 0.713 (320 gpm)	23,899 ft³ 8,415ft³	23,899 ft³ -- 8,415 ft³ 15,484 ft³ storage volume
2 yr.	0.800" 3.64 hrs	0.220 in hr	435,600 ft² or 10 acres	0.71 0.25	1.560 0.549	20,448 ft³ 7,200 ft³	20,448 ft³ -- 7,200 ft³ 13,248 ft³ storage volume

CITY OF WOODBURN

RUN OFF DETENTION REQUIREMENT

1) Construct a device that has capacity for detaining difference in run off volume received by undeveloped and developed land for a 25-year storm.
2) Construct a discharge orifice of a size that the quantity of run off through the orifice is equal to run off flow from a storm of 5-year or less, undeveloped land.
3) Construct a detention facility to have a post-development 25-year capacity with a discharge orifice (or structure) sized to limit outflow to no more than the undeveloped site peak run off for the existing (undeveloped) 5 year frequency storm. Detention volumes calculated by the following methods are acceptable:
   A. Santa Barbara Urban Hydrograph routing model (as prescribed by the King County Surface Water Design Manual) for the post development 25-year runoff hydrograph detained back to the existing 5 year peak site discharge.
   B. 18,883 CF/ 10 Acre drainage area as per City of Woodburn standard table, above, based on the rational method.

SAFETY REQUIREMENTS

1) Depth of storm water within 30 feet from the edge of detention ponds, if open to public, shall be limited to 3 feet, then gradual slope (3%) to higher depth shall be allowed. Maximum pond side slopes shall be 3' horizontal to 1' vertical, however, gentler slope is desirable.

REV. A STRMVOLM-10/02/95 updated 08/30/96 Item #3 added 12/9/96 Safety Item revised.
REV. B. APPROVED BY CITY COUNCIL 12/9/96

design of all future detention facilities.

Portions of the existing drainageways currently function as detention sites where high water flow is backed up by road crossings such as East Lincoln Street and Hardcastle Street. These crossings were built with culverts intended to pass normal stream flows but do not pass high flows as easily. The hydraulic model simulates the high water level created during flood conditions and these levels are verified by the historical record of high water levels observed in both Mill Creek and Senecal Creek. These sites, four located in the Mill Creek drainage and one located in the Senecal Creek drainage basin will continue to function as detention areas and, with the exception of a proposed high level overflow structure at Hardcastle will not be modified to increase flows past them during storm conditions. However programs directed at improving public safeguards during periods of high flow and incorporation of storm water treatment wherever possible will be continued as a part of the Master Plan.

In addition, the City's detention policy should be made available to private developers and others who plan to alter drainage conditions or runoff volumes or rates. This policy addresses both 'arge and small properties throughout the Mill Creek and Senecal Creek drainages. The goals of the policy should be publicized and discussed whenever the opportunity presents itself.

Continued Planning

City staff should become familiar with and use computer-modeling techniques to assess the impacts of proposed development. With available tools such as HEC-1, the Santa Barbara Urban Hydrograph (SBUH), the Storm Water Management Model (SWMM) and similar, well-documented programs, forecasts of future runoff should be developed and reviewed periodically to document the changes in flow rates and volume of storm water. Continued use of a system model will also allow City staff to update the facilities plan portion of the Comprehensive Plan

as dictated by state regulation.

The City should also plan to reanalyze the entire system and prepare new forecasts of storm water conditions every 20 years, a period typically used in major facility planning. This major effort provides opportunity to re-evaluate the entire system and incorporate changes in land use and other stormwater runoff conditions and parameters.

Operations and Maintenance

The City has and follows a plan for ongoing operations and maintenance of the storm drainage system. This system should be continued and expanded to include regular inspection of drainage facilities including major culverts, bridges, detention areas (public and private) and major open stream segments. Periodic cleaning of debris in the stream and adjoining floodway areas should be done to prevent the buildup of flow-inhibiting materials.

Storm sewer maintenance activities which include regular inspections of inlets, catch basins, major storm sewers and outfalls should also be scheduled and findings documented.

Chapter 8

PROJECT PHASING

Projects required to maintain the storm drainage system capacity by construction of new conveyance facilities or expansion of existing facilities must be prioritized to level the demands on the City's funds and staff. All projects will eventually be needed to maintain system capacity as the service area grows and is developed with new residential and commercial areas. This Chapter of the Study sets the methods and criteria for determining which individual projects should be funded and constructed first and which may be deferred until a later time.

PROJECT PHASING

A detailed analysis of the runoff conditions as found in Chapter 5, Analysis of Rainfall Runoff, was used to identify problem areas in the existing system where peak hydrologic conditions reached or exceeded the facilities' ability to safely handle these flows. This data and model projections were categorized using the base assumptions and criteria outlined in Chapter 3, Study Methodology. Accordingly, budget level cost estimates for the construction of each capital project were developed and can be found in Chapter 9, Recommended Capital Improvement Projects. These cost estimates include the construction costs and other project-related costs such as design and inspection services, legal support and, where necessary, costs of land needed to implement the improvement.

Based on the severity of the problem and the cost of the improvement as determined by applying specific criteria, projects are divided into specific groups and placed into phases that will allow prudent expenditure of public funds. Each proposed project has been given a designation of high, medium or low priority. The phasing periods and the specific criteria, used to separate

capital projects into a priority grouping follow.

PHASING PERIODS

The City typically operates on a 5-year capital improvements plan (CIP) which directs planning and construction of capital public works projects. Usually, projects placed in this plan have been identified through engineering study by the City staff and citizen input. In this case, some projects were deemed suitable to be placed on the CIP due to their impact on public safety and health and are suggested herein for "high" priority for implementation within one to three years. Other projects, necessary for efficient operation of the drainage system but not threatening in terms of public health and safety are given "medium" priority and targeted for inclusion on the CIP within the succeeding 3- to 6- year portion of the plan.

Finally, some projects are driven by the rate of land development within the service area and are given "low" priority for project planning. Projects in this category should be revisited each year in preparation of the current CIP and their necessity weighed in light of local development rates upstream of the potential project. In this Study, the long-term phase is defined as the period extending beyond the CIP 5-year window.

In the case of potential development outside the jurisdiction of the City, some projects may require a change of priority to alleviate increases in runoff due to these development projects.

The phasing of drainage improvement projects was divided into the following categories which are shown with their respective time frames:

Phase Designation	Time Frame
3 Year	FY 2002 - FY 2005
6 Year	FY 2005 - FY 2008
10 Year	Beyond FY 2008

It is recognized in this Study that any of the projects identified may change priority as storm water runoff conditions upstream change. Usually, no single factor will dictate the priority of a project, however, the following discussion provides a guide for project prioritization and is intended to allow flexibility within the financial and technical ability of the City to implement them.

CRITERIA FOR PROJECT PHASING

The improvements identified are needed to provide adequate capacity for fully developed lands within the two major watersheds. In other words, existing drainage conveyances were evaluated to determine which would need to be modified or replaced to handle increasing peak flows as development occurs. Estimates of future facility improvements were made to allow for continued proper function of the drainage system.

Additionally, more local drainage facilities will be needed within developments on large parcels. These local facilities, usually storm water inlets and piping systems are typically provided by the developer of the parcel as part of the development's infrastructure and are either kept as private drainage facilities or are constructed to City standards and turned over to the City upon acceptance by the City. It is not the intent of this Study to place restrictions on the alignment of drainage facilities within these currently undeveloped lands, except as specifically provided for

in this Study.

Chapter 5, Analysis of Rainfall Runoff, provides estimates of gross subbasin runoff information and outlines the methodologies which may be used to determine design flows for these on-site improvements. Drainage facilities should be planned for these development parcels as part of the City's normal site design review process. These facilities should have capacity to handle the flows estimated by this Study and should provide for continuity of existing drainage ways.

As a first step, drainage improvement projects were identified which were needed to correct existing problems as identified by the model analysis or problems known by City staff and citizens. These improvements were checked against peak runoff flows that will be created by future development to make certain that a project would handle both current and future runoff conditions. These improvements were classified as 3-YEAR phase improvements. Within this category, the priority was rated as "High" if there was a relatively large risk associated with not completing the improvement or if the problem created by the existing situation was frequent and caused a public safety concern or significant inconvenience.

These projects were then arranged within the phasing categories by considering the following criteria:

A. Extent of a current system or facility inadequacy as judged by the relative inadequacy when compared to the peak runoff requirements for an adequate structure or drainageway feature.

B. Estimated time frame for further development within the catchment area, assuming development which will exacerbate the condition or make it untenable.

C. Relative risk from failure to make timely improvements as judged by the potential for structural failure of the facility or creation of a public hazard.

Chapter 9

RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

Capacities of existing and drainage system facilities were analyzed and the analysis presented in Chapter 5, Analysis of Rainfall Runoff. Using the criteria and methods outlined earlier in the Study, this analysis shows system deficiencies in several geographic areas. Based also on the discussion of Chapter 7, Recommendations for Drainage Improvements, the following projects are recommended for adoption by the City and should be included in the City's future Capital Improvement Program (CIP). Figure 15, Proposed Capital Improvements Key Map, shows the location of all proposed CIP projects and Table 9-1, CIP Project Summary, provides a brief summary of these proposed projects.

These projects have been defined to the extent of the information available at this time with the best information provided pertaining to their cost, phasing and implementation. Prior to actual initiation of any individual project, a detailed preliminary engineering study should be prepared and a more precise cost estimate prepared. In addition, preliminary and final designs of these projects to determine dimensions, location and facility sizes will be required. Also, detailed review of property ownership and property line location should be done during preliminary design of an individual improvement to assure new or rebuilt facilities are located on public lands or have the appropriate easements.

It should be noted here that proposed improvements are based on information available at the time of completing the modeling for this Study. The existing site information has been updated to represent the facilities as of July 2001. **Re-evaluation of these proposed improvements is recommended at the time of preliminary design.** System re-routing, upgrades and future development will affect these recommendations. Any alterations of the existing system layout or unforeseen developments should be carefully evaluated for downstream adequacy and potential conflict with the objectives of this Study.

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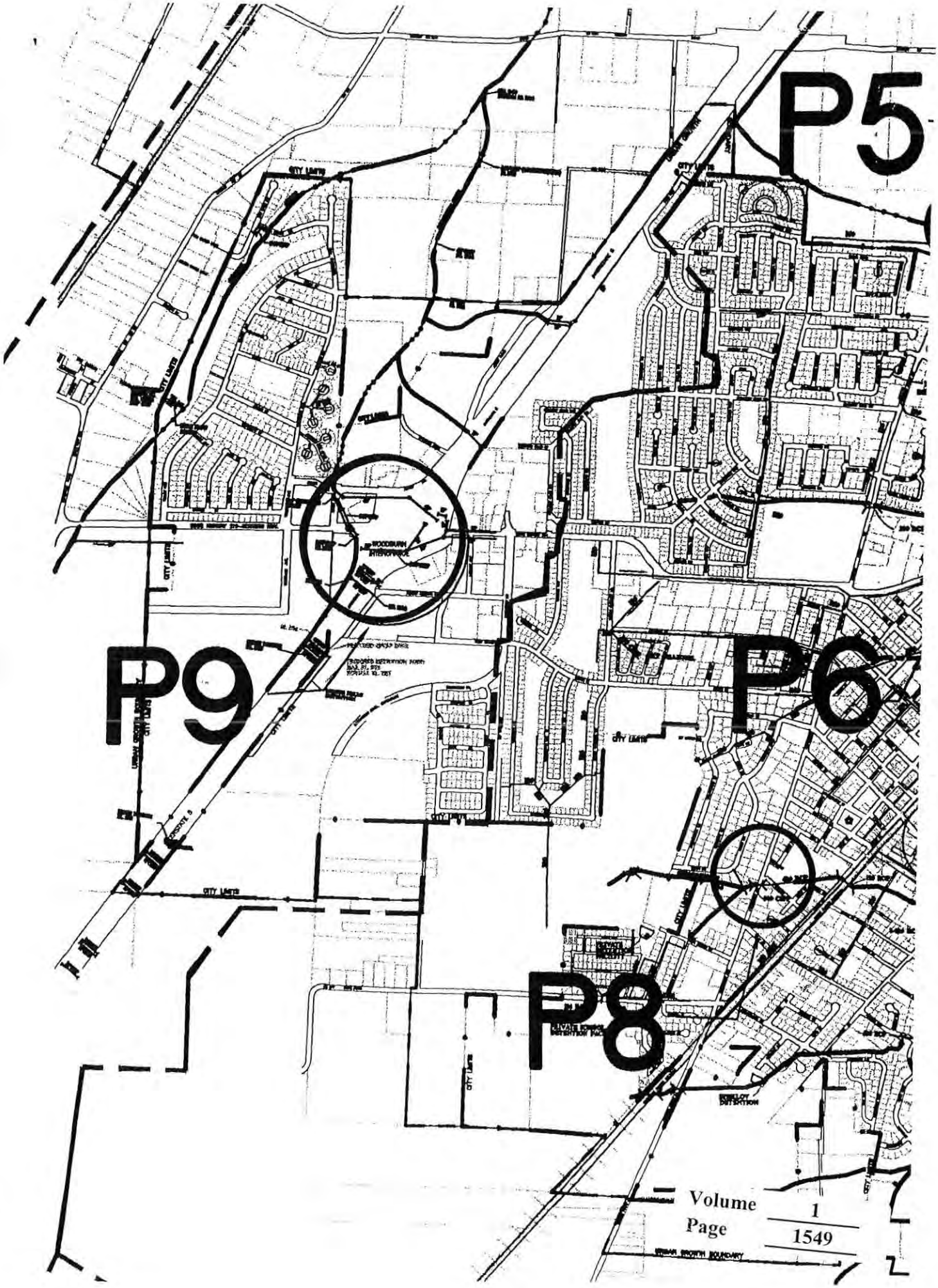

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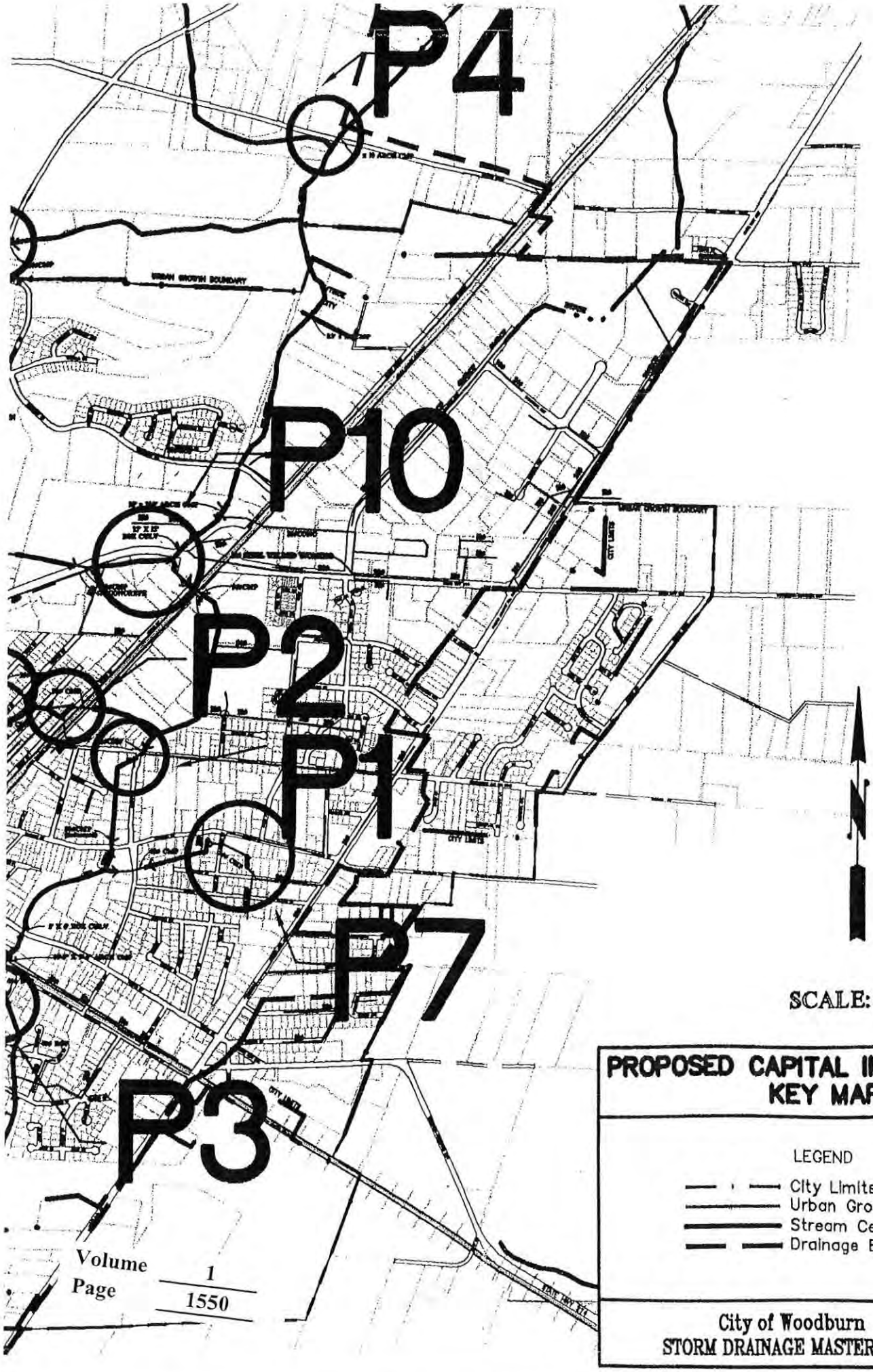

PROPOSED CAPITAL IMPROVEMENTS KEY MAP

LEGEND

- City Limits
- Urban Growth boundary
- Stream Centerline
- Drainage Basin Boundary

City of Woodburn
STORM DRAINAGE MASTER PLAN

FIGURE 15

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TABLE 9-1

CIP PROJECT SUMMARY

Woodburn Drainage Master Plan

Project ID	Project Name	Drainage Basin	Subbasin ID	Priority	Estimated Cost ($)
P1	Hardcastle Crossing	Mill Ck	M-8	High	$ 191,729
P2	Front Street Detention & Crossing	Mill Ck	M-7	High	$ 151,436
P3	Marshall Street	Mill Ck	M-10	High	$ 78,560
P4	Crosby Road Crossing	Mill Ck	M-1	N/A (county)	$ 587,159
P5	Boones Ferry Crossing	Mill Ck	M-1a	Low	$ 53,157
P6	Old town - 2nd Street	Mill Ck	M-7	Medium	$ 188,965
P7	East McKinley	Mill Ck	M-9a	High	$ 953,101
P8	Stubb Rd Detention	Mill Ck	M-11a	Medium	$ 359,571
P9	Connect 48" at I-5 & Hwy 214	Senecal Ck	ES-2	High	N/A
P10	Goose Creek Re-alignment	Mill Ck	M-5	Low	$ 224,577

CIP Total= $ 2,788,255

table9-1.xls8/27/02

The following CIP projects are recommended for implementation:

Five proposed projects within the Study area have been given high priority for improvement. These are the Hardcastle Road crossing; development of a detention facility at the Front Street park and addition of a 42-inch line across Front Street and the railroad; adding capacity at Marshall Street; increasing capacity at East McKinley near Bryan Street; and consolidation of storm flows into the existing 48-inch line crossing I-5 immediately north of Hwy 214.

On Hardcastle Road, addition of an auxiliary (overflow) line in the embankment of the fill crossing Mill Creek is recommended. This should be designed as a box culvert to minimize head loss while minimizing use of the embankment. Details of this recommendation are found the outline for Project No. 1, Hardcastle Crossing.

On Front Street, flow from an open ditch in the park reenters an 18" diameter pipe before it goes under Front Street. Flows beyond the capacity of the 18" pipe are diverted to an open ditch and routed northerly to an existing 30" diameter pipe which crosses under Front Street and the Railroad. The new system would create a detention facility at the park and increase capacity of the line under Front Street and the railroad by constructing a 42-inch line in place of the existing 30" pipe. Control structures would also be constructed at the detention facility.

At the Marshall Street crossing of Mill Creek, addition of a second conduit to increase capacity of the crossing and avoid flows that overtop the street in all but the most extreme storm events is recommended for immediate development. At this location, a second, parallel pipe of 54-inch diameter should be installed to relieve flooding conditions immediately upstream. Details of this project are itemized in the write up titled Project No. 3, Marshall Street.

In the area of Blaine and East McKinley Streets, the existing storm system has inadequate capacity to carry existing high flows and the system does not meet present City standards for

alignment. Complaints of flooding have been received from local residents. In order to alleviate these problems the sub-standard pipes will be abandoned and new larger diameter pipes will be constructed within the alignment of the public right-of-way.

Analysis of the flood elevation for various storm events show a significant head loss being incurred at the Crosby Road Crossing. This facility is owned by Marion County and appears to cause significant headloss in the higher flow ranges. Improvement to this facility is recommended, and the City should initiate discussions with county staff to this end. Elimination of the head losses caused at Crosby Road will lower the immediate upstream flood elevation significantly and, with that, lower flood elevations for the 100-year event as far south on Mill Creek as Highway 214.

An unused 48-inch storm sewer was constructed as part of the ODOT I-5 construction. This system can be utilized to relieve hydraulic loading to the storm system crossing under I-5 to the south of Hwy 214. This project requires further investigation to determine the best potential re-routing plan.

In addition to the five CIP projects listed above, two other locations along the main stem of Mill Creek appear to be overtopped during periods of very high flow. These are the Goose Creek confluence at Highway 214 near the Mill Creek Pump Station and the private road crossing just south of Crosby Road.

At Mill Creek at the confluence of Goose Creek just south of Highway 214 at the Mill Creek Pump Station there is significant probability of backwater build up during the 25-yr. event and overtopping appears to be possible during the 100-year storm event. To resolve this potential problem it is recommended that the Goose Creek Tributary which presently enters Mill Creek at the Pump Station south of Hwy 214 be re-aligned to cross Hwy 214 and intersect Mill Creek to the north of Hwy 214. This would include the installation of a 60" diameter culvert and is designated as Project No. 10, Goose Creek Re-alignment. This project is assigned as a lower

priority, however should state or federal funds become available for a project of this nature, it could be moved higher on the list.

The private drive south of Crosby Road is within the City limits but is not a publicly-owned facility nor is it located within a public right-of-way. This site is not recommended for inclusion on the CIP list for these reasons but is mentioned in this Study because the capacity of the existing culvert (7.8'x 8.3' CMP) is inadequate to pass the existing 25-yr event. During the floods of 1996 the water surface elevation reached approximately 152.0', three feet above the existing driveway elevation of 149.0'. The type, configuration and slope of the culvert limits the capacity to less than 250 cfs. The full build-out 100-yr event flow at this location is estimated at 500 cfs. The culvert should be replaced with a more hydraulically efficient 90" or 96" pipe with increased slope on the culvert as the topography will allow. Depending on the policy of the City and discussions with the property owner, capital improvement funds should only be used to increase capacity of the crossing if such expenditure falls within the goals of the City's storm management policy and can be shown to benefit City property owners or City-owned property.

COST DATA

The following figures and tables present the capital improvement projects recommended for implementation. Most construction costs are based on information from recent project bid tabulations and unit prices for this area as documented in a technical memorandum from *City of Portland, Environmental Services Public Facilities Plan Technical Memo, T7.C.1. Basis of Cost Estimates,* dated June 1998. These prices have been adjusted (increased by 7.6 percent) to reflect construction costs in 2001 and are now based on the July 2001 ENR CCI of **6404.** All costs should be re-evaluated at the time of preliminary and final design to refine individual items estimates. The costs provided on the following project outlines are total project costs and include design and administrative costs as well as a contingency allowance. A range of contingencies was used to allow for varied construction scenarios of each project site.

Project No. 1

Drainage: Mill Creek

Subbasin: M-8

Project Name: Hardcastle Crossing

PRIORITY: High

Description: The embankment of the Hardcastle crossing of Mill Creek restricts flows in Mill Creek during the forecast 100-year flood event. This restriction causes water to back up as far as Marshall Street and will, during a 100-year storm event, cause the water surface to come within 6 inches of overtopping the roadway. See Figure P1, Hardcastle Crossing, for the existing site layout. The existing culvert capacity is 255 CFS and future 100-year flood flows are estimated at 285 CFS.

This project proposes to create an overflow channel with an invert elevation of 160.5' which will allow continued storage to occur upstream of the embankment and allow any flows reaching the 160.5' elevation to pass. At flood flows, this high-level overflow will maintain a water surface elevation of 161.5'. Construction of this overflow will provide relief of the high backwater condition at Marshall Street and the intervening crossings and make maximum use of the detention storage in the park areas along Mill Creek.

It is most likely that use of a 2 foot high box culvert, 5 feet wide set at a slope of 0.005 (ie. in 160.5' - ie. out 160.3) will allow maximum passage of storm flows while minimizing headloss through the structure.

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Cost Estimate: Hardcastle Crossing

Project	Item	Unit	Quantity	Unit Cost	Total
	2'x3' Box Culvert	lf	190	409	$ 77,710
Hardcastle Crossing	Headwalls	ea	2	2,153	4,305
	Concrete Encasement	cy	50	135	6,727
	Slope Protection	cy	20	108	2,153
	Site Demo/Flow Diversion	25%	1	22723	22,723
	Subtotal				113,617
	Contingency	35%	1	39766	39,766
	Subtotal				153,383
	Eng, Legal, Admin	25%	1	38346	38,346
				TOTAL=	$ 191,729

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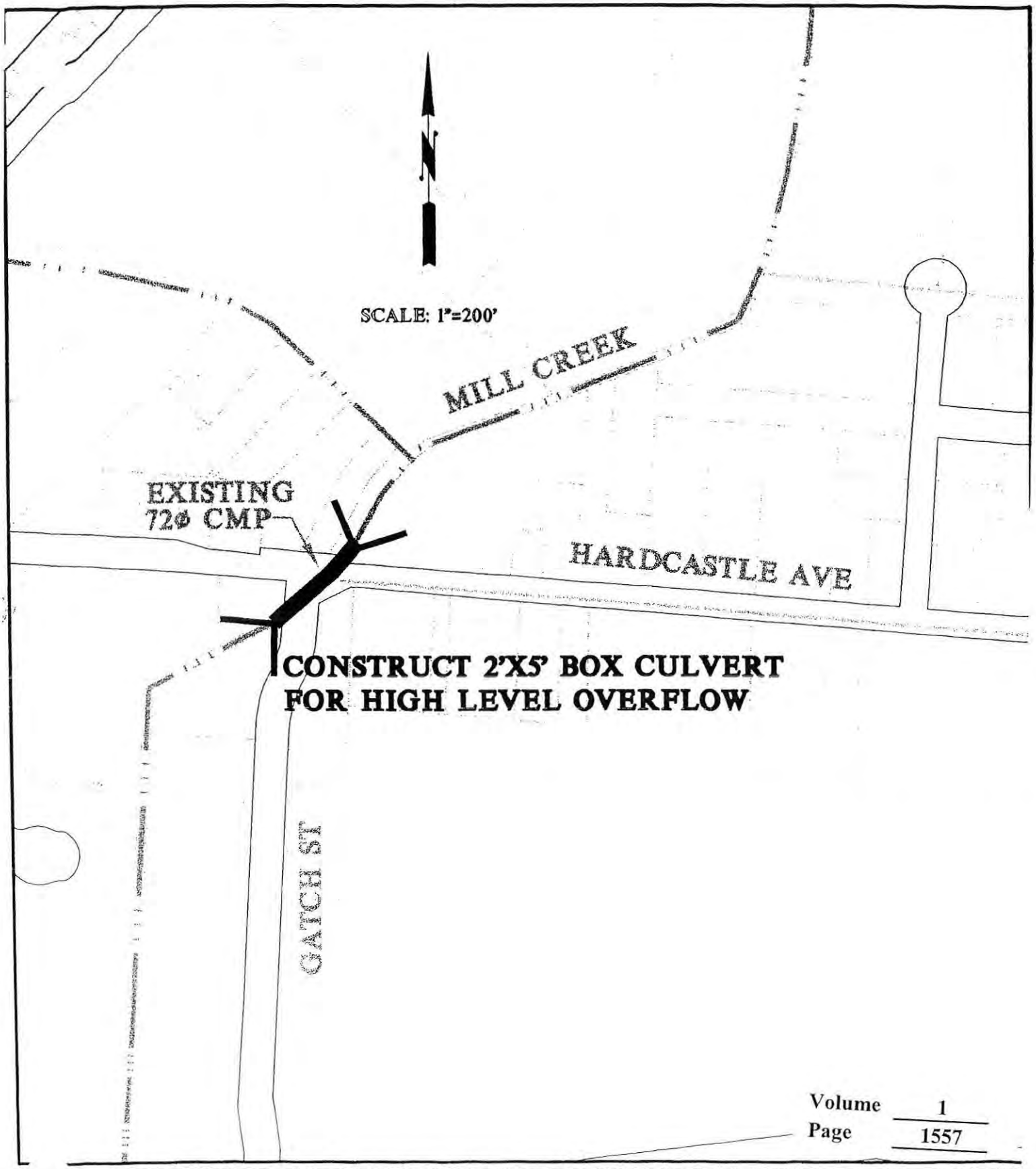

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JULY 2001	CRANE & MERSETH Engineering/Surveying 6566 SE LAKE Rd., SUITE D MILWAUKIE, OREGON 97222 BUS: (503) 654-2005 FAX: (503) 654-2575	PROPOSED CAPITAL IMPROVEMENT HARDCASTLE CROSSING City of Woodburn STORM DRAINAGE MASTER PLAN	FIGURE P1

Project No. 2

Drainage: Mill Creek

Subbasin: M-7

Project Name: Front Street Detention and Crossing

PRIORITY: High

Description: West and south Front Street, drainage flows from subbasin M-7 join to enter an open ditch system in Front Street Park and eventually flow into pipe systems under Front Street and the railroad. The southerly pipe is an 18" diameter concrete pipe and low flows exit the Park via this pipe. When the hydraulic capacity of the 18" pipe is reached, overflows enter a second open ditch running north and into an existing 30" diameter concrete pipe which runs under Front Street and the Railroad. The Park can be converted into a detention facility if flows out of the Park are controlled. Also, the replacement of the 30" pipe under Front Street and the railroad with a 42" pipe will allow for high flow by-pass as needed for future development.

Modeling indicates that buildout conditions will increase 100-year flood flows from 65 CFS currently to 77 CFS in the future, assuming that subbasin M-11c2 will be routed to the south.

Model analysis indicates that maximum outflow capacity is 37 CFS when storage and ponding in the park area reaches 168.0', approaching the pavement on Front Street. Currently, a 25-year flood event will cause a backup of water about 1 foot

deep in the park and a 100-year flood event will cause a backup of about 3 feet deep. With surrounding properties as currently developed, no damage to property or homes should occur. Future flooding conditions after complete infill in the upstream basins will create a water depth of 2 feet in the park during a 25-year event and water will overtop Front Street during a 100-year event.

To mitigate this potential for future flooding and inundation of Front Street, it is recommended that the park area be excavated to provide an additional 0.7 acre-feet of storage below elevation 167.0' and that the existing 30" CMP pipe crossing Front Street and the railroad be replaced with a 42-inch diameter reinforced concrete storm sewer line. See Figure P2, Front Street Detention & Crossing, for the existing site layout.

Cost Estimate: Front Street Detention & Crossing

Project	Item	Unit	Quantity	Unit Cost	Total
P2	Excavation	cy	1150	11	$ 12,6[illegible]
Leaping Weir at Front St.	Seeding and Restoration	ac	0.7	2153	1,507
	42 inch CSP w/ boring	lf	200	300	60,058
	Headwalls	ea	2	2153	4,305
	Flow control structure	ea	2	5382	10,764
	Flow control	5%	1	4181	4,181
	Subtotal				93,192
	Contingency	30%	1	26343	27,957
	Subtotal				121,149
	Eng., Legal, Admin.	25%	1	28538	30,287
				Total=	$ 151,436

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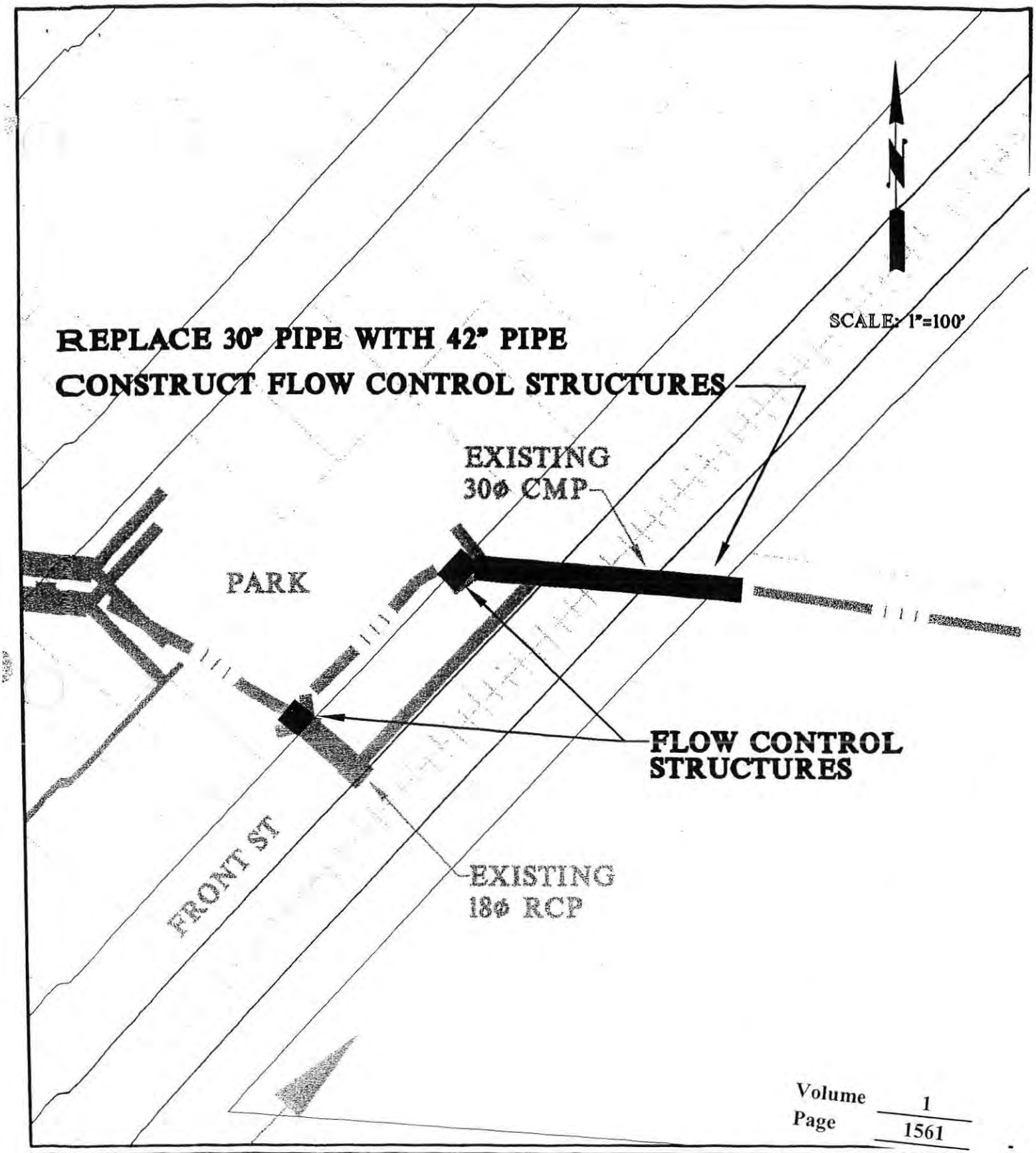

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DATE			FIGURE
LY 2001	CRANE & MERSETH Engineering/Surveying 6566 SE LAKE Rd., SUITE D MILWAUKIE, OREGON 97222 BUS: (503) 654-2005 FAX: (503) 654-2575	PROPOSED CAPITAL IMPROVEMENT FRONT ST DETENTION & CROSSING City of Woodburn STORM DRAINAGE MASTER PLAN	P2

Project No. 3

Drainage: Mill Creek

Subbasin: M-10

Project Name: Marshall Street

PRIORITY: High

Description: The existing crossing of Marshall Street at Mill Creek is conveyed through a single 48-inch diameter line. The capacity of this line is inadequate to convey the future 5-year event and currently overtops during the existing 25-year storm event as was evidenced during the February floods in 1996. In addition, the head loss through this line during flood conditions is almost 3 feet. A future 100-year event will overtop the street by about 2.5 feet, likely causing severe damage to the pavement and embankment.

This condition will be mitigated through installation of a 54-inch diameter line paralleling the existing line. Realignment will not be necessary, however, some additional land may be required to install a second line of this diameter. See Figure P3, Marshall Street, for the existing site layout.

Cost Estimate: Marshall Street

Project	Item	Unit	Quantity	Unit Cost	Total
PG	54 inch pipe	lf	80	443	$ 35,473
Marshall Street	Headwalls	ea	2	4305	8,610
	Site Demo/Flow Diversion	10%	1	4309	4,309
	Subtotal				48,494
	Contingency	35%	1	16973	16,973
	Subtotal				65,467
	Eng. Legal Admin	20%	1	13093	13,093
				Total =	**$ 78,560**

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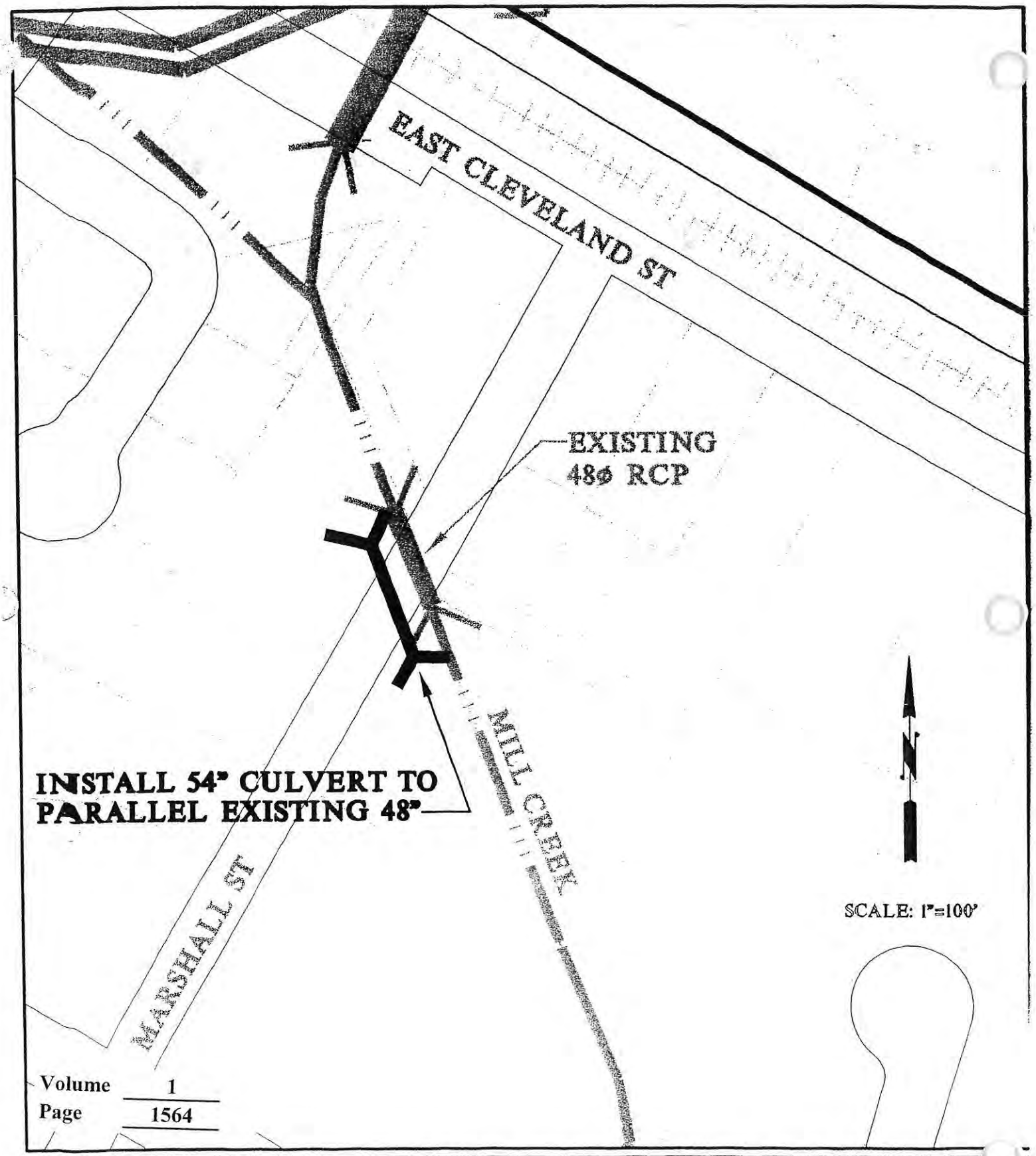

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DATE			FIGURE
JULY 2001	CRANE & MERSETH Engineering/Surveying 6566 SE LAKE Rd., SUITE D MILWAUKIE, OREGON 97222 BUS: (503) 654-2005 FAX: (503) 654-2575	PROPOSED CAPITAL IMPROVEMENT MARSHALL STREET City of Woodburn STORM DRAINAGE MASTER PLAN	P3

Project No. 4

Drainage: Mill Creek

Subbasin: M-1

Project Name: Crosby Road Crossing (In County)

PRIORITY: Subject to be discussed with Marion County

Description: A major Mill Creek crossing at Crosby Road north of the City is conveyed through a 7' x 10' arch CMP culvert. This facility has an existing capacity of 340 CFS and, during periods of unusually high water conditions, restricts the Mill Creek flows and creates a significant headloss. Model analysis indicates a 100-year flood flow of 624 CFS.

While flood profiles indicate that Crosby Road will not be overtopped by the 100-year event, the headloss and resulting backwater created by this flow raises the flood elevation in Mill Creek as far south as Highway 214 and, increases the potential for damage to structures along the stream.

In order that the flood elevation be lowered to an acceptable level, it is recommended that the existing arch culvert be replaced with 8' by 14' box culvert or structure of equivalent capacity. See Figure P4, Crosby Road Crossing, for the existing site layout. Installation of a new culvert will have the effect of lowering the flood elevation upstream of the Crosby Road structure by approximately 2 feet to a new water level of about 147.0'.

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Since the Crosby Road structure is located on a roadway owned and maintained by Marion County, it is recommended that City staff notify the Marion County of this situation and together begin discussion of a mutually acceptable solution.

Cost Estimate: Crosby Road Crossing

Project	Item	Unit	Quantity	Unit Cost	Total
P4	8x14 box culvert	lf	100	2368	$ 236,787
Crosby Road Crossing	Headwalls	ea	2	8500	17,000
	Site demo/Flow Diversion	25%	1	68447	68,447
	Stream Mitigation	ls	1	5382	5,382
	Subtotal				322,616
	Contingency	40%	1	129046	129,046
	Subtotal				451,661
	Eng., Legal, Admin.	30%	1	135498	135,498
				Total =	$ 587,159

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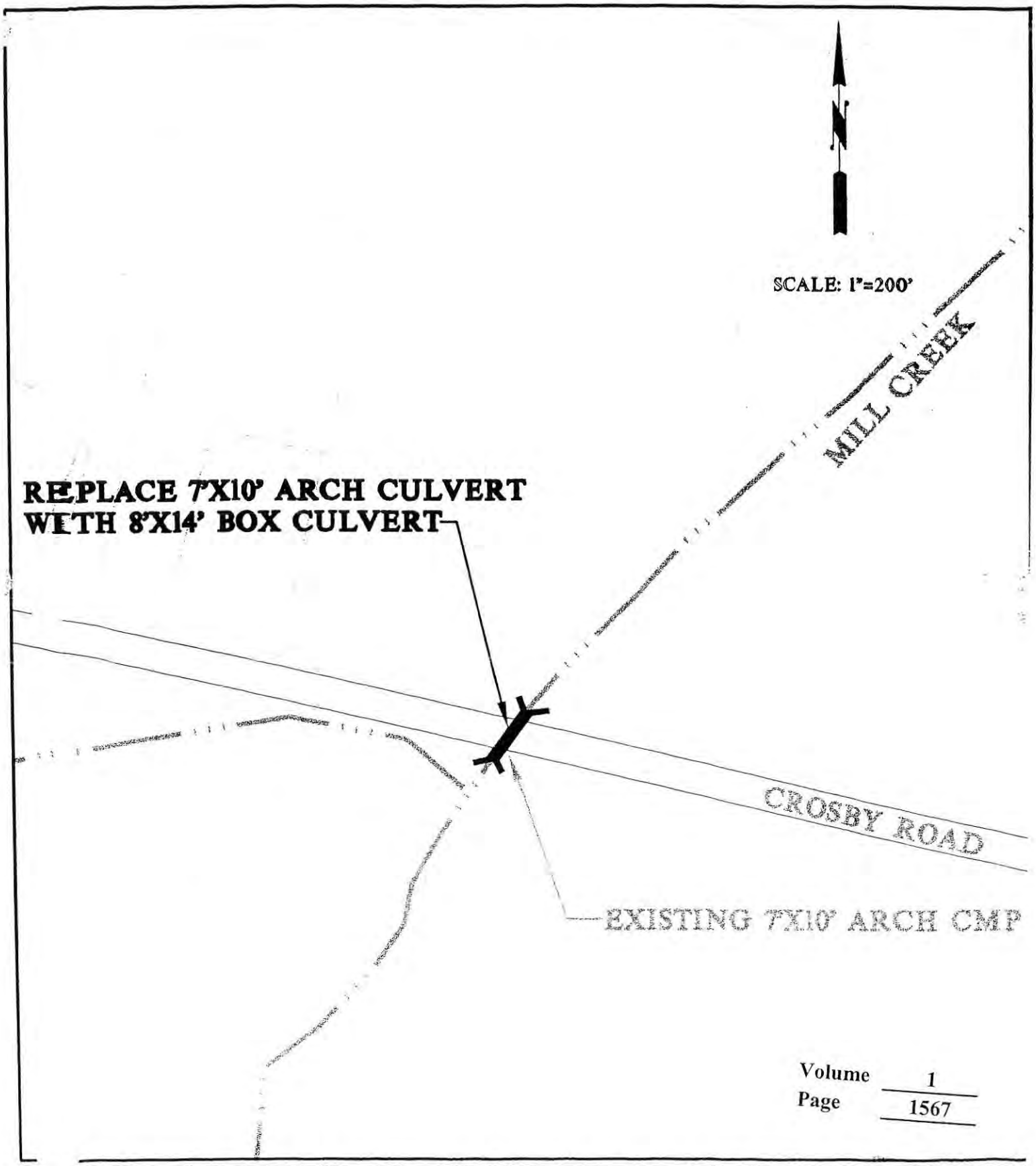

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PROPOSED CAPITAL IMPROVEMENT
CROSBY RD CROSSING

City of Woodburn
STORM DRAINAGE MASTER PLAN

FIGURE
P4

Project No. 5

Drainage: Mill Creek

Subbasin: M-1a

Project Name: Boones Ferry Crossing

PRIORITY: Low

Description: This crossing of Boones Ferry Road immediately north of the current City limits carries runoff from the developed and undeveloped areas west of Boones Ferry Road including flows from subbasin M-1c. In time it will also receive runoff flows from subbasin M-1b. Subbasin M-1b is zoned for single family dwellings and will increase the runoff from this area after development. Projections show the existing 24-inch culvert and the 36" pipe crossing Boones Ferry limited at a 2-year storm flow under future (buildout) conditions. Future flows will require a 42-inch diameter line to replace the existing 36" pipe. See Figure P5, Boone's Ferry Crossing, for the existing site layout. This project proposes to only replace the section of pipe under Boones Ferry Rd. The required extent of replacement of the 36" needs to be investigated further. Further field investigations should be conducted to determine if all or portions of the 36" pipe will need to be replaced.

Since the existing crossing is outside the City limit, financial responsibility may not be the City's. Options include involving Marion County in the decision to enlarge the crossing capacity and/or strictly enforce detention policies in both subbasin M-1b and the undeveloped areas north of the swale leading to the crossing. If future flows can be limited to existing conditions, the crossing may handle a 10-year event and be suitable for some time.

Cost Estimate: Boones Ferry Crossing

Project	Item	Unit	Quantity	Unit Cost	Total
P5	42-inch pipe	lf	85	300	$ 25,525
Boones Ferry Crossing	Headwalls	ea	2	2153	4,305
	Site demo/Flow Diversion	10%	1	2983	2,983
	Subtotal				32,813
	Contingency	35%	1	114844	11,484
	Subtotal				44,297
	Eng, Legal, Admin	20%	1	88594	8,859
				Total =	$ 53,157

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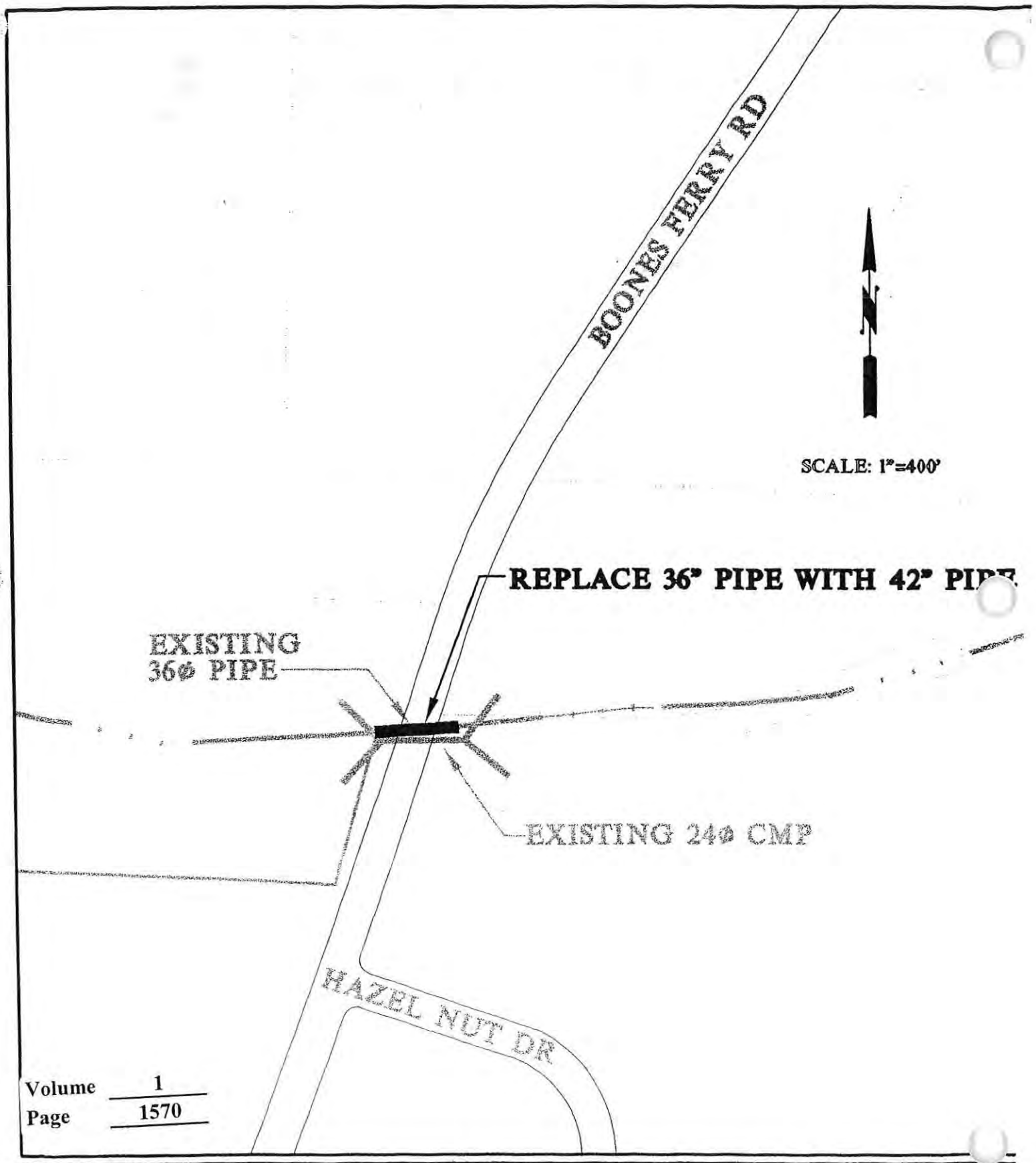

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DATE				FIGURE
JULY 2001		CRANE & MERSETH Engineering/Surveying 8566 SE LAKE Rd., SUITE D MILWAUKIE, OREGON 97222 BUS: (503) 654-2005 FAX: (503) 654-2575	PROPOSED CAPITAL IMPROVEMENT BOONES FERRY CROSSING City of Woodburn STORM DRAINAGE MASTER PLAN	P5

Project No. 6

Drainage: Mill Creek

Subbasin: M-7

Project Name: Old Town (1st and 2nd)

PRIORITY: Medium

Description: One crossing on the Old Town tributary of Mill Creek west of Front Avenue is undersized for future capacity needs. This crossing is a culvert that extends from the west side of Third Street and outlets on the east side of Second Street. The crossing is a single 36-inch diameter (2nd Street) and will be limited to a 2-year storm event at buildout conditions. Primary future flows for this tributary system will come from subbasin M-7b2, a large residentially-zoned area south of Highway 214. Replacement conduits for these lines can be either replacement lines or parallel lines depending on the existing conditions of the two crossings and the anticipated future life. See Figure P6, Old Town- 2nd St., for the existing site layout.

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Cost Estimates: Old town – 2nd St

Project	Item	Unit	Quantity	Unit Cost	Total
B6	36 inch culvert	lf	310	265	$82,079
Old Town-2nd St	Headwalls	ea	2	2,153	4,305
	Site Demo/Site Restoration	25%	1	21,596	21,596
	Subtotal				107,980
	Contingency	40%	1	43,192	43,192
	Subtotal				151,172
	Eng, Legal, Admin	25%	1	37,793	37,793
				Total=	$ 188,965

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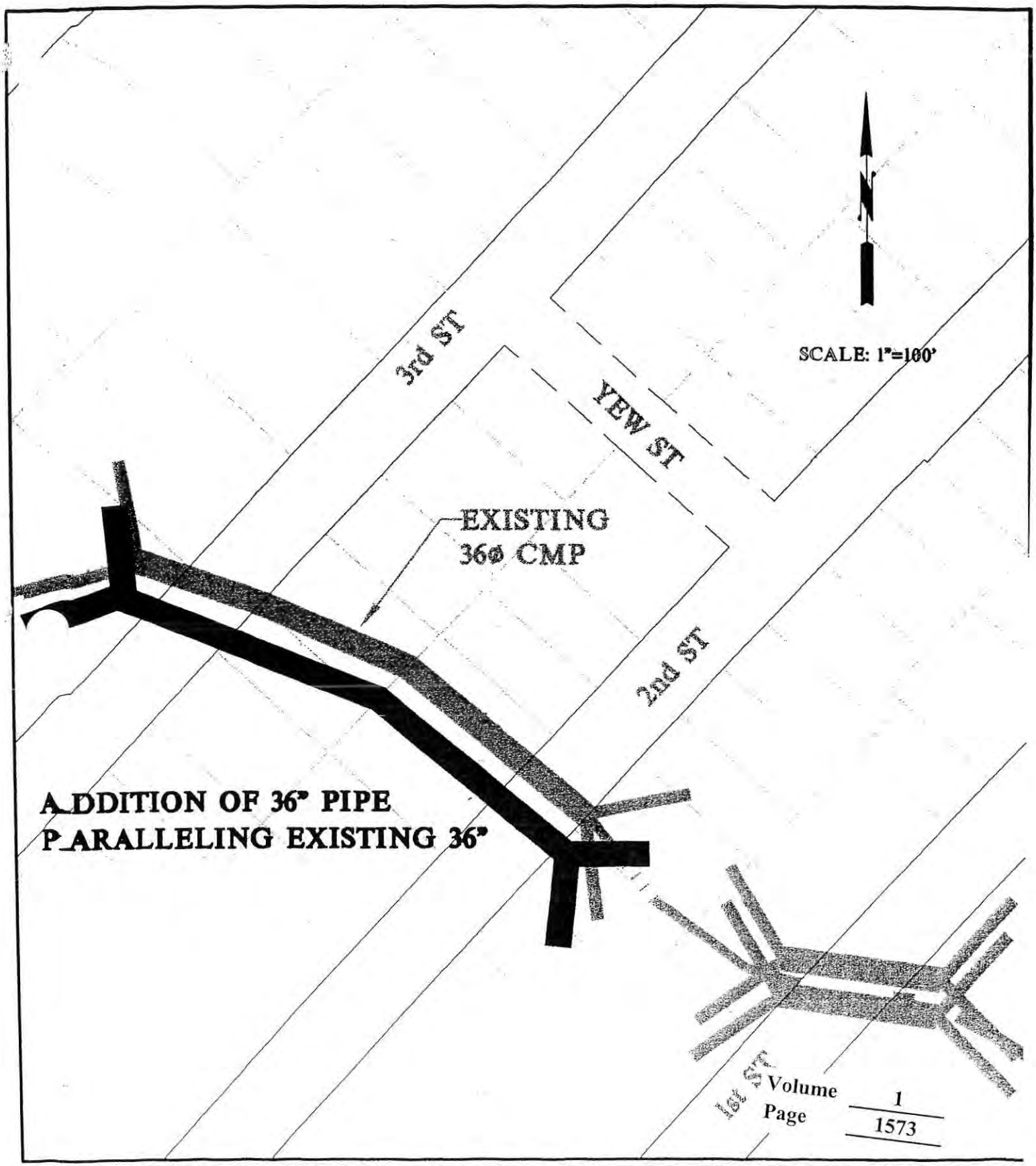

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PROPOSED CAPITAL IMPROVEMENT
OLD TOWN - 2ND ST

City of Woodburn
STORM DRAINAGE MASTER PLAN

FIGURE
P6

Project No. 7

Drainage: Mill Creek

Subbasin: M-9a

Project Name: East McKinley

PRIORITY: High

Description: Flows entering the 24-inch diameter line on East McKinley from the Highway 99E area cause significant headloss due to the limited capacity of the existing corrugated metal pipe. A combination of high flows from the commercial areas along the highway and use of a corrugated pipe along McKinley cause this condition to exist. The existing 24" runs along East McKinley and flows to the north through a series of private properties. The exact location of the pipes within the private properties is unknown and the alignment is non-standard. This is also the case with an existing 18" pipe located on private properties between East McKinley and Blaine Streets. Additional capacity can be provided by up-sizing the existing 24" and 18" pipes. Also, the pipes located on private property should be abandoned and newly constructed pipes within public right-of-way can service these areas.

Presently, it is proposed to replace the existing 24" pipe in East McKinley with a 36" pipe and replace the existing 18" pipe with a 21" pipe. Where the two systems converge at the intersection of McKinley and Bryan Streets a 48" diameter pipe would be constructed. The newly constructed storm sewer would follow the alignment of East McKinley and outfall to the open drainage located south of Lincoln Street and to the west of McKinley Street.

Cost Estimate: East McKinley

Project	Item	Unit	Quantity	Unit Cost	Total
P7	36-inch pipe	lf	1250	265	$ 330,963
East McKinley	48-inch pipe	lf	525	357	187,600
	21-inch pipe	lf	610	182	110,956
	Permanent Plug	ea	2	250	500
	Headwalls	ea	1	2153	2,153
	Misc. connections	ea	3	1076	3,229
	Subtotal				635,401
	Contingency	20%	1	127080	127,080
	Subtotal				762,481
	Eng. Legal Admin	25%	1	190620	190,620
				Total=	**$ 953,101**

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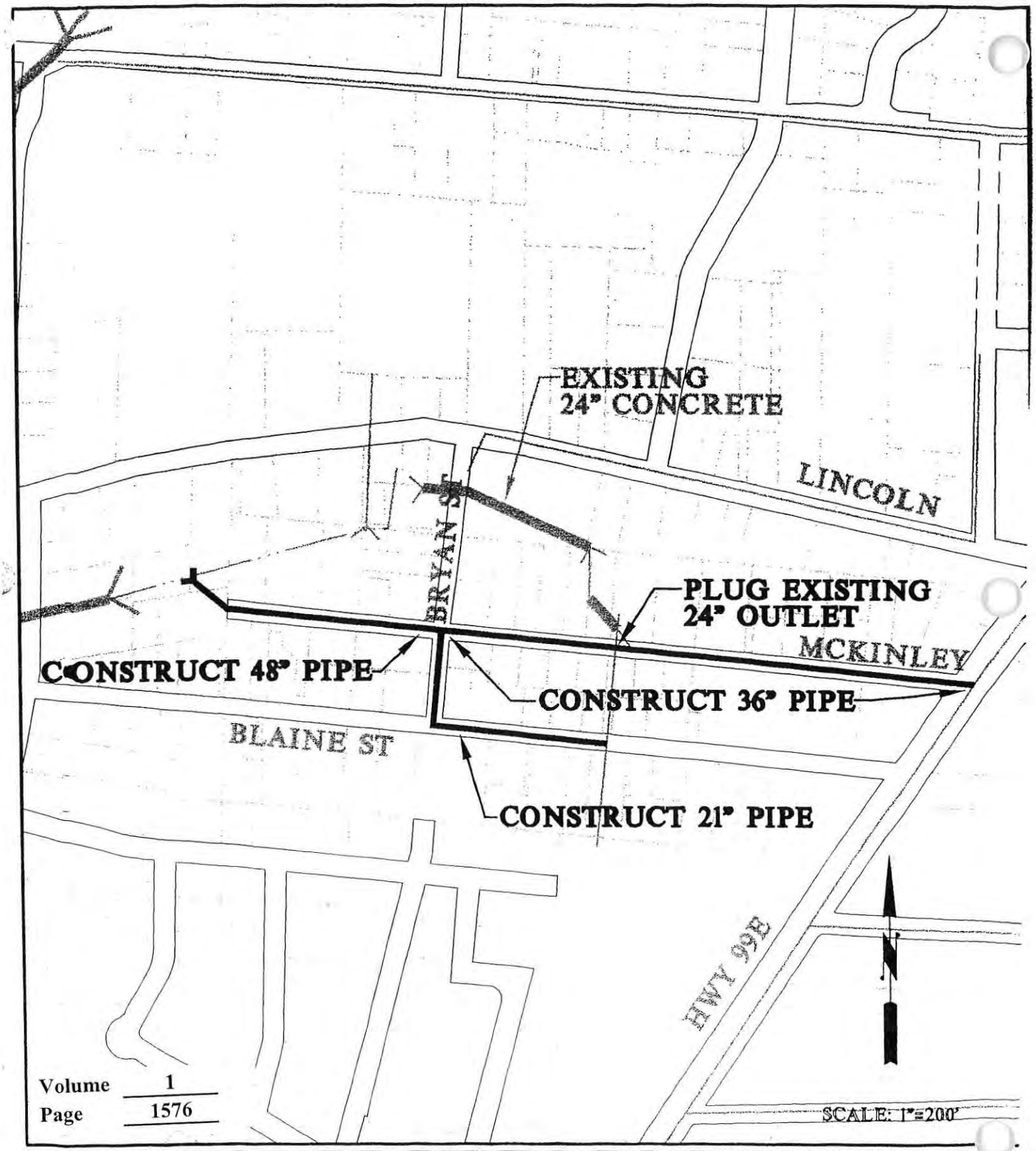

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DATE				FIGURE
JULY 2001		CRANE & MERSETH Engineering/Surveying 6566 SE LAKE Rd., SUITE D MILWAUKIE, OREGON 97222 BUS: (503) 654-2005 FAX: (503) 654-2575	PROPOSED CAPITAL IMPROVEMENT EAST MCKINLEY City of Woodburn STORM DRAINAGE MASTER PLAN	P7

Project No. 8

Drainage: Mill Creek

Subbasin: M-11a

Project Name: Stubb Road Detention

PRIORITY: Medium

Description: This project is comprised of two elements; a 17 ac-ft detention lagoon west of Settlemier Avenue and a constructed swale in the park east of Settlemier. The detention above Settlemier should be 17 ac-ft below elevation 173.4'. These two facilities compliment each other and with both in place, detention of flood flows from the westerly areas of Woodburn will be provided to protect downstream properties.

Conveyance of storm runoff through the park area can be increased if the flow that exceeds the capacity of the existing pipeline is allowed to exit the pipe downstream from Settlemier Road and flow through the park area in a swale created for this purpose. This overland flow would then reenter the pipeline at the east side of the park, just upstream of where the storm sewer crosses under the railroad tracks. This park swale should be designed to convey 15 cfs with a limit on the upstream water surface of 173.0'. This will allow the Settlemier detention facility to be designed with a volume of 17 acre-feet. Without the ability to route flows through the new swale in the park, the detention pond volume will be 27 ac-ft and considerably more land and excavation will be required. Land for the detention facility is currently in private ownership and would have to be acquired

by the city or granted to public ownership as part of a larger project development. See Figure P8, Stubb Road Detention, for the existing site layout.

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Cost Estimate: Stubb Rd Detention

Project	Item	Unit	Quantity	Unit Cost	Total
P8	Earthwork (excav/fill)	Cy	24000	9	$ 206,650
Stubb Rd Detention	Erosion control	Ls	1	10763	10,763
	Structures	Ls	1	10763	10,763
	Seeding/landscaping	Ls	1	21526	21,526
	Subtotal				249,702
	Contingency	20%	1	49940	49,940
	Subtotal				299,642
	Eng., Legal, Admin.	25%	1	59929	59,929
				Total=	$ 359,571

Land acquisition of approximately 5.7 acres that will be needed for this project is estimated at $20,000 per acre for a total land expenditure of $114,784.

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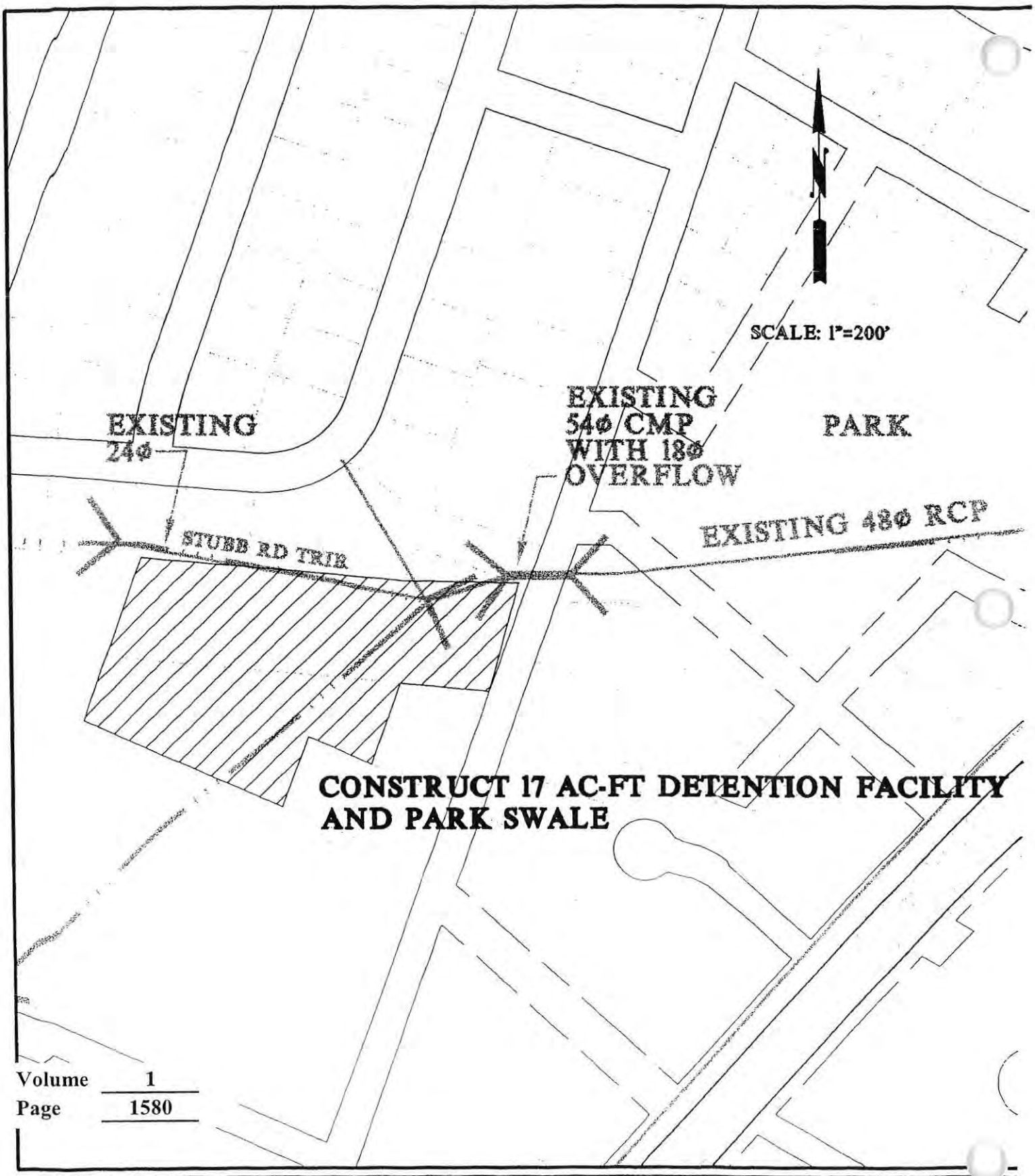

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DATE				FIGURE
JULY 2001		CRANE & MERSETH Engineering/Surveying 6566 SE LAKE Rd., SUITE D MILWAUKIE, OREGON 97222 BUS: (503) 654-2005 FAX: (503) 654-2575	PROPOSED CAPITAL IMPROVEMENT STUBB RD DETENTION City of Woodburn STORM DRAINAGE MASTER PLAN	P[

Project No. 9

Drainage: Senecal Creek

Subbasin: M-11a

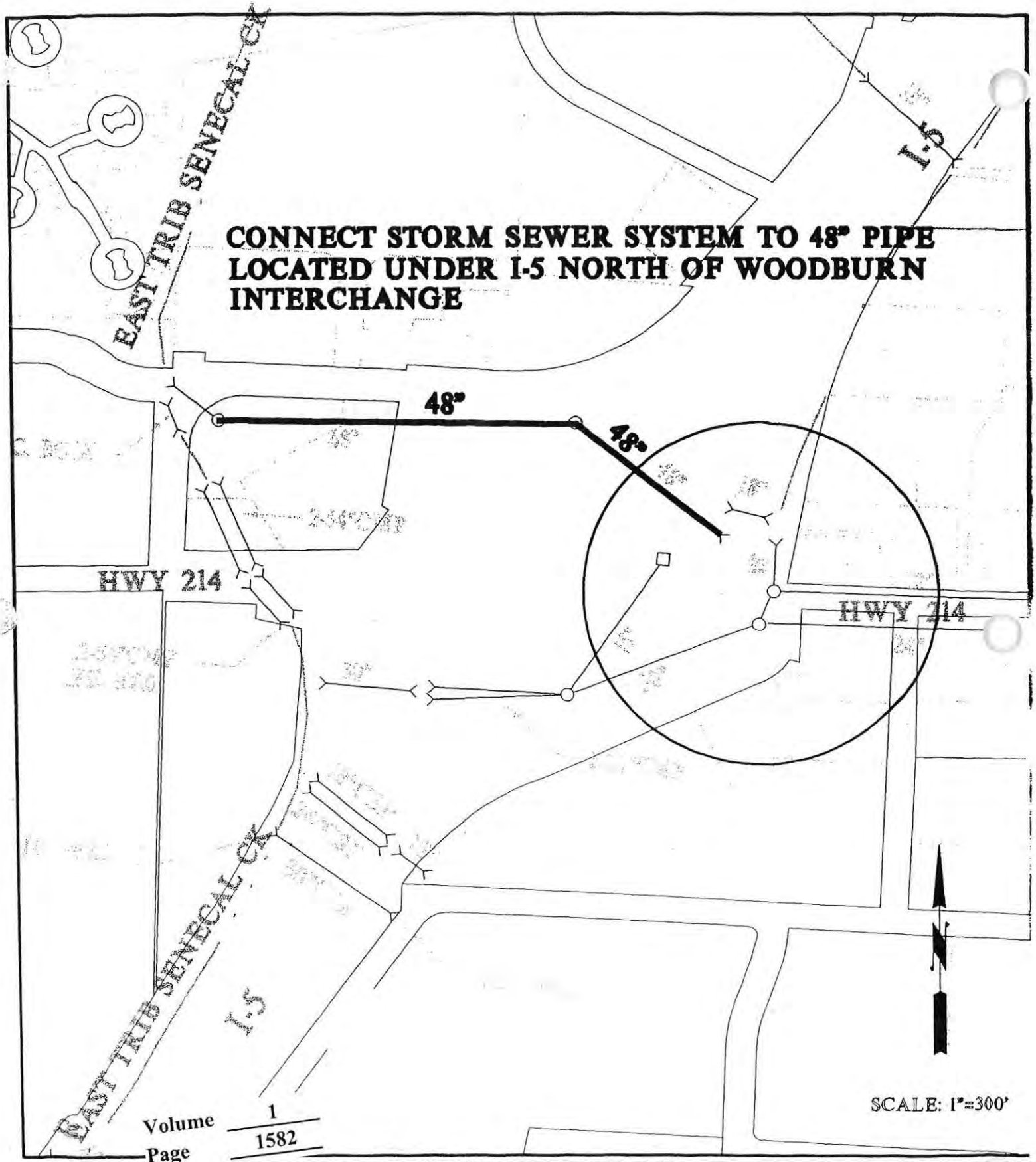
Project Name: Connecting 48" at I-5 and Hwy 214

PRIORITY: High

Description: A dry, existing 48-inch diameter storm sewer extends under Interstate 5 from the northeast quadrant of the intersection with Highway 214 to the northwest quadrant of the same intersection. The 48-inch diameter storm sewer was completed as part of the Interstate 5 construction project and extends westerly across the freeway. Its apparent intended use was to convey storm water from the east side of the interchange to the Senecal Creek drainage. This project would connect the existing storm sewers in the northeast quadrant of the intersection into the 48-inch line where ever possible. See Figure P9, Connect 48" at I-5 and Hwy 214, for the existing storm sewer locations and layout.

Potential connections from the existing local storm sewers into the 48-inch line have not been identified and no new connections have been made to the 48-inch line. The 48-inch line is accessible from the west end through a manhole but no manhole or other access point to the 48-inch line has been identified east of the interstate highway. Numerous attempts at locating a manhole on the east end of the line have been made, but with no success.

Development of the properties northeast of the interchange have increased the



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DATE				FIG
JULY 2001		CRANE & MERSETH Engineering/Surveying 6566 SE LAKE Rd., SUITE D MILWAUKIE, OREGON 97222 BUS: (503) 654-2005 FAX: (503) 654-2575	PROPOSED CAPITAL IMPROVEMENT CONNECT 48 " AT I-5 & HWY 214 City of Woodburn STORM DRAINAGE MASTER PLAN	P9

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volume of storm runoff. These flows are now routed through an existing storm sewer system, taking a circuitous route around the intersection to the south of Hwy 214, eventually discharging to the storm sewer system west of the interchange.

At its completion, this project will allow full use of the existing 48-inch diameter line.

Cost Estimate: Preparation of a preliminary design report should be budgeted at $10,000.

As a minimum, the Predesign Report should:

1. Identify the potential connections between the smaller existing lines east of I-5 and the 48-inch line using field surveys of invert elevations and confirmation of pipe diameters,
2. Calculate the storm flow rates for all lines with potential of being discharged to the 48-inch line,
3. Provide hydraulic analysis necessary to forecast new flows in the pipes and open channels downstream from the project, and
4. Provide an estimate of project cost to construct the improvements.

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Project No. 10

Drainage: Mill Creek

Subbasin: M-5

Project Name: Goose Creek Re-alignment

PRIORITY: Low

Description: The flow capacity of the existing 12' x 7.7' box culvert crossing Hwy 214 immediately west of Front Street is approximately 500 cfs. The results of computer simulation modeling as shown on Figure 10A, Mill Creek Undetained Flows Structures and Flood Profiles, indicates that the water surface profile at Hwy 214 will cause backwater flooding for the 25-year event and possible overtopping of Hwy 214.

Goose Creek is a significant tributary of Mill Creek and joins Mill creek at a point just south of the box culvert. Flows for the full build out scenario in the Goose Creek subbasin when calculated at the Mill Creek confluence indicate a 25-year flow rate of 156 cfs and a100-year flow rate of 198 cfs.

In order to reduce the possibility of overtopping Hwy 214 it is recommended that flows from Goose Creek be redirected to the north, across Hwy 214 prior to flowing into Mill Creek. This would require the installation of a 60" culvert, crossing Hwy 214 located approximately 300 feet upstream of the Mill Creek confluence.

See Figure P10, Goose Creek Re-alignment, for the existing site layout.

Cost Estimate: Goose Creek Re-alignment

Project	Item	Unit	Quantity	Unit Cost	Total
P10	60 inch culvert	lf	175	526	$ 92,105
Goose Creek Re-alignment	Headwall	ea	2	4305	8,610
	Site Demo/Flow Diversion	25%	1	25179	25,179
	Subtotal				125,894
	Contingency	30%	1	37768	37,768
	Subtotal				163,662
	Engineering, Legal, Admin.	25%	1	40915	40,915
	Pre-design Report/permits	ls	1	20,000	20,000
				Total=	$ 224,577

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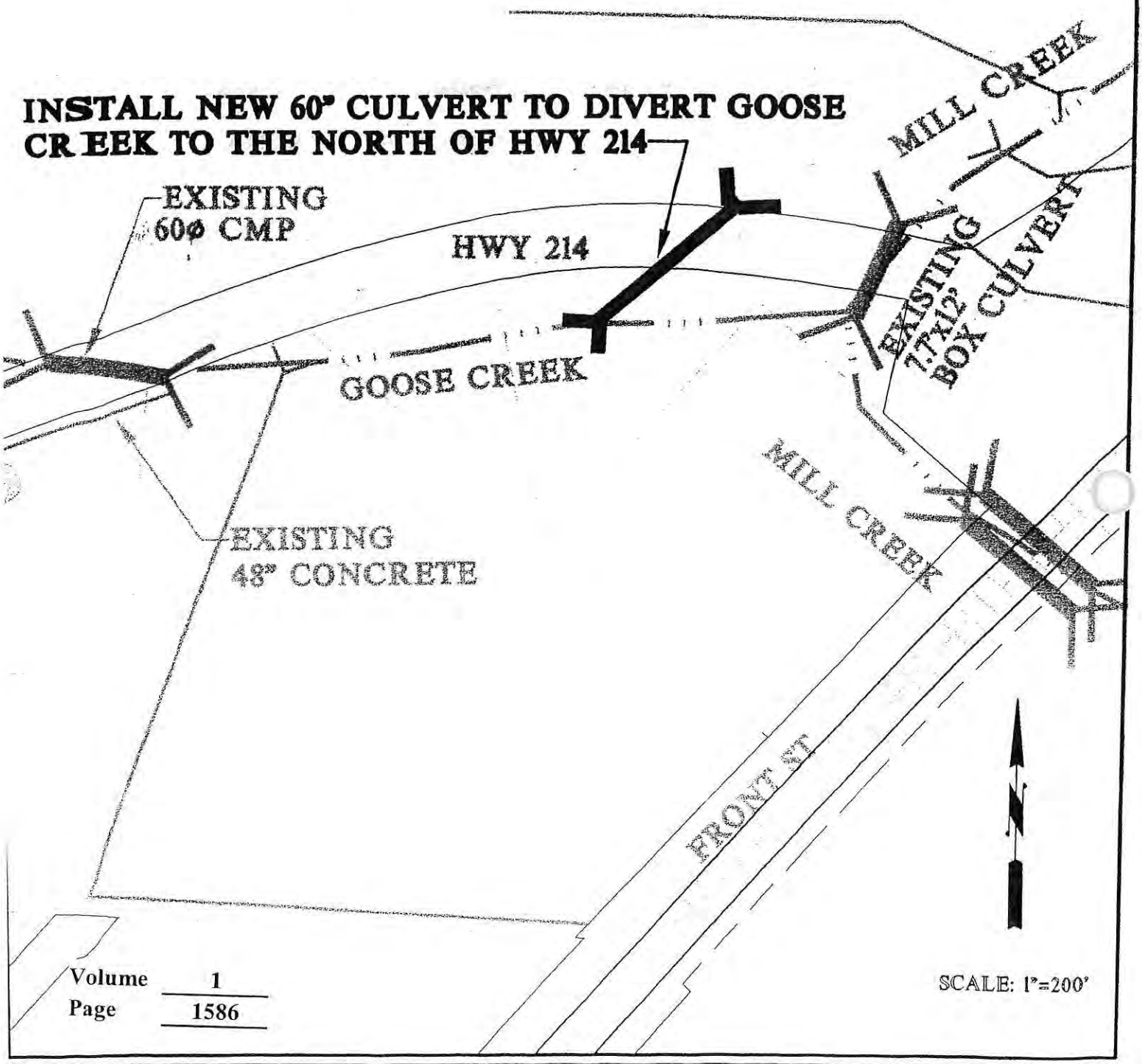

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DATE			FIGURE
JULY 2001	CRANE & MERSETH Engineering/Surveying 6566 SE LAKE Rd., SUITE D MILWAUKIE, OREGON 97222 BUS: (503) 654-2005 FAX: (503) 654-2575	PROPOSED CAPITAL IMPROVEMENT GOOSE CREEK RE-ALIGNMENT City of Woodburn STORM DRAINAGE MASTER PLAN	P10

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Chapter 10

WATER QUALITY REQUIREMENTS

Phase I Requirements

The Environmental Protection Agency (EPA) has adopted regulations pertaining to storm water quality nationwide. These regulations take a phased approach toward implementing standards leading to improving storm water runoff quality. Initial phases of the program have addressed major urban areas and cities where water quality is threatened. Rules outlined by the EPA are implemented through the National Pollutant Discharge Elimination System (NPDES) Storm Water Program. Specific areas of concern have targeted cities of over 100,000 population and major systems where sanitary and storm sewer systems are combined. In using these combined storm and sanitary sewer systems, overflows of combined sewage often occur when storm runoff exceeds the capacity of the receiving sewers. This condition causes Combined Sewer Overflows (CSO's), a major target of initial storm water quality action. Woodburn doesn't have combined sewers and has not been required to spend resources in this way.

Phase II Requirements

Cities using municipal separate storm sewer systems (MS4s) to transport stormwater from the point of collection to the local streams without treatment will be required by EPA's Storm Water Phase II program. These regulations apply to cities or urban areas having a density greater than 1000 people per square mile or having a total size greater than 10,000 people may be regulated by Phase II requirements. Woodburn falls into this category.

The Phase II Final Rule was published in the Federal Register in December 1999. Designation of Phase II requirements by the NPDES authority of municipalities within this population category

will be on a case-by-case basis. In Oregon, the DEQ is delegated the responsibility for implementing and enforcing provisions of the regulations.

As of 1997 several specific rules having direct impacts on Woodburn have been placed into effect. These requirements include:

1. That the storm runoff from the city's wastewater treatment plant site be controlled with the discharge of such stormwater falling under a permit with the DEQ. Woodburn has met this requirement and is currently in compliance with this regulation.

2. That any city-owned site which is used as a maintenance yard and where maintenance of city equipment and vehicles is done outside must be permitted through the state's WPCF program

3. That any construction site in the city exceeding 5 acres in area must be maintained during construction in a manner that mitigates storm water runoff from the site. Specific site requirements for such sites will be set by the city following DEQ guidelines.

With finalization of the Phase II requirements, Woodburn will also be required to begin implementing water quality programs in several specific areas and take measures to begin educating citizens in the area about the need and benefits of protecting storm water quality. As of June, 2002, final rules are being processed by the Department of Environmental Quality and are expected to be considered by the Environmental Quality Commission in December, 2002. If these rules are approved, Woodburn will have until July, 2003 to develop the following six MS4 elements:

1. The city must develop and begin a Public Education and Outreach Program relating to storm water quality. This could be done through distribution of educational materials and performing outreach to inform citizens about the impacts polluted storm water

discharges can have on water quality.

2. The city must develop and initiate a Public Participation/Involvement program such as effectively publicizing public hearings and encouraging citizen representatives on a storm water management panel.

3. The city must develop and implement a plan to detect and eliminate illicit discharges to the storm sewer system. This could include updating the system map and inventory, informing the community about hazards associated with illegal discharges and improper disposal of wastes.

4. The city must develop, implement, and enforce an erosion and sediment control program for construction activities that disturb 1 or more acres of land. Controls could include silt fences and temporary storm water detention ponds.

5. The city must develop, implement, and enforce a program to address discharges of post-construction storm water runoff from new development and redevelopment areas. Applicable controls could include preventative actions such as protecting sensitive areas (e.g., wetlands) or the use of structural Best Management Practices such as grassed swales or porous pavement installations.

6. The city must develop and implement a program with the goal of preventing or reducing pollutant runoff from municipal systems. This must include municipal staff training on pollution prevention measures and techniques. This should also include a program to develop and maintain the municipal system and keeping records in order to participate in a reporting system to appraise the DEQ of system conditions and changes.

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Chapter 11

STORMWATER FLOW MANAGEMENT PROGRAM

The following policies are intended to provide clear guidance for construction of public or private drainage facilities located within the jurisdiction of the City of Woodburn. These guidelines will provide land developers, city staff and design engineers with a common set of rules to be applied when calculating stormwater runoff quantities and flow rates and determining sizes for stormwater facilities downstream from the impacting property.

AUTHORIZATION

Under Oregon Water Law, all water is publicly owned. The State of Oregon has adopted the civil law of drainage. Under this law, adjoining landowners are entitled to have the normal course of natural drainage maintained. Landowners with water flowing past, through, or under their property do not have the right to use or control the water without following specific state and local laws and regulations pertaining to such use. Under the provisions of the Oregon Revised Statutes, Section 536.360, all cities (public corporations) are required to provide for management and control of public waters in accord with the provisions of the statute.

INTRODUCTION

The City is served by two major natural drainageways -- Senecal Creek and Mill Creek. Within each of these two major drainageways, smaller drainages (denoted as subbasins) may require specific solutions to stormwater management problems including capital construction of public facilities, detention facilities and on-site detention or retention facilities. Each solution developed as a part of the City's Stormwater Master Plan has been proposed after assessing the risk of flood and high water damage to public facilities and overall risk management goals of the City. Generally, the City policy on funding major improvements to the storm water system are:

- Construction of detention, retention and some conveyance facilities may be required prior to completion of developments and are intended to be constructed with private funds.

- Areawide Capital Improvements which are designed to facilitate future property development, in addition to resolving current problems, may be funded cooperatively by the developer, the City, and the benefiting property owners.

- Areawide Capital Improvement Projects outlined in the Stormwater Master Plan for resolution of existing problems are intended to be funded primarily by the City budget and as such are subject to budget constraints.

PROGRAM HISTORY

Recent, rapid population growth and new federal and state regulations pertaining to operation of a stormwater utility brought a new initiative to the city's public works programs. Various tasks necessary to begin this process included documentation of the system inventory, hydraulic assessment of the natural and manmade storm sewer system, review of fiscal management of utility resources and eventual provision for stormwater treatment have led to development of this program.

Historically, the City has relied on a series of stormwater ordinances, published technical guidance, and regulations issued by the Federal Emergency Management Agency (FEMA) and the Corps of Engineers (COE) to guide and regulate development within its jurisdiction. This program intends to supplement and replace existing ordinances and technical guidance.

Most communities of Woodburn's size have not developed a comprehensive approach to management of the storm water system as they have for the water and wastewater utility systems. Woodburn is no exception. Due to a lack of dedicated revenue sources, the City has relied primarily on revenue provided by the Street Fund to finance storm water system cleaning and related maintenance activities and use of System Development Charges to undertake capitol improvement projects.

READERS GUIDE

General storm water management policies apply to all properties in the City and are presented on pages 4 through 12 of this chapter. These are supplemented with additional, specific stormwater management policies created for each of the two major drainage basins, Senecal Creek and Mill Creek. Specific policies for the Mill Creek and Senecal Creek drainage basins begin on page 13 of this chapter. Detailed hydraulic analysis of two small drainage areas generally east of Highway 99E have not been done as a part of this project since they drain to the Pudding River. However, the policies and recommendations contained in this document will apply to all land within the City.

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STORMWATER MANAGEMENT GOALS, DETENTION and DEVELOPMENT GUIDELINES

The following goals outline the City's intent to continue orderly development of the storm drainage facility system and provide for the **protection, enhancement and general public safety of life and property.**

These goals are:

- To mitigate for the hydraulic impacts on downstream properties and drainage conveyance structures resulting from increased runoff due to urbanization of parcels within the drainage basin.

- To provide for the conveyance of stormwater to established drainageways in a safe and economical manner and minimize environmental impacts.

- To establish a drainage routing plan which designates watershed limits in developing areas which do not directly abut an existing drainageway or a public storm sewer system facility.

- To establish detention performance criteria limiting stormwater discharge rates to a level which limits impacts on downstream properties and structures to acceptable levels.

- To integrate and formalize existing policies and provide developers with a known and predictable set of detention standards.

- To identify a mechanism whereby developers and property owners can be reimbursed for constructing or enlarging drainage system facilities which solely increases capacity to upstream users.

- To establish standards whereby the public or private nature of the ownership of storm water and detention facilities may be made.

- To provide for maintenance of storm water conveyance and detention facilities.

- To comply with state and federal rules and regulations pertaining to stormwater and runoff management.

- To continue preservation of existing (natural and constructed) floodwater storage volume.

GENERAL STORMWATER POLICY PROVISIONS

A. Responsibility to Convey Surface Runoff

It is the responsibility of any landowner, owning property which currently receives stormwater flows from parcels which are topographically upstream, to allow the continued discharge of such flows in such manner as preserves existing conveyance and provides for future upstream connections to waterways, drainageways and other routes carrying stormwater runoff.

B. Restrictions on Runoff Discharge to an Existing Drainageway where it is:

1. Private Property with an easement for the drainageway;
When the receiving drainageway is located on private property and an easement for the drainageway exists, no person shall cause an increase in the volume or rate of flows onto the downstream properties by channelizing existing flows, or by increasing impervious areas which discharge onto other privately owned properties, without the approval of the City Engineer. Single family residences located in an approved subdivision are excepted from this provision.

2. Private Property without an existing drainageway easement;
When the receiving drainageway is located on private property and no easement for the drainageway exists, no person shall cause an increase in the volume or rate of flows onto the downstream properties by channelizing existing flows, or by increasing impervious areas which discharge onto other privately owned property, without the approval of the City Engineer and the affected property owner(s). This condition is intended to include and apply to all affected properties located between the property to be developed and the public storm water system, drainageway with a public easement, or a primary drainageway.

3. A Public or Primary Drainageway;
When the receiving drainageway is located on public property or is classified as a Primary Drainageway, any new stormwater sources or increases in existing stormwater flows discharged directly to City stormwater facilities shall be permitted only upon approval by the City Engineer. Such approval shall be granted only if and when the applicant demonstrates to the satisfaction of the City Engineer that such new or increased discharges, (1) will not cause the capacity of downstream structures to be significantly impacted, and (2) will not cause increased erosion of downstream drainageways. Single family residences located in an approved subdivision are excepted from this provision.

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C. Extension of Drainage Services to Upstream Parcels.

1. In general, any new development shall install closed conduit drainage conveyances which are of sufficient capacity and depth, and are suitable to serve parcels topographically upstream of the development site. Such conveyances shall be sized to receive future post-development upstream, undetained flows for a 25-year storm event in a Local Drainageway and a 50-year storm event in a Secondary Drainageway.

   In a Primary Drainageway, open channel conveyances shall be designed to convey a 100-year storm event. Open channels shall be used exclusively in Primary Drainageways except as roadway and pedestrian crossings where bridges and culverts may be used.

   These criteria also apply to all structures designed as roadway crossings.

2. All stormwater facility designs must adhere to the following basic criteria:

   a. Upstream flowrates and volumes must be calculated using the entire upstream basin area whether it is within or outside the city's Urban Growth Boundary. Calculation methods and assumptions must be provided as part of the design submittal.

   b. Any stormwater conveyance facility designated for use by upstream properties must be extended to the upstream property limit of the proposed development.

   c. The hydraulic capacity of new stormwater conveyance facilities must be calculated to convey post development runoff of the drainage basin. Runoff must be based on full buildout development created in accordance with the City's Comprehensive Plan in effect at the time of the proposal and the storm water policies and practices of the City.

3. A new development shall continue to receive upstream stormwater runoff in a manner that does not require alteration of the upstream drainage pattern unless specific written permission and appropriate easements are received from the upstream property owner. If the source of the upstream drainage flow is a public stormwater facility, then alteration of its point(s) of entry into, or exit from, the new development shall be at the discretion of the City Engineer.

4. The following provisions shall apply for all constructed stormwater conveyances:

   a. Drainage conveyances shall provide suitable invert elevations and design hydraulic grade lines for the upstream points of service.

   b. All piped (closed conduit) systems shall be designed and constructed in accordance with City of Woodburn *"Standard Design Manual"* and *the "Standard Construction Specifications"*. American Public Works Association (APWA) documents will be utilized until the Woodburn Design Manual is

approved by the City Engineer. All systems shall be located within a public right-of-way or a public utility easement no less than sixteen (16) feet in width. Wider easements may be required at the discretion of the City Engineer if needed to accommodate larger or deeper pipes.

5. In unusual circumstances, or to comply with federal, state, or City rules or regulations and laws, the City Engineer may approve open channel designs that meet the following criteria:

a. All open channel systems shall be designed and constructed in accordance with the City of Woodburn *"Standard Design Manual"* and the *"Standard Construction Specifications"*. Oregon Department of Transportation (ODOT) design documents will be used in cases where City standards have not been approved by the City Engineer. All systems shall be located within a public right-of-way or a public utility easement. Such easements shall, at a minimum, extend from the top-of-bank to top-of-bank and include an additional twenty (20) feet in width outward from the top of bank along one side of the entire length of the open channel conveyance.

b. Open channel systems shall be designed using a Manning's "n" of no less than 0.080 to compensate for vegetative growth, accumulation of debris during and following storm events, and sediment accumulation between maintenance activities.

c. Open channel side slopes shall not exceed 3H:1V in inclination unless engineering and/or geotechnical analysis indicate the stability of another configuration. New open channel facilities shall allow for a maximum water depth no greater than 3 feet as measured at any point along the channel. A minimum of one (1) foot of freeboard shall be included in channel design.

d. Open channels shall be seeded or planted in order to stabilize the channel sides and shall be provided with sufficient erosion protection to minimize erosion until such seeding or planting has become mature and established.

D. Reimbursement for Extension of Stormwater Service to Future Upstream Users.

Developers of property located on a Primary Drainageway are required to allow the 100-year, undetained, existing stormwater flows from upstream properties to continue unimpeded to the next downstream properties and will do so at their own cost and are not eligible for reimbursement by the City. With the exception of roadway crossings, systems which are oversized may be eligible for reimbursement when oversizing is done at the request and approval of the City Engineer.

Developers of property located on a Secondary Drainageway are required to allow the 50-year, undetained, existing stormwater flows from upstream to continue unimpeded to the next downstream properties and will do so at their own cost and are not eligible for

reimbursement by the City. With the exception of roadway crossings, systems which are oversized may be eligible for reimbursement when oversizing is done at the request and approval of the City Engineer.

Developers who construct public stormwater conveyances in a Local Drainageway which are intended to increase capacity to benefit upstream properties (ie. flows greater than the 25-year undetained, post-development flows) may be eligible for reimbursement according to the following conditions:

1. Facilities considered for City participation may include:

   a. Offsite lines, when the size of such lines are larger than required for the specific development under consideration as outlined above. The City's reimbursement will be limited to the incremental difference of the material cost of the oversized portion of the pipe only. Under special circumstances, consideration will be given to additional construction costs incurred as a result of increased diameter or extra depth, when required by the City

   b. Onsite lines when such lines are designed and constructed in a local drainageway and with the expressed purpose of increasing capacity beyond that required to convey the 25-year, post-development, undetained flows from upstream properties plus the additional runoff due to the proposed development. The reimbursement will be limited to the incremental difference of cost incurred as a result of increased diameter or extra depth, when required by the City.

2. To be eligible for reimbursement, the developer must:

   a. Provide a written statement to the City Engineer **within two (2) weeks of Preapplication Conference** outlining the developers intention to request reimbursement funds for the project or have **received notification by the City of specific conveyance requirement**. All reimbursements are subject to the City's budget constraints and any requests exceeding $7,500 in the aggregate will be subject to City Council approval by motion or resolution unless the cost sharing was part of an earlier council approval process for the project. The cost sharing for such improvements must meet the budget constraints of the City.

   b(1). Prepare estimates of cost for those portions of the drainage improvements which provide increased capacity for upstream properties,

   b(2). Identify the area encompassing all benefiting upstream properties,

   b(3). Propose a reasonable pro rata method for distributing a portion of the costs to benefiting upstream properties. The method shall be based on full-buildout impervious areas or number of developable lots, and degree of benefit to upstream properties relative to property being developed.

b(4). Submit a detailed reimbursement request concurrently with submittal of design drawings for review and approval.

3. The City Engineer, after review of requests from the developer, shall notify the developer in writing as to the applicability of the project for reimbursement and the acceptability of the reimbursement computation. The stormwater System Development Charges (SDC) paid by the developer for the project may be reduced by the amount of credits received for the project. However, the reimbursement amount will not exceed the total of the stormwater SDC for the project.

4. If reimbursement for oversized facilities downstream of a Secondary or Local Drainageway is approved, the following table will be used to determine the amount of reimbursement:

Percent Diameter Increase	Reimbursement in $/LF
Up to 31 percent	$ 10 / Lineal foot
Between 31 % and 60 %	$ 20 / Lineal foot
Over 61 percent	$ 40 / Lineal foot

5. Facilities excluded from City participation include:
   - New facilities or rehabilitated existing facilities using open channel conveyance,
   - local (non-regional) detention facilities,
   - any closed conduits of 18-inch diameter or less,
   - any structure constructed for vehicular, bikeway or pedestrian crossings (ie. bridges, culverts,etc.),
   - any facilities constructed in designated floodways or flood plains,

6. If a Reimbursement District or Local Improvement District is formed, it shall conform to City ordinances and policies.

E. Fill within the 100-Year Floodplain

Fill may be allowed in the floodway fringe of the 100 year floodplain of any primary drainageway. Filling must be done in accordance with Section 8, "Fill Standards", City of Woodburn Floodplain Ordinance, No. 2018, and be placed as engineered fill in accordance with a plan prepared by a Registered Engineer and submitted to the City for review and approval.

F. Fill within the Floodway of a Primary Drainageway.

No new fill, debris, or other obstructions shall be placed in the floodway of a Primary Drainageway. An exception to this requirement may be considered for purposes of

constructing an essential roadway crossing of the drainageway if all the following conditions are met:

1. The road crossing is essential as determined by the City of Woodburn. Typically, approval will be limited to those cases where a roadway crossing is needed to facilitate the public transportation system.

2. All local, state and federal requirements are met.

3. The new culvert(s) or other structure must have a hydraulic capacity to pass the 100 year undetained runoff flows from the upstream watershed. Watershed runoff shall be calculated using parameters in accord with the City's current Comprehensive Land Use Plan. The culvert or other structure shall be designed to minimize the resulting head loss to no more than 0.3 feet including entrance losses. Losses greater than 0.3 feet must receive approval by the City Engineer.

4. The invert elevation of the culvert shall be set at an elevation and grade as approved by the City Engineer. In no circumstances shall the culvert invert be below the natural stream bottom.

5. The inlet and outlet of the culvert are to be sufficiently armored to prevent scour.

6. The embankment is to be constructed of compacted earth with sideslopes inclined no steeper than 3 feet horizontal to 1 foot vertical. Embankments must be seeded as specified in the city's design standards and newly-seeded areas protected from erosion until vegetation is safely established.

7. The lower chord of any bridge must be located at least 0.5 feet higher than the projected 100-year flood elevation which results from full buildout of the upstream areas as projected by the City's Comprehensive Plan. Head losses through any bridge structure must be no more than 0.3 feet, unless the City Engineer approves a higher loss design.

8. Private agricultural stream crossings are exempt from the performance standards of this section if the width and elevation of the crossing design is such that an overtopping flood causes no adverse upstream impacts. The landowner will be responsible for demonstrating this to the satisfaction of the City Engineer.

G. Detention Requirement for Large Developments

Any new construction, or expansion of existing construction, for commercial, industrial, institutional, or multi-family development uses which creates greater than 2.5 acres of total impervious areas (not including public roads created as a part of the development) are required to provide onsite detention of storm flows. Any new single family

residential development larger than 5 acres (gross area, all phases), shall also provide on-site storm water detention facilities. All onsite detention facilities shall meet the following design criteria:

1. All detention facilities shall be designed and constructed in accordance with City of Woodburn *"Standard Design Manual"* and the *"Standard Construction Specifications"*. The City's Detention Facility Sizing Table or the Santa Barbara Urban Hydrograph method as specified in the current edition of the King County (Washington) Surface Water Quality Manual, shall be used to determine the volume of the detention facility. Technical issues not addressed in the City's design guides will defer to Oregon American Public Works Association/ODOT documents until the Woodburn Design Manual is approved by the City Engineer.

Detention facilities must be designed to contain stormwater flows resulting from a post-development 25 year storm event with a discharge orifice (or structure) sized to limit the outflow to a flow no greater than the undeveloped site peak run off for the existing 5 year frequency storm.

The detention facility shall include provisions for a high flow bypass and maintain a 1-foot minimum freeboard at the highest water surface elevation during a bypass event. The facility designer must also provide a hydraulic analysis showing the overflow conveyance route and downstream impacts of passing the 100-year storm event.

2. Such detention shall be provided off-line from the Primary Drainageway. Off-line is defined as outside the Primary Drainageway floodway/floodplain.

3. Such detention shall also be provided off-line for Secondary Drainageways except as approved by the City Engineer. In-channel detention within Secondary Drainageways may be used if designed using dynamic hydraulic modeling performed by a qualified engineer registered in the State of Oregon. Such designs must be submitted to the City Engineer for review and must receive specific approval prior to any construction. The design must demonstrate that peak discharges are equivalent to the off-line detention specified above when calculated using both existing and future upstream development conditions.

4. The developer must provide a permanent, all weather road access for vehicular traffic to the detention facility inlet and outlet structures.

5. The developer must provide the City with a stormwater facilities easement to provide for future maintenance needs.

Derivation of the criteria for selection of the 5-acre and 2.5-acre development sizes is found in the Storm Drainage Master Plan.

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H. Detention Requirement for Small Developments

Any new construction, or expansion of existing construction, for commercial, industrial, institutional, or multi-family uses which creates less than 2.5 acres of total impervious areas (not including public roads created as a part of the development) may be required to provide on-site detention to address downstream system capacity limitations, satisfy requirements of other jurisdictions, or mitigate local conditions which preclude full discharge of stormwater. At a minimum, the following information will be required for City staff review:

1. Calculations of the volume and rate of stormwater runoff prior to and following development, done in conformance with City policy and the Storm Drainage Master Plan.

2. Identification of the closest public storm sewer or drainageway which will receive the runoff from the development.

3. Calculations showing the peak flow rate of storm water which will be discharged to the public system including any deleterious hydraulic impacts of stormwater runoff on downstream facilities (pipes, culverts, ditches, etc.)

I. Developer Maintenance Responsibilities of Constructed Facilities

For any detention facility or open channel drainage facility which a developer constructs or causes to be constructed;

1. The developer shall provide adequate maintenance and erosion control, ensure proper performance, and re-grade, re-seed and/or re-plant as necessary to replace any eroded or failed areas within a period of two (2) years following completion and acceptance of the facility by the City.

2. Long term maintenance responsibility for all detention facilities or open channel drainage facilities must be specified prior to construction. The City may elect, but is not required, to accept responsibility for maintenance of detention facilities. If the party deemed responsible for maintenance is not the City and is other than the owner(s) of the property served by the facility, then a maintenance bond shall be posted by the developer until such time that the maintenance responsibility has been accepted by the home owners association or the City.

3. The detention facilities must be properly maintained by the responsible party. If they are not so maintained, and, following 30 days written notice from the City, the City is authorized to enter the facility, perform maintenance on the facility as needed, and to lien the property for payment of three times the cost of such services or by utilizing policies authorized by the City Council for such reimbursements.

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J. Authorization of Adoption of Watershed Management Standards

The City Engineer may establish or adopt written standards which affect individual watersheds within the City limits. Such standards may include, but are not limited to the following:

1. Technical specifications and design standards.

2. Routing of a storm drainage conveyance within, or outside of, public rights-of-way.

3. Identification of public storm sewer easements or acquisitions necessary for the provision of City storm drainage services.

4. Adoption of specific storm drainage performance standards for individual watersheds in response to requirements of other regulatory agencies such as the Oregon Department of Environmental Quality (DEQ), the Oregon State Division of State Lands (DSL) or the Corps of Engineers (COE).

K. Final Design for Stormwater Detention Facilities

All elevations, slopes, dimensions and pipe sizes shown in the Storm Drainage Master Plan are preliminary and must be verified as part of the final design of stormwater detention facilities. Final design decisions must be based on actual field conditions and routing patterns selected by the designer at the time of final design.

L. Variances and Referral

Interpretation of the policies in this document adopted by the City Council shall be the responsibility of the City Engineer or his designated representative.

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SPECIFIC BASIN REQUIREMENTS

INTRODUCTION

The following sections outline specific detention requirements for individual basins contributing stormwater to either Mill Creek or Senecal Creek and within the jurisdiction of the City.

MILL CREEK

In addition to the City's General Detention Policy Provisions, the following provisions apply to the Mill Creek drainage areas. References to specific tables and figures are taken from the City of Woodburn Storm Drainage Master Plan. Areas intended for use as Primary Drainageway detention facilities have been identified along the main stem of Mill Creek. Flood elevations referenced below are based on FEMA studies and reported flood levels. Elevations referenced in this document are based on the NGVD 29 datum. Also, in keeping with historical practice, a freeboard zone of 1.5 vertical feet is established above the FEMA flood elevation and sets the elevation below which no permanent structures may be erected in the flood plain. The following flood water storage/detention areas are shown on Figure 15 of the City's Storm Drainage Master Plan. Specifically they are:

Goose Creek - Goose Creek is a tributary drainage to Mill Creek generally north of and parallel to Highway 214. Goose Creek is a well defined channel whose storm water flows originate in the North Senior Estates area and the properties immediately north and south of the drainage. While not currently used for detention for storm water, the Goose Creek drainageway should be preserved by the city for use as a storm water control and treatment facility.

Detention Area Between the Railroad Embankment and Hardcastle Avenue - An area of approximately 4.8 acres immediately upstream of the Front Street/SPRR line along Mill Creek and extending to Hardcastle Avenue within the 100 year floodplain. With a 100-year flood event elevation projected to be 156.0 msl, a floodwater storage elevation for this area has been set at an elevation of 157.5 feet msl. Below this elevation, no permanent structures should be constructed without adequate flood protection nor should filling in the flood plain be allowed without offsetting mitigation. Posted warnings of potential flood water detention should be placed in the area, specifically at the common entrances to the area from Legion Park to the east.

Hardcastle Avenue to Lincoln Avenue Detention - An area of approximately 2.5 acres extending from Hardcastle Avenue to Charles Street and is currently part of the City's park system. A 100-year flood event occurring in this area is projected to reach an elevation of 160.5 feet msl. A floodwater storage elevation for this area has been set at an elevation of 162.0 feet msl. This land use will be

continued and approval to construct permanent structures which would be damaged by high water levels will not be allowed if the structure is below 162.0 feet msl. Filling in the floodplain will not be allowed unless offsetting mitigation measures proposed and accepted. Posted warnings of potential flood water detention should be placed in the area, specifically at the common entrances to the park area.

Brown Street Detention Area - The City is preserving the Settlemier Park tributary of the Mill Creek floodplain extending from Brown Street on the east to the Southern Pacific Railroad right-of-way on the west. This area serves as a natural detention site and can be expected to flood to an elevation of about 169.5 during a 100-year storm event. The City owns most of the low-lying land in this reach of Mill Creek and will continue maintenance of the area by cutting the grass and limiting the number of trees and shrubs that grow there. Any permanent construction below elevation 171.0 will not be allowed. In the future, this area could be reshaped to maximize detention volume, provide for a controlled outlet and ensure complete drainage after high water events. Like other detention areas accessible to the public, posted warnings of potential floodwater detention should be erected in the area.

Settlemier Park Detention Area - The floodplain immediately downstream of Settlemier Park is 171.0 as shown on the FEMA maps. Controlling the floodplain at this elevation within this area will allow continued use of the park facilities, however this area provides for flood storage and should continue to remain an open space. Improving facilities, adding parking or constructing other, similar improvements in Settlemier Park may be done providing that no filling occurs below the flood plain elevation.

Construction of an engineered swale extending from a point near the east side of Settlemier Road and extending east toward the railroad embankment will allow excess flows to exit the 48 inch storm drain conduit and overflow to the low-lying park area. At the east side of the park, a grated entry will allow overflowing storm water to reenter the storm drain after flooding subsides. Construction of this surface overflow will mitigate the restricted capacity of the underground conduit during 100-year storm events. With it's proximity to Settlemier Park, posted warnings of potential flood levels should be installed in this flood storage area.

Stubb Road Detention Facility - Future storm runoff flows entering the culvert at Settlemier Road are computed to be 177 cfs for the 100 year frequency event. Flood elevations upstream of Settlemier Road must be controlled in a manner that does not allow future floodwater to exceed elevation 173.4 in the area west of Settlemier Road. Detention of storm water at this location is required for three reasons. These are:

- to prevent flood overtopping of Settlemier Road, a major thoroughfare and emergency vehicle route;

- to allow development of upstream properties to the densities specified in the City's Comprehensive Plan; and

- to limit detention system outflows at a flow rate that will allow the downstream primary drainageway to function as planned.

When constructed in a manner that will allow its operation to complement the Settlemier Park overflow swale facility, the Stubb Road detention facility will contain about 17.5 acre-feet of storage and detain storm flows coming from the developing upstream land. As development occurs upstream of this point, land owners and land developers may be required to contribute financial support to this project.

In addition to these planned detention facilities and protected areas, the following detention facilities exist or being planned for construction in the Mill Creek drainage area:

Woodburn School Site Detention - The Woodburn School District has constructed a 0.7 acre-foot detention facility is located at the north east corner of the Middle School property on Parr Road. This facility collects storm runoff from the school district property and discharges controlled flows to the west branch of Mill Creek through the storm drainage system serving the Parr Acres development.

Steklov Addition Detention Site - This 0.85 acre-foot, single pond, private detention facility is located west of Brown Street and south of Parr Road and serves the Steklov Addition development site and includes piping suitable for flows from 83 acres upstream of the development. The detention facility itself is sized to only accommodate flows from the Steklov Addition.

North Front Street Park - This 1-acre site is currently owned by the City and provides a small but effective detention site. It is located at the confluence of two storm water systems and will lessen downstream flooding conditions with construction of a detention facility. To mitigate this potential for future flooding and inundation of Front Street, the park area should be converted to a detention facility to provide an additional 0.7 acre-feet of storage below elevation 167.0. In addition to construction of the detention facility, the storm sewer crossing Front Street and the railroad immediately east of the park should be replaced with a 42 inch diameter reinforced concrete storm sewerline. (Refer to CIP Project No. 2).

Young Street to Cleveland Street - The area between Young and Cleveland Streets provides flood storage to approximately elevation 169.5 when storm conditions reach a 100 year frequency event intensity or a series of smaller intensity storms occur in a relative short time span. The City should restrict construction in this area and post flood warnings in this area as well.

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Marshall Street to Wilson Street – The Marshall Street embankment acts as a weir when the conduit under Marshall Street becomes filled to capacity. When the basin floods, the backwater extends south from Marshall Street to Wilson Street. With construction of a second conduit (54-inch diameter) at Marshall Street, floodwaters that currently overtop Marshall Street during a 5 year event will be lessened to a frequency of a 25 year event. High water warnings should be posted in this area.

Wilson Street to the South City Limit - This area is currently designated as part of the City's green space areas and should be maintained as a part of the storm water control and management area. The City should acquire storm utility easements covering the flood plain at a minimum from Wilson Street to the south city limit line. If the city limit line is extended further to the south, additional flood plain easements in the new areas should also be acquired.

Parr Acres - A privately owned, single pond detention facility is currently in operation west of Settlemier Avenue. This 1.1 acre/foot facility controls storm runoff coming from the Parr Acres development and discharges a controlled flow to the west arm of Mill Creek.

Heritage Park - A privately constructed detention facility is currently in operation in the Heritage Park subdivision located west of Boones Ferry Road between Vanderbeck and Centennial Roads. Detention facilities for this development includes two ponds, one a park area which has been deeded to the City, and the second designed as underground storage giving a total detained volume of 1.5 acre feet of water. Subsequent development of the subdivision will cause a third facility to be constructed.

Storm water discharged from this facilities, crosses Boones Ferry Road, enters the storm drainage system in Hazelnut Road and is finally discharged to Mill Creek.

SENECAL CREEK

In addition to the City's General Detention Policy Provisions, the following provisions apply to the Senecal Creek drainage areas. References to specific tables and figures are taken from the City of Woodburn Storm Drainage Master Plan. This stream has been divided into five primary subbasins (S-1, S-2, S-3, S-4 and S-5). Of these, most of the area within subbasins S-1, S-2, S-3 and S-5 is located outside the City's Urban Growth Boundary both north and south of the existing boundary. Very little development is expected in subbasins S-1, S-3 and S-5 in the near future and they have been modeled as undeveloped. Subbasin S-2 contains a portion of the West Woodburn development area. New development in this area is not anticipated at this time as it is almost completely built out according to the City's Comprehensive Plan.

Subbasin S-4 contains the East Tributary of Senecal Creek which is wholly within the UGB and in which most of the development is expected to occur in the foreseeable

future. This major subbasin has been divided into 13 smaller subbasins for analysis purposes. Refer to Chapter 4 for specific information on this developing area.

Detention and management controls in subbasin S-4 are controlled by the two major thoroughfares that bisect the basin, Interstate 5 and Highway 214. In order to set specific detention and stormwater management control requirements in the East Tributary subbasin (S-4) it has been divided into four quadrants, ES-1, ES-2, ES-3 and ES-4. The management criteria for these four areas are:

MANAGEMENT ZONE ES - 1 (North of Highway 214 and west of I - 5)

On the East Tributary of Senecal Creek, a wetlands area west of Interstate 5 and north of Highway 214 serves to detain storm water and should be preserved as part of the City's wetlands inventory unless it is replaced by a constructed wetland approved by regulatory agencies. An area immediately east of the wetlands has recently been developed with high density commercial facilities. This development has installed on-site storm water detention facilities that discharge to a small subtributary of the East Tributary of Senecal Creek.

MANAGEMENT ZONE ES - 2 (North of Highway 214 and east of I - 5)

The following conditions will apply to development and storm water infrastructure changes in Zone ES-2:

1. Any new development that creates over 1 acre of impervious area shall be routed directly to the existing 48-inch diameter storm drain that crosses I - 5 immediately north of the Highway 214 interchange. The east end of this 48-inch storm sewer is not accessible from the ground surface as it was covered over during construction of the I-5 freeway. The end of this line should be excavated and a manhole access constructed at that point. Piping changes should also be made to connect this line to existing storm sewers on the east side of Interstate 5. See CIP project No. 11.

2. No new storm water flows generated in this subbasin should be allowed to discharge to the existing 18-inch culvert that crosses I - 5 north of the 48-inch culvert.

3. No additional or new detention facilities are planned for construction in this basin.

MANAGEMENT ZONE ES - 3 (South of Highway 214 and west of I - 5)

The following conditions will apply to development and storm water infrastructure changes in Zone ES-3:

1. The East Tributary shall be retained as an open channel drainageway. The location of the creek may be altered upstream (south) of the future connecting

culvert across I - 5, provided that all other local, state and federal requirements are met and that drainage is provided to the upstream property at Point "C" as shown on Figure ___. Point "C" is the location at which the East Tributary enters the City limits from the subbasin south of Zone ES - 3.

2. Sufficient hydraulic capacity for the East Tributary in Zone ES - 3 shall be maintained by constructing a minimum of 3-acre feet detention facility east of Interstate 5. (See ES-4 narrative). Surface water flows must be controlled to assure that the water surface at Point "B" does not exceed an elevation of 174.5 feet (NGVD 29) during the 100 year detained flow event.

3. Two (2.0) acre-feet of flood storage volume shall be retained on Parcel "A" as shown on Figure ___ of the Storm Drainage Master Plan. This flood storage volume shall be located contiguous with the East Tributary, above the normal water surface level and below an elevation of 174.0. The East Tributary floodway shall not be filled or piped through this parcel.

4. Except for Parcel "A", all new development within Zone ES - 3 shall provide on-site detention as specified in the General Policy.

5. When development occurs on parcels that abut the existing East Tributary in Zone ES - 3, creek maintenance easements specific to the East Tributary shall be deeded to the City of Woodburn.

MANAGEMENT ZONE ES - 4 (South of Highway 214 and east of I - 5)

Development of detention and conveyance facilities in Zone ES-4 are required to control flows and mitigate runoff resulting from development in the management zone. The following design parameters and conditions will apply to development of infrastructure facilities in Zone ES-4:

1. A culvert shall be constructed at Point "B" (Figure ___ of the Storm Drainage Master Plan) across I - 5. Design and construction shall be coordinated with the Oregon Department of Transportation and other state and federal agencies that may be involved. Design of the crossing shall comply with the following criteria:

   a. The culvert shall have the capacity of a 42-inch diameter concrete sewer pipe.

   b. The downstream invert shall be placed at approximately 171.0 feet and shall hydraulically connect to the East Tributary.

   c. The pipe slope shall be between 0.0012 and 0.005 feet per foot if a 42-inch pipe is used.

2. A detention facility should be constructed near the upstream (east) end of the culvert described above. The facility will be located as close as possible to the Interstate 5 right-of-way and shall use the following design parameters:

a. The facility shall provide a minimum of 7 acre-feet of off-line detention and:

1. limit the upper water elevation to 177.0',
2. limit the post development release flows from a 25-year event to a rate no greater than produced by a predevelopment 5-year storm event, and
3. detain the full flows of the 100-year storm event

b. The facility shall be designed to cause the water surface in the detention facility to return to elevation 172.50 between rainfall events and the facility shall be designed to empty completely following cessation of runoff.

c. Facility side slopes shall not exceed 3H:1V.

d. The facility excavation shall be stabilized to minimize erosion and shall be seeded or planted with vegetation native to the region and suitable for the hydraulic and soils conditions of the site. Vegetation that may hinder the filling, emptying or maintenance of the facility shall not be used.

e. A 15-foot wide access road shall be provided to the facility and shall extend along one side of the facility and shall include access to the inlet and outlet structures. The access road shall be an all weather road suitable for vehicular use.

f. The detention facility including the perimeter access roadway shall be deeded to the City of Woodburn. A 20-foot wide access easement from a public street shall be granted to the City of Woodburn if the facility does not abut a public right-of-way.

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APPENDIX A

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APPENDIX B

COUNCIL BILL NO. 1138

ORDINANCE NO. 2018

AN ORDINANCE REGULATING AND CONSTRAINING DEVELOPMENT AND CONSTRUCTION WITHIN THE FLOOD-PLAIN AREAS OF WOODBURN, REPEALING ORDINANCE NO. 2010, AND DECLARING AN EMERGENCY.

THE CITY OF WOODBURN ORDAINS AS FOLLOWS:

Section 1. Purpose and Intent. It is the purpose and intent of this ordinance to promote the public health, safety and welfare, and to minimize public and private losses due to flood conditions by regulating and constraining development and construction within the flood-plain areas of Woodburn.

Section 2. Definitions.

(a) "Area of Special Flood Hazard" means the land in the flood plain within a community subject to a one percent or greater chance of flooding in any given year. Designation on the FIRM maps always include the letters A or V.

(b) "Base Flood" means the flood having a one percent chance of being equalled or exceeded in any given year. Also referred to as the "100-year flood." Designation on maps always includes the letters A or V.

(c) "Development" means any man-made changes to improved or unimproved real estate including, but not limited to, buildings or other structures, mining, dredging, filling, grading, paving, excavation, or drilling operations located within the area of special flood hazard.

(d) "Firm". An acronym for Flood Insurance Rate Map.

(e) "Flood or Flooding" means a general and temporary condition of partial or complete inundation of normally dry land areas.

(f) "Flood Insurance Study" means the official report provided by the Federal Insurance Administration that includes flood profiles, the flood boundary floodway map, and water surface elevation of a base flood.

(g) "Floodway" means the channel of a stream or other water course and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevations more than one (1) foot.

(h) "Manufactured Home" means a structure, transportable in one or more sections, which is built on a permanent chassis and is designed for use with or without a permanent foundation when connected to the required utilities. For flood plain management purposes the term "manufactured home" also includes park trailers, travel trailers, and other similar vehicles placed on a site for greater than 180 consecutive days. For insurance purposes the term "manufactured home" does not include park trailers, travel trailers, and other similar vehicles.

(i) "New Construction" means structures for which the start of construction commenced on or after the effective date of this ordinance.

(j) "Start of Construction" includes substantial improvement, and means the date the building permit was issued, provided the actual start of construction, repair, reconstruction, placement or other improvement was within 180 days of the permit date. The actual start means either the first placement of permanent construction of a structure on a site, such as the pouring of slab or footings, the installation of piles, the construction of columns, or any work beyond the stage of excavation; or the placement of a manufactured home on a foundation. Permanent construction does not include land preparation, such as clearing, grading and filling; nor does it include the installation of streets and/or walkways; nor does it include excavation for a basement, footings, piers, or foundation or the erection of temporary forms; nor does it include the installation on the property of accessory buildings, such as garages or sheds not occupied as dwelling units or not part of the main structure.

(k) "Lowest Floor" means the lowest floor of the lowest enclosed area (including basement). An unfinished or flood resistant enclosure, usable solely for parking of vehicles, building access or storage, in an area other than a basement area, is not considered a building's lowest floor, provided that such enclosure is not built so as to render the structure in violation of the applicable nonelevation design requirements of this ordinance found at Section 5.2-1(2).

(l) "Storm Water Management Plan" means the section of the City's officially adopted Comprehensive Plan which deals with storm water and flood water management.

(m) "Structure" means a walled and roofed building including a gas or liquid storage tank that is principally above ground.

(n) "Substantial Improvement" means any repair, reconstruction or improvement of the structure, the cost of which equals or exceeds fifty percent (50%) of the market value of the structure either,

(1) before the improvement or repair is started, or
(2) if the structure has been damaged and is being restored, before the damage occurred. For the purpose of this definition, substantial improvement is considered to occur when the first alteration of any wall, ceiling, floor, or other structural part of the building commences ... whether or not that alteration affects the external dimensions of the structure.

Section 3. General Provisions.

(a) Land to which this ordinance applies. This ordinance shall apply to all areas of special flood hazard within the jurisdiction of the City of Woodburn.

(b) Subdivision Proposals:

(1) All subdivision proposals shall be consistent with the need to minimize flood damage;

(2) All subdivision proposals shall have public utilities and facilities such as sewer, gas, electrical, and water systems located and constructed to minimize flood damage;

(3) All subdivision proposals shall have adequate drainage provided to reduce exposure to flood damage; and,

(4) Where base flood elevation data has not been provided or is not available from another authoritative source, it shall be generated for subdivision proposals and other proposed developments Which contain at least 50 lots or 5 acres (which ever is less).

(c) Review of Building Permits: Where elevation data is not available either through the Flood Insurance Study or from another authoritative source, applications for building permits shall be reviewed to assure that proposed construction will be reasonably safe from flooding. The test of reasonableness is a local judgement and includes use of historical data, high-water marks, photographs of past flooding, etc., where available. Failure to elevate at least two feet above grade in these zones may result in higher insurance rates.

(d) Basis for establishing the areas of special flood hazard. The area of special flood hazard identified by the Federal Insurance Administration in a scientific and engineering report entitled "The Flood Insurance Study for the City of Woodburn" dated March 1, 1979, with accompanying flood insurance maps is hereby adopted by reference and declared to be a part of this ordinance. In addition, the City's Storm Water Management Plan is also adopted by this ordinance and included as a part thereof.

(e) Minimum floor elevations for structures in the flood hazard area. The minimum floor elevations for structures in the Flood Hazard Areas shall be determined on a site specific basis using surveys and survey data or data found to be acceptable under the sections of this ordinance or the National Flood Insurance Standards.

(f) Floodways defined. The following floodways are hereby defined by this ordinance:

(1) For Mill Creek main drainage channel A maximum Floodway width of 150' as defined on data table #2 of the Woodburn Flood Insurance Study.

(2) For Senecal Creek main channel, a maximum floodway width of 145' as defined on Data Table #2 of the Woodburn Flood Insurance Study.

(3) For the tributary in drainage basin No. 2 as defined on the Storm Water Management Plan, a floodway of 80 feet from the confluence with tributary No. 2 with Mill Creek upstream 1,600 feet.

(4) For the tributary in drainage basin No. 3, a floodway channel of 60 feet from the confluence of tributary No. 3 with the main Mill Creek channel upstream 1,000 feet.

(5) For the tributary in drainage basin No. 5, a floodway of 80 feet from the confluence of tributary No. 5 with the Mill Creek channel upstream 1,600 feet.

(6) For the tributary in drainage basin No. 6, a floodway of 100 feet from the confluence of tributary No. 6 with the Mill Creek channel upstream 1,000 feet, a floodway of 80 feet from 1,000 feet to 1,500 feet, and a floodway of 60 feet from 1,500 feet to 2,000 feet above the confluence of Mill Creek.

(7) For the tributary in drainage basin No. 7, a floodway of 80 feet from the confluence of tributary No. 7 with Mill Creek upstream 1,800 feet.

(8) For the Senecal Creek tributary which is unnumbered on the Storm Water Management Plan but which drains the area from Interstate 5 to Woodland Avenue, a floodway of 80 feet from the point of its confluence with Senecal Creek upstream to the point at which it crosses underneath State Highway 214.

(g) In addition to the above mentioned floodways, a floodway of 40 feet shall be maintained on all open existing drainage channels within the City of Woodburn.

Section 4. Administration.

(a) Establishment of development permit. A development permit shall be obtained before construction or development begins within any area of special flood hazard established in Section 3 (~~b~~). The permits shall be for all structures including manufactured homes as set forth in the definitions and for all other developments including fill and other activities as also set forth in the definitions.

(b) Designation of the City Engineer. The City Engineer, or his designate, is hereby appointed to administer and implement this ordinance by granting or denying development applications in accordance with its provisions.

(c) Duties and responsibilities of the City Engineer. Duties of the City Engineer shall include, but are not limited to:

(1) Permit review. Review all development permits to determine whether the permit requirements of this ordinance have been satisfied.

(2) Review all development permits to determine that all necessary permits have been obtained from

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Those federal, state or local governmental agencies from which prior approval is required.

(3) Review all development permits to determine if the proposed development is located in the floodway.

(4) Review all requests to fill in the flood hazard area to determine if the requests are in conformance with the criteria set forth in this ordinance.

(d) Use of other base flood data. When base flood elevation data has not been provided in accordance with Section 3 (d), basis for establishing the areas of special flood hazard, the City Engineer shall obtain, review, and reasonably utilize any base flood elevation and floodway data available from federal, state, or other sources in order to administer the provisions of this ordinance.

(e) Information to be obtained and maintained.

(1) Where base flood elevation data is provided through the Flood Insurance Study or required as in Section 4 (d), obtain and record the actual elevation in relation to mean sea level of the lowest floor (including basement) of all new or substantially improved structures and whether or not the structure contains a basement.

(2) For all new or substantially improved flood-proof structures:

(i) Obtain and record the actual elevation (in relation to mean sea level) and,

(ii) Maintain the flood proofing certifications required in Section 6 (b)(3).

(3) Elevations required above shall be provided by the owner along with a certification by an engineer or registered land surveyor of the actual elevation above mean sea level of the lowest floor of the structure.

(f) Alteration of water courses.

(1) Notify adjacent communities and the state agency responsible (DEPARTMENT OF LAND CONSERVATION AND DEVELOPMENT) alteration or relocation of a water course, and submit evidence of such notification to the Federal Insurance Administration.

(2) Require that maintenance is provided within the altered and relocated portion of said water course so that the flood carrying capacity is not diminished.

Section 5. General Standards. In all areas of special flood hazards the following standards are required.

(a) Anchoring.

(1) All new construction and substantial improvements to existing structures shall be anchored to prevent flotation, collapse, or lateral movement of the structure.

(2) All manufactured homes in a special flood hazard area shall be placed on fill AND elevated to the minimum elevations established in Section 3 (c) or 1.5 feet above the elevation of the base flood.

(3) All manufactured homes must likewise be anchored to prevent flotation, collapse or lateral movement, and shall be installed using methods and practices that minimize flood damage. Anchoring methods may include, but are not limited to, use of over-the-top or frame ties to ground anchors.

(b) Utilities.

(1) All new and replacement water supply systems shall be designed and constructed to minimize or elimi nate infiltration of flood waters into the system.

(2) New and replacement sanitary sewer systems shall be designed and constructed to minimize or elimi-nate infiltration of flood waters into the systems and discharge of the systems into the flood waters.

(3) On-site waste disposal systems shall be located to avoid impairment to them or contamination from them during flooding.

(c) Storage of materials and equipment. Materials that are buoyant, flammable, obnoxious, toxic or otherwise injurious to persons or property, if transported by flood-waters, are prohibited in the flood hazard area. Storage of materials and equipment not having these characteristics is permissible only if the materials and equipment have low-damage potential and are anchored or are readily removable from the area within the time available after forecasting and warning, however, no storage is allowed in the floodway.

Section 6. Specific Standards. In all areas of special flood hazards where base flood elevation data has been provided in this ordinance under Section 3 (c) or Section 4 (d), the following provisions are required.

(a) Electrical, heating, ventilation, plumbing, and air-conditioning equipment and other service facilities shall be designed and/or otherwise elevated or located so as to prevent water from entering or accumulating within the components during conditions of flooding.

ALL NEW CONSTRUCTION AND SUBSTANTIAL IMPROVEMENTS SHALL BE CONSTRUCTED WITH MATERIALS AND UTILITY EQUIPMENT RESISTANT TO FLOOD DAMAGE.

ALL NEW CONSTRUCTION AND SUBSTANTIAL IMPROVEMENTS SHALL BE CONSTRUCTED USING METHODS AND PRACTICES THAT MINIMIZE FLOOD DAMAGE.

(b) All manufactured homes to be placed or substantially improved within Zones A1-30, AH, and AE shall be elevated on a permanent foundation such that the lowest floor of the manufactured home is above base flood elevation and be securely

anchored to an adequately anchored foundation system in accordance with the provisions of section 5 (A)(2) & 5 (A)(3).

(c) Residential construction. New construction and substantial improvement of any residential structures shall have the lowest floor, including basement, elevated to or above the elevation established in Section 3 (c), or 1.5 feet above the elevation established in Section 3 (D) & 4 (d).

(d) Fully enclosed areas below the lowest floor that are subject to flooding are prohibited, or shall be designed to automatically equalize hydrostatic flood forces on exterior walls by allowing for the entry and exit of floodwaters. Designs for meeting this requirement must either be certified by a registered professional engineer or architect or must meet or exceed the following minimum criteria:

(i) A minimum of two openings having a total of not less than one square inch for every square foot of enclosed area subject to flooding shall be provided.

(ii) The bottom of all openings shall be no higher than one foot above grade.

(iii) Openings may be equipped with screens, louvers, or other coverings or devices provided that they permit the automatic entry and exit of flood waters.

(e) Non-Residential construction. New construction and substantial improvement of any commercial, industrial or other non-residential structure shall either have the lowest floor, including basement, elevated to the level of the elevation established in Section 3 (c), or 1.5 feet above the elevation of the base flood established in Section 3 (d) & 4 (d); or, together with the attendant utility and sanitary facilities shall:

(1) Be flood proofed so that below the base flood level of the structure is water-tight with walls substantially impermeable to the passage of water.

(2) Have structural components capable of resisting hydrostatic loads and effect of buoyancy in a base flood.

(3) Be certified by a registered professional engineer or architect that the design and methods of construction are in accordance with accepted standards of practice of meeting provisions of this sub section based on their development and/or review of the structural design, specifications and plans. Such certifications shall be provided to the City Engineer.

(4) Nonresidential structures that are elevated, not floodproofed, must meet the same standards for space below the lowest floor as described in 6 (D).

(5) Applicants floodproofing nonresidential buildings shall be notified that flood insurance premiums will be based on rates that are one foot below the flood-proofed level (e.g. a building constructed to

the base flood level will be rated as one foot below that level).

Section 7. Floodways.

(A) In the Floodways as defined under Section 3 (f), no encroachments including fill, new construction, substantial improvements, and other development, within the adopted regulatory flood way that would result in any increase in flood levels, is permitted.

(B) The normal and routine maintenance of stream channels is not precluded by this ordinance provided such main tenance complies with the no rise standard in flood levels. as outlined in Section 7 (a).

Section 8. Fill Standards.

(a) All structures built in the special flood area shall be constructed on engineered fill or shall have designed footings at suitable depth, both as required by the Uniform Building Code, or in conformance with other additional standards as required by the City Engineer in accordance with good engineering practices.

(b) The slope on a fill in the special flood hazard area shall not exceed 33%. Toe of such fill shall be outside the floodways defined in Section 3 (d).

(c) The amount of fill in the special flood hazard area shall be kept to a minimum. The following standards shall apply.

(1) Only one structure per existing lot at the time of passage of this ordinance shall be allowed for areas within the special flood hazard area. The structure shall be located so that a minimum amount of fill will be necessary for the elevation of the structure above the flood level.

(2) All subdivision, partitioning, and planned unit developments which envision development of any special flood hazard area shall indicate on the preliminary plan the location of all structures proposed to be located in the flood hazard area. These structures shall be located so that a minimum amount of fill is required to develop the land.

(3) Development proposals, whether nonresidential or residential, together with public utilities and facilities attendant to them, shall be constructed to minimize flood damage, and adequate drainage shall be provided. In areas not covered by

Section 3 (b), flood elevation data shall be provided by the developer.

(4) Multiple family residential or nonresidential structures shall be located as far as practical on the existing contiguous property from the floodway.

Section 9. Density Transfer. The Planning Commission may, upon application under the variance procedure, allow a higher density of dwelling units or structures on a parcel of property which contains areas of special flood hazard if the areas of special flood hazard are left substantially without fill. The Commission shall determine the amount of fill which would practicably be allowed in the flood hazard, and the additional amount of density on land outside the special flood hazard area which should be allowed due to the loss of the developable land in the flood hazard area.

Section 10. Variances. Variances to this ordinance shall comply with the same standards and follow the same procedures for variances to the Zoning Code of the City of Woodburn.

Section 11. Enforcement.

(a) Violation of this ordinance IS A CLASS I CIVIL INFRACTION AND shall be punishable by a fine of up to $500 for the first offense (finding of violation), and by a fine of up to $500 for the second and succeeding offenses (finding of violation). A separate offense will be deemed to occur on each calendar day that the infraction continues to exist, and a separate citation may be filed for each such offense.

(b) Alternate Remedy. If a parcel of land is, or is proposed to be used, developed, or maintained in violation of this ordinance, the aforesaid use shall constitute a nuisance, and the City may, as an addition to other remedies that are legally available for enforcing this ordinance institute injunction, mandamus, abatement, or other appropriate proceedings to prevent, enjoin temporarily or permanently, abate or remove the unlawful use, development, or maintenance of the land.

Section 12. Violation as Nuisance. Violation of any provision of this ordinance is hereby declared to be a nuisance, for which remedy may be pursued by the City to the full extent of law, notwithstanding any limitation in this or any other ordinance.

Section 13. Severability. If any word, clause, phrase, section, subsection, or other portion of this ordinance is found invalid by a court of competent jurisdiction, then the remainder of the ordinance shall be given full effect.

Section 14. Ordinance Repealed. Ordinance No. 2010 is hereby repealed AND ORDINANCE No. 1967 AND No. 1664 ARE NOT THEREBY RESURRECTED.

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Section 15. This ordinance being necessary for the immediate preservation of the public peace, health, and safety, an emergency is declared to exist and this ordinance shall take effect immediately upon passage by the City Council and approval by the Mayor.

Approved as to form: _____ 3/9/89
City Attorney Date

APPROVED: _____
NANCY A. KIRKSEY, MAYOR

Passed by the Council	March 27, 1989
Submitted to the Mayor	March 27, 1989
Approved by the Mayor	March 27, 1989
Filed in the Office of the Recorder	March 27, 1989

ATTEST: _____
BARNEY Ø. BURRIS, Recorder
City of Woodburn, Oregon

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APPENDIX C

City of Woodburn

SENECAL CREEK EAST TRIBUTARY CAPACITY ANALYSIS

prepared for
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DAVID C. SMITH & ASSOCIATES, INC.

March 1994

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CITY OF WOODBURN

SENECAL CREEK EAST TRIBUTARY CAPACITY ANALYSIS

March 1994

1. PURPOSE AND OVERVIEW

Figure 1, "Vicinity Map" shows Senecal Creek watershed and the watershed for the East Tributary of Senecal Creek. Existing flood conditions in Main Senecal Creek were evaluated and presented in a previous report: "Senecal Creek Hydraulic Analysis: Existing Conditions," Gordon L. Merseth/Oakley Engineering, Sept. 1993. This second analysis was conducted to evaluate the existing and future conveyance capacity of the East Tributary of Senecal Creek. The capacity of the East Tributary is significant because large areas of future development land exist at the upper (southern) end of the East Tributary watershed.

The main goals of this analysis are:

1) Evaluate the existing and future 25 year and 100 year flood profile conditions for undetained flows in the East Tributary.

2) Evaluate the maximum potential hydraulic capacity of the East Tributary drainageway and its culverted crossings to convey future flows.

3) Recommend possible mitigation strategies for the East Tributary, including culvert improvements and/or detention alternatives to fully utilize the conveyance capacity of the East Tributary as a drainage corridor for the City of Woodburn.

The assumptions and results of the analysis are presented in the following sections: Watershed Parameters and Flow Calculations; Senecal Creek Flood Profiles, Future Flows; East Tributary Capacity Analysis Results; and Summary of Improvements and Recommendations.

2. WATERSHED PARAMETERS AND FLOW CALCULATIONS

Basin Delineation

Figure 2, "Basin and Drainageway Map," delineates the key subbasins which drain to the East Tributary. Subbasins were delineated to reflect existing drainage patterns, areas of similar land use, and potential future drainage routing.

The solid basin line in Figure 2 represents the natural watershed boundary. In addition to these natural watershed areas which currently drain to the East Tributary, the capacity analysis indicates that some additional areas outside the natural watershed could be routed to the East Tributary. These additional areas are located at the upper (southerly) end of the East Tributary and have very flat topography. Consequently, relatively large areas could be routed via storm sewers or ditches, towards the East Tributary. The parcels recommended to drain to the East Tributary can easily be routed to this drainageway. This extension of the natural watershed clarifies the decisions placed on individual land owners by specifying the direction the entire parcel can be drained.

The basin extensions shown indicate the areas which do not currently drain to the East Tributary but could be served by this drainage in the future:

* Basin S-I represents a portion of a parcel zoned for industrial use. Most of the parcel drains to the East Tributary; the S-I basin portion drains to main Senecal Creek. Rather than route part of the parcel to Main Senecal Creek and part of the parcel to East Senecal Creek, the entire S-I basin could be routed to the East Tributary.

* Basins M-C, M-LDR and M-HDR represent areas currently draining to a shallow ditch system in the Mill Creek watershed. This ditch is not sufficiently deep to serve future developments and these runoff flows may be more economically routed to the East Tributary.

Existing and Future Land Use

For each subbasin, runoff parameters were estimated for existing and future land use conditions. Existing land use conditions were determined using the City's Zoning Map and aerial photography (1992). (See Figure 2, "Basin and Drainageway Map.") Runoff parameters for future land use conditions were estimated assuming full buildout to the maximum densities designated by the City's Comprehensive Land Use Plan. Future land use designations are shown in Figure 3, "Comprehensive Plan Land Use Map."

Currently, only about 35% of the portion of the Woodburn Urban Growth Boundary (UGB) currently draining to the East Tributary is developed at full buildout densities. Of the remaining area in the UGB, development in the East Tributary watershed is expected to be distributed by land use as follows: 33% commercial, 23% industrial, 17% high density residential, 27% low density residential.

Runoff Parameters

The Corps of Engineers HEC-1 computer model was used to compute peak sub-basin flows. The following input parameters are required: Basin area, effective impervious area, runoff curve number and lag time. Basin areas and the approximate area of existing mapped impervious surface (MIA) were computed from the aerial photo map in Figure 2, "Basin and Drainageway Map." Future MIA values were determined by land use as follows:

Land Use	Full Buildout MIA
Low Density Residential.	45%
High Density Residential	65%
Commercial	75%
Industrial	85%

Future MIA values were determined from the City of Woodburn's maximum site coverage and on-site landscaping requirements and also account for estimated off-site (public) impervious surface.

Effective impervious area (EIA) represents the effective area over which no infiltration occurs. This area is typically less than the actual mapped impervious area (MIA) due to depression storage, runoff which flows off impervious surfaces and across pervious areas before entering the storm system and other similar factors. For input into the HEC-1 models, EIA was determined using the following regression equations (originally published by OTAK, Inc. based on an analysis of USGS data in the Willamette Valley):

Older development areas: $EIA = 0.1x(MIA)^{1.5}$
Newer development areas and future development: $EIA = 0.4x(MIA)^{1.2}$

Soil runoff characteristics for each basin were determined using the Marion County Soils Survey. A composite runoff curve number corresponding to typical soils and ground cover conditions in each sub-basin was determined using standard Soil Conservation Service (SCS) tables.

The lag time input parameter is computed as 60% of the sub-basin time of concentration. Time of concentration for each sub-basin was calculated using the methodology published in the SCS publication TR-55.

Runoff parameters for each subbasin are summarized in Table 1, "East Tributary of Senecal Creek Sub-basin Parameters."

Flow Calculations

Peak sub-basin flows as calculated by the HEC-1 models are summarized in Figure 5, "East Tributary of Senecal Creek Peak Subbasin Flows," for existing and full buildout conditions. These figures represent the peak flow at the basin outlet for free-flow, undetained conditions.

In-stream flows were calculated by combining and routing individual subbasin flow hydrographs using a combination of HEC-1 and HEC-2 computer models. HEC-1 was used to route the hydrographs using the storage/outflow method in conjunction with volumes calculated by the HEC-2 flood profile model at key cross sections.

The peak in-stream flows used for the capacity analysis are shown on the flood profiles in Figure 4 and described in Section 4, "East Tributary Capacity Analysis Results and Recommendations."

3. SENECAL CREEK FLOOD PROFILES, FUTURE FLOWS

The HEC-1 models for future conditions in the East Tributary were integrated with the HEC-1 models previously prepared for Senecal Creek in order to evaluate the impacts of uture development on Senecal Creek. Calculations were conducted assuming full buildout within the Urban Growth Boundary for both Senecal Creek and the East Tributary basins.

Most of the land yet to be developed in the Senecal Creek watershed is located in the East Tributary basin. Since the East Tributary (and consequently most of the runoff from possible future development) enters Senecal Creek downstream of the City Limits, future development was found to have only a small impact on Senecal Creek where it is located within the City. For the 100 year event, future buildout resulted in a flow increase of 8 CFS in the portion of Senecal Creek upstream of the confluence with the East Tributary.

In Senecal Creek downstream of the East Tributary confluence, upstream, upstream development will result in a 100 year flow increase of about 36 CFS in the natural watershed, or 75 CFS with runoff from the additional basins. Both the Crosby Road bridge crossing and the existing East Tributary cross section were found to have adequate capacity to convey the entire 75 CFS flow increase with only minor (less than 0.1') increases in flood elevation.

For a 75 CFS future 100 year flow increase, a 0.4' increase in the floodplain elevation was calculated for the Agricultural Crossing located in Senecal Creek downstream of the City Limits. Backwater due to a 75 CFS future flow increase at the Agricultural Crossing

was found to result in a increase of 0.2' in the 100 year floodplain elevation calculated at the City Limits. This increase does not result in flooding of any existing structures. An increase of less than a 0.1' at the City Limits was calculated for the future 25 year event.

4. EAST TRIBUTARY CAPACITY ANALYSIS RESULTS

Peak flood elevations in the East Tributary west of I-5 were calculated using the Corps of Engineers HEC-2 computer modelling program for the 25 year and 100 year flood events. Channel/floodplain cross sections and culvert configuration data input into the models were obtained from the DeHaas and Associates field survey data provided by the City and from the City's 1976 1"=100' orthophoto topographical maps.

Flood profiles were calculated for the 25 year and 100 year events for the following conditions:

1) Existing conditions of open and developed acreage, and,

2) Full buildout of the East Tributary watershed including the future development areas (S-I, M-C, M-LDR, and M-HDR) as shown in Figure 2, "Basin and Drainageway Map," recommended to be routed to the East Tributary. (The total East Tributary watershed plus these additional areas as identified in Figure 2, will be referred to as the "expanded area" in this report.)

Flood profile calculations are presented in Figure 4, "East Tributary of Senecal Creek Flood Profiles." The profiles shown in Figure 4 are intended to represent future conditions if no culvert improvements or detention requirements are implemented. Existing culvert configurations, channel and floodplain cross sections were used for both the existing and full buildout hydraulic profile calculations. Existing and future in-stream flows reflect routing through the existing channel sections and storage routing through the existing culvert restrictions north of the UGB.

The flood profiles do not account for any flow reductions or detention storage due to the culvert system under Highway 214, the Texaco station and Arney Road. Calculations indicate that these culverts have adequate capacity to convey existing flows without detention. However, future flows will create surcharged conditions through this system of culvert crossings. If the low lying lands, which are situated immediately upstream of the Highway 214 crossing, are used for detention, a 30 CFS reduction in flow would result. The effects of this potential detention are not shown in the flood profiles in Figure 4, but are addressed later in this discussion.

The results of the flood profile calculations are discussed below for three key sections of the East Tributary conveyance.

Mouth of the East Tributary to the Urban Growth Boundary (Station 0+00 to 24+80)

This portion of the East Tributary is outside the City's UGB. The conveyance is primarily natural drainageway with three minor culverted crossings. The culvert configuration and location of each crossing are shown in Figure 2, "Basin and Drainageway Map," and on the flood profiles in Figure 4.

The analysis indicated that no improvements to these culverts are required to protect existing houses or to facilitate development in the City. However, future flows can be expected to increase the frequency with which these crossings overtop. Upstream detention will lessen this impact but over-topping will still occur without substantial investment. The degree of over-topping is shown on Figure 4, "Flood Profiles".

UGB to Arney Road (Station 24+65 to 52+00)

This reach of the creek has adequate capacity for future flow increases, assuming that the existing creek cross section area is maintained. High flows are currently conveyed by a bottom lands open channel ranging from 140' to 250' in width. Creek embankment slopes range from 5H:1V to 10H:1V. There are two foot bridges and these are expected to have a negligible affect on the floodplain. No road crossings or other structures estrict flow in this reach.

For the expanded watershed area, undetained future flow increases result in an increase of 0.5' to 1.0' in the 100 year flood profile throughout this reach. Because of the floodplain configuration, these increases result in only a small increase in the flood width and are not expected to significantly affect future development or any existing houses or major structures.

The 140' to 250' wide existing conveyance area is not currently shown as open space or a greenway on the City Zoning and Comprehensive Plan Maps. However, in order to accommodate both existing and future flows, it is recommended that this conveyance area be maintained for future flood conveyance. Specific floodway recommendations will be made during a later phase of the overall drainage master planning study. Final recommendations will include minimum finish floor elevations, minimum floodway widths to be maintained and the maximum allowable cumulative head loss for all future road crossings within this reach.

Arney Road, Texaco and Highway 214 Culvert System

This system of culverts consists of a 6' x 4' concrete box culvert under Arney Road, two 54" CMP culverts under the Texaco station and two 54" CMP culverts under Highway ?14. The capacity of these culverts affects water levels in the East Tributary upstream

(south) of Highway 214. The upper reaches of the East Tributary in this area serves the adjacent freeway drainage systems and receives flow from the 30" Walmart storm drain.

Analysis of existing 1"=100' City topo maps indicates that a maximum 25 year water surface elevation of 174.0 feet could be tolerated in the East Tributary immediately upstream of Highway 214. Flood elevations of 175.0 feet begin to flood the I-5 median and adjacent low areas. This water level is not acceptable for the 25 year flood event, but is probably tolerable for the 100 year frequency. The freeway pavement itself is above elevation 178.0 feet and would not be flooded by a 100 year flood elevation of 175.0 feet. Commercial land east of the freeway typically range in elevation from 180 feet to 184 feet and would not be impacted by a 100 year flood elevation of 175.0 feet.

Hydraulic calculations indicate that a maximum 100 year flow of 155 CFS and 25 year flow of 130 CFS can be conveyed through the Highway 214 culvert system without exceeding tolerable in-stream water surface elevations. This capacity is sufficient to convey the 25 year and 100 year flows calculated for existing conditions. Routing full buildout flows from the expanded area, however, exceeds the capacity of the East Tributary's culvert system in the vicinity of Highway 214 by about 40 to 50 CFS.

The existing topography immediately upstream (south) of Highway 214 currently provides up to 3.7 acre-feet of storage if full buildout flows are routed through the existing culvert system. This volume of storage reduces the 100 year flood elevation upstream of Highway 214 to 176.0 feet for full buildout flows from the expanded watershed area.

Options to control the 100 year water surface in the East Tributary immediately upstream of Highway 214 to less than 176.0 feet include: 1) constructing a diversion to route flow to the 48" pipe which crosses the freeway north of Highway 214 and discharges into the East Tributary downstream of Arney Road or 2) requiring detention for future upstream developments.

The 48" pipe crossing the freeway north of Highway 214 has adequate capacity of about 90 CFS and, for example, will carry the total full buildout runoff from basins F, H, I, and J. While diverting flow to the 48" freeway crossing may be feasible, more information on the invert depth, pipe slope and access to the pipe is required to fully evaluate this alternative. A diversion of this nature would not provide any flow reduction benefits downstream of Arney Road.

The total detention volume needed upstream of Highway 214 in order to safely convey full buildout flows for the 100 year event from the natural watershed plus the additional sub-basins is approximately 11 acre-feet. Less detention would necessitate the eventual replacement of the Highway 214 culverts. Also, less detention would also further impact the existing agricultural crossings located downstream of Highway 214.

5. SUMMARY OF IMPROVEMENT RECOMMENDATIONS

The improvement alternatives discussed in the previous sections are summarized for the East Tributary:

Culvert Crossing at the UGB

The crossing at Station 24+65 is located at the UGB boundary. Two new 42" CSP culverts are required in addition to the existing 42" CMP to accommodate future flows and maintain the existing 10 year capacity of this crossing.

Open Channel Reach Between the UGB and Arney Road:

No structural or detention improvements are required. Maintain the existing 140' to 250' wide open channel bottom for flood conveyance. No fill or encroachment of this drainageway should be allowed, or, if allowed, compensating flood storage should be provided.

Highway 214, Texaco and Arney Road Culvert System:

Maintain at least 2 acre-feet of the existing 3.7 acre-feet of flood storage area immediately upstream of the Highway 214 culverts and limit the maximum water surface elevation to an elevation of 175.0 feet.

Area Upstream of Highway 214:

No additional detention or structural improvements are required to maintain a 100 year conveyance capacity in the East Tributary if an additional 9 acre-feet of detention is provided in this upper portion of the basin.

The above improvements specified are recommended in order to maintain optimum 25 year and 100 year water surface profiles in the East Tributary. Subsequent phases of the Drainage Master Plan study will identify specific detention improvements and policies to address these capacity issues for the East Tributary of Senecal Creek.

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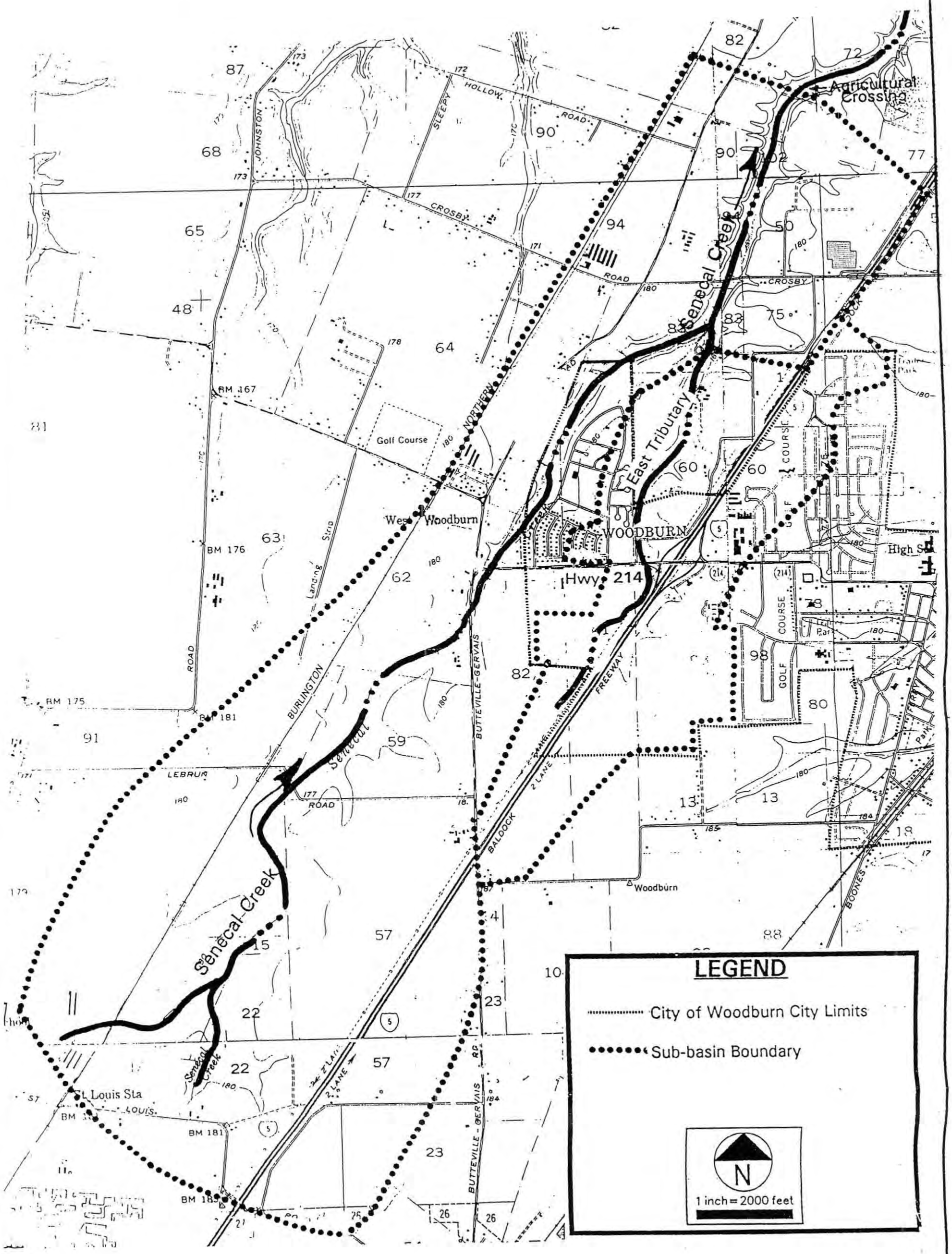

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DATE

VICINITY MAP

City of Woodburn
Senecal Creek, East Tributary Capacity Analysis

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FIGURE 1

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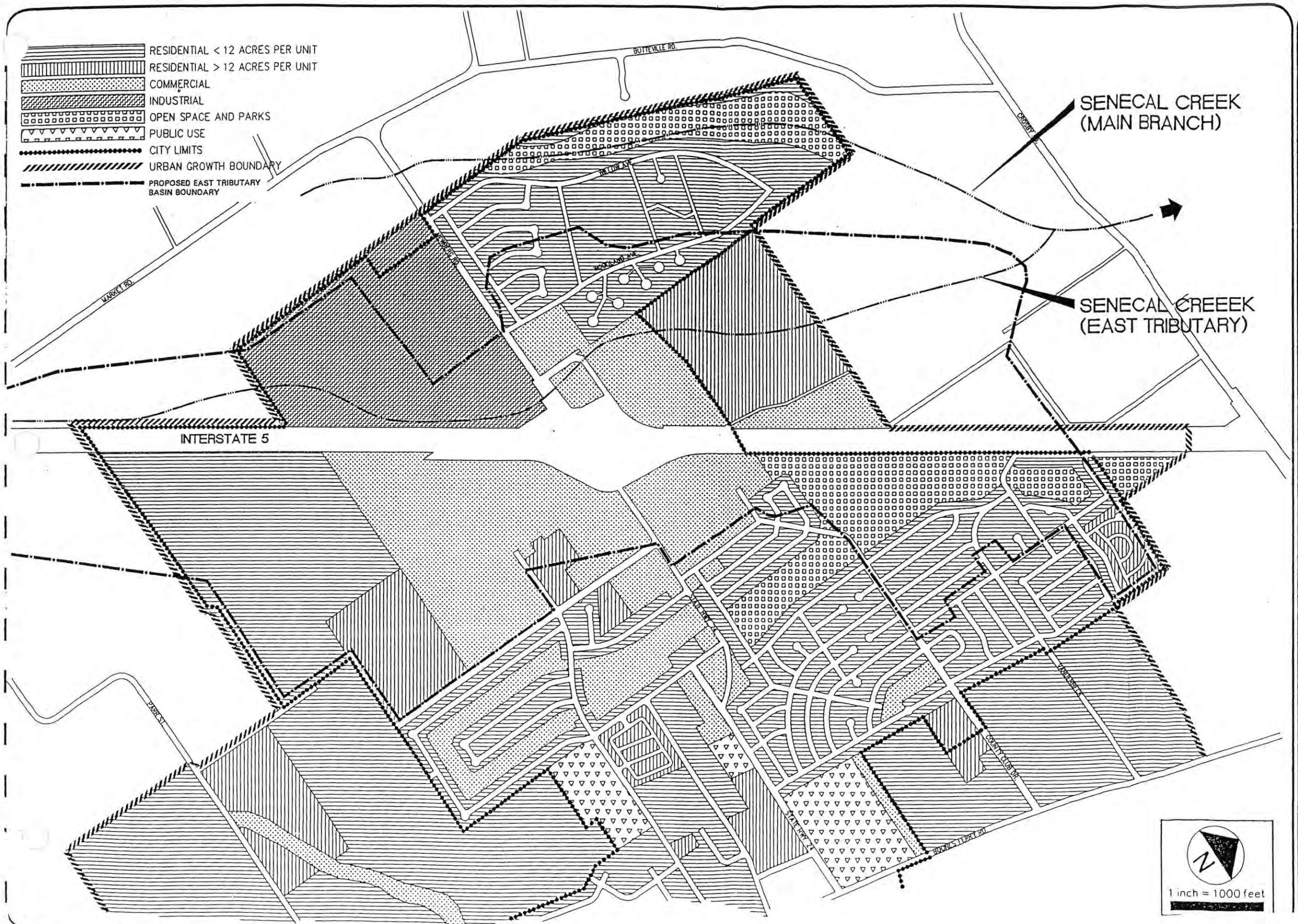

FIGURE 3

OAKLEY ENGINEERING, INC.
DRAINAGE PLANNING & DESIGN, HYDROLOGY, CIVIL ENGINEERING, & SITE DEVELOPMENT
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COMPREHENSIVE PLAN LAND USE MAP

City of Woodburn
Senecal Creek East Tributary Capacity Analysis

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TABLE 1
East Tributary of Senecal Creek
Subbasin Parameters

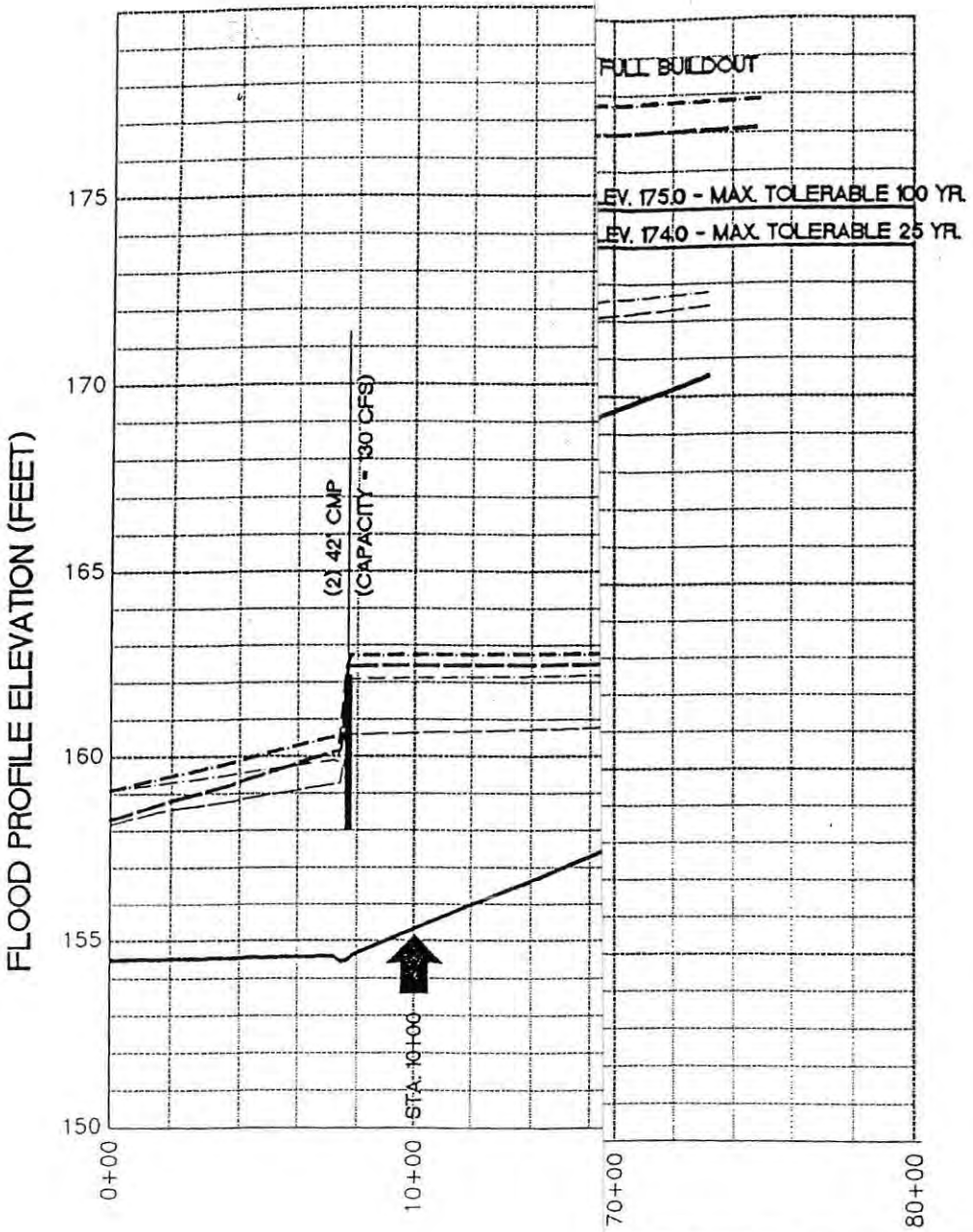
Sub-basin	Area (Acres)	Area (Sq. Miles)	% Impervious MIA	% Impervious EIA	SCS Curve No., Pervious Areas	Time of Conc. (Minutes)	Lag Time (Hours)
Existing 1993 Conditions							
A	124.5	0.195	8.0%	1.0%	78	102	1.02
B-1	60.3	0.094	60.0%	46.5%	74	60	0.60
B-2	49.4	0.077	2.0%	0.5%	74	31	0.31
C	49.0	0.077	38.0%	23.4%	74	19	0.19
D	78.3	0.122	3.0%	0.5%	80	35	0.35
E	50.2	0.078	22.0%	10.3%	80	28	0.28
F	30.0	0.047	35.0%	20.7%	80	20	0.20
G	76.6	0.120	5.0%	0.5%	80	127	1.27
H	26.7	0.042	60.0%	54.4%	77	20	0.20
I	33.6	0.053	57.0%	51.2%	77	20	0.20
J	40.6	0.063	2.0%	0.5%	80	130	1.30
K	83.1	0.130	5.0%	0.5%	80	160	1.60
L	121.0	0.189	3.0%	0.5%	81	190	1.90
Full Buildout Development Conditions							
A	124.5	0.195	8.0%	1.0%	78	102	1.02
B-1	60.3	0.094	60.0%	46.5%	74	60	0.60
B-2	49.4	0.077	2.0%	0.5%	74	31	0.31
C	49.0	0.077	45.0%	30.2%	74	19	0.19
D	78.3	0.122	70.0%	65.5%	77	22	0.22
E	50.2	0.078	67.0%	62.1%	77	16	0.16
F	30.0	0.047	66.0%	61.0%	77	18	0.16
G	76.6	0.120	72.5%	68.3%	77	37	0.37
H	26.7	0.042	68.0%	63.3%	77	16	0.16
I	33.6	0.053	72.0%	67.5%	77	14	0.14
J	40.6	0.063	75.0%	71.1%	77	18	0.18
K	83.1	0.130	45.0%	38.5%	77	24	0.24
L	121.0	0.189	3.0%	0.5%	81	190	1.90
New Development Areas to Be Routed (Full Buildout) *							
M-C	24.7	0.039	75.0%	71.1%	77	15	0.15
S-I	17.0	0.027	85.0%	82.7%	77	13	0.13
M-HDR	30.3	0.047	65.0%	59.5%	77	15	0.15
M-LDR	42.9	0.067	45.0%	38.5%	74	24	0.24

NOTE: M denotes basins currently draining to Mill Creek.
S denotes basins currently draining to Main Senecal Creek.

TABLE 2
East Tributary of Senecal Creek
Peak Subbasin Flows

Sub-basin	Area (Acres)	Area (Sq. Miles)	Existing 25 YR (CFS)	Existing 100 YR (CFS)	Full Buildout 25 YR (CFS)	Full Buildout 100 YR (CFS)
Natural Watershed						
A	124.5	0.195	20	28	20	28
B-1	60.3	0.094	24	29	24	29
B-2	49.4	0.077	7	10	7	10
C	49.0	0.077	15	20	17	22
D	78.3	0.122	20	27	42	50
E	42.7	0.067	16	20	28	33
F	31.1	0.049	11	15	17	20
G	76.6	0.120	13	17	38	45
H	26.7	0.042	13	16	15	18
I	33.6	0.053	16	20	20	24
J	40.6	0.063	7	9	24	28
K	83.1	0.130	13	17	33	41
L	121.0	0.189	18	24	18	24
Potential Re-routing of Future Development						
M-C	24.7	0.039	-	-	15	18
S-I	17.0	0.027	-	-	12	14
M-HDR	30.3	0.047	-	-	16	19
M-LDR	42.9	0.067	-	-	11	14

* NOTE: M denotes basins currently draining to Mill Creek.
S denotes basins currently draining to Main Senecal Creek.



	STATION 10+00	STATION 26+00	STATION 58+00
	115 CFS	85 CFS	58 CFS
	155 CFS	112 CFS	76 CFS
	250 CFS	230 CFS	180 CFS
	350 CFS	280 CFS	220 CFS

PREPARED FOR

GORDON L. MERSETH,
CONSULTING ENGINEER

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DATE			FIGURE
Mar., 1994	OAKLEY ENG DRAINAGE PLANNING CIVIL ENGINEERING 700 N.E Hayden Is. Dr. TEL. (503) 289-7411	OF SENECAL CREEK PROFILES	4

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Oversized Map Exhibits

Figure 1
City of Woodburn
Storm Drainage Master Plan

Figure 4
City of Woodburn
Strom Drainage Master Plan

Figure 5
City of Woodburn
Strom Drainage Master Plan

Figure 9
City of Woodburn
Strom Drainage Master Plan

Figure 13
City of Woodburn
Strom Drainage Master Plan

Appendix A
City of Woodburn
Strom Drainage Master Plan

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