CHAPTER 11

WATERSHED PLANNING AND ANALYSIS: OAK CREEK

11.1 INTRODUCTION

The Oak Creek watershed is the largest watershed within the study area of this plan. The upper reaches of Oak Creek lie outside of the city limits and the Urban Growth Boundary. The stream's headwaters are located northwest of Corvallis in McDonald State Forest, on the southern slopes of Cardwell Hills at about 1,400 feet in elevation. Oak Creek follows logging roads southward past Dimple Hill and Oregon State University (OSU) Experimental Station. The creek follows Oak Creek Drive, where it is joined by Alder Creek downstream of Skillings Drive. Mulkey Creek joins Oak Creek from the west, downstream of Bald Hill Park. Oak Creek flows under 53rd Street just north of Harrison Boulevard. The lower reaches lie within the city limits, beginning where Oak Creek crosses Harrison Boulevard to the south. The stream then flows southeast toward OSU. In this reach it flows through pastures and by farm buildings and research facilities before reaching the main body of the campus. On the south side of the OSU campus, the creek is bound by the Reser Stadium parking lot to the northeast, and mixed residential use to the southwest. As Oak Creek leaves OSU, it flows through a short residential section before flowing under Highway 20/34 and entering Marys River.

The Oak Creek watershed contains 8,300 acres. The largest current land use is state forest land, which covers almost 5,900 acres, representing over 70 percent of the watershed. About 12 percent of the watershed (1,030 acres) is used for agricultural purposes. OSU manages both the forest land and agricultural land. With the addition of the campus itself, OSU manages almost 90 percent of the land in the watershed. Over 500 acres are listed as undeveloped.

Under future development, the undeveloped land may be built out as light residential, and some of the OSU agricultural land may be developed for university non-agricultural purposes. The quantity of impervious surfaces in the watershed will increase only slightly under these conditions.

11.2 WATERSHED FINDINGS

Information on watershed conditions was obtained by collecting public comments at open houses, working with City staff to identify maintenance and operation problems, conducting a technical stream evaluation of selected reaches, and by modeling the conveyance system for the existing and build-out scenarios. This information was compiled by stream reach and is summarized in Section 11.2.6. A map of the Oak Creek watershed is presented as Figure 11-1. Figure 11-2 shows the location of the stream within the UGB and identifies some of the major observations made during the watershed study.

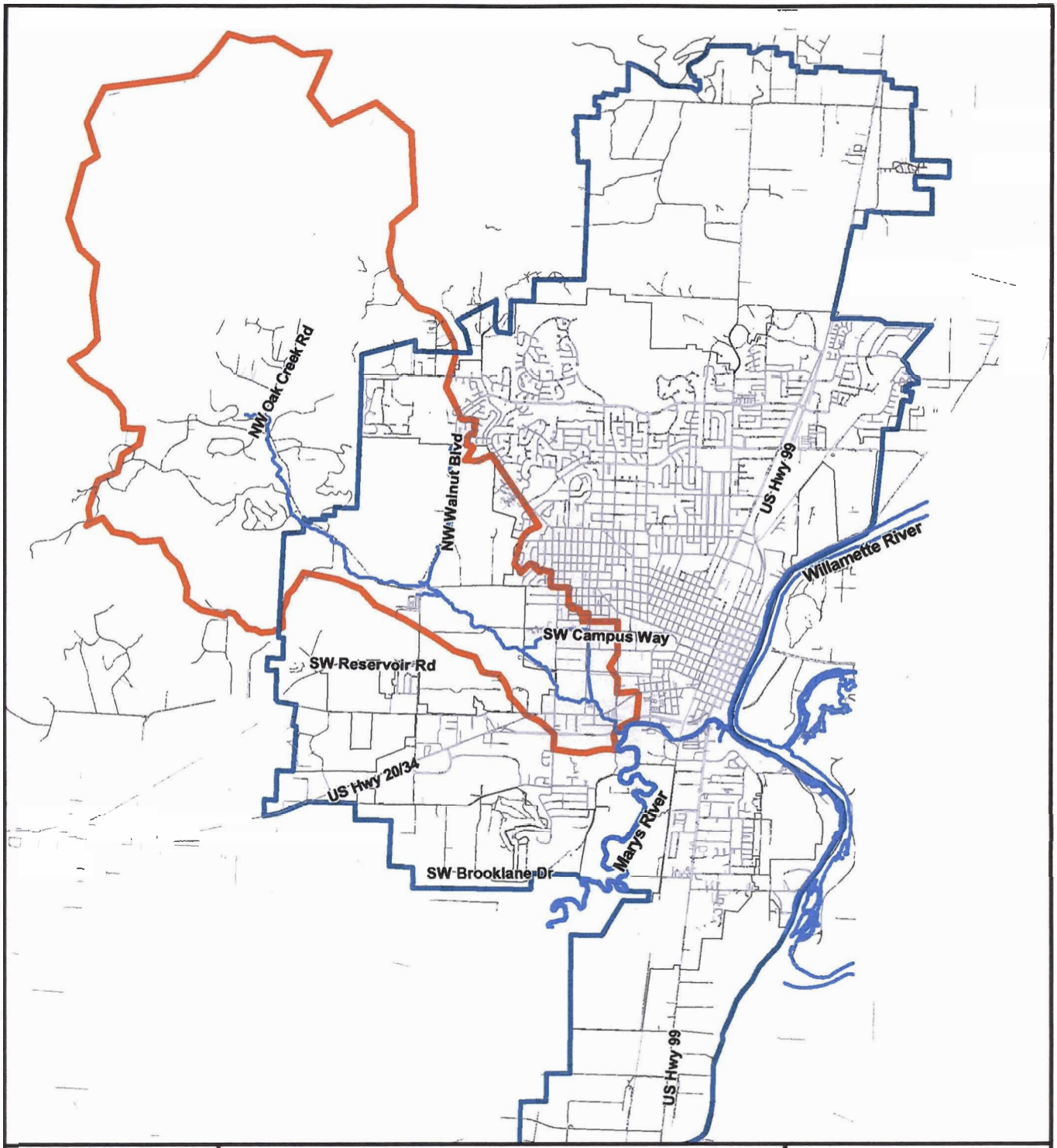
The conditions found in Oak Creek reflect the various land uses along the stream reaches. Urban influences on the stream are apparent in its lower reaches. Figure 11-3, Photo 1, shows gravel bars that form most of the channel substrate downstream of Highway 20/34. The Highway 20/34 culverts shown in Figure 11-3, Photo 2, represent a fish obstacle during low-flow conditions, but are probably not a significant barrier during winter months when Marys River runs high. The large pool

of water upstream of the culverts has limited shade and the streambanks are covered with blackberry thickets, as shown in Figure 11-3, Photo 3. The canopy cover improves farther upstream, as shown in Figure 11-3, Photo 4. However, stream conditions have been degraded due to riprap and concrete debris that have been placed or dumped in the channel. The channel bottom is scoured down to soft bedrock in this stream reach with occasional deposits of densely packed gravel. A number of hoses were found in the stream originating from some of the homes located adjacent to the creek. Pumping of water for lawn and garden irrigation is suspected. Figure 11-3, Photo 5, shows the Irish Bend Bridge as reconstructed along Campus Way. It serves as an alternate crossing to the low-water ford, which also provides access to OSU's agricultural property to the west. The OSU dairy is located in the background of the photo. A manure-spreading gun, Figure 11-3, Photo 6, spreads manure stored at the dairy operation.

11.2.1 Public Comments

Public meetings were held to encourage and facilitate public input into the planning process. The first of the meetings for the Oak Creek, Marys River, and South Corvallis watersheds was held on June 17, 1999 at the LaSells Stewart Center. During that meeting and a subsequent meeting, on September 30, 1999, residents were encouraged to share their knowledge of problem areas and to identify opportunities for improving the health of the three watersheds. Public comments for specific reaches of Oak Creek are included in Section 11.2.6. General comments about the Oak Creek watershed are listed below:

- "In Urban Growth Boundary – have mixed jurisdictions (i.e. Benton County, OSU). How do we bring them into the planning/development, etc. processes?"
- "Has the SWPC looked at using permeable paving and requiring it?"
- "Retention basins may be another solution (approach) to parking lot runoff that also deals with water quality."
- "Why does the City require driveways to be paved? Why can't we use other treatment?"
- "At the moment, the City requires generously wide streets that are probably not necessary. Narrower streets could be looked at."
- "Is Oak Creek an 'essential Chinook habitat'?"
- "Spill containment plan—consider workup on, especially for industrial sites."
- "Spill containment is only one contaminant—herbicide use on green strips between street (along curb) and lawn—OSU landscaping—source of pollutants."
- "Are stream corridors being used for recreation? Have trails along streams, on detention areas as parks? i.e., multiple uses of these spaces?"



LEGEND

Figure 11-1 Oak Creek Watershed

Urban Growth Boundary

Oak Creek Watershed

City Limits

N

Feet 2000 0 2000 4000 6000 8000 Feet

ENHANCING COMMUNITY LIVABILITY

Public Works Department

BROWN AND CALDWELL

and Associated Firms

report/figures/final/Fig11-1.wor, November 6, 2000, base data from City of Corvallis GIS Department

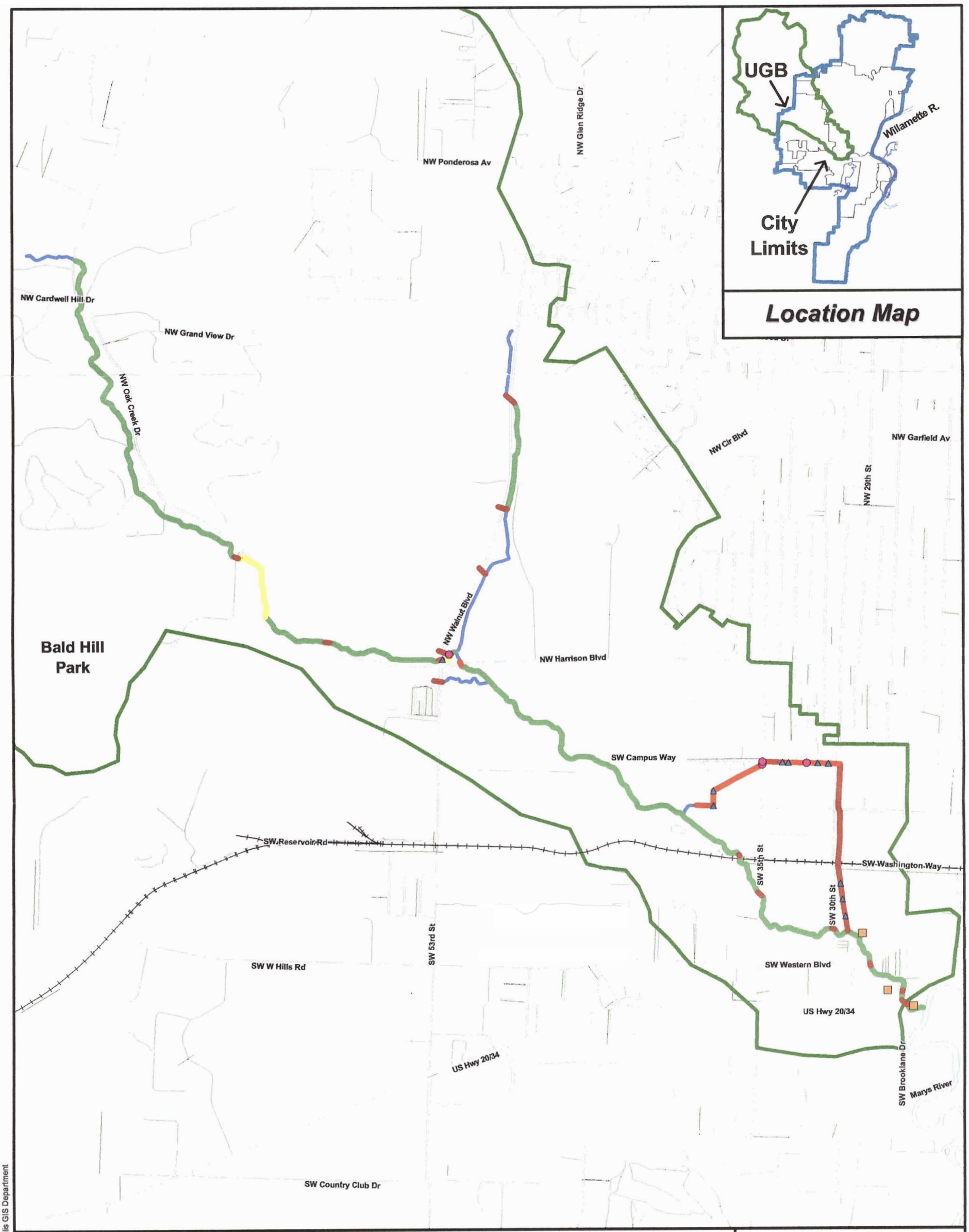


Figure 11-2 Oak Creek Problem Areas

LEGEND

- Pipes/Bridges
- Channels
- Basin Boundary
- Reported Problems (recorded at open house)
- Surcharged Manholes (10-year future storm)
- Flooded Manholes (10-year future storm)
- High Velocity Areas (> 4 fps, 2-year future storm)
- Undersized Conduits (10-year future storm)
- Undersized Channels (10-year future storm)

N

Feet 600 0 600 1200 1800 2400 Feet

CORVALLIS Public Works Department

BROWN AND CALDWELL and Associated Firms

report/figures/final/Fig11-2.wor, November 6, 2000, base data from City of Corvallis GIS Department

Figure 11-3. Watershed Photos

Photo 1. Gravel bottom and trees near Marys River

Photo 2. Fish barrier at Hwy 20/34

Photo 3. Large pool upstream of Hwy 20/34

Photo 4. Habitat near Western Blvd.

Photo 5. Irish Bend Bridge along Campus Way

Photo 6. Manure application on OSU farm fields

11.2.2 Oregon State University Oak Creek Action Team Report

In May 1999, OSU created an Action Team consisting of OSU scientists and engineers to study the impacts of university activities on the Oak Creek watershed. The findings and recommendations of the Action Team are documented in the *Report of the Oak Creek Action Team to Oregon State University*, (OSU Report, June 2000). The report identified six critical issues or activities that impact the Oak Creek basin, including:

1. Manure application and water quality
2. Riparian condition and water quality
3. Water withdrawal
4. Dams and barriers
5. Storm water drainage
6. Toxic waste storage and handling

To assess the impact of these OSU-controlled issues, the Action Team recommended the following "critical actions":

- Appoint an OSU Oak Creek governing body
- Establish an Oak Creek Riparian Study Area
- Develop environmental monitoring sites and systematic measurements in the Oak Creek Riparian Study Area
- Conduct an analysis of winter manure spreading
- Develop a policy to evaluate all structural development in the Oak Creek Riparian Study Area
- Remove dams and stop water withdrawal from Oak Creek
- Incorporate assessment of storm drains into OSU policies for hazardous waste management

Additional findings of the 12-month study are documented in the OSU Report. Excerpts of the findings are provided in Section 11.2.6.

11.2.3 City Staff Reports

City Engineering and Utilities Operations staff members are familiar with the Oak Creek watershed through their day-to-day activities. They provided input into the planning process by identifying known problem areas, recommending areas for stream enhancement activities, and recounting the extent and duration of flooding during major storm events. The February 1996 storm caused a number of flooding problems within the watershed. Most of the high water and road closures occurred in the reaches just upstream of Highway 20/34.

11.2.4 Field Study Observations

Watershed Applications, a stream rehabilitation specialty firm, conducted a series of field investigations beginning in November 1997. Field personnel evaluated selected lengths of Oak Creek during stream walks. A summary of their observations is included in Section 11.2.6. Detailed descriptions of the field study observations are in Appendix B.

11.2.5 Modeling Results

A computer model for the Oak Creek watershed identified the hydraulic capacity and projected flows in the pipes, culverts, and channels of the conveyance system for existing and future build-out scenarios. Existing conditions are based on the current level of development at the time of modeling. Future conditions are based on full development (build-out) of the watershed as identified in the City's Comprehensive Plan. A full range of storm events was modeled for the existing and future scenarios, including the 2-, 10-, 25-, and 100-year storm events. Table 11-1 lists the hydraulic structures (pipes, culverts, bridge crossings, etc.) that are undersized for the City's 10-year design storm. A complete summary of all modeled segments is in Appendix C.

Table 11-1. Modeled Flow for Undersized Hydraulic Structures within the Oak Creek Watershed, cubic feet per second

Reach/Location/Model segment	Full pipe or channel capacity[1]	10-year storm flows		Flooding predicted by model	Flooding reported by staff or public
		Existing	Future		
Western Boulevard to 35th Street/Pipe system along Campus Way flowing east (OAK415, OAK410, OAK405, OAK400)	5.7	9.5	9.5	Yes	Yes
Western Boulevard to 35th Street/Pipe system along 30th Street (OAK305)	71	37	37	No	No
Western Boulevard to 35th Street/Pipe system along 30th Street (OAK295)	127	37	37	No	No
35th Street to Harrison Boulevard/Crossing at Campus Way	75	882	886	Yes	Yes
35th Street to Harrison Boulevard/Pipe system near 35th Street (OAK375, OAK370, OAK365, OAK360)	5.4	6.8	6.8	Yes	Yes
35th Street to Harrison Boulevard/Channel by OSU dairy farm (OAK103)	17	835	835	Yes	No
Harrison Boulevard to Cardwell Hill Drive/Culvert under Harrison Boulevard (OAK115)	287	425	425	Yes	Yes
Harrison Boulevard to Cardwell Hill Drive/Channel downstream of Oak Creek Drive crossing (OAK140)	1070	1090	1090	Yes	NA

Table 11-1. Modeled Flow for Undersized Hydraulic Structures within the Oak Creek Watershed, cubic feet per second (continued)

Reach/Location/Model segment	Full pipe or channel capacity[1]	10-year storm flows		Flooding predicted by model	Flooding reported by staff or public
		Existing	Future		
Harrison Boulevard to Cardwell Hill Drive/Channel on agricultural land to east of Bald Hill (OAK150)	548	1080	1080	Yes	NA
Harrison Boulevard to Cardwell Hill Drive/Channel at entrance to Bald Hill (OAK155)	628	979	980	Yes	NA

[1] The full pipe or channel capacity is based on Manning's Equation. It does not account for hydraulic effects from downstream backwater effects.

NA – Not applicable, City staff or public input not provided for this location, usually limited to inside the city limits.

Not all of the undersized structures listed in Table 11-1 result in flooding even though some of the piped segments are surcharged. The greatest flooding problems are located away from the stream, caused by undersized pipe systems along Campus Way between 30th and 35th Streets. Most of the undersized channels and culverts along the creek occur in agricultural areas owned by OSU, where the impact of flooding is considered to be minor. One undersized culvert, at the Campus Way crossing, is designed to act as a ford during larger storm events.

The hydrologic/hydraulic model also estimated flow velocities in channel segments to determine areas at risk for channel or streambank erosion. Velocities in excess of 4 feet per second (fps) may cause erosion of the streambank or streambed. The model predicted velocities based on the 2-year storm event—the storm size most responsible for determining the channel configuration. Table 11-2 lists the reaches where the velocities exceeded 4 feet-per-second.

The model showed velocities that exceeded the erosion criteria along the majority of the stream reaches. Most of the stream reaches above 35th Street were not observed as part of this planning process. In this area, reports of erosion were based on OSU's June 2000 *Report of the Oak Creek Action Team to Oregon State University*. Field verification of actual erosion problems is required prior to implementing streambank restoration or other related management actions.

Table 11-2. Modeled Velocities for Oak Creek, Channel Segments Exceeding 4 Feet per Second

Reach/Model segment	2-year storm		Erosion observed	Existing bank stabilization
	Existing velocities	Future velocities		
Marys River to Highway 20/34 /Upstream of river	6.5	6.5	No	No
Highway 20/34 to Western Boulevard/Highway 20/34 to Morris Avenue	5.9	5.9	No	No
Highway 20/34 to Western Boulevard/Morris Avenue to Western Boulevard	5.5	5.6	Yes	Yes
Western Boulevard to 35th Street/Western Boulevard to near Grove Street	5.7	5.7	Yes	No
Western Boulevard to 35th Street/near Grove Street to 30th Street	6.2	6.2	Yes	No
Western Boulevard to 35th Street/30th Street to OSU Forestry Lab	6.1	6.1	Yes	Yes
Western Boulevard to 35th Street/OSU Forestry Lab to 35th Street	5.0	5.0	Yes	Yes
35th Street to Harrison Boulevard/35th Street to Washington Way extension	4.9	4.9	Yes	Yes
35th Street to Harrison Boulevard/Behind fire station along Washington Way extension	5.1	5.1	Yes	Yes
35th Street to Harrison Boulevard/Campus Way to Washington Way extension	7.4	7.5	Yes	Yes
35th Street to Harrison Boulevard/Campus Way to west of OSU dairy farm	6.1	6.1	Yes	No
35th Street to Harrison Boulevard/west of OSU dairy farm to stream junction	5.1	5.1	Yes	No
35th Street to Harrison Boulevard/stream junction to Harrison Boulevard	5.4	5.4	Yes	No
Harrison Boulevard to Cardwell Hill Drive/upstream of junction with Walnut Boulevard Branch	5.3	5.2	Yes	No
Harrison Boulevard to Cardwell Hill Drive/downstream of Walnut Boulevard	4.7	4.7	Yes	Yes
Harrison Boulevard to Cardwell Hill Drive/Walnut Boulevard to Oak Creek Drive	5.8	5.8	Yes	NA
Harrison Boulevard to Cardwell Hill Drive/upstream of Oak Creek Drive	6.0	6.0	Yes	NA
Harrison Boulevard to Cardwell Hill Drive/downstream of Bald Hill Park entrance	4.6	4.6	Yes	NA
Harrison Boulevard to Cardwell Hill Drive/Bald Hill Park entrance to Ridgewood Drive	5.0	5.0	Yes	NA
Harrison Boulevard to Cardwell Hill Drive/Ridgewood Drive to Canyon Drive	7.5	7.5	Yes	NA
Walnut Boulevard Branch/ Along Walnut Boulevard near OSU Equestrian Center	4.8	4.8	NA	NA

NA – Not applicable; City staff or public input not provided for this location, usually limited to outside of city limits.

11.2.6 Stream Reach Summaries

For study purposes, Oak Creek was divided into a number of stream reaches based on the physical characteristics of the stream, property ownership, and other unique characteristics that would distin-

guish one section of the stream from the rest. The study findings are summarized in the following sections by reach description. Excerpts from the OSU Report are included. Public or City staff comments are noted as they were heard or provided, with minimal editing to preserve the context. If required, clarification is provided in parentheses.

Marys River to Highway 20/34

Public Comments: "Right below highway culvert on Oak Creek, water temperature was 70 degrees, too high. Took temperature on June 15, 1999."

OSU Report: Large amount of trash, broken concrete, and asphalt has been dumped into the lower reaches. The short section of the Oak Creek channel downstream of the highway culvert is incised and hydrologically disconnected from floodplain. The disconnection is a result of the deeply incised channel caused by a downcutting action of the creek. The deeper channel does not permit the frequent flooding (i.e., once every couple of years) of the floodplain surfaces as would normally occur in a healthy stream.

City Staff Reports: No comments provided for this reach.

Field Observations: Oak Creek downstream of Highway 20/34 has a narrow, confined functional floodplain. The overstory consists of oak, maple, and ash, with extensive blackberry thickets beneath. The stream habitat in this reach lacks diversity. The stream is almost completely composed of riffle habitat, consisting of a sinuous channel through a gravel streambed. The channel lacks large woody debris or other beneficial instream roughness structures.

A substantial obstacle to fish passage is located approximately 35 feet downstream of the twin box culverts under Highway 20/34. The concrete apron that extends about 20 feet downstream from the culverts is suspended 24 to 30 inches above the downstream streambed (12 to 18 inches above the water surface), with a residual low-flow pool. This structure represents an impassable barrier to fish under most flow conditions. Flow over the apron and through the highway culverts is extremely shallow during low-flow conditions, creating an additional barrier to fish passage.

Modeling Results: The model predicted no capacity problems in this reach. Velocities in the channel exceeded the 4 feet-per-second erosion criteria.

Highway 20/34 to Western Boulevard

Public Comments: "With new OSU hotel, will the drainage be addressed? Off parking lots?"

"Business on Morris Avenue (on north side of street) that backs up onto creek—could there be contamination issues (herbicides) or cleaning out tanks?"

OSU Report: The Oak Creek channel is incised and hydrologically disconnected from the floodplain. The overstory vegetation is oak and maple trees.

City Staff Reports: During the February 1996 flood, Western Boulevard was closed from Grove Street to 35th Street. High water was observed along Morris Avenue and on Grove Street, south of Western Boulevard.

Field Observations: The culverts beneath Highway 20/34 impound water, creating a long pool extending upstream past Morris Avenue. The banks in this reach are steep and covered by dense blackberry thickets that overhang the water surface. Also, a few clumps of native shrubbery, such as red osier dogwood, can be found in this reach. The channel width is roughly 20 feet, with the channel entrenched approximately 20 feet below the surrounding grade.

Concrete rubble was used to reinforce the lower banks and channel bottom several hundred feet upstream of Morris Avenue. Portions of the steep banks consist of old fill material. The outside (north) bank of the 90-degree bend near the Santana Court Apartment complex is bare and eroded. A recent effort to install erosion control fabric and native vegetation along the top of the steep bank does not appear to be working. The streambed has been scoured down to the bedrock of siltstone or mudstone.

The sinuous channel extending downstream of 30th Street is entrenched 15 to 20 feet below the prevailing grade. The banks are composed of silt. Steep slopes coupled with a sterile substrate and dense shade have resulted in relatively bare lower bank areas subject to scour erosion. Many of the streamside trees have suffered extensive root exposure due to scouring, making them prone to toppling. Once toppled, the trees are more likely to promote additional bank erosion in this reach than provide fish habitat since they often remain suspended above the confined low-flow channel. In-stream, riffle and glide habitat predominate with a few small bedrock scour pools (some with submerged undercut ledges).

A stand of native trees, consisting predominantly of bigleaf maple, Oregon ash, Garry oak and red alder, is located in the vicinity of the bend. The stand continues relatively uninterrupted (except for road crossings) upstream beyond 35th Street. The trees provide good canopy cover and shade to the creek. Although bare slopes or blackberry-covered areas are common along the banks, some native snowberry, red osier dogwood, and Pacific ninebark shrubs provide limited cover.

Homemade bank revetments have been placed in a few areas between Western Boulevard and Morris Avenue. A few manmade dams composed of demolition rubble and basalt boulders are present in this area, although none appears to pose fish passage problems. A number of private water diversion structures were found. It is likely that most of these diversions do not have state water withdrawal permits. Some of the observed small boulder dams are used to facilitate water extraction.

Modeling Results: The model predicted no capacity problems in this reach. Velocities in the channel exceeded the 4 feet-per-second erosion criteria.

Western Boulevard to 35th Street

Public Comments: "The OSU parking lot in many areas encroaches onto the creek corridor and there is not an adequate buffer."

OSU Report: The Reser Stadium parking lot extends to the edge of the Oak Creek channel. During heavy rainfall, portions of the parking lot drain directly into the creek. A large amount of gravel from the parking lot has entered the creek, along with trash, broken concrete, and asphalt. Several low-rock check dams have been placed in the channel.

Along this reach of the stream, the university manages a variety of campus facilities, ranging from research laboratories to athletic fields and stadiums. The Forest Research Laboratory buildings and parking lot are immediately adjacent to Oak Creek. The Entomology Laboratory is located at 35th Street. A chemical storage facility is located only a few feet from the upper bank of the creek.

The Oak Creek channel is incised and hydrologically disconnected from the floodplain. As with its other reaches, oak and maple trees make up the overstory vegetation. Significant amounts of riprap have been placed along the channel bank along with a sheet pile diversion structure (at the Entomology Laboratory). Past water withdrawals at the Entomology Laboratory were not permitted.

City Staff Reports: A few streets located away from the creek flooded during the February 1996 storm. High water was reported at the intersection of 35th Street and Jackson Avenue. Orchard Avenue was closed from 35th Street to just east of 30th Street along with a small portion of 30th Street.

Field Observations: Channel entrenchment varies from roughly 20 feet deep between Western Boulevard and 30th Street to less than 10 feet deep near 35th Street. Fill was placed along the left bank of Oak Creek to expand the parking area for Reser Stadium. It appears that fill was placed up to about the same level on the other side of the creek as well. The fill forms a steep slope roughly 6 to 8 feet high. Drainage from the stadium parking area has produced gullies along this slope.

Rock fill under the 30th Street bridge has created an armored riffle habitat that encourages lateral bank erosion under high-flow conditions. The fill material appears to have created a long backwater pool in this relatively low-gradient reach. The rock accumulation does not appear to create an obstacle to fish passage.

A large-diameter pipe crosses the channel approximately 30 feet or so upstream of the 30th Street bridge. The bottom of the pipe is only about 1 foot above the water surface under winter flow conditions. This pipe risks failure if a debris jam were to move downstream during a high-flow period and become lodged against it.

A steel dam is located about 250 feet downstream of the 35th Street bridge. The dam has two spillways. The structure appears to be passable for larger fish under high-flow conditions, but would most likely constitute a barrier to the upstream migration of fish under lower flow conditions. A large gravel and sand bar has accumulated along the left bank downstream of 35th Street, apparently due to the backwater affects of the dam.

The streambanks are over-steepened with vertical slopes in a few places. The banks consist of predominantly fine-grained material and non-engineered fills. A revetment composed of demolition debris is failing and exacerbating scour erosion. Some OSU facilities crowd the channel in the lower end of the reach. A number of stormwater pipes associated with the facilities extend out from the bank; without the benefit of energy-dissipating aprons, this can cause local bank erosion.

Canopy coverage is generally good throughout the reach, with a mix of overstory species similar to that downstream, although blackberry thickets are far more abundant here than in other reaches. Because of the over-steep banks, many of the trees rooted on the slopes are prone to scour and eventual toppling. Large fallen trees have accumulated in the channel several hundred feet upstream of 30th Street. Although they add structural diversity to the channel, they also encourage fluvial erosion and slumping because of the entrenched channel condition. The largest bank failure observed in this reach was located on the left bank about 700 feet downstream of the steel dam. The failed bank is about 75 feet long and 10 feet high. A large tree, still partially rooted on the lower bank, forms the downstream end of the failure zone. The tree is likely to promote further bank erosion in this immediate area.

Modeling Results: The piped systems along Campus Way, 30th Street, and 35th Street are over capacity according to the modeling results. The culvert where Campus Way crosses Oak Creek is extremely undersized, but was designed to operate as a ford. The model also shows overtopping of the Oak Creek channel near the OSU dairy. Velocities in the channel exceeded the 4 feet-per-second erosion criteria.

35th Street to Harrison Boulevard

Public Comments: "OSU has 2 cubic feet per second (cfs) water rights and they often irrigate during midday (12 – 2 p.m.)."

OSU Report: The University manages a large number of livestock in this reach. Poultry facilities are located north of Harrison Boulevard and east of 53rd Street. The facilities cover about 100 acres and contain 5,000 broilers. Manure is stored under a roof until spring or summer when it is spread over farm fields.

The campus dairy is located southeast of the poultry facilities, across Harrison Boulevard. The dairy operation covers 220 acres and houses 145 milk cows and 80 calves. Manure is flushed or scraped into a collection sump. There, a mechanical screen separates larger solids from the waste stream, and the solids are hauled away by a private contractor. During the winter, a 520,000-gallon storage tank stores about 70 days worth of liquid wastes before it is spread across farm fields.

A swine facility is located south of the Irish Bend covered bridge that crosses Oak Creek at Campus Way. The facility contains about 10 sows, and wastes are washed into a lagoon near the buildings. Once a year, during the summer, the lagoon is pumped and the accumulated wastes are applied to the fields.

Just west of 35th Street, 50 head of beef cattle are housed in a 30-acre facility. Most of the chip bedding for the animals is hauled away by a private contractor, with about 10 percent of the wastes spread on land north of the buildings.

Other activities within this reach include: an area for use by OSU military programs southwest of the EPA laboratory, a spoils area immediately west of the fire station on 35th Street, and a pop-up dam that allows 2 cfs of water withdrawals for irrigation during the summer.

The Oak Creek channel is incised and hydrologically disconnected from the floodplain. Gravel deposits are found upstream of the covered bridge and the low-water ford at Campus Way. Overstory vegetation is primarily oak and ash. Upstream of Campus Way, blackberry is the dominant understory vegetation.

City Staff Reports: City staff confirmed a number of flooding problems near OSU's Orchard Court housing complex (between 30th and 35th Streets). Some of the stormwater pipes are located beneath houses, making access difficult. In another instance, an outlet pipe in a manhole is at a higher elevation than the inlet pipe.

Field Observations: A small portion of Oak Creek upstream of 35th Street was investigated in the spring of 1998. The channel is incised about 15 feet upstream of the railroad right-of-way, along Washington Way. This reach contains the same general type of native deciduous tree canopy that was observed downstream (ash, oak, alder, bigleaf maple, cottonwood). Understory vegetation includes native species (rose, snowberry, red osier dogwood), in addition to areas of dense blackberry thickets and ivy. Much of this woody riparian vegetation has grown up through old manmade fills and revetments of demolition debris. Instream habitat complexity is generally far greater than found downstream of 35th Street. Habitat complexity is provided by apparently stable undercut tree roots and toppled large woody debris, including a few woody debris jams. Unfortunately, extensive dumping has significantly impacted the visual quality of the channel.

The rural area upstream of the main OSU campus appears to possess good water quality and surprisingly clean gravel areas that are potential fish spawning sites. Riparian canopy coverage is also generally good and the depth of entrenchment is usually much less than on the lower reaches of the stream within the urban area. A water diversion dam located just downstream of Harrison Boulevard appears to be an impassable fish barrier.

Modeling Results: Velocities in the channel exceeded the 4 feet-per-second criteria, indicating the potential for streambed or streambank erosion.

Walnut Boulevard Branch

Public Comments: No comments provided for this reach.

OSU Report: OSU operates the Equestrian Center along this tributary branch to Oak Creek. The Center is located north of Harrison Boulevard and 53rd Street. The facility houses 80 horses on 120 acres. Manure is hauled offsite during the winter, but during the summer the stall bedding is spread on the pastures. Llamas graze for the entire season. The overstory vegetation is predominantly willow.

City Staff Reports: No comments provided for this reach.

Field Observations: Field observations were not performed.

Modeling Results: The model predicted no capacity problems in this reach. Near the OSU Equestrian Center, velocities in the channel exceeded the 4 feet-per-second erosion criteria.

Harrison Boulevard to Cardwell Hill Drive

Public Comments: No comments provided for this reach.

OSU Report: The University manages the McDonald State Forest and the Wilson Sheep Farm in this reach. The sheep facility contains approximately 325 sheep on 300 acres where Oak Creek Drive crosses Oak Creek. Manure spreading and sheep access to the creek are concerns during the summer months. Long-term grazing may have led to formation of gullies. In the downstream area of this reach near Harrison Boulevard, the Oak Creek channel is incised and hydrologically disconnected from the floodplain.

City Staff Reports: No comments provided for this reach.

Field Observations: Only the lower section of this reach was observed. Several channels converge in a small wooded area between Harrison Boulevard and Walnut Boulevard. The main channel is slightly entrenched and has a standing pool of water during the summer from the irrigation dam operated by OSU downstream of Harrison Boulevard. (This section is shown on the National Wetland Inventory map). Another channel just to the north crosses under Walnut Boulevard. A small concrete apron creates an approximate 1-foot drop between the culvert and the water in the channel. A dense tangle of trees and shrubs occupies most of the channel and would likely restrict high flows through the channel. This area represents an opportunity for the construction of a regional detention or water quality facility.

Modeling Results: The model showed the culvert under Harrison Boulevard is undersized for the 10-year storm event. This restriction appears to cause flooding between Harrison and Walnut Boulevards where the northern tributary joins the main stem of Oak Creek. However, no buildings or other structures are threatened. The model also shows that the culvert at Walnut Boulevard is barely overtopped during the 10-year storm event (less than 0.1 cfs). Farther upstream, the model shows the channel is undersized below the entrance to Bald Hill Park. Velocities exceeded the 4 feet-per-second erosion criteria.

Cardwell Hill Drive to Headwaters

Public Comments: No comments provided for this reach.

City Staff Reports: No comments provided for this reach.

Field Observations: Field observations were not performed.

Modeling Results: The area defined by this reach and the other headwaters of the watershed were included in the hydrologic model to determine the quantity and distribution of stormwater runoff, but a hydraulic model was not constructed for this particular reach.

11.2.7 Watershed Summary

The headwaters of Oak Creek are located in the McDonald State Forest with over 70 percent of the watershed located within the forest. Downstream of the forest land, the land use changes to a mixture of agricultural and residential. Upon entering the City, the land use expands to include the OSU campus.

Within the City, the creek channel is incised and hydrologically disconnected from the overbank areas. Fish passage barriers exist at several locations as a result of manmade structures. In the lower reaches, the creek lacks habitat diversity, due in part to a lack of large woody debris and other beneficial structures. Canopy cover and the width of the riparian buffer vary considerably. The OSU Report states that water quality may be impacted by some existing agricultural practices, specifically manure spreading practices at the OSU dairy. Other OSU practices cited in the report that should be investigated include encroachment on the creek from development, water withdrawal, dams and barriers, stormwater drainage from the OSU campus, and toxic waste handling and storage practices.

11.3 WATERSHED MANAGEMENT OPTIONS

Recommendations for the Oak Creek watershed are shown in Table 11-3. The short-term options detailed in Table 11-4 include a wide range of activities, many of which will require cooperation with OSU. Many of the OSU Report recommendations focus on improving water quality and instream and riparian habitat. Some of the activities, such as tree plantings and the removal of non-native vegetation, could be performed by community groups as part of a stream stewardship program. Figure 11-4 shows the general locations of the short-term projects.

The long-term options shown in Table 11-5 include several capital improvement projects to enhance the channel and reduce the potential for bank erosion. Other activities include measures to improve fish passage at culverts and to improve instream water quality. Many of the recommendations will require a pre-design effort to determine the actual site, type, and size of facilities required to provide the desired results. Figure 11-5 shows the general locations of the long-term projects.

The computer modeling predicted high velocities throughout Oak Creek. The creek should be investigated to determine the exact locations where high velocities have eroded the stream banks. In these areas, a pre-design effort is required to determine the most appropriate type of streambank or channel improvement required to stabilize the bank to prevent further erosion. At several locations, fish passage issues were noted.

A large percentage of this watershed is owned and/or operated by OSU. The university has recognized that some of its activities may have an adverse impact on the creek. As a result, OSU has developed a plan for assessing six critical issues potentially impacting instream water quality and the condition of instream and riparian habitat (see Section 11.2.2). The City will want to coordinate with the university in this further assessment of Oak Creek. Equally important, the City will want to work with OSU in developing recommendations for this watershed. As identified in the OSU Report, the Oak Creek watershed represents an opportunity for teaching, research, demonstration sites, and public outreach. As with the other watersheds, many of the recommendations will require coordination with other government bodies, since much of it lies outside of the city limits or is regulated by state or federal agencies.

Table 11-3. Oak Creek Options

Reach	Abridged observations	Recommended activity	Priority
Marys River to Highway 20/34	1) Below the highway culvert, the water temperature was too high (70° F) on June 15, 1999.	a. Develop citywide requirements for minimum buffer widths.	Ongoing
		b. Plant trees for shade.	Short-term
		c. Develop conservation easements to protect existing stands of trees and riparian habitat.	Long-term
	2) Large amount of trash, broken concrete, and asphalt has been dumped in lower reaches.	a. Remove trash and debris without further impacting habitat.	Short-term
		b. Provide information to local landowners on acceptable stream stewardship practices.	Ongoing
	3) The channel lacks large woody debris or other beneficial instream roughness structures. Modeled velocities exceeded the 4-fps criteria at several locations.	a. In areas with erosion, anchor large logs in stream to channel high flow to center of stream to help prevent bank under cutting.	Long-term
	4) A fish passage obstacle is located 35 feet downstream of the twin box culverts under Highway 20/34.	a. Work with ODOT on fish passage issues.	Short-term
Highway 20/34 to Western Boulevard	1) How will the drainage and parking lot runoff from the new OSU hotel be addressed?	a. Coordinate with OSU on treatment requirements for stormwater runoff from parking lots.	Short-term
	2) Contamination issues may exist from a business on Morris Avenue.	a. City to inspect business for potential water quality related issues.	Short-term
		b. Develop citywide measures for improving quality of stormwater runoff from commercial facilities.	Ongoing
	3) The channel is incised and hydrologically disconnected from the floodplain.	a. Reconnect creek with floodplain by laying back stream banks allowing for more storage.	Long-term
	4) Flooding was observed during the February 1996 storm along Western Boulevard from Grove Street to 35th Street.	a. Work with local property owners to flood proof structures.	Long-term
	5) The culverts at Highway 20/34 impound water upstream past Morris Avenue.	a. Coordinate with ODOT on low-flow channel through culverts to provide better fish passage and to reduce water impoundment.	Long-term

Table 11-3. Oak Creek Options (continued)

Reach	Abridged observations	Recommended activity	Priority
	6) Dense blackberry thickets can be found on the steep banks.	a. Remove non-native vegetation and replant with native species.	Short-term
	7) Erosion control efforts along the north bank of the 90-degree bend near the Santana Court Apartment complex do not appear to be working. The steep slopes of the incised creek have tree roots that have been exposed and the trees are now prone to toppling.	a. Stabilize stream bank using vegetative techniques, if possible. Provide instream improvements to reduce potential for undercutting of stream banks.	Long-term
	8) A number of private diversion structures for water withdrawal were found.	a. Educate property owners in regards to legal water withdrawals. Coordinate with ODWR to provide enforcement if necessary.	Short-term
	9) Velocities exceeded the 4-fps criteria at several locations.	a. In areas with erosion, anchor large logs in stream to channel high flow to center of stream to help prevent bank under cutting.	Long-term
Western Boulevard to 35th Street	1) The parking lot at Reser Stadium encroaches on the creek corridor. Fill placed along the left bank of Oak Creek for the expansion of the Reser Stadium parking lot is experiencing erosion.	a. Establish a riparian buffer at Reser Stadium with parking lot set back from stream's edge. Stabilize the existing fill with vegetative plantings.	Long-term
	2) Portions of the parking lot at Reser Stadium drain directly into the creek. A large amount of gravel from the parking lot has entered the creek, along with trash, broken concrete, and asphalt.	a. Coordinate with OSU on treatment options for runoff from Reser Stadium parking lots.	Short-term
		b. Remove trash and debris without further impacting habitat.	Short-term
	3) A chemical storage facility is located only a few feet from the upper bank of the creek.	a. Work with OSU to have chemical storage facility removed from the flood plain.	Short-term
	4) The channel is incised and hydrologically disconnected from the floodplain.	a. Reconnect creek with floodplain by laying back stream banks upstream of 30th Street, allowing more storage.	Long-term
	5) The Entomology Laboratory has placed significant amounts of riprap along the channel bank, along with a sheet pile diversion structure for water withdrawals. Past water withdrawals at the Entomology Laboratory have not been permitted.	a. Remove diversion structure and find alternate source for water.	Short-term

Table 11-3. Oak Creek Options (continued)

Reach	Abridged observations	Recommended activity	Priority
	6) High water was reported at the intersection of 35th Street and Jackson Avenue during the February 1996 storm.	a. Work with local property owners to flood proof structures.	Long-term
	7) Rock fill under the 30th Street bridge is encouraging lateral bank erosion.	a. Stabilize streambank at 30th Street and provide for stream meander.	Long-term
	8) A large diameter pipe crossing the channel risks failure during high-flow events.	a. Evaluate existing pipe crossing upstream of 30th Street and determine if it is at risk. Provide upstream trash structure, if required by structural analysis of pipe.	Short-term
	9) The streambanks are overly steep and vertical in some locations. A revetment constructed from demolition debris is failing.	a. Stabilize stream bank using vegetative techniques, if possible. Provide instream improvements to reduce potential for undercutting of stream banks.	Long-term
	10) Stormwater pipes discharging into the creek do not have energy dissipation devices.	a. Provide energy dissipation structure and bank protection at locations of discharge pipes.	Short-term
	11) A large bank failure (75 feet long by 10 feet high) is located 700 feet downstream of the steel dam.	a. Stabilize stream bank downstream of steel dam using vegetative techniques, if possible. Provide instream improvements to reduce potential for undercutting of stream banks.	Long-term
	12) Stormwater piped systems along 30th and 35th Streets are under capacity for the design storm.	a. Replace undercapacity pipes near 30th and 35th Streets.	Short-term
	13) Velocities exceeded the 4-fps criteria at several locations.	a. In areas with erosion, anchor large logs in stream to channel high flow to center of stream to help prevent bank under cutting.	Long-term

Table 11-3. Oak Creek Options (continued)

Reach	Abridged observations	Recommended activity	Priority
35th Street to Harrison Boulevard	1) A number of OSU managed agricultural activities are conducted within this stream reach. Manure spreading may be contributing to water quality degradation.	a. Coordinate with OSU on agricultural management practices for dairy farm.	Short-term
	2) The channel is incised and hydrologically disconnected from the floodplain.	a. Reconnect creek with floodplain by widening stream and allowing for more storage upstream of Campus Way.	Long-term
	3) Blackberry is the dominant understory vegetation.	a. Coordinate with OSU on removal of non-native vegetation and replant with native species.	Short-term
	4) Extensive dumping in this area has significantly impacted the visual quality of the channel.	a. Remove trash and debris without further impacting habitat.	Short-term
	5) A water diversion dam located just downstream of Harrison Boulevard appears to be impassable by fish.	a. Coordinate with OSU on stopping stream withdrawals and finding other source for irrigation water. Remove diversion dam at Harrison Boulevard.	Short-term
	6) Instream water quality appears to be good upstream of the main OSU campus.	a. Work with OSU to develop stream buffers for protecting existing habitat and vegetation.	Long-term
	7) Velocities exceeded the 4-fps criteria at several locations.	a. In areas with erosion, anchor large logs in stream to channel high flow to center of stream to help prevent bank under cutting.	Long-term
	8) Crossing at Campus way is undersized.	a. Designed as a ford. No action required.	No action
	9) Pipe system near 35th Street is undersized.	a. Replace pipes as part of activity #12 in Western Boulevard to 35th Street stream reach.	Short-term
Walnut Boulevard Branch	1) Manure is spread over pasture lands during the summer at the OSU Equestrian Center.	a. Coordinate with OSU to determine acceptable agricultural management practices for Equestrian Center.	Short-term
	2) Velocities exceeded the 4-fps criteria at several locations.	a. Perform stream walk to look for evidence of erosion due to high velocities. In areas with erosion, anchor large logs in stream to channel high flow to center of stream to help prevent bank under cutting.	Long-term

Table 11-3. Oak Creek Options (continued)

Reach	Abridged observations	Recommended activity	Priority
Harrison Boulevard to Cardwell Hill Drive	1) OSU manages the McDonald State Forest.	a. Coordinate with OSU to determine acceptable forest management practices appropriate for headwaters.	Short-term
	2) OSU manages the Wilson Sheep Ranch. Manure is spread over pasture lands during summer months.	a. Coordinate with OSU to determine acceptable agricultural management practices for sheep ranch.	Short-term
	3) The channel is incised and hydrologically disconnected from the floodplain near Harrison Boulevard.	a. Reconnect creek with floodplain by laying back stream banks allowing for more storage.	Long-term
	4) The area near the creek crossing of Walnut represents the potential for a detention or water quality facility.	a. Investigate potential for constructing a multi-objective facility at this location.	Long-term
	5) Velocities exceeded the 4-fps criteria at several locations.	a. Perform stream walk to look for evidence of erosion due to high velocities. In areas with erosion, anchor large logs in stream to channel high flow to center of stream to help prevent bank under cutting.	Long-term
	6) Culvert under Harrison Boulevard is undersized.	a. There are no reports of flooding problems, so replacement is not recommended.	No action
	7) Undersized channel downstream of Oak Creek Drive crossing.	a. There are no reports of flooding problems, so further action is not recommended.	No action
	8) Undersized channel on agricultural land to east of Bald Hill.	a. There are no reports of flooding problems, so further action is not recommended.	No action
	9) Undersized channel at entrance to Bald Hill.	a. There are no reports of flooding problems, so further action is not recommended.	No action

Table 11-4. Oak Creek Short-Term Program

Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
Marys River to Highway 20/34	1) Plant trees for shade.	800	40	Orange line
	2) Remove trash and debris without further impacting habitat.	400	20	
	4) Work with ODOT on fish passage issues.	400	NA	
Highway 20/34 to Western Boulevard	1) Coordinate with OSU on treatment requirements for stormwater runoff from parking lots.	800	NA	
	2) City to inspect business along Morris Avenue for potential water quality related issues.	200	NA	
	6) Remove non-native vegetation and replant with native species.	9,000	450	
	8) Provide information to educate property owners in regards to legal water withdrawals. Coordinate with ODWR to provide enforcement if necessary.	600	NA	
Western Boulevard to 35th Street	2) Coordinate with OSU on treatment options for runoff from Reser Stadium parking lots.	1,200	NA	
	2) Remove trash and debris without further impacting habitat.	4,000	200	
	3) Work with OSU to have chemical storage facility removed from the flood plain.	200	NA	
	5) Remove diversion structure at Entomology Laboratory and find alternate source for water.	1,200	NA	
	8) Evaluate existing pipe crossing upstream of 30th Street and determine if it is at risk. Provide trash structure if necessary.	2,100	NA	
	10) Provide energy dissipation structure and bank protection at locations of discharge pipes at Reser Stadium.	2,500	125	
	12) Replace under-capacity pipes near 30th and 35th Streets, including those that flow into the 35th Street to Harrison Boulevard stream reach.	400,000	NA	Red line
35th Street to Harrison Boulevard	1) Coordinate with OSU on agricultural management practices for dairy farm.	200	NA	
	3) Coordinate with OSU on removal of non-native vegetation and replant with native species.	200	NA	

Table 11-4. Oak Creek Short-term Program (continued)

Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
	4) Remove trash and debris without further impacting habitat.	8,250	NA	
	5) Coordinate with OSU on removing diversion dam at Harrison Boulevard, stopping stream withdrawals, and finding other source for irrigation water.	2,400	NA	
	9) Replace undersized pipes near 35th and 30th Streets. (See #12 in Western Boulevard to 35th Street reach.)	See #12 above	See #12 above	See #12 above
Walnut Boulevard Branch	1) Coordinate with OSU to determine acceptable agricultural management practices for Equestrian Center.	200	NA	
Harrison Boulevard to Cardwell Hill Drive	1) Coordinate with OSU to determine acceptable forest management practices appropriate for headwaters.	400	NA	
	2) Coordinate with OSU to determine acceptable agricultural management practices for sheep ranch.	200	NA	
Total		**435,250**	**835**	

[1]Project types are in the Figure 11-4 map legend.

Table 11-5. Oak Creek Long-Term Program

Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
Marys River to Highway 20/34	1) Develop conservation easements to protect existing stands of trees and riparian habitat.	NA	NA	
	3) Anchor large, woody debris to slow flows, decrease erosion and provide more varied habitat.	8,000	400	
Highway 20/34 to Western Boulevard	3) Reconnect creek with floodplain and allow for more storage.	80,000	4,000	
	4) Work with local property owners to flood proof structures (homes, businesses, etc.) if they were inundated during the February 1996 storm.	225,000	NA	
	5) Coordinate with ODOT on low-flow channel through culverts to provide better fish passage and to reduce water impoundment, if possible.	800	NA	
	7) Stabilize streambank using vegetative techniques, if possible. Provide instream improvements to reduce potential for undercutting of streambanks.	7,000	350	Green line
	9) In areas with erosion, anchor large logs in stream to channel high flow to center of stream to help prevent bank under cutting.	12,000	600	
Western Boulevard to 35th Street	1) Establish a riparian buffer near Reser Stadium with parking lot set back from stream's edge. Stabilize fill with vegetative plantings.	2,400	120	
	4) Reconnect creek with floodplain by allowing for more storage upstream of 30th Street.	100,000	5,000	Yellow line
	6) Work with local property owners to flood proof structures.	150,000	NA	
	7) Stabilize streambank at 30th Street with and provide for stream meander.	14,000	700	Green line
	9) Stabilize streambank using vegetative techniques, if possible. Provide instream improvements to reduce potential for undercutting of streambanks.	7,000	350	Green line
	11) Stabilize streambank downstream of steel dam using vegetative techniques, if possible. Provide instream improvements to reduce potential for undercutting of streambanks.	7,000	350	Green line

Table 11-5. Oak Creek Long-term Program (continued)

Reach	Recommended activity	Capital cost ($)	Annual O&M ($)	Project type[1]
	13) In areas with erosion, anchor large logs in stream to channel high flow to center of stream to help prevent bank under cutting.	16,000	800	
35th Street to Harrison Boulevard	2) Reconnect creek with floodplain allowing for more storage upstream of Campus Way.	4,000	NA	Yellow line
	6) Work with OSU to develop stream buffers for protecting existing habitat and vegetation.	800	NA	
	7) In areas with erosion, anchor large logs in stream to channel high flow to center of stream to help prevent bank under cutting.	24,000	1,200	
Walnut Boulevard Branch	2) Perform stream walk to look for evidence of erosion due to high velocities. In areas with erosion, anchor large logs in stream to channel high flow to center of stream to help prevent bank under cutting.	100	NA	☑
Harrison Boulevard to Cardwell Hill Drive	3) Reconnect creek with floodplain by allowing for more storage.	100,000	5,000	Yellow line
	4) Investigate potential for constructing a multi-objective facility at this location.	40,000	2,000	
	5) Perform stream walk to look for evidence of erosion due to high velocities. In areas with erosion, anchor large logs in stream to channel high flow to center of stream to help prevent bank under cutting.	400	NA	☑
Total		**798,500**	**20,870**	

[1]Project types are in the Figure 11-5 map legend.

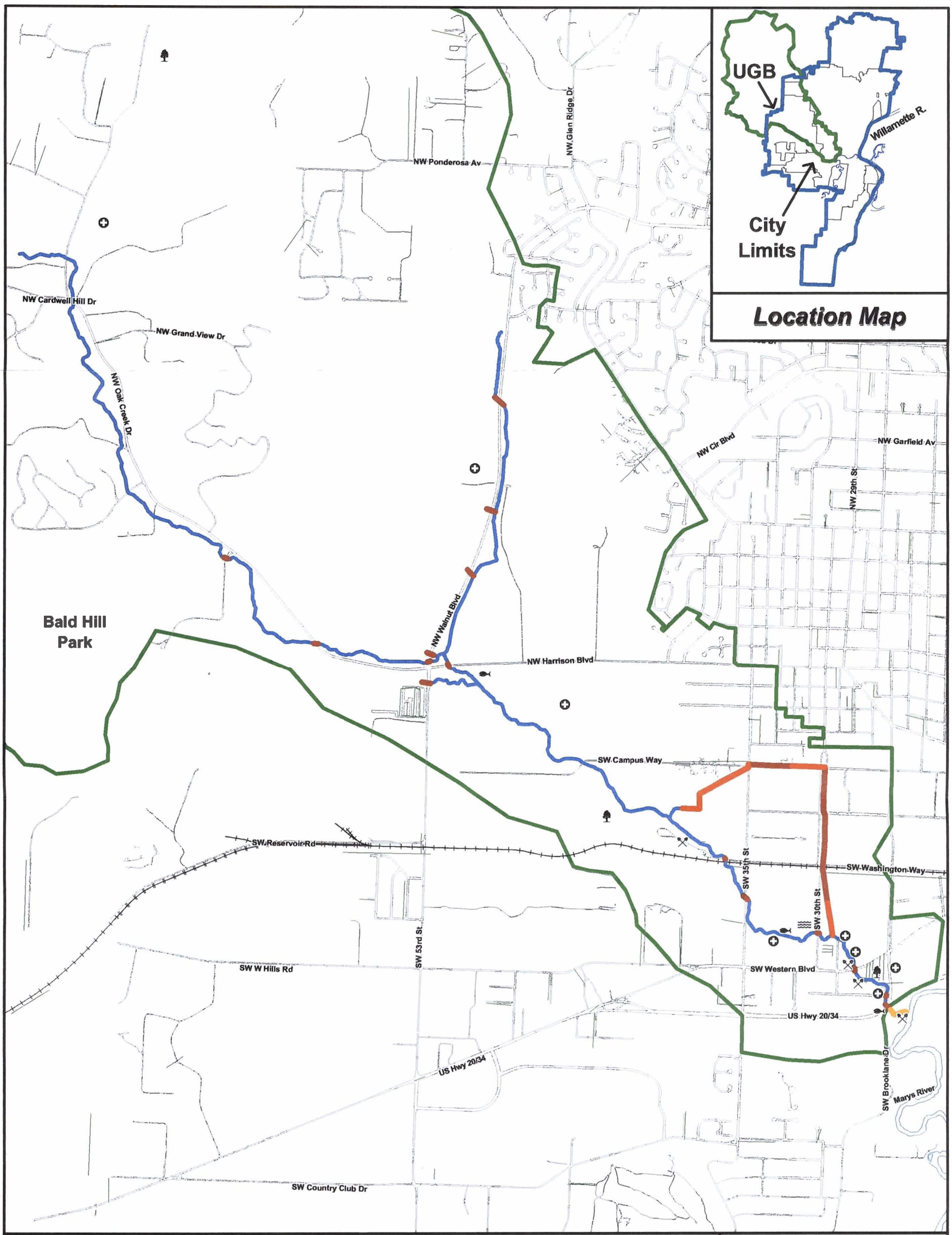


Figure 11-4 Short Term Project Locations

LEGEND

- Pipes/Bridges
- Channels
- Basin Boundary
- Bank Stabilization
- Canopy Revegetation
- Channel Improvement
- Replace Pipe/Bridge
- Fish Passage
- Buffer/Riparian Habitat
- Floodplain Reconnection
- Water Quality BMP
- Flood BMP
- Maintenance
- Monitor
- Multi-Use Facility

N

Feet 600 0 600 1200 1800 2400 Feet

CORVALLIS ENHANCING COMMUNITY LIVABILITY

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report/figures/final/Fig11-4.wor, November 6, 2000, base data from City of Corvallis GIS Department

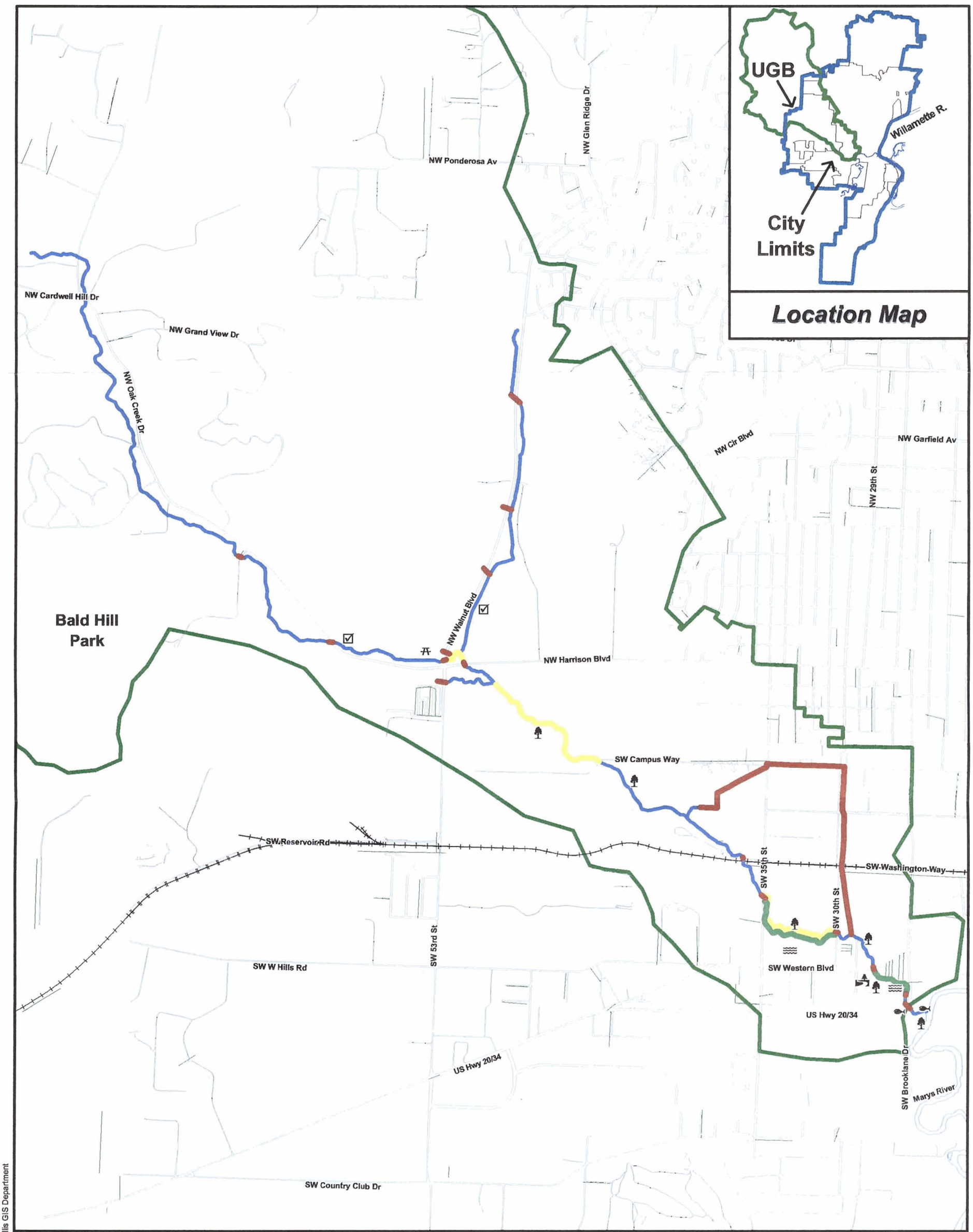

Figure 11-5 Long Term Project Locations

LEGEND

- Pipes/Bridges
- Bank Stabilization
- Replace Pipe/Bridge
- Floodplain Reconnection
- Maintenance
- Channels
- Canopy Revegetation
- Fish Passage
- Water Quality BMP
- Monitor
- Basin Boundary
- Channel Improvement
- Buffer/Riparian Habitat
- Flood BMP
- Multi-Use Facility

N

Feet 600 0 600 1200 1800 2400 Feet

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report/figures/final/Fig11-5.wor, November 6, 2000, base data from City of Corvallis GIS Department