IDEA Design & Engineering

Storm Water Master Plan

For the City of Cave Junction, Oregon

HOME OF THE
OREGON CAVES

JANUARY 2000

Storm Water Master Plan

City of Cave Junction, Oregon

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Prepared By:

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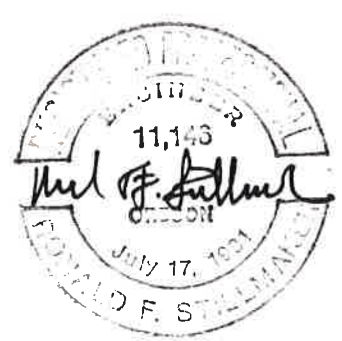

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INTRODUCTION

Project Objective

The City of Cave Junction determined there was the need for a Storm Water Master Plan. A Storm Water Master Plan which analyzes the existing systems collection capacity, outfalls, storage and receiving streams and determines drainage system infrastructure improvements necessary to provide adequate current and future (2020) services to the community.

Background

The City is located in southwestern Oregon along the Illinois River. It has population is approximately 1435. Cave Junction is currently operating under a connection moratorium for water and sewer connections while it updates both its water and wastewater plants. The moratoriums will be lifted when the projects are complete. According to the Public Works Department, there are as many as 800 outstanding service connections awaiting the removal of the moratorium. The current stormwater drainage system is inadequate and cannot handle the current storm water flows. Culverts are undersized and businesses experience flooding annually, economically distressing the business community. The City is concerned about the impacts of new construction on an inadequate system. Increased development without a Storm Water Master Plan will increase the likelihood of flooding of businesses and streets. The City needs a Storm Water Master Plan that will address fixing current problems with drainage and provide guidance to storm sewer locations for future development.

Project Scope

The Scope of Work related to this project contains the following elements:

1. Evaluate the needs of the CITY pursuant to all applicable State, Federal and Local laws, ordinances and codes, especially as related to waterways within the City's Urban Growth Boundary.
2. Identify existing stormwater and drainage system deficiencies for both quality and quantity. Analyze the existing systems collection capacity, outfalls, storage and receiving streams capacity.
3. Identify drainage system infrastructure improvements necessary to provide adequate current and future (2020) services to the community. Areas of special concern

include: drainage at the north end of Hussey Ave. and the east end of Stevenson St; The county drainage ditch that runs through town; the drainage on the south side of Jubilee Park (S. Junction Ave); and George Creek from Old Stage Rd. to the Redwood Highway.

4. Determine O&M practices. Discuss cost effective and potential innovative cost cutting O&M procedures with water quality management practices in mind. Discuss maintenance recommendations and cost effective improvements over the next 20 years to undersized culverts.
5. Develop a prioritized list of recommendations and established costs for improvements to the storm water and drainage system.
6. Develop recommendations for the financing of improvements.
7. Evaluate existing design standards and recommend changes.
8. Prepare a water quality management plan.

EXISTING SYSTEM

Stream/Basin Description

The City currently has six major water ways and associated drainage basins. The primary receiving stream for all of the storm run-off in Cave Junction and surrounding area is the Illinois river. There are three named creeks and two other minor receiving streams which collect the major portion of storm water run-off and deposit it in the river. The major water ways and their basins are depicted on map #1.

Basins 4a and 4b drain directly to the Kirby ditch or the Illinois river. Basin 1 is collected by George Creek, Basin 2 by Brook Creek and Basin 6 is collected by Mill Creek. For purposes of this report, the streams serving basins 3 and 5 shall be identified by the associated basin number.

George Creek (Drainage Basin 1)

George Creek is a drainage way that originates in the hills to the east of Cave Junction and is initially fed from the run-off of a portion of those hills. The Majority of the drainage area for George Creek is undeveloped (approx. 95+ %). The largest area of development which George Creek passes through is the Illinois Valley golf Club. The Creek is primarily made up of natural channel and drops through 120' of elevation between it's interception with Laurel Ave. down stream to it's interception with the Redwoods Highway. The channel slope varies generally between 1 and 3%. The flattest section is located along it's route through the golf course. George Creek Discharges into the Illinois River immediately north of the City.

Brook Creek (Drainage Basin 2)

This stream also originates in the hills east of Cave Junction, though it does not drain as large an area of the hills as George Creek. The portion of the drainage basin located in the urban development areas of the City of Cave Junction (within the City limits and Urban Growth Boundary) and associated with stream 2, has had approximately 30% of it's area developed. The stream channel is all natural and ranges in slope between approximately 1 and 3%. This stream discharges into a man made pond located on the north side of fairway #1 at the golf club. The pond functions as storage of irrigation water which is used on the golf course. The pond can also receive flow from the Kirby ditch and George Creek through various diversion appurtenances. During periods of high flow, the discharge from stream 2 will flow through the pond and into George Creek.

Stream 3 (Drainage Basin 3)

Stream 3 and it's associated basin provide the major portion of drainage for the existing urban area defined by the City of Cave Junction and it's Urban Growth Boundary. The basin is contained entirely within the designated urban area and drains between 50-55% of that area. Approximately 75% of existing land that is developed in the Cave Junction urban area is currently drained to stream 3. Approximately 67% of the basin has developed. The stream bed is made up of several types of materials; natural, man made with vegetative, gravel, and concrete lined surfaces, and underground piping and culverts. The channel slopes an average of 1% throughout it's course. The Stream discharges into the Illinois river West of the City's wastewater treatment facilities.

Stream 5 (Drainage Basin 5)

Stream 5 is also contained entirely within Cave Junction's urban area. It drains the southwest corner of the City. Approximately 80% of the basin area has been developed. It is the shortest stream and smallest drainage basin of the system. The stream bed is made up of several types of materials; natural, man made with vegetative, gravel, and concrete lined surfaces, and underground piping and culverts. The stream discharges into the East Fork of the Illinois River, in the vicinity of the Redwoods Highway.

Mill Creek (Drainage Basin 6)

Mill Creek originates from run-off collected form a small drainage basin located in the hills east of Cave Junction. The Creek passes through the South East corner of Cave Junction's Urban Growth area and discharges into the East Fork of the Illinois River. Approximately 97% of the drainage basin associated with Mill Creek is undeveloped. The Channel is all natural with the exception of a couple of culverts.

Stream Capacities

A streams capacity varies significantly throughout It's coarse. The capacity is defined by the shape, slope and materials which make up any given section. While each stream has more than sufficient capacities throughout their courses to handle existing and future demands, they all have certain locations which have more limited capacities than their upstream or downstream portions. Those limited sections essentially define each streams water handling capabilities. The capacities listed below for each stream, represent my calculations for stream capacity based upon field measurements at the various locations in question.

All of the streams under discussion (with exception of the river) run dry during the early part of the dry season. George Creek was the only flowing stream observed upon a site visit at the end of May.

For determining the capacities related to open channel flow and through culverts, the Manning Formula was used.

George Creek

No identified problem areas

In section East of Redwoods Highway - 219 CFS

In vicinity of golf course (stretch of least slope) - 126 CFS

Brook Creek

In section East of Old Stage Road - 47 CFS

In section East of Redwoods Highway - 81 CFS

Problem Section @ North end of Hussey Ave - 11.2 CFS

Problem Section @ Golf Course - 27.6 CFS

Stream 3

Grass Channel @ Jubilee Park - 257 CFS

Problem Section @ Culverts under Schumacher St. - 88 CFS

Problem Seciton @ Grass Channel North of Lister St. - 99.3 CFS

Stream 5

No Problems Identified (possible future problem upon further development upstream of location listed below)

Culvert under road @ Forest Service Residential - 7.9 CFS

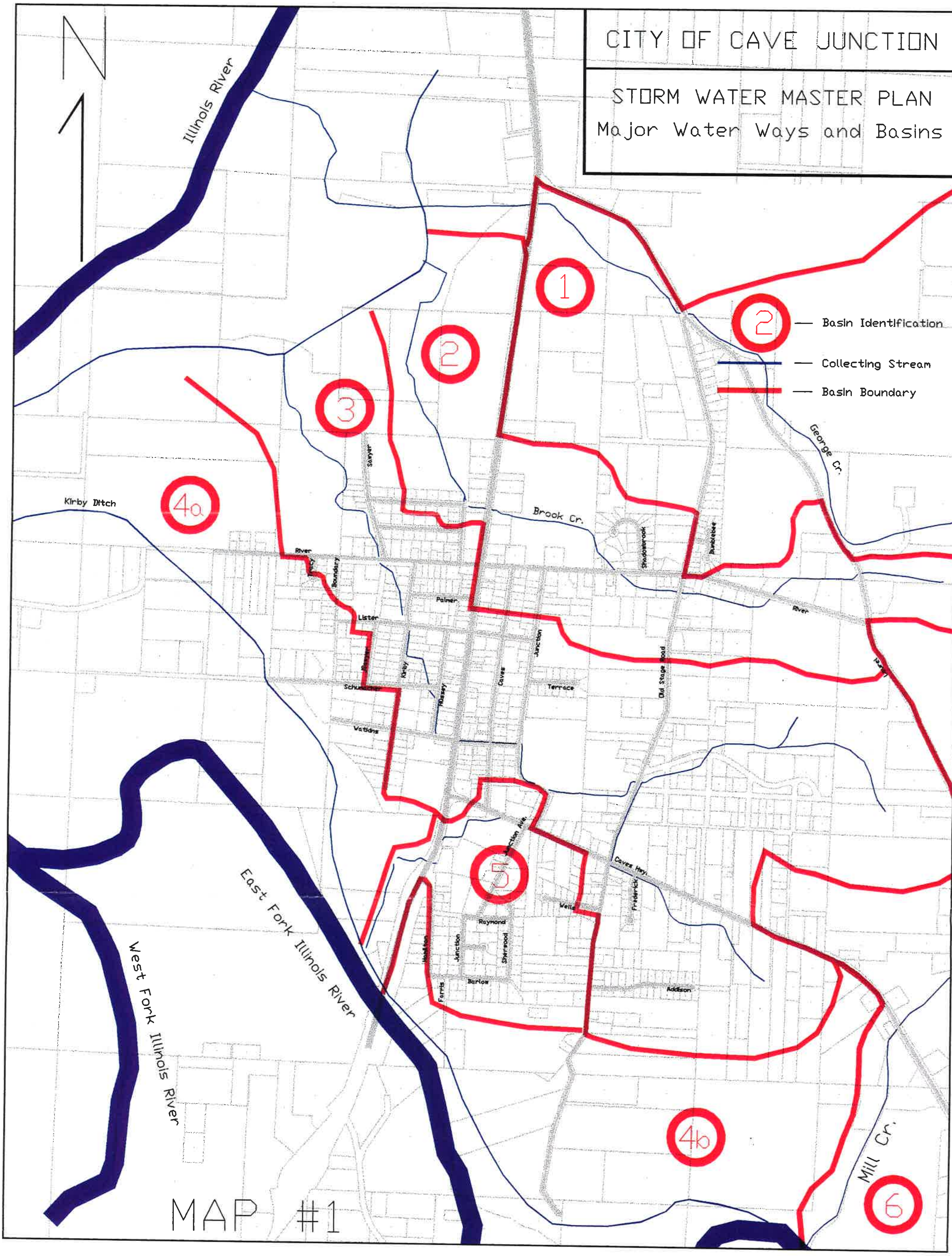
Mill Creek

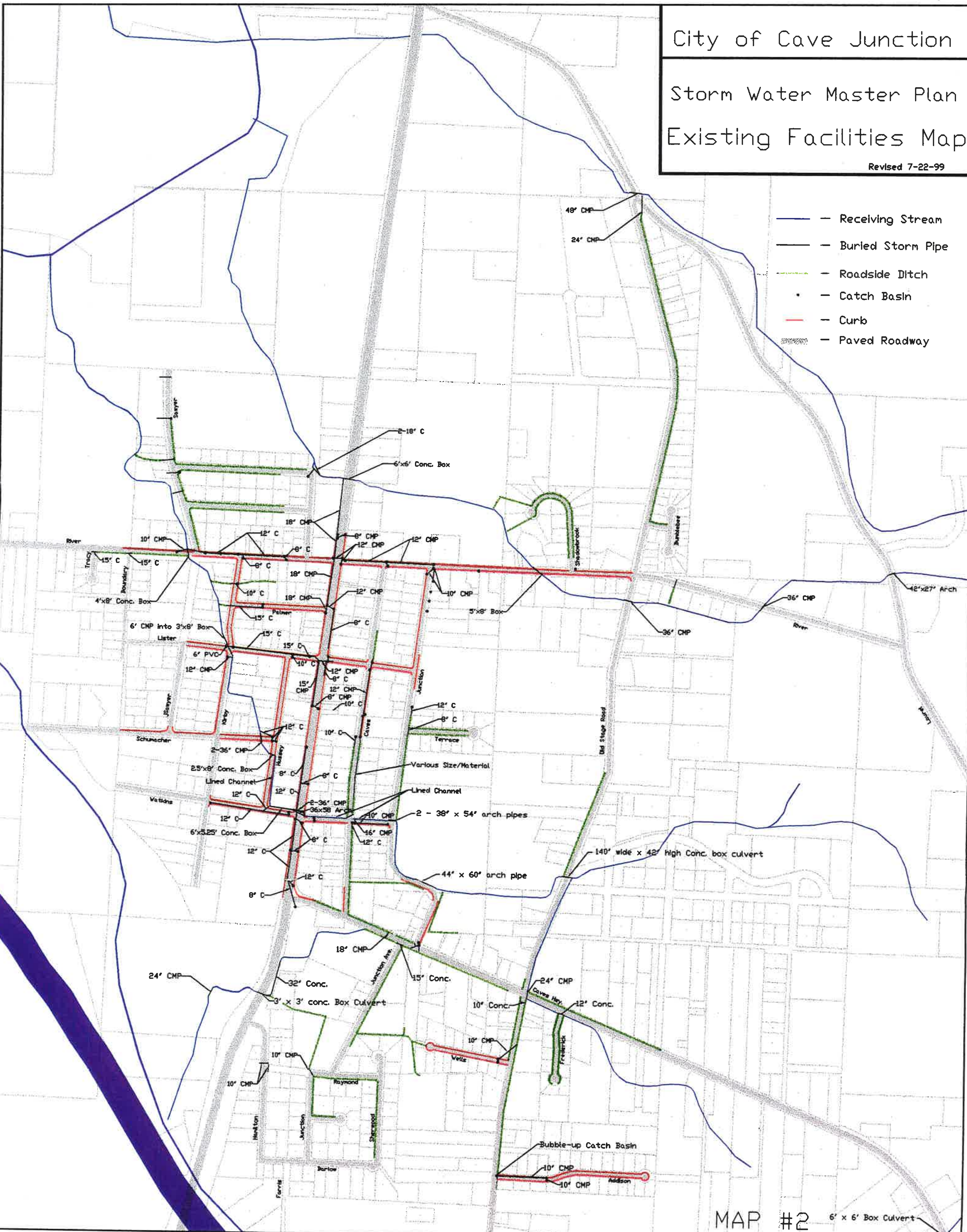
No Problems Identified

South of Cave Highway - 67.4 CFS

Storm Sewers ----	4,332 Linear Feet	
Culverts ----------	14 - 799 Linear Feet	
Channel ----------	Natural	1,712 Linear Feet
	Concrete Lined	1,010 Linear Feet
	Grass	450 Linear Feet

Infrastructure Facilities is presented on map #2.


CITY OF CAVE JUNCTION
STORM WATER MASTER PLAN
Major Water Ways and Basins
Basin Identification
Collecting Stream
Basin Boundary
Illinois River
Kirby Ditch
Brook Cr.
George Cr.
East Fork Illinois River
West Fork Illinois River
Mill Cr.
River
Palmer
Lister
Schumacher
Watkins
Sawyer
Kirby
Junction
Caves
Terrace
Old Stage Road
Junction Ave.
Caves Hwy
Raymond
Barlow
Sherwood
Frederick
Addison
1
2
3
4a
4b
5
6
MAP #1


City of Cave Junction
Storm Water Master Plan
Existing Facilities Map
Revised 7-22-99
— Receiving Stream
— Buried Storm Pipe
— Roadside Ditch
— Catch Basin
— Curb
— Paved Roadway
48" CMP
24" CMP
2-18" C
6'x6' Conc. Box
18" CMP
8" CMP
12" CMP
12" C
10" CMP
15" C
4'x8' Conc. Box
6' CMP into 3'x8' Box
6' PVC
5'x8' Box
36" CMP
42"x27" Arch
Various Size/Material
Lined Channel
2 - 38" x 54" arch pipes
2.5'x8' Conc. Box
6'x3.25' Conc. Box
140' wide x 42' high Conc. box culvert
44" x 60" arch pipe
24" CMP
32" Conc.
3' x 3' conc. Box Culvert
15" Conc.
10" Conc.
12" Conc.
Bubble-up Catch Basin
10" CMP
Old Stage Road
Caves Hwy.
River
Schumacher
Watkins
Terrace
Junction Ave.
Raymond
Barlow
Addison
Wells
Frederick
MAP #2
6' x 6' Box Culvert

METHODOLOGY FOR PROBLEM IDENTIFICATION

General

Upon considering Cave Junctions' storm drainage system, three specific areas were looked at when identifying deficiencies or problems with the program:

1. The needs of the CITY pursuant to all applicable State, Federal and Local laws, ordinances and codes, especially as related to waterways within the City.
2. Problems and concerns associated with the current drainage facilities.
3. Requirements to provide adequate facilities for services in the future (2020).

Data Collected

To identify problems associated with those areas, data was gathered then analyzed. The types of data used for this process consisted of:

⇒ Collection of all current written documentation and mapping available

⇒ Interviews with members of the City staff and local community

⇒ Obtain field data on facilities

Written Documentation and Mapping

The following is a list of all written documentation was collected, reviewed and analyzed for use with this report:

<u>City</u>

Flood Insurance Study

Comprehensive Plan

1998 Draft

1984 Adopted

Zoning Ordinance

Water System Master Plan

Wastewater Facilities Report

& 1994 Addendum

WWTP Improvements - Environmental Assessment

Land Division Ordinance

1998-99 Budget

Design Standards and Improvements Ordinance

Record of Rainfall (1994-95 thru 1998-99 rainyears)

All associated land use maps

<u>Josephine County</u>

Assessor's Maps

Blue-prints of aerial photo's

Contour maps

<u>State Highway</u>

Cave Junction Section, Redwood Highway improvement plans

<u>Federal Government</u>

Proposed Storm Water NPDES, Phase II Regulations

Interviews

Interviews with members of City staff and the community, along with on-site data collection took place on four occasions. Primary contact with the City was Tim Stetz, Public Works Director. Other staff members with which this project was discussed were the City Finance Director and several employees of the Public Works Department.

City staff was consulted on three separate occasions. The first visit involved a review of the storm system with primary emphasis on existing problems and took place prior to proposal submittal. City staff was involved on two additional occasions to more thoroughly tour the storm drainage system, revisit problem areas discuss growth patterns and problems. Interviews were used to identify problems currently experienced with the existing drainage facilities, how the City was expected to grow, and what operation and maintenance practices were in effect. What staff perceived as possible future problems based upon the expected Growth patterns were also a part of the interview process. On all occasions the primary contact person was Tim Stetz.

Field Data

Subsequent to the site visits with staff, three separate field investigations related to the storm system data collection was also performed. Two took place during wet weather conditions for flow observance and field data collection. A third visit took place during dry weather conditions to allow field data to be gathered which could not be acquired during wet weather conditions.

Field data was collected during wet weather flows and when the system was dry, experiencing little or no flows. Typical data gathered consisted of:

Flow measurement
Physical characteristics of drainage facilities
- Location of inlets and out-falls
- Pipe dimensions & materials
- Ditch/Open channel dimensions and material make-up
- Pipe/Ditch slope
- Terrain Features

Data for the physical facilities was analyzed using standard engineering practices. Flow characteristics in open channels, pipes and culverts were evaluated using Manning's Formula.

SYSTEM DEFICIENCIES

Needs Pursuant to State, Federal and Local Laws

Current Requirements

A review of current requirements associated with State, Federal and Local Laws, ordinance and codes, as related to waterways within the City reveals four instances where such issue are addressed:

The Zoning Ordinance (Title 17), Flood Hazard Protection section, requires that, "All subdivision proposals shall have adequate drainage provided to reduce exposure to flood damage,"

The Design Standards and Improvements Ordinance (Title 16), requires all new subdivisions be provided with surface drainage facilities which take into account "the capacity and grade necessary to maintain unrestricted flow from areas draining through the subdivision and to allow extension of the system to serve such areas."

The Draft Comprehensive plan recommends that a master storm drainage map be maintained in the Public Work Department Offices.

The United State Environmental Protection agency requires that construction activities which disturb five or more acres acquire a permit, through the Oregon Department of Environmental Quality, which addresses storm runoff quantity and quality during construction activities.

Future Requirements

The United States Environmental Protection Agency is currently developing final regulations for storm water management in smaller communities - known as the National Pollutant Discharge Elimination system (NPDES) Phase II Rule. This proposed rule is designed to comply with the requirements of the Clean Water Act and to further protect the nation's streams. The Phase II rule is expected to be finalized toward the end of 1999. It is not expected that the Phase II rule will impose any requirements upon the City of Cave Junction. The Phase II rule is intended to impose storm water management requirements which affect communities and agencies that own and operate separate storm water facilities serving a population of less than 100,000 and located in an urbanized area or designated by the permitting authority (DEQ). An urbanized area is defined as an area containing a population of at least 50,000 and will include "urban fringe." (contiguous area with a density of 1,000 persons per square mile).

In a discussion with Raghu Namburi of DEQ's Water Quality Division, he indicated that EPA's Phase II rules would only affect communities with populations in excess of 10,000 or area's which meet the above described density requirement. He did not believe that Cave Junction would be required to apply for a NPDES storm discharge permit and comply with the management plan requirements. Mr. Namburi was concerned because the new rules affect construction activities in excess of one acre and all related permitting and site inspections requirements would be passed down to the local jurisdictions.

City's Needs

The City's needs associated with rules and regulations are those which allow the community to accomplish it's goals and objectives related to storm water collection and discharge. Existing rules and regulations in effect for the City are relatively non-existent when considering how they address storm drainage quantity and quality issues.

Though existing studies and literature related to Cave Junction do not indicate that any storm drainage problems exist. Uncontrolled, future land development shall certainly result in flooding problems and possibly water quality problems.

The City needs to strengthen it's land development ordinance with regard to those issues.

Problems With the Current Drainage System

Based upon data collected through local interviews and field observation, the following problems were identified with the existing facilities:

1

Location:

Culverts @ Hussey & Schumacher

Problem:

At capacity, possible roadway overflow

2

Location:

Drainage ditch West of Sawyer & North of river

Problem:

At capacity, possible overflow into adjacent apartment buildings

3

Location :

Culverts/ditch North of Stevenson & East of Hussey

Problem:

At capacity, possible overflow into adjacent apartment buildings

4

Location:

Residential land area South of Wells Drive

Problem:

Standing water, (flat area - no drainage)

5

Location :

Fairway #1, Illinois Valley Golf Club

Problem:

Ditch overflow into fairway creating standing water

6

Location:

Drainage ditch on east side of Old Stage Rode extending North from Caves Highway to it's interception with the main drainage stream.

Problem:

At capacity, possible overflow into adjacent properties

7

Location :

North East corner of the intersection of Lister and Redwood Highway.

Problem:

Temporary flooding of roads and adjacent building

8

Location :

Ditch and pipe line on east side of Caves St., North of Watkins.

Problem:

The ditch is at capacity and has overflowed into adjacent residential areas. The buried pipe is a conglomerate of pipes installed initially as driveway culverts.

9

Location :

Bumblebee Subdivision

Problem:

This area occasionally experiences flooding in the yards of the residences located in the Southeast portion of the subdivision.

10

Location :

Ditch and culverts on the west side of Hamilton Ave. (Barlow St. to Hwy. 199).

Problem:

Ditching is inadequate and both ditching and culverts are poorly maintained. Ditch also crosses private property

11

Location :

Various locations throughout the City, on streets which have been developed without curb and gutter, i.e. Sevenson and Mille Streets.

Problem:

As private properties were developed along such streets, the roadside drainage was dictated by the property owner/developer. Much of the ditching and driveway culverts are inadequately sized and/or maintained. Many of the properties were developed at elevations lower than that of the adjacent street, resulting in poorly drained properties.

Also: City Staff indicated a concern regarding the safety to the public of having open ditches flowing with swift water during wet weather periods. The primary concern was related to the concrete lined ditches and the difficulty a child (or even an adult) would have in getting out of the ditch if they were to fall into them while flowing full.

Existing problems are identified on Map #3

Facility Requirements for Services to the Year 2000

Growth Areas

Methodology

1. Using aerial photos, along with some field confirmation, currently developed properties within the city and it's urban growth areas were identified.

2. Lands which are not likely to be developed were also identified. Some of the reasons which properties would not be developed consist of the following factors:

   ⇒ Governmentally owned land

   ⇒ Land within flood plains

   ⇒ Agriculturally zoned land (exclusive)

   ⇒ Power Transmission/sub-station sites

   ⇒ Cemeteries

⇒ Properties completely contained within the city limits but have not been annexed, nor are they part of the Urban Growth Areas.

3. Excluding developed land and those identified above, areas were mapped which could be developed within the city limits and those available for development in the Urban Growth Areas.

4. Based upon discussions with City Staff, I identified on the map some areas which have had some indication by the owners of pending development.

See map #4 for identified growth areas

Growth Rates

Both the Wastewater Facilities Report, (1994) and the Water System Master Plan (1995) project population growth for the City of Cave Junction ate 5% per year. The January 1, 1998, Draft Comprehensive Plan, also projects a annual population increase of 5% for a total of 3500, in the year 2017. None of the existing reports and studies project both high and low growth rates. For purposes of this plan, I propose to use the 5% projection as a high growth rate, (considering growth rates throughout the state, a 5% rate is pretty high). For comparative purposes, I will use a 2% for low growth rate figure.

The Current (1999) population of Cave Junction is reported as1425.

- High Growth Rate Requirements

Given the existing population, the projected population at a 5% rate for the year 2020 will be approximately 3780. That figure represents an increase of 2355. In order to accommodate that growth, approximately 184 acres of residential land will need to be developed. That figure is based upon 2.13 persons per household and 6 dwellings per acre, projected in the Draft Comprehensive Plan for the City of Cave Junction.

Within the City there is approximately 90 acres of commercially zoned property. 24 acres of that property has not been developed. The Urban Growth Area contains an additional 43.6 acres. To accommodate the service needs of the City at the high growth rate, I am projecting that all of the undeveloped commercially zoned property (67.6 acres) will be utilized by the year 2020.

- Low Growth Rate Requirements

At a 2% growth rate, it is estimated that Cave Junction will have a population of 2117. That figure represents an increase of 690. In order to accommodate that growth, approximately 54 acres of residential land will need to be developed. That figure is also based upon 2.13 persons per household and 6 dwellings per acre, projected in the Draft Comprehensive Plan for the City of Cave Junction.

Within the City there is approximately 90 acres of commercially zoned property. 24 acres of that property has not been developed. The Urban Growth Area contains an additional 43.6 acres. To accommodate the service needs of the City at the low growth rate, I am projecting that 50% of the commercially zoned property (34 acres) will be utilized by the year 2020.

- Future Development

The majority of land development which shall take place within the City of Cave Junction shall involve residential properties. It is anticipated that growth in Cave Junction shall be associated primarily with the area's further development as a "bed-room" community to the City of Grants Pass (and surrounding areas) and as a place for retirees to locate. Commercial development shall be limited to that needed to provide services to those population groups. Significant industrial development is not expected.

Undeveloped residentially zoned properties that have the potential for improvement, and lie within existing City limits, make up approximately 300 acres of land area. The City has approximately 420 additional acres of developable residential properties located within it's Urban Growth Area. Those figures equate to approximately 30% development at the high growth rate of 5% and 9% development at the low growth rate of 2%.

The City appears to have more than enough residentially zoned and developable properties to accommodate their future needs. It is difficult to predict exactly where future development shall take place within those areas. Discussions with City Staff and looking at the availability of utilities give some direction as to where development could take place. However, all of the developable property within the City and It's Urban Growth Area have the potential to be developed at any given time.

Because of restrictions placed upon land development due to the lack of adequate sewer and water facilities, past development plans within the City have been put on hold. With the recent completion of improvements to water and sewer utilities, planned development in the community can proceed. City staff has had some discussions with property owners and developers regarding impeding development. Therefore, anticipated areas of commercial and residential development have been identified on the accompanying map.

Deficiencies Due to Growth

⇒ Basin 1

Currently, indications are this basin shall be an area of considerable impeding development. City Staff has had communications with potential developers regarding the siting of new residential, commercial (clinic & motel) and church facilities, (see accompanying map).

This basin is primarily undeveloped and is made up of natural drainage through George Creek. Development of 30 to 40 acres for residential and church uses along with 10-20 acres of commercial uses (including clinic) will replace a considerable amount of natural vegetation with impervious area (roof top, pavement).

1

The increase of surface run-off would create deficiencies in the lower reaches of George Creek, primarily in the area of the golf coarse.

⇒ Basin 2

This basin is relatively narrow and has very little identifiable growth areas associated with it. Much of the drainage includes areas of governmental ownership (schools, WWTP), slopes, and those under county jurisdiction. The only areas of concern related to future development are those associated with the existing problems previously identified (problems listed as #3, Appts. @ Hussey & #5, golf course fairway).

⇒ Basin 3

This basin is the most complex of the drainage systems currently contained within the City. This system contains the majority of existing drainage problems, and will develop several more as additional land is improved. City Staff has had some indication of the interest in developing new residential subdivision(s) in the Southeast corner of the City. Other future development in this basin would consist of continued development in and around the subdivision, (approved and under jurisdiction of Josephine County), located on the unimproved roads of Fir, Oak, and Madrona. All new development in this basin will exacerbate the several existing problems previously identified. As development in this basin proceeds, some new problems that would arise consist of the following:

2. The upper reaches of the South fork of the receiving stream consists of rough ditching through the back yards of existing residences. This drainage way will not handle additional flows during peak periods.

3. The ditch located on the South side of Caves Highway and East of Old Stage Road (along with the culvert under Frederick Ct.) will reach it's capacity with full development of available lands in this area.

4. ODOT recently replaced the culvert under Caves Highway and Old Stage Road with a 24" Corrugated Metal Pipe. This pipe is estimated to have a capacity of 17.9 cubic feet per second (cfs). The drainage area it serves has the potential of producing a quantity of 20 - 25 cfs at full build-out.

5. The drainage ditch from Old Stage Road to Jubilee Park is a combination of natural drainage and re-channeled ditching which varies in shape and capacity. There are some constriction points in this section that will reach capacity upon continued development of the upper reaches of this drainage basin.

⇒ Basin 4a & 4b

Both of these basins shed directly into the Illinois river or have some of their run-off captured by the Kirby Ditch. Neither of these basins contain any formal public drainage facilities (the recently abandoned Kirby Ditch is an irrigation utility). Future development in these areas will have to address drainage, however, no deficiencies can be associated with these areas.

⇒ Basin 5

This is a small drainage area which has little potential for further development. What little development can and is occurring will stress a couple of it's drainage points. A small land development has taken place and six residential lots are currently on the market. As development in this basin proceeds, some new problems that would arise consist of the following:

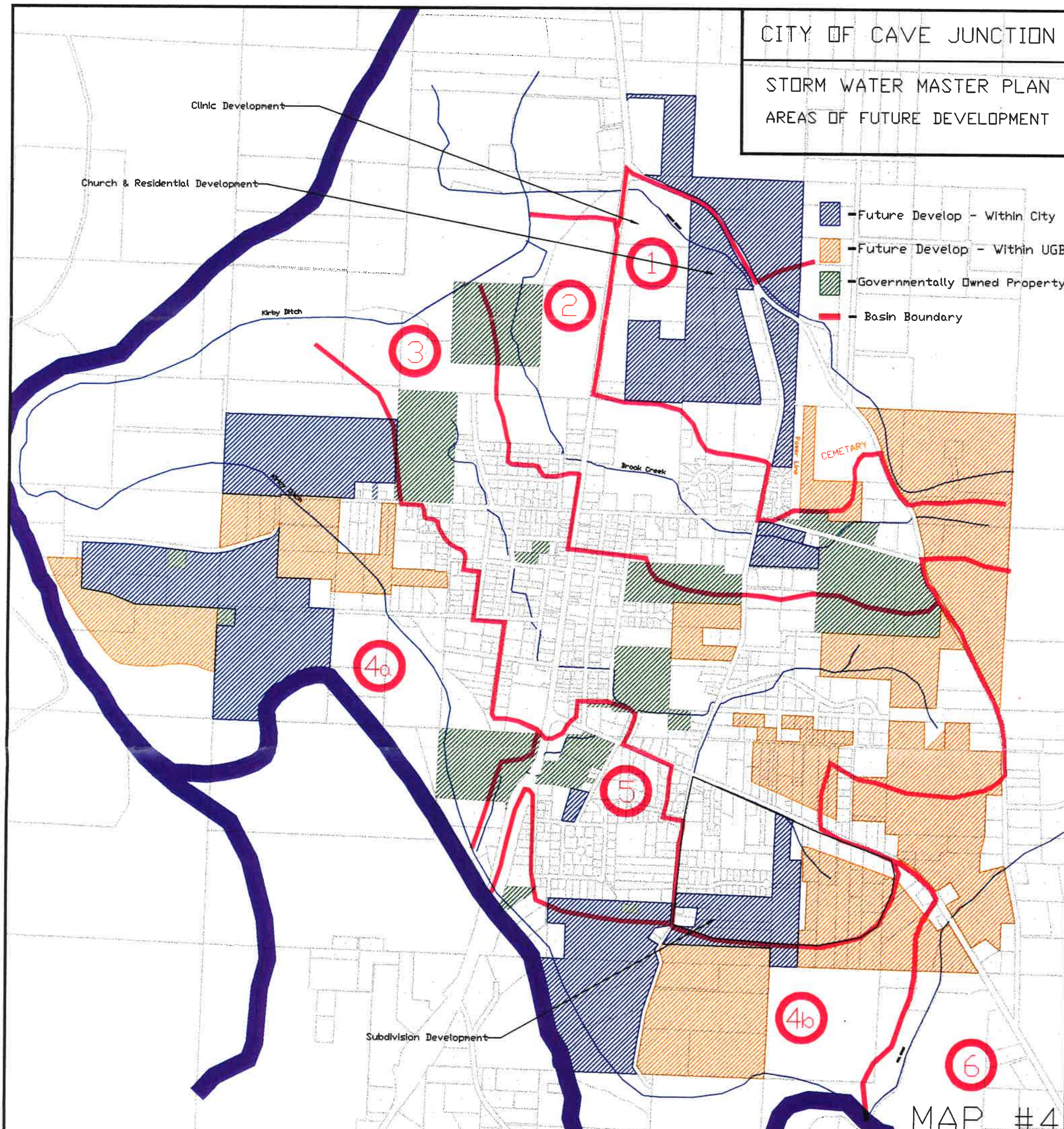
(6) There is a drainage ditch running to the North from the intersection of Junction and Raymond which will be affected by the residential improvements cited above.

(7) A 24" corrugated metal pipe is used for a culvert which crosses under an access driveway to the US Forest Service housing on the south end of the community. That pipe is currently at capacity and further development will create problems at this location.

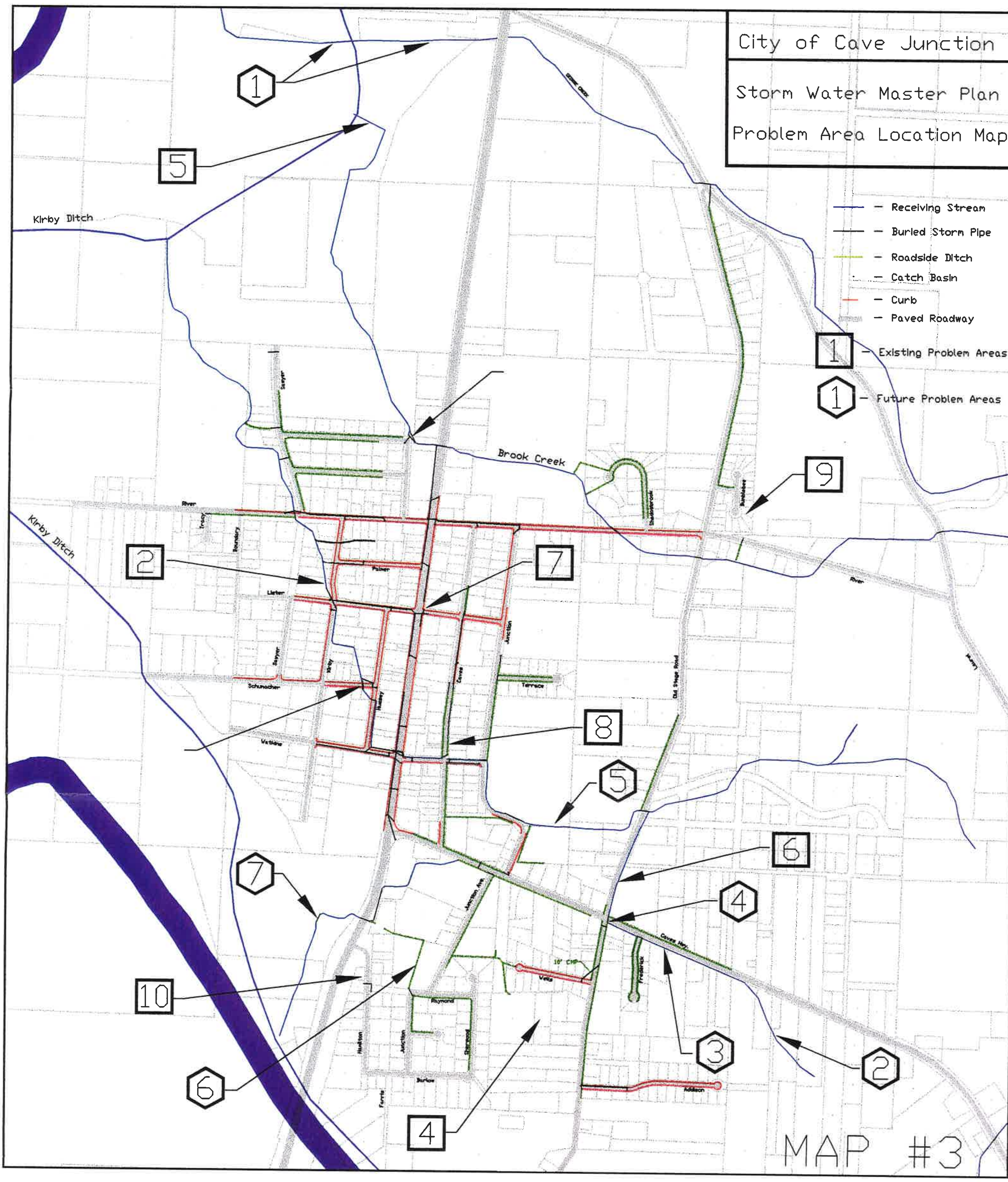
⇒ Basin 6

This is a very small drainage area associated with the City of Cave Junction and it's Urban Growth Area. There are no existing problems identified with this system and it would appear that what little growth potential associated with this area would be adequately handled by the Mill Creek receiving stream.

Deficiencies due to growth are shown on map #3



CITY OF CAVE JUNCTION
STORM WATER MASTER PLAN
AREAS OF FUTURE DEVELOPMENT
Future Develop - Within City
Future Develop - Within UGB
Governmentally Owned Property
Basin Boundary
Clinic Development
Church & Residential Development
Kirby Ditch
Brook Creek
Power Line
CEMETARY
Subdivision Development
1
2
3
4a
4b
5
6
MAP #4


City of Cave Junction
Storm Water Master Plan
Problem Area Location Map
Receiving Stream
Buried Storm Pipe
Roadside Ditch
Catch Basin
Curb
Paved Roadway
Existing Problem Areas
Future Problem Areas
Kirby Ditch
Brook Creek
River
Caves Hwy.
Old Stage Road
Junction Ave.
MAP #3

SYSTEM REQUIREMENTS BASED ON IDENTIFIED DEFICIENCIES

General

Typical practices for addressing storm water issues come in two forms: 1) Structural and 2) Non-structural. Structural practices are required for addressing the existing problems identified with the system. Both structural and non-structural practices need to be used for managing future development.

The storm system in Cave Junction shall require several approaches to address existing and future deficiencies along with directing growth in a planned manner which will not result in additional drainage problems. Approaches that will be required include:

1. Adopting development regulations that shall require large commercial, industrial and residential developments to retain or detain storm water in order to reduce peak flows.

2. Construct capacity increasing projects directed at solve existing problems along with addressing growth.

3. Possibly diverting some storm run-off from originating basin to other basins which can handle the growth impacts with more cost effective improvements than the originating basin.

General Solutions

Apparently, all of the problems identified have not yet created any major flooding situations which have resulted in significant property damage. However, all of the issues have the potential to do so.

Problems 1, 2, 3, & 5 are all related to limited capacity of the existing conveyance system. Possible engineering solutions to these situation include:

Increasing capacity of existing storm water conveyance facility

Reduce quantity of storm water in system through:

Diversion of all or a portion of the storm water by conveying it around the deficiency or in to another system.

Detention during high flow situations for release when storm event has passed

Underground Infiltration systems

Considering two factors; 1) the lack of having sufficient land and/or right-of-way, and 2) the costs associated with quantity reduction techniques, the practical solution to the existing problems is to enact capacity increasing measures. It should be noted, however, that because of the existing design constraints, increasing the capacity of the storm water conveyance methods will only address the current volume of storm water in the system. Increases due to future development in the upper reaches of the associated drainage systems could re-create the problems experienced at this time. How future development will affect the system will be addressed in other tasks associated with this master plan.

Existing Problem Solutions

Problem

1. The Culverts @ Hussey & Schumacher are at capacity, which could result in possible roadway overflow.

Solution

Replace two 36" CMP culverts (capacity - 93 CFS) with a 3' x 8'. pre-cast box culvert (capacity - 208 CFS)

Problem

2. The drainage ditch West of Kirby & North of Lister is at capacity, which could result in a possible overflow into adjacent apartment buildings.

Solution

Build up (dike) the west bank to contain high flows from flooding adjacent yard and structures. The existing foot bridge crossing the ditch at this location is also a constriction to high flows. The span needs to be widened or the bridge removed. (Existing ditch capacity - 100 CFS. New ditch capacity to be approx. 200 CFS.)

Problem

3. The culverts/ditch North of Stevenson & East of Hussey are at capacity, which could result in a possible overflow into adjacent apartment buildings.

Solution

Construct re-aligned ditch which will pass east of the apartments and then back to intercept original drainage way, (with cooperation of ODOT).

Alternate, (w/o cooperation of ODOT), clean and concrete line ditch south of apartments and install three 28 x 20 arch pipes under access drive. This will increase the ditch capacity from 14.4 CFS to 36 CFS and the culverts from 16 to 33 CFS.

Problem

4. The residential development area South of Wells Drive contains standing water, (flat area - no drainage).

Solution

The standing water problem located in the residential area South of Wells Drive exists because the area is relatively flat and residential housing was developed without consideration given to handling the runoff. Re-grading and drainage of the area will be difficult to perform because many of the properties have been developed with housing and associated yards and landscaping. The alternatives to this problem are to; 1) ignore it because no property damage nor health problems are presented by the temporary flooding and ; 2) work with the property owners in coming up with a grading and drainage plan. Drainage considerations would include collection at low points and piping to the nearby roadside ditch located on the Old Stage Rd. or collection at sites and underground infiltration through wet wells or other systems.

Problem

5. In Fairway #1, at the Illinois Valley Golf Club the ditch is overflowing into the fairway creating standing water.

Solution

Widen drainage ditch through Fairway to increase capacity to approximately 40 CFS. Clean out existing (half silted in) 24" CMP culvert under cart path and install another 24" along side (Capacity approx. 50 CFS).

Problem

6. The drainage ditch on east side of Old Stage Road, extending North from Caves Highway to it's interception with the main drainage stream, is at capacity which could result in a possible overflow into adjacent properties.

Solution

This ditch could be widened by approximately 1' and the ditch lined with concrete. The capacity would increase from 20 CFS to better than 60 CFS.

Alternate: Divert some of the run-off from upper reaches of this basin (#3) into adjacent basin (#5)

Problem

7. North East corner of the intersection of Lister and Redwood Highway is experiencing temporary flooding of roads and adjacent building.

Solution

The driveways located on the north side of Lister, east of Redwood Highway will have to be reconstructed to assure integrity of the curb drainage and not allow water to run-off from the street to the back of the property. Surface water from the hillside to the east needs to be collected behind the building located at this corner and piped into the underground storm sewers on the Highway. The 8" storm piping, under Redwood Highway, that serves this area needs to be upgraded to 15". Sections of the 15" piping on Lister, west of the Highway, needs to be replaced with 24".

Problem

8. Ditch and pipe line on east side of Caves St., North of Watkins is at capacity and has overflowed into adjacent residential areas. The buried pipe is a conglomerate of pipes installed initially as driveway culverts.

Solution

The existing pipe and ditches that serve this area need to be replaced with on contiguous 18" buried storm pipe.

Problem

9. Occasional flooding in the yards of the residences located in the Southeast portion of the Bumblebee subdivision.

Solution

The existing ditch which carries the drainage away from the subdivision to the Southwest and the culvert that crosses under River St. are of sufficient capacity. The drainage ditches and culvert need to be maintained on a regular basis in this area.

Problem

10. Ditch and culverts on the west side of Hamilton Ave. (Barlow St. to Hwy. 199) are not carrying the runoff combing off the hillside to the east and some of the existing ditching is located on private property.

Solution

New roadside ditching needs to be installed along this stretch of road. An easement for the portion of ditch which crosses private property ot drain the area into the Highway system must be acquired. If no easement can be acquired the ditch will need to be extended farther to the north to connect into the Highway system.

Problem

11. As private properties were developed along local streets which do not have curb and gutter, the roadside drainage was dictated by the property owner/developer. Much of the ditching and driveway culverts are inadequately sized and/or maintained. Many of the properties were developed at elevations lower than that of the adjacent street, resulting in poorly drained properties.

Solution

Because this problem has developed throughout many years and varies significantly from location to location, there is no one realistically affordable solution for the City to pursue. Dependent upon the resources available, a systematic program of driveway culvert replacement (standardized) and roadside shoulder and ditch renovation should be developed and implemented. Until funding for such a program is available, working with individual property owners on solving urgent problems and concentration of available maintenance efforts in such areas is recommended. Development standards, as previously recommended by this report, will help the City to avoid expanding this problem into new areas.

Problem (additional noted problem)

Reduce or eliminate Public safety hazard presented by open channels.

Solution

Boarder channels with fencing (i.e. 3 ½' chain link)

<u>Growth Problem Solutions</u>

The major basin of concern related to ability to handle runoff increases related to future urban development is basin 3. Because the lower stream sections of this basin have already been developed, there are some constraints on increasing capacity of the existing system.

Basins 1, 2, & 6 are relatively undeveloped, drainage requirements associate with quantity issues will have to be addressed upon planning the future development of those areas.

Basin 5 will have some future capacity problems in the downstream section of that basin with the culvert crossing the road entering the Forest Service Housing area.

Problem

1. The increase of surface run-off would create deficiencies in the lower reaches of George Creek, primarily in the area of the golf coarse.

Solution

This problem should be handled through growth management techniques using structural and non-structural solutions, (See attached).

Problem

2. The upper reaches of the South fork of the receiving stream in Basin 3 consists of rough ditching through the back yards of existing residences. This drainage way will not handle additional flows during peak periods.

Solution

Re-grading of area to allow for location of new ditch into easements located along property boundaries (to maximize yard use by residents) and bringing ditch out to Caves Highway roadside ditch. along an existing driveway.

Problem

3. The ditch located on the South side of Caves Highway and East of Old Stage Road (along with the culvert under Frederick Ct.) will reach it's capacity with full development of available lands in this area.

Solution

Clean and widen ditch to approximately 2' x 2' with a capacity of approximately 20 CFS. Replace existing culvert under Frederick Ct. with 24" plastic pipe.

Problem

4. ODOT recently replaced the culvert under Caves Highway and Old Stage Road with a 24" Corrugated Metal Pipe. This pipe is estimated to have a capacity of 17.9 cubic feet per second (cfs). The drainage area it serves has the potential of producing a quantity of 20 - 25 cfs at full build-out.

Solution

Replace culvert with 36" diameter CMP or 31 x 40 CMP arch pipe.

Alternate: Divert flow at this point across Old Stage Road into different drainage basin (#5).

Problem

5. The drainage ditch from Old Stage Road to Jubilee Park is a combination of natural drainage and re-channeled ditching which varies in shape and capacity. There are some constriction points in this section that will reach capacity upon continued development of the upper reaches of this drainage basin.

Solution

Clean, re-shape ditch into uniform section with a capacity of approximately 200 CFS (3' wide x 3' deep).

Problem

6. There is a drainage ditch running to the North from the intersection of Junction and Raymond which will be affected by the residential improvements cited above.

Solution

Acquire easements for ditch, shape uniformly and maintain

Problem

7. A 24" corrugated metal pipe is used for a culvert which crosses under an access driveway to the US Forest Service housing on the south end of the community. That pipe is currently at capacity and further development will create problems at this location.

Solution

Replace culvert with 36" diameter CMP or 31 x 40 CMP arch pipe.

An Alternative

Upon reviewing the newly identified problems along with associating them with the existing system components and drainage basins, City Staff pointed out an idea for helping provide a solution or some relief to several existing problems. The idea presented involves the diversion of the drainage associated with the South East portion of Basin #3, into Basin #5. This could be accomplished through diversion of the existing drainage ditch, located at the south East intersection of Old Stage Road and Caves Highway, into the drainage ditch, associate with Basin #5, located on the South side of Caves Highway, just West of Old Stage Road. This would reduce the run-off into basin #3 approximately 15 - 20%. Such a reduction would help alleviate existing problems identified with Basin #3, (problems #1, #2, #6 & #7). The proposed diversion would require increasing the capacity of some of the sections of the drainage associated with Basin #5.

PRIORITIZED PROJECT LIST

General

Project prioritization is always a difficult issue. Prioritization is often determined by a political process rather than technical merits. Many programs try to remove any bias by developing a weighted average process based on various criteria. The scoring and weighting are always subjective. Typical criteria include:

- Health and safety
- Preservation of Property
- Environmental impact
- Cost effective ratio
- Political or geographic dispersion
- Short and long-term benefit
- Public awareness
- Previous commitments and promises
- Chance of success of the proposed solution

Several of the proposed solutions to the identified projects are outside of the City of Cave Junctions jurisdiction, ownership or control. The responsible party(s) related to each project have been identified in the priority list

Attached as Appendix B is a work sheet which was used to formulate the prioritized projects list, based upon the above criteria. While the rating decisions have some subjective aspects to them, they give a guideline for giving some thought to each project and help steer the prioritization.

<u>Priority List</u> (all projects)

Projects to Solve Existing Problems

Priority No.	Prob. No.	Description	Responsible Party
1	3	Relocate or Increase Capacity of Pipe/Ditch N. end of Hussey	P
2	2	Increase Capacity of Ditch North of Lister	P
3	1	Replace 2 - 36" Under Shumacher with 3' x 8' Box Culvert	C
4	7	Intersection of Lister/Redwood Hwy.	C, S
5	8	Ditch/Pipe Replacement East Side of Caves	C
6	4	Drain Developed area South of Wells Dr.	P
7	6	Clean/widen Ditch East of Stage Rd.	JC
7	10	Renovate Ditch/Culverts - West side of Hamilton Ave.	C
8	5	Improve Drainage @ Golf Course - Fairway #1	P
9	9	Maintain Drainage ways for Bumblebee Subdiv.	C
10	11	Renovate Ditch/Culverts - Curb-less Streets in City	C

Projects to Solve Future Problems

Priority No.	Prob. No.	Description	Responsible Party
1	6	Capacity Increase 24" Under Forest Service Property Driveway	O *
2	2	Re-align/Capacity Increase Ditch - Upper Stream #3	P
3	3	Ditch Widen, South Caves Hwy.	S
4	5	Clean/Widen Ditch East of Jubilee Park	C
5	4	Replace 24" Under Caves Hwy. (Stream #3)	S
6	1	Capacity Increase George Cr.	P, C

Combined Projects

Install Fencing Along Lined, Open Channels (Watkins, Hussey)
Divert Run-off From Upper, South Basin #3 to Basin #5

Responsible Party Key

C - City of Cave Junction
JC - Josephine County
S - State of Oregon (ODOT)
P - Private Property Owner
O - Other

* - US Forest Service

Priority List (City Projects)

Projects to Solve Existing Problems

Priority No.	Prob. No.	Description	Responsible Party
1	1	Replace 2 - 36" Under Shumacher with 3' x 8' Box Culvert	C
2	7	Intersection of Lister/Redwood Hwy.	C, S
3	8	Ditch/Pipe Replacement East Side of Caves	C
4	10	Renovate Ditch/Culverts - West side of Hamilton Ave.	C
5	9	Maintain Drainage ways for Bumblebee Subdiv.	C
6	11	Renovate Ditch/Culverts - Curb-less Streets in City	C

Projects to Solve Future Problems

Priority No.	Prob. No.	Description	Responsible Party
1	5	Clean/Widen Ditch East of Jubilee Park	C
2	1	Capacity Increase George Cr.	P, C

OTHER CITY ACTIONS NEEDED

The City needs to adopt ordinances and regulations which will control the impacts of future development on the storm system

FOR PROJECT COSTS, SEE APPENDIX C

WATER QUALITY MANAGEMENT

General

The quality of storm runoff is important to the community of Cave Junction because it's drainage streams are primarily open drainage ways which are accessible to the public and animals. Also they are conveyed to the Illinois river which is a source of drinking water, recreation and wildlife habitat.

Though no current water quality issues have been identified, typical pollutants associated with different types of runoff are listed below:

Urban

Oils and heavy Metals

Industrial Chemicals

Bacteria

Grease

Salt/sand

Pesticides

Herbicides

Nutrients

Suburban

Excessive nutrients

Pesticides

Cleaning agents

Grease

Household chemical

Yard waste

Trash

Salt/Sand

Agricultural

Excess nutrients

Pesticides

Soil/sediment

Bacteria

Construction Site

Soil/silt

Trash

Toxins

Bacterial

Note:

During wet weather and high flow situations, turbidity levels are high. However, the receiving stream (Illinois River) also has extremely high turbidity levels along with high flows. The quantity of flow received by the Illinois river from the drainage streams associated with Cave Junction is negligible during high flow situations. Therefore, turbidity of the collection streams of Cave Junction have an insignificant effect upon their receiving stream.

Primary Issues

No specific water quality problems have been identified for the City of Cave Junction. Therefore, the primary issue related to water quality, when dealing with storm water run-off, is to maintain or improve upon the existing levels of quality in relation to pollutant loading. Increases in loading will occur from:

⇒ Illicit discharges

⇒ Heavy rainfall

⇒ Poorly maintained system

⇒ Heavy use of fertilizer, pesticides or other chemicals in the water shed

⇒ High level of developmental urbanization

⇒ Cross connection from sanitary sewer system

NOTE: A description of specific pollutant types is attached as Appendix D.

Goals

In order for any program to succeed, a specific goal or set of goals are necessary to define what the community is wishing to achieve through a Water Quality Management Plan. Considering the City of Cave Junction, the goals associated with this plan are:

⇒ Abundant Clean Drinking Water.

⇒ Maintaining healthy streams for fishing, swimming, recreation and tourism.

⇒ Preservation of property and public safety.

Best Management Practices

Strategically, the best way to control and treat urban stormwater runoff is through a program that is known in the industry as, Best Management Practices (BMPs). BMPs for storm water management are schedules of activities, prohibitions of practices, maintenance procedures, the use of pollution control devices and other management practices used to prevent or reduce the mount of pollution introduced to receiving bodies of storm water runoff. BMPs are usually made up of structural and non structural elements.

Non-structural BMPs include: ordinances and zoning requirements (such as erosion and sediment control ordinances); maintenance activities (such as storm drain cleaning and street sweeping); and education/outreach activities.

Structural BMPs include structures like: Detention ponds; grassed swales, sand filters and filter strips; infiltration basins; and porous pavement, etc.

NOTE: Due to the types of soils (poorly drained clays) found in the Cave Junction Area, infiltration techniques are not practical.

Structural BMPs may also include using the existing drainage systems for storage (in-line or in-sewer storage) or creating off-line storage facilities. Off-line storage methods such as retention and detention ponds are designed to produce a flow balance. Flow balance is intended to store overflow until such time as the existing system can handle the volume of overflow. The ponds also function as settling basins for certain amounts of suspended solids removal from storm water.

End-of-Pipe treatment is a last resort technique for controlling stormwater pollution and is not proposed at this time for the City of Cave Junction. This can be expensive if not used in conjunction with the other methods mentioned above. There are times when this cannot be avoided and the costs may therefore be high. The problem with End-of-Pipe treatment is that most of these systems are based on continuous flow. Stormwater is intermittent in nature and can pose a problem for traditional treatment methods, e.g., maintaining biomass in a biological treatment system, or proper amount of chemical addition to variable flows. Some methods will function better than others and it is up to the designer to determine the best treatment system.

The regulation and public education aspects of BMPs will be the most effective tools for controlling urban stormwater runoff in Cave Junction because they tend to be preventative in nature.

Regulations

Developing and enforcing appropriate regulations will minimize the future costs of implementing and maintaining storm water facilities for newly developed areas within the City. Such regulations usually address the two primary areas of concern when dealing with storm water, 1) flooding and 2) water quality. Current City regulations are general in nature and do not adequately steer the community towards the above listed goals.

Current Regulations

The Zoning Ordinance (Title 17), Flood Hazard Protection section, requires that, "All subdivision proposals shall have adequate drainage provided to reduce exposure to flood damage,"

The Design Standards and Improvements Ordinance (Title 16), requires all new subdivisions be provided with surface drainage facilities which take into account "the capacity and grade necessary to maintain unrestricted flow from areas draining through the subdivision and to allow extension of the system to serve such areas."

Proposed Additions

It is proposed that the Design Standards and Improvements Ordinance be amended to include provisions addressing stormwater management related to the following areas:

- New residential subdivisions and non-residential development.

  Regulations shall define new developments and treat them as a closed system within which drainage systems must be designed using the best available technology to:

  1. Contain runoff and surface water pollution increases within in the site in order to minimize off-site impacts, and;
  2. manage runoff so that downstream flooding shall not occur due to increases in impervious area.

  NOTE: The regulations must also require maintenance of both public and private systems.

- Construction site storm water runoff control

  Regulations need to be developed which will implement and enforce a program to reduce nonpoint source pollution from construction sites of more than one acre. Such program shall be used to control erosion and sediment to the maximum extent practicable.

- Illicit discharge detection and elimination

  Regulations to establish the authority to prevent illicit connections.

Public Education and Involvement

The city should establish a minimal public education and involvement program which will enable it to meet the following objectives:

1. Improve water quality by modifying community awareness and behavior, and;

2. Obtain the necessary community support for the program.

The initial step for the City would be to establish a special committee, panel or task force to help formulate a public education/involvement program. Their task would be to:

- Define the target audience(s):
- Understand the importance of stakeholder involvement:
- Select a stakeholder involvement approach
- Develop effective outreach and education programs; and
- Evaluate your efforts

Some sample information strategies are contained in Appendix E.

MAINTENANCE PROCEEDURES

To prevent and reduce pollutant runoff form Cave Junction's' municipal system, an ongoing operations and maintenance program is required. It is recommended that the attached Operations and Maintenance Manual for the City of Cave Junction be implemented.

OPERATION AND MAINTENANCE

Introduction

Maintenance practices which remove sediment trash, and debris from roadways and storm sewers can help prevent flooding and related damage and erosion. But these practices can also help protect stormwater and stream quality. Sediment removal is particularly important. This is because metals, pesticides, and other pollutants are often physically or chemically bound to the dirt and organic leaf materials that wash from city streets and other paved surfaces.

A maintenance program which removes this material before it's discharged into storm sewers and drainage courses helps improve water quality. Sediments reaching streams and rivers can cover fish spawning gravel's, create cloudy water conditions, and lead to silt build-up. Pollutants carried in these sediments including oil and grease, hydrocarbons and metals from auto use can degrade water quality and build up in stream bottom materials.

Floatable wastes e.g., trash and debris carried to streams through the storm sewers collect at points where the stream narrows, blocking water flow and creating an eyesore and public nuisance. Large amounts of vegetative [organic} material reaching the streams will deplete oxygen levels as it breaks down, and these low oxygen levels will not support fish and aquatic life.

Other maintenance operations also can affect stormwater quality. These include inspection and servicing of fleet vehicles and equipment and the manner in which the maintenance facilities and yards are operated. When waste materials and chemicals leak or spill at these locations, they may be carried from the site in stormwater runoff to the storm sewers or nearby creeks. Simple housekeeping practices can reduce the risk of adding these pollutants to the environment.

Every program should emphasize operations and maintenance (O&M). Policies and operating criteria should be designed to assure facilities function during a storm event at their capacity and are maintained in a manner to maximize their useful life. The main elements of a O&M program consist of:

- Description/Inventory of existing facilities
- O & M activities to take place
- Frequency of activities

Existing Facilities

Existing storm drainage facilities within the City of Cave Junction consist of buried storm sewers, roadside ditches, culverts, stream channels, and roadway curb and gutter. The drainage ways which are contained within the City are not made up of facilities which are exclusively the responsibility of the City of Cave Junction. All of the drainage ways are made up of a conglomerate of privately owned properties along with ones installed, operated and maintained by the City and other jurisdictions such as, Josephine County and the Oregon Department of Transportation. Maintaining a drainage way in it's optimum condition is extremely difficult given the condition of multiple ownership. It is not financially practical for any one jurisdiction to accept responsibility for maintaining the drainage ways within the city. However, it is to the Communities advantage if the City help monitor and coordinate maintenance efforts of all the drainage ways within it's boundaries.

The following is a brief inventory of existing facilities within the City and under City jurisdiction. Attached are maps which depict the locations of all of the facilities.

Inventory of Facilities

Catch Basins —— 72 (23 of which are in Hwy. 199 & installed by ODOT)

Curb & Gutter —— 21,960 Linear Feet (4.29 miles, City installed only)

Roadside Ditches – 13,866 Linear Feet (2.63 miles, City maintained only)

Storm Sewers —— 4,332 Linear Feet

Culverts ———— 14 - 799 Linear Feet

Channel ————	Natural	1,712 Linear Feet
	Concrete Lined	1,010 Linear Feet
	Grass	450 Linear Feet

OPERATION AND MAINTENANCE TASKS

The following is a list of O&M tasks

- Inspect catch basins
- Clean/repair catch basins
- Inspect inlets and sumps
- Repair inlets and sumps
- Inspect manholes
- Repair manholes

- Replace manholes
- Inspect pipe
- Clean pipe
- Inspect culverts
- Inspect roadside ditches
- Roadside ditches (remove vegetation)
- Roadside ditches (reshape channels)
- Inspect open channels
- Open channels (remove vegetation)
- Open channels (reshape channels)
- Inspect detention basins (public)
- Clean detention basins (vegetation)
- Clean detention basins (sediment)
- Clean curb and gutter (street sweeping)

INSPECTION

Why inspect? Regular maintenance of the storm sewers is important for flood control, structural integrity, and water quality reasons. This manual suggests how often to clean, based on what literature has indicated other communities have found. But, ultimately The City should determine the best schedule to meet its needs. The way to do this is through a routine inspection program.

In addition to helping determine how often to clean, regular inspection of the storm sewer system will identify problems. Small problems such as clogged inlets and illegal dumping can be addressed in short order before they cause serious damage or harm. Greater problems such as large amounts of silt build-up or stream bank erosion should be studied further to identify the source of the problem and plan the best solution. Other problems that routine inspections might uncover are collapsed pipe and leaking joints. Both of these situations can saturate soils and cause sinkholes and flooding. Failing pipes can also allow dirt and sediment to enter stormwater, which carries the material out to streams and rivers.

How often to inspect? A good rule of thumb is to conduct inspection of storm drain inlets, ditches, channels, ponds and other treatment facilities at least once a year, prior to the beginning of the rainy season (August-September). Complete inspections early enough so that repairs can be made during dry weather. Catch basins should be inspected at least once every six months. Some stormwater treatment devices, such as oil/water separators, may require more frequent inspection. For these, check the manufacturer's specification or other design guidance handbooks. Sewer pipes and culverts should be inspected every three to five years, or in response to a reported problem. Most agencies inspect their sewer pipes six inches or larger with a TV camera, and pipes 36 inches or larger with a walk-through inspection. All other parts of the system are inspected visually.

What to look for during an inspection? Look for excessive silt build-up, erosion, unusual algal growth, cracked or collapsed pipes, misaligned joints, and other signs of problems such as a sheen on the water surface, discolored water, or an unpleasant odor. Check with product manufacturers or stormwater handbooks for advice on what to look for when inspecting more sophisticated treatment devices such as flow splitters and diverters. When a problem is noted, take steps to correct the problem, or route this information immediately to the appropriate individualist in your organization who can respond. If needed, develop a good response plan to ensure quick follow-up in the future.

CATCH BASINS

Catchbasin/inlet cleaning and repair has traditionally been performed to respond to localized flooding problems in streets. Catchbasins are inlets at the curb with a small trap (usually six inches to one foot deep) below the sewer pipe. These devices help to clean stormwater because particles in street runoff settle into the trap before the water enters the storm sewers. Catchbasins require regular cleaning of the sediment trap to be effective (see below). Since the late 1960's, however, most agencies have stopped using catchbasins and are installing "self-cleaning" storm drain inlets instead. The inlets do not trap sediments and don't need cleaning unless they are plugged. Cleaning for either catchbasins or inlets can be done by hand (e.g., with a clamshell or shovel) or with a vacuum truck.

Inspect and clean catchbasins every six months. Unlike inlets, catchbasins need to be cleaned even if they are not plugged, in order to receive the water quality benefits. Studies have shown that when 50 percent of the trap is filled, efficiency drops a lot. Therefore, to protect water quality, inspect catchbasins every six months and clean them out before they are half-full. Larger cities in Oregon have found that catchbasins in high traffic areas and in areas near construction sites may require more frequent cleaning. Many will also need cleaning each fall when the trees drop their leaves.

Inspect and clean storm drain inlets once a year. A good rule of thumb is to inspect inlets at least once a year before the rainy season, and clean them as needed based on the observations. However, inlets in problem areas may need cleaning several times a year to respond to complaints. In these cases, its usually worthwhile to track down the source of the problem and eliminate it, so that the cleaning schedule becomes more reasonable.

Dispose of sediments and debris properly. The sediment removed from a catchbasin may contain high levels of pollutants. It must be tested to determine if the waste is hazardous. Hazardous wastes must be disposed of in a licensed hazardous waste landfill. Collected leaves may be landfilled, or if possible, composted. Additional regulations for disposal of wastes cleaned out of stormwater facilities may be published by federal and state regulatory agencies in the future.

STORM SEWER PIPE/CULVERTS

A culvert is a relatively short section of pipe usually designed to convey flow under or away from a roadway. Because of its semi-open nature, it is prone to blockages from vegetation, trash, and other debris in addition to sediment. Localized flooding indicates the existence of problems. Inspection is usually a simple visual observation. Cleaning procedures also tend to be relatively easy, due to access from the open end, although it often requires some hand work. Most maintenance crews have an assigned territory and know which culverts are likely to cause flooding problems. In Western Oregon, routine inspections are typically conducted after large storms and in the fall, prior to the rainy season. At that time, culverts showing signs of structural failure are targeted for repair or replacement. Pipes are longer than culverts and more likely to be deeper underground and located in areas such as backyards where access is difficult. Inspection and cleaning of pipes generally requires confined space entry training and procedures. That's the bad news. The good news is that pipes are less likely than culverts to become clogged. Tree roots, sediment buildup, collapse and poor alignment are all causes of blockage problems. In a survey conducted in Seattle in the 1970's, over half of sewer maintenance involved root growths, and about one third of pipes clogged due to sand deposits. Structural failure was reported as rare, unless the pipes were installed incorrectly. Problems with tree roots occur mostly in smaller, older pipes at shallow depths d(12 inches or less, 1950's or earlier, and less than 10 feet in depth). Willows, poplars, cottonwoods, and other moisture loving trees tend to be the most common culprits.

Culvert and pipe cleaning is usually done in response to flooding complaints. The main sources of maintenance problems in culverts and pipes are sediment accumulation, entry of roots and infiltration and inflow. Commonly used cleaning methods to remove sediments from storm sewer pipes (roughly in order of increasing costs) are:

- **Jet cleaning/Vactor cleaning.** Jet cleaning flushes the sewer with water and collects the material flushed from the sewer in a basket as it gravity flows down the pipe. A vector assembly is often combined with the jet to vacuum out the flushed water and debris.

- **Sewer balls are** placed in the upstream end of the sewer and forced through the pipe by a jet of water. There are many variations in terms of the sewer balls; some are ridged, for instance, causing them to spin and more thoroughly clean the pipe. This technique can be risky in terms of damage to pipes and is generally more common in Europe than the U.S.

- **Rodding** involves pushing cleaning tools through the sewer to clear blockages.

- **Bucket machines** drag buckets along a line from manhole to manhole to clear sewers.

There are four main ways to control root infiltration in sewer pipes:

⇒ Construct infiltration-free systems.

⇒ Seal joints or defects in existing pipes to prevent entrance of roots.

⇒ Cut and physically remove root formations in the pipes.

⇒ Kill roots with chemical applications.

Inspect sewer pipes and culverts at least every five years. Schedule TV or walk-through inspections in order to identify and eliminate water quality and other structural problems.

Use long-lasting cleaning measures. For root removal, build-out and block-out are more permanent and have the least water quality impacts. These methods can last for 20 years or more. Removal of roots with power rodders with an attached cutting tool (clean-out), on the other hand, is effective for only three to twelve months. According to a study done by Sullivan in 1977, chemical applications tend to be effective for three to five years, if the pipes are temporarily blocked during application to increase residence time. However, there's always the risk that using chemicals will add pollution to stormwater.

Use rodding instead or chemicals for removing roots. Rodding is effective at removing roots, and to a lesser degree, sediment buildup.

Prevent chemical pollution. If chemicals must be used to kill roots, block pipes downstream of the application to prevent chemicals from traveling downstream. This also increases chemical effectiveness by increasing contact time with the roots. Foam chemicals are also more effective than liquid to increase the contact time and better fill the pipe. When the job is completed, vacuum the chemical residue and dispose of properly. Note that this residue may be regulated as a hazardous waste.

Target maintenance to sewers most in need. Perform maintenance only on those pipes which really need it. Sediment buildup depends on several factors, including sewer size and gradient. For most storm sewers that are sized and placed correctly, silt will begin to build up immediately after cleaning and reach an equilibrium within a few weeks or months. These pipes can go for years without requiring sediment removal. If sewer slopes are too gradual, however, the sewers are at risk of clogging. An optimization model developed for the City of Portland in 1995 showed these minimum slopes necessary to avoid clogging:

- 2.1 % for 8-12 inch pipes
- 0.9 % for 13-24 inch pipes
- 0.3 % for 25-47 inch pipes

Install downstream debris traps before cleaning sewers. Use baskets or other materials to trap silt and debris and a vacuum hose to collect it, instead of flushing the materials downstream.

DITCHES AND CHANNELS

Removal of silt, debris, and overgrown vegetation helps to maintain the flood control capacity of drainage ditches. Sediment and debris removal may also improve water quality downstream by removing the pollutants contained in those deposits However, leaving some vegetation in place helps to prevent erosion, trap sediment, and filter stormwater. Maintenance frequency for ditches will vary and should be based on problems identified during inspection.

Inspect and clean ditches and channels once a year. Generally, sediments need to be removed annually and mowing is necessary several times during the growing season. Small amounts of sediment or debris may be removed by hand. Larger deposits may require heavy machinery, such as a backhoe or specialized ditch cleaning equipment.

Do not over clean. Leave some vegetation along the banks of channels to help stabilize the soil and prevent erosion.

Alternate cleaning. When cleaning ditches, use machines to clear select sections and leave untouched sections in between to allow for filtering of stormwater and settling of sediments. The sections not cleaned on the first pass may be cleaned once the vegetation has reestablished itself in the previously cleaned sections.

Dispose of sediments properly. The sediment removed from a ditch may contain high levels of pollutants; if so, it should be disposed of properly.

Natural stream channel maintenance. Like ditches, removal of silt, debris, trash, and overgrown vegetation helps to maintain the flood control capacity of stream channels. Sediment and debris removal may also improve water quality down-stream by removing the pollutants contained in those deposits. However, leaving some vegetation in place can help prevent erosion, trap sediment, and filter stormwater. Care should be taken not to disturb wildlife or aquatic life in the stream, including any riparian vegetation which is needed for the wildlife to survive. Agencies usually clean stream channels in response to complaints or a field stales observation of a problem. Much of the maintenance work in natural streams is done by hand. When necessary, large sediment deposits may need to be removed by heavy machinery. Unlike maintenance of man-made land regularly cleaned} ditches, most of the maintenance of natural stream channels in Oregon requires permits from the Division of State Lands 1-503-378-3805, and coordination with Oregon Department of Fish and Wildlife (ODFW), Habitat Conservation Division 1-503-872-5255. This is particularly important for salmon-bearing streams. The permits specify a window of time for doing the work, as well as restrictions on how much disturbance is allowed.

Keep records of problem areas. Keep records of problems and complaints, and schedule more frequent cleaning of these areas accordingly.

Control pollution sources to streams. The emphasis in natural streams should be prevention of water quality problems by eliminating sources of pollutants. Use proper erosion control measures for construction activities occurring near streams. Maintain buffer strips of vegetation between the stream and roadways or other paved areas. For buffer areas, native grasses, shrubs, and trees are more effective than manicured lawns in filtering pollutants as well as providing shade.

Stabilize erosion areas. Stabilize eroded banks and stream channels to prevent sediments from washing downstream. Consider "bioengineered" methods that use jute netting, staked live willows, and other natural means to keep the bank secure while vegetation is establishing. Use structural measures such as riprap and log walls sparingly, since these usually do not provide wildlife habitat or shade.

Revegetate with native species. Revegetate exposed and eroding stream banks with native vegetation as much as possible, and establish trees to shade the streams and lower water temperature. Nuisance plant species, including non-native Himalayan blackberries and English ivy should generally be replaced with native species, which provide more environmental benefits. Get local volunteer citizens groups involved in planting activities, as a low-cost alternative to agency staff.

Dispose of sediments properly. The sediment removed from a stream bed, especially in urban areas, may contain high levels of pollutants and should be disposed of properly.

DETENTION PONDS

Detention ponds provide temporary storage for stormwater, which allows sediments and pollutants to settle out of the water to the bottom of the pond. Most ponds in the past were designed to hold back flood waters and release it slowly to streams, but these days, agencies are installing ponds for water quality benefits as well. The effectiveness of a pond is based on its ability to hold a certain amount of water, or design volume, for at least 24 hours. This allows enough time for particles to settle out. In order to maintain the pond's design capacity, silt must be removed from time to time. This is usually done using draglines or bucket dredges (when the pond contains water), or bulldozer/backhoe (when the pond is drained of water). However, unless construction activities or other highly erosive activities take place upstream, it may be twenty years or so before sediment removal is required. More frequently, maintenance is needed to remove trash and debris, mow, and remove blockages from the pond's outlet structure.

Inspect detention ponds annually. Inspect ponds once a year, preferably, after large storms. Check for flooding, trash, excessive silt build-up, undue algal growth and other signs of pollution such as oil sheens, discolored water or unpleasant odors. Schedule cleaning if needed.

Monitor drain times. For the best water quality benefit, the pond should hold water for at least 24 hours. It should drain within 72 hours to avoid conditions which might increase water temperatures, deplete oxygen, and/or cause odors.

Maintain and protect vegetative buffer around ponds. As with natural channels, a buffer zone of vegetation should be left around the pond perimeter. Within the buffer strip the grass should be kept at a longer height and shrubs and trees encouraged for shade. Also take care to protect native vegetation and wetland plants in and around ponds.

Dispose of sediments properly. The sediment removed from a detention pond, especially in urban areas, may contain high levels of pollutants and should be disposed of properly.

STREET CLEANING

Traditionally, street cleaning has been performed to meet these goals:

- Remove street dirt, debris and other hazards for health, safety and appearance.
- Protect air quality through road dust removal.
- Remove street debris and sediments which tend to block flow and cause flooding.
- Protect public investment in transportation facilities from damage.

In recent years, many agencies have added another objective: to protect water quality by removing excess debris and pollutant carrying sediments before they reach streams. Ideally, it's best to keep these materials out of the storm sewers in the first place. Street cleaning generally involves one or more of the following activities: mechanical sweeping, vacuum/air sweeping, flushing, and leaf removal.

Mechanical and vacuum/air sweeping Should occur on regularly scheduled routes, typically very often (e.g., daily or weekly) in downtown business districts and only periodically along major arterial (e.g., weekly or monthly) and residential neighborhoods (e.g., monthly or quarterly). Frequencies vary depending on the expected average daily traffic, air quality regulations (dust control), or budget available. Typically signs are posted to inform residents of sweeping operations in congested areas. This reduces parking obstructions and increases effectiveness. Most agencies issue parking citations for those not obeying signs. To minimize non-productive travel or "standby time" of sweepers, many agencies have sweepers transfer loads to drop boxes placed along the route. The boxes are moved daily. Currently, there are 4 types of sweepers on the market:

- mechanical or "broom" (rotating brush/broom with water spray)
- regenerative air (dry blower and vacuum system)
- vacuum-assisted Broom and vacuum combination (usually wet)
- EV-series (combines a brush/broom with a high powered vacuum - dry)

Flushing is done in two stages: (1) advance flushing to reduce dust and increase effectiveness of street sweeping operations that follow, and (2) back flushing to move residual material away from traffic lanes.

Leaf removal prevents flooding and traffic hazards through localized seasonal leaf pick up. Generally, flushers and sweepers work together (i.e., flushing follows sweeping) to reduce dust and pickup leaf debris. Roll-off trucks and drop boxes are placed along the route to temporarily store materials and reduce the unproductive travel time of sweepers.

Use a more effective street sweeper. In general, street sweeping with mechanical sweepers has a poor reputation as a best management practice for protecting water quality. Mechanical sweepers are good at picking up litter and debris, but cannot pick up the fine sediments that generally contain the pollutants of concern for stormwater quality. Most sweeper experts agree that mechanical-broom sweeper efficiency can be improved by broom height/angle adjustment, but only marginally.

Vacuum sweepers have been shown to be more effective than mechanical sweepers at removing fine particles from street surfaces. However, keep in mind that vacuum sweepers are most effective on dry pavement and may not work well much of the year in very wet areas such as Northwest Oregon.

Eliminate street flushing activities, or temporarily protect storm drain inlets during flushing. Flushing street surfaces can add petroleum hydrocarbons or metals pollutants to the storm sewer systems. Cover inlets with plates or mats, or consider several filter inserts that are on the market, to filter out fine sediments, dust, gravel, and oil and grease. Use booms and vacuum or allow area to dry before uncovering storm drain inlets.

Recycle street sweeping debris. A study is under way by ODOT and Multnomah County to consider recycling options for street cleaning debris. Consider recycling debris in your community as a way to protect the environment and save money on landfill disposal costs.

Recycle leaf material as compost for use in city parks and facilities. Look for opportunities to sell the compost to local suppliers.

Use covered storage containers. Use only covered roll-off trucks and drop boxes to temporarily store street cleaning debris and leaf material. This will prevent rainfall and street runoff from carrying the debris to the storm sewers.

Deal quickly with illegal dumps. Establish an agency procedure for quickly dealing with illegally dumped materials discovered by street cleaning crews. Consider posting "do not dump" signs in areas where dumping tends to occur the most.

Create a record keeping system that allows crews to track curb miles swept, amount of debris collected, and problems requiring follow-up. Set up a routing procedure for the forms to make sure incidents are followed up promptly.

VEGETATION MANAGEMENT

Vegetation along roadside areas, while attractive, can be a maintenance nuisance. Traffic safety considerations preclude frequent mowing and pruning, so most agencies use self-sustaining native vegetation as much as possible. Management measures include irrigation, pesticide/herbicide application and vegetation removal by hand.

Use native vegetation. Where possible, use native plants and trees which can require less water, chemical, and fertilizer use. This will help to keep pollutants out of the storm sewers.

Contain plant and grass clippings and recycle as compost for use elsewhere.

Use only covered roll-off trucks and drop boxes to temporarily store vegetative waste. This will prevent rainfall and street runoff from leaching nutrients out of the stockpiled materials to the storm sewers.

Limit irrigation water by installing low-flow automatic sprinkler systems. This will help reduce the volume of water discharged to the storm sewers.

Don t kill all the vegetation. If chemicals are being applied to roadside areas to keep vegetative growth down, use them sparingly and make sure that some vegetation is maintained to stabilize slopes. Vegetation is one of the most cost-effective erosion controls available.

Follow application guidelines on all chemical products. Do not apply chemicals near sensitive waterways or small streams.

OTHER STORMWATER TREATMENT DEVICES

Many other types of stormwater treatment devices exist and more are being invented all the time. Most fall into one of three categories:

- Settling devices that remove pollutants by settling, such as oil/water separators, sedimentation basins, vortex separators, and sedimentation manholes;
- Filtration devices that remove pollutants by filtration, including grassy swales, vegetated filter strips, compost filters, sand filters, and infiltration sumps;
- Facilities which remove pollutants by a combination of settling and filtration, such as wetlands.

Generally speaking, the settling devices are better at removing large loads of sediment and require less maintenance. Devices which use filtration measures tend to be overwhelmed by large loads of sediment and require more maintenance, but they are better at removing finer particles and associated pollutants which are suspended in water. Because each type of treatment device treats stormwater differently, many agencies encourage them to be installed in series e.g., a sedimentation basin followed by a wetland;.

Inspect monthly. Inspection frequencies for treatment devices will vary according to the amount of rain, presence of leaves and nearby construction activities. A good rule of thumb is monthly just before and during the wet season.

Monitor sediment build-up. Check stormwater setting devices and filters regularly for sediment build-up, and remove when about half of catchment area of filter capacity is reached.

Check for clogged filter. The most common cause of failure for filtration devices is clogging. If water is not draining through the filter it may need cleaning or replacement.

Dispose of sediments properly. The sediment removed from sedimentation and filtration facilities may have elevated levels of pollutants (particularly in industrial areas) and should be disposed of properly

SYSTEM RETROFITTING

In the past, flood control efforts have focused primarily on decreasing the volume or peak rate of water that abruptly enters waterways as a result of new development and an associated increase in paved surfaces. Traditional methods to reduce flooding include dry detention basins to temporarily detain and store water, channelization of drainage courses and stream bank hardening to increase carrying capacity of the receiving stream, and flood plain restrictions that limit development in flood-prone stream side areas. These types of flood control measures were not designed to control stormwater pollution caused by increased urbanization. The historical focus was on quantity control, not quality control. Today, urban planners and designers recognize the importance of designing systems with both flood control and pollutant removal in mind. This works for new facilities, but existing facilities may require modifying, or retrofitting. Projects might include enlarging structures, changing the inflow and outflow patterns, and increasing detention times. Retrofits can be done as stand-alone projects, or as a part of repair and replacement projects scheduled for the future. Usually retrofits are done on older parts of the storm sewers in areas that are already built out. With the premium on space, the following suggested measures are typically more feasible than large land-intensive facilities:

- Replace simple drain inlets with trapped catch basins.
- Install compost filters in manholes.
- Replace lawns with sustainable, low-maintenance native vegetation for greater pollutant filtering.

Include water quality considerations in retrofits. If a storm sewer facility needs replacement because of poor condition, consider replacing it with one that also improve water quality. An example is replacing inlets with trapped catch basins.

Match retrofits to land use. Opportunities for retrofits of the storm sewer system often exist in older, more industrialized areas where pipes tend to be older. For retrofits, choose facilities that provide the best stormwater treatment benefits for the type of pollutants expected from the land use e.g., industrial, commercial or residential).

TASK FREQUENCY

MAINTENANCE ACTIVITY	*ANNUAL FREQUENCY*
Inspect catch basins	2x
Clean/repair catch basins	2x
Inspect inlets and sumps	lx
Repair inlets and sumps	2x
Inspect manholes	lx
Repair manholes	5% of total
Replace manholes	1% of total
Inspect pipe (< 24")	20% of total (once every 5 yrs)
Clean pipe (< 24")	20% of total
Inspect pipe (> 24")	25% of total (once every 4 yrs)
Clean pipe (> 24")	25% of total
Inspect culverts (< 18")	lx
Clean culverts (< 18")	50% of total (once every 2 yrs)
Inspect culverts (> 18")	lx
Clean culverts (> 18")	50% of total
Inspect roadside ditches	lx
Roadside ditches (remove vegetation)	1 - 3x
Roadside ditches (reshape channels)	25% of total
Inspect open channels	lx
Open channels (remove vegetation)	1 - 3x
Open channels (reshape channels)	33% (once every 3 yrs)
Inspect detention basins (public)	lx
Clean detention basins (vegetation)	2x
Clean detention basins (sediment)	20% of total
Inspect detention basins (private)	lx
Clean detention basins (vegetation)	2x
Clean detention basins (sediment)	20% of total
Inspect retention basins	lx
Clean curb and gutter (street sweeping)	4x

FINANCING ALTERNATIVES

A wide array of funding sources and financing approaches may be used to support the City of Cave Junction's storm water management program. Some of the approaches are described below.

Debt Financing - Typically used for capital-intensive projects, local governments can issue debt to finance storm water management programs and facilities. Revenue bonds or bonds that rely on an ongoing source of revenue (such as assessments or utility fees) may be used. Alternatively, you could choose to issue general obligation bonds, which are backed by the full faith and credit of your municipality (based on your ability to generate revenues through taxes and other fees).

Federal, State or Regional Grant and Loans - Grant or loan funds may be available for some elements of your storm water program, depending on the BMPs that you select and your location. Grants and loans are usually applicable to specific projects and not on-going activities, such as operations and maintenance.

Utility Service Charges - These charges are rates billed to customers for providing storm water management services. The service charges may be flat rates, or variable rates based on classes of customers. Utility service charges may represent a dedicated source of funding (i.e., collected fees are dedicated to the storm water management program via an Enterprise Fund or similar accounting structure) and an ongoing method of funding some or all storm water management program elements.

Special Assessments - Properties can be assessed annually to fund a storm water management program. Often, special assessments are used to fund a special district or authority that can implement all or portions of a region's storm water management program.

Local Improvement Districts - Under this type of funding system, individual properties benefited by storm water projects are assessed to fund the project.

General Fund - General Fund monies are used for many storm water programs. If storm water programs are funded from your General Fund, the programs are at risk in each budget cycle. In addition, in order to increase funding levels for your program, other local government services may be affected or a general tax increase may be required.

Plan Review Inspection Fees - Communities may recover some or all of the direct costs associated with performing design reviews for pre and post construction BMPs by implementing plan review and inspection fees.

Fee-in-Lien of On Site Construction - Instead of constructing on-site facilities to meet development requirements, developers may be given the option of paying a comparable fee to be used by the local government to build regional facilities that are designed to meet the same objectives as the developer-constructed on-site mitigation.

Developer participation - Developers construct needed facilities as a condition of development, and bear associated costs.

System Development Fees/Connection Charges. - One time charges assessed at the time of development to recover a proportionate share of the cost of existing facilities and planned future facilities. Applicability depends upon legislation in your state.

Combination Approaches - In many jurisdictions, a combination of funding sources is used for storm water management programs.

Storm Water Utilities

Many communities develop storm water utilities to create a dedicated and reliable funding mechanism for their storm water management program.

The basic philosophy behind the utility fee is that "users" should pay for storm water programs to the extent that they contribute to the problem. The term "users," in this case, includes property owners, particularly, property owners that have impervious surfaces on their property.

Most storm water utilities charge either a monthly or annual fee based upon the amount of impervious area on the property. A base rate is set for each household based on the average amount of impervious surface (known as equivalent residential units (ERUs)). A fee is then developed in association with this ERU. For example, the average amount of impervious surface per household may be 2,500 square feet, for which a resident pays $5.00 per month.

In most communities that use this method, each household is charged for one ERU. However, some communities charge households based on actual measurements of impervious surface.

Typically, the impervious surfaces of businesses and institutions are measured, and these customers are charged according to the number of ERUs calculated from their property measurements.

Some storm water utilities only charge if there is impervious surface on the property. Others charge all landowners, however if there is no development on the property the rate is typically lower than that charged for a single ERU.

The community may wish to add a water quality component to their utility fee rate formula. This quality factor would allow communities to have user pay for not only the quantity of storm water that they contribute, but also the quality.

Because a utility charges a user fee, not a tax, schools and churches typically are not exempted from paying the fee. Some storm water utilities receive additional funding from developers' fees and permit application fees.

Some advantages of forming a storm water utility include:

- A steady funding mechanism is dedicated to storm water management;
- Fees can be based on the amount of impervious surface on the property, which is a more equitable means of charging property owners than a flat fee;
- Financial incentives can be used to encourage businesses and institutions to implement storm water BMPs;
- Utilities tend to run more efficiently (more like a business); and
- Implementing a storm water fee is often more appealing politically than imposing a new tax or raising property taxes.

Some challenges associated with storm water utilities include:

- Some residents, businesses or institutions may resist paying the fees;
- The idea may face political opposition;

- Once rates are in place, it may be difficult to secure additional funding;

- Enabling legislation is often required;

- It may be difficult and/or time-consuming to devise an equitable rate structure, and to develop a database with required information, such as amount of impervious surface; and

- A billing tee, will he needed.

Picking the Approach that Is Right for Cave Junction

Evaluating funding options and deciding which combination of revenue sources is most appropriate for your community is dependent on a number of criteria, including:

Political acceptance - Elected officials or other persons responsible for adopting a storm water program must compare any proposed funding package to other local needs and resources.

Fairness and equity - The degree to which the funding package is linked to a payee's specific contribution to storm water problems

Administrative simplicity - The ease of administering the funding package

Feasibility of Implementation - The relative ease or difficulty of making a funding package operational

Legal Defensibility - The probability of the funding package being defended in the courts

Revenue Generating Capacity - The ability of the funding package to produce sufficient revenue for the program

Dedicated Funding Source - The ability of the funding package to be available in future years to maintain an ongoing program.

Developing a funding and financing strategy will likely involve a number of funding sources. The City should initiate a public involvement process which would provide input about local attitudes about storm water spending levels and funding sources. The ability to inform stakeholders about the need for your program and obtain the necessary community support may determine whether your elected officials approve a funding package. A good way to inform stakeholders about what they will receive for their fee is to do a level of service analysis. Costs associated with different elements of service can then be communicated clearly. If there are objections to the rate, it would then be easier to negotiate specific program changes and cost reductions with stakeholders.

O&M and Capital Improvements

Upon considering financing of a complete Storm-water management plan, two primary areas of funding are needed. A source or sources of funds are required to finance 1) ongoing operation, maintenance and replacement and 2) Capital Improvements.

The following is a list of the application of the funding options:

- Operation, Maintenance and Replacement

  General operating funds (property taxes)

  Storm water utility fees

  Plan review and inspection fees

  Special assessments

  State Gas Tax revenue sharing

- Capital Improvements

  General obligation bonds

  Revenue bonds (based upon user fees, systems development fees or anticipated, and excess, state gas tax revenues)

  State/Federal Grants

  Special Improvement Districts

APPENDIX A

CITY OF CAVE JUNCTION

STORM WATER PROBLEM LIST

EXISTING PROBLEMS

1. The Culverts @ Hussey & Schumacher are at capacity, which could result in possible roadway overflow.
2. The drainage ditch West of Kirby & North of Lister is at capacity, which could result in a possible overflow into adjacent apartment buildings.
3. The culverts/ditch North of Stevenson & East of Hussey are at capacity, which could result in a possible overflow into adjacent apartment buildings.
4. The residential development area South of Wells Drive contains standing water, (flat area - no drainage).
5. In Fairway #1, at the Illinois Valley Golf Club the ditch is overflowing into the fairway creating standing water.
6. The drainage ditch on east side of Old Stage Road, extending North from Caves Highway to it's interception with the main drainage stream, is at capacity which could result in a possible overflow into adjacent properties.
7. North East corner of the intersection of Lister and Redwood Highway is experiencing temporary flooding of roads and adjacent building.
8. Ditch and pipe line on east side of Caves St., North of Watkins is at capacity and has overflowed into adjacent residential areas. The buried pipe is a conglomerate of pipes installed initially as driveway culverts.
9. Occasional flooding in the yards of the residences located in the Southeast portion of the Bumblebee subdivision.
10. Ditch and culverts on the west side of Hamilton Ave. (Barlow St. to Hwy. 199) are not carrying the runoff combing off the hillside to the east.

11. As private properties were developed along local streets which do not have curb and gutter, the roadside drainage was dictated by the property owner/developer. Much of the ditching and driveway culverts are inadequately sized and/or maintained. Many of the properties were developed at elevations lower than that of the adjacent street, resulting in poorly drained properties.

Also: fencing needed along swift flowing channels

FUTURE PROBLEMS

1. The increase of surface run-off would create deficiencies in the lower reaches of George Creek, primarily in the area of the golf coarse.

2. The upper reaches of the South fork of the receiving stream in Basin 3 consists of rough ditching through the back yards of existing residences. This drainage way will not handle additional flows during peak periods.

3. The ditch located on the South side of Caves Highway and East of Old Stage Road (along with the culvert under Frederick Ct.) will reach it's capacity with full development of available lands in this area.

4. ODOT recently replaced the culvert under Caves Highway and Old Stage Road with a 24" Corrugated Metal Pipe. This pipe is estimated to have a capacity of 17.9 cubic feet per second (cfs). The drainage area it serves has the potential of producing a quantity of 20 - 25 cfs at full build-out.

5. The drainage ditch from Old Stage Road to Jubilee Park is a combination of natural drainage and re-channeled ditching which varies in shape and capacity. There are some constriction points in this section that will reach capacity upon continued development of the upper reaches of this drainage basin.

6. There is a drainage ditch running to the North from the intersection of Junction and Raymond which will be affected by the residential improvements cited above.

7. A 24" corrugated metal pipe is used for a culvert which crosses under an access driveway to the US Forest Service housing on the south end of the community. That pipe is currently at capacity and further development will create problems at this location.

CITY OF CAVE JUNCITON STORMWATER PROJECT PRIOIRTIZATION

APPENDIX B

Rating Criteria

Projects to Solve Existing Problems

Prob. No.	Description	Health and safety	Preservation of Property	Environmental impact	Cost effective ratio	Political or geographic dispersion	Short and long-term benefit	Public awareness	Previous commitments and promises	Chance of success of the proposed solution	TOTAL	PRIORITY
1	Replace 2 - 36" Under Shumacher with 3' x 8' Box Culvert	7	8	5	7		7			9	**43**	3
2	Increase Capacity of Ditch North of Lister	8	8	4	7		8			9	**44**	2
3	Relocate or Increase Capacity of Pipe/Ditch North end of Hussey	9	9	4	8		7			9	**46**	1
4	Drain Devloped area South of Wells Dr.	7	7	6	6		5			9	**40**	6
5	Improve Drainage @ Golf Course - Fairway #1	5	6	4	5		6			9	**35**	9
6	Clean/widen Ditch East of Stage Rd.	6	7	4	6		6			9	**38**	7
7	Intersection of Lister/Redwood Hwy	6	8	5	6		8			9	**42**	4
8	Ditch/Pipe Replacement East Side of Caves	6	7	5	7		7			9	**41**	5
9	Maintenance of Ditch/Culvert which Drains Bumblebee Subdiv.	5	6	4	8		6			9	**38**	7
10	Ditch/Pipe West Side of Hamilton Ave.	5	5	5	7		6			8	**36**	8
11	Replace/Renovate Roadside Ditches/Driveway Culverts - Various Areas	5	6	5	5		7			5	**33**	10

Projects to Solve Future Problems

Prob. No.	Description	Health and safety	Preservation of Property	Environmental impact	Cost effective ratio	Political or geographic dispersion	Short and long-term benefit	Public awareness	Previous commitments and promises	Chance of success of the proposed solution	TOTAL	PRIORITY
1	Capacity Increase George Cr.	6	6	4	5		6	0	0	9	**36**	6
2	Re-align/Capacity Increase Ditch - Upper Stream #3	7	7	5	7		7	0	0	9	**42**	2
3	Ditch Widen, South Caves Hwy.	7	6	5	7		7	0	0	9	**41**	3
4	Replace 24" Under Caves Hwy. (Stream #3)	6	6	5	5		6	0	0	9	**37**	5
5	Clean/Widen Ditch East of Jubilee Park	6	6	5	7		7	0	0	9	**40**	4
6	Capacity Increase 24" Under Forest Service Property Driveway	7	8	5	7		8	0	0	9	**44**	1

Combined Projects

Description	Health and safety	Preservation of Property	Environmental impact	Cost effective ratio	Political or geographic dispersion	Short and long-term benefit	Public awareness	Previous commitments and promises	Chance of success of the proposed solution	TOTAL	PRIORITY
Divert Run-off From Upper, South Basin #3 to Basin #5	8	7	6	5		7	0	0	9	**42**	
Install Fencing Along Lined, Open Channels (Watkins, Hussey)	9	5	5	8		8	0	0	9	**44**	

Rating each criteria on a scale of 1-10 based upon the following

1- greatest negative impact

▲ Increasing negative impacts

5- neutral (project has no impact on criteria

▼ Increasing positive impacts

10- greatest positive impact

PROJECT COSTS

Projects to Solve Existing Problems

Priority No.	Prob. No.	Description			Jurisdiction
1	3	Relocate or Increase Capacity of Pipe/Ditch North end of Hussey	$10,763.83	$21,496.72	P
2	2	Increase Capacity of Ditch North of Lister	$16,157.60		P
3	1	Replace 2 - 36" Under Shumacher with 3' x 8' Box Culvert	$26,289.79		C
4	7	Intersection of Lister/Redwood Hwy	$55,928.68		S, C
5	8	Ditch/Pipe Replacement East Side of Caves	$36,608.47		C
6	4	Drain Developed area South of Wells Dr.	$12,196.41		P
7	6	Clean/widen Ditch East of Stage Rd.	$3,415.50		JC
7	9	Renovate Ditch/Culverts - West side of Hamilton Ave.	$7,740.40		C
8	10	Maintain Drainage Culverts for Bumblebee Subdivision	Maintenance		C
9	5	Improve Drainage @ Golf Course - Fairway #1	$7,148.69		P
10	11	Reconstruct Drainage Ditches, Driveway Culverts - Curbless Streets	Long Term Program		C

Projects to Solve Future Problems

Priority No.	Prob. No.	Description		Jurisdiction
1	6	Capacity Increase 24" Under Forest Service Property Driveway	$8,383.80	O *
2	2	Re-align/Capacity Increase Ditch - Upper Stream #3	$15,248.87	P
3	3	Ditch Widen, South Caves Hwy.	$6,432.00	S
4	5	Clean/Widen Ditch East of Jubilee Park	$13,620.60	C
5	4	Replace 24" Under Caves Hwy. (Stream #3)	$14,546.96	S
6	1	Capacity Increase George Cr.	$62,729.18 **	P, C

Combined Projects

Description		Jurisdiction
Divert Run-off From Upper, South Basin #3 to Basin #5	$47,163.63	S, C, O *
Install Fencing Along Lined, Open Channels (Watkins, Hussey)	$7,218.60	C

Jurisdiction Key
- C - City
- JC - Josephine County
- S - State of Oregon (ODOT)
- P - Private Property Owner
- O - Other

* - US Forest Service
** - Non-Structural Solutions For This Problem Are Recommended

PROJECT COSTS
(City)

Projects to Solve Existing Problems

Priority No.	Prob. No.	Description		Jurisdiction
1	1	Replace 2 - 36" Under Shumacher with 3' x 8' Box Culvert	$26,289.79	C
2	7	Intersection of Lister/Redwood Hwy	$55,928.68	S, C
3	8	Ditch/Pipe Replacement East Side of Caves	$36,608.47	C
4	9	Renovate Ditch/Culverts - West side of Hamilton Ave.	$7,740.40	C
5	10	Maintain Drainage Culverts for Bumblebee Subdivision	Maintenance	C
6	11	Reconstruct Drainage Ditches, Driveway Culverts - Curbless Streets	Long Term Program	C

Projects to Solve Future Problems

Priority No.	Prob. No.	Description		
1	5	Clean/Widen Ditch East of Jubilee Park	$13,620.60	C
2	1	Capacity Increase George Cr.	$62,729.18 **	P, C

Combined Projects

Divert Run-off From Upper, South Basin #3 to Basin #5	$47,163.63	S, C, O *
Install Fencing Along Lined, Open Channels (Watkins, Hussey)	$7,218.60	C

Jurisdiction Key
- C - City
- JC - Josephine County
- S - State of Oregon (ODOT)
- P - Private Property Owner
- O - Other

* - US Forest Service
** - Non-Structural Solutions For This Problem Are Recommended

APPENDIX D

POLLUTANTS IN STORM WATER AND ASSOCIATED IMPACTS

The nature of the impacts associated with specific urban storm water pollutants are reviewed in this section. The following types of pollutants found in urban runoff are addressed:

Sediment/habitat alteration;
Oxygen-demanding substances (organic matter);
Nutrients (phosphorus, nitrogen);
Toxic substances (heavy metals, oil and grease);
Bacteria;
Floatables; and
Multiple impacts of several of these pollutants acting in concert.

Sediment/Habitat Alteration

High concentrations of suspended sediment in streams can cause multiple impacts including increased turbidity, reduced light penetration, reduced prey capture for sight- feeding predators, clogging of gills/ filters of fish and aquatic invertebrates, reduced spawning and juvenile fish survival, and reduced angling success. Additional impacts result after sediment is deposited in slower moving receiving waters, such as smothering of the benthic community, changes in the composition of the bottom substrate, more rapid filling of small impoundments which create the need for costly dredging, and reduction in aesthetic values. Sediment having a high organic or clay content is also an efficient carrier of toxicants and trace metals. Once deposited, pollutants in these enriched sediments can be remobilized under suitable environmental conditions to pose an additional risk to benthic and other aquatic life. The greatest sediment loads are exported during the construction phase of any development activity. Furthermore, in intensively developed watersheds, increased stream flow can result in channel degradation, requiring stream bank erosion control.

Oxygen-Demanding Substances

Decomposition of organic matter by microorganisms depletes dissolved oxygen (DO) levels in receiving waters, especially in slower moving streams and lakes and estuaries. There are several measures of the degree of potential DO depletion, the most common of which are the Biochemical Oxygen Demand (BOD5) test and the Chemical Oxygen Demand (COD) test. Both of these tests have problems associated with their use in urban runoff, but it has been demonstrated (e.g., Rouge River, Western Long Island Sound) that urban runoff can severely depress DO levels after large storms, and that BODs solids can accumulate in bottom sediment causing impacts during periods of dry weather. BODs levels can exceed 10 to 20 mg/1 during storm events which can lead to anoxic conditions (zero oxygen) in shallow, slow moving, or poorly flushed receiving waters. The problem is particularly acute in some older urban areas, where storm runoff BODs mixes with overflows from combined or sanitary sewers. The greatest export of BODs typically occurs from older, highly impervious, highly populated urban areas with outdated combined storm sewers. In contrast, only moderate BODs export has been reported from newer, low-density suburban residential development.

Nutrients

The levels of phosphorus and nitrogen in urban runoff can lead to accelerated eutrophication in downstream receiving waters. Generally, phosphorus is the controlling nutrient in freshwater systems. The greatest risk of eutrophication is in urban lakes and impoundments with long detention times (two weeks or greater). Surface algal scums, water discoloration, strong odors, depressed oxygen levels (as the bloom decomposes), release of toxins, and reduced palatability to aquatic consumers are among the problems encountered. High nutrient levels can also promote the growth of dense mats of green algae that attach to rocks and cobbles in shallow, unshaded headwater streams. High nutrient loads from urban runoff, in combination with other sources, can contribute to eutrophication in both fresh and tidal waters. As a general rule of thumb, as impervious area increases, nutrients build up on surfaces and runoff transport capacities rise as well, leading to high pollution loads. Exceptions include land under development and land activities that receive unusually high fertilizer inputs, such as golf courses, cemeteries, and other intensively landscaped areas

Toxic Substances

Toxic substances are all defined as materials capable of producing an adverse response or effect in a biological system. A large number of potentially toxic compounds are routinely detected in urban storm water. These include trace metals (lead, zinc, copper, and cadmium), pesticides and herbicides, and hydrocarbons (derived from oil and grease, and gasoline runoff). These toxic chemicals tend to accumulate in benthic sediments of urban streams, lakes, and estuaries.

Heavy Metals: Heavy metals are of concern because of their toxic effects in aquatic life and their potential to contaminate drinking water supplies The heavy metals having the highest concentrations in urban runoff are are copper, lead, and zinc, with cadmium a distant fourth. However, when inappropriate connections between sanitary and storm sewers are present, other heavy metals such as arsenic, beryllium, chromium, mercury, nickel, selenium, and thallium can be found. A large fraction of the heavy metals in urban runoff are absorbed to particulates and thus, are not readily available for biological uptakes and subsequent bioaccumulation. Also, the typical Periods of exposure are those of urban runoff events (typically under 8 hours), which are much shorter than the exposure periods used in bioassay tests (typically 24 to 96 hours for toxicity testing). Nonetheless, it is likely that the heavy metals in urban runoff are toxic to aquatic life in certain situations, particularly for the more soluble metals such as copper and zinc. Additionally, resuspension of bottom deposits from high flow events may impact on downstream benthic invertebrates. Compared to risks to aquatic life, human health risks appear to be more remote.

Oil and Grease: Oil and grease contain a wide variety of hydrocarbon compounds, some aromatic hydrae known to be toxic to aquatic life at low concentrations. Hydrocarbons are often initially found as a rainbow colored film or sheen on the water's surface. Other hydrocarbons, especially weathered crankcase oil, appear in solution or in emulsion and have no sheen. However, hydrocarbons have a strong affinity for sediment, and much of the hydrocarbon load eventually adsorbs to particles and settles out. Hydrocarbons tend to accumulate rapidly in the bottom sediments of lakes and estuaries, where they may persist for long periods of time and exert adverse impacts on benthic organisms. The precise impacts of hydrocarbons on the aquatic environment are not well understood. Bioassay data which do exist are largely confined to laboratory exposure tests for specific hydrocarbon compounds. Remarkably few toxicity tests have been performed to examine the effect of urban runoff hydrocarbon loads on aquatic communities under the typical exposure conditions found in urban streams.

Other Pollutants: Other toxic compounds that have been detected in urban runoff include pesticides, herbicides, and synthetic organic compounds. Concentrations of these toxic substances in runoff from residential and commercial areas rarely exceed current water quality criteria. However, it should be noted that there has been relatively little sampling of runoff reported from industrial areas, where toxic compounds might be expected to be more prevalent.

Bacteria

Bacterial levels in undiluted urban runoff usually will exceed federal public health standards for water contact recreation and shellfish harvesting. Because bacteria multiply faster during warm weather, it is not uncommon to find a twentyfold difference in bacterial levels between summer and winter. The substantial seasonal differences often found do not correspond with comparable variations in urban activities. This suggests that in addition to temperature effects, many sources of coliform unrelated to those traditionally associated with human health risk (e.g., animal excrement, illicit connections, leaking sanitary collection systems) may be significant. Thus, despite the high numbers of coliforms found in urban runoff, in the absence of contamination from sanitary sewage, the health implications are unclear. The current literature suggests that fecal coliform may not be consistently reliable in identifying human health risks from urban runoff pollution.

Although nearly every urban and suburban land use can export bacteria at levels which will violate health standards, older and more intensively developed urban areas typically produce the greatest export. The problem is especially significant in urban areas that experience combined or sanitary sewer overflows that export bacteria derived from human wastes.

Floatables

Floatable debris in storm water runoff commonly includes plastic and paper products, garden refuse, tires and metal and glass containers. These pollutants degrade the aesthetic quality of both the receiving waters and river banks and shorelines. Vegetation and wildlife may also be impacted. Floating debris may impair restoration efforts by hindering the establishment of emergent vegetation. Fish and aquatic wildlife mortality may also be attributed to debris. Due to either ingestion or entanglement in the slowly decomposing materials.

APPENDIX E

SAMPLE PUBULIC INFORMATION STRATEGIES

Media Relations
- Press releases
- Media kits
- News conferences and related media events
- Articles and editorials
- Editorial Board meetings
- Appearances on local television, city cable channel, or radio programs

Advertising/promotion
- Logos/mascots/themes
- Print and broadcast public service announcements
- Paid advertisements
- Legal notices
- Illegal dumping hotline

Special events and public forums
- Environmental fairs
- Clean-up days
- Conferences or symposia
- Other speaking engagements

Direct mail
- Brochures
- Flyers
- Utility bill inserts
- Newsletters Signage
- Drain stencils/signs
- Manhole labels
- Point of purchase displays

Educational Programs (Schools)
- Field trips
- Educational curricula. Use of volunteers
- Water quality monitoring
- Labeling storm sewer inlets
- Adopt a Tree, Adopt a Drain, Adopt a Highway, Adopt a Stream programs
- Clean up programs

APPENDIX F

CITY OF CAVE JUNCTION
Catch Basin Inventory - Location

199 SOUTH

1) S.END PLAZA NEST TO P.POLE D6067
2) N.W. CORNER RIVER/199 25' FROM P.POLE D3457
3) N.W. CORNER PALMER/I99 BY BANK
4) S.W. CORNER PALMER/I99 BY RESTAURANTS
5) S.W. CORNER LISTER/I99 BY COUNTY BUILDING
6) ON 199 IN FRONT OF 30MPH SIGN
7) ON 199 IN FRONT OF HAMMER MKT
8) ON 199 IN FRONT OF FARM AND FEED
9) S.W CORNER OF WATKINS/199
10) S.W CORNER OF PIZZA FACTORY BY LIGHT POLE
11) N.W CORNER OF JUNCTION INN DRIVEWAY

199 NORTH

12) N.E CORNER OF 199/CAVES HWY
13) IN FRONT OF SENIOR STORE
14) S.E. CORNER OF 199/WATKINS
15) S.E. CORNER DRIVEWAY @ OREGON REALITY
16) 199 IN FRONT OF 20MPH SIGN
17) S.E. CORNER OF LISTER/199
18) N.E CORNER OF LISTER/199
19) IN FRONT OF OUTLET STORE 9' NORTH OF M/H
20) CORNER OF RIVER/199 10' EAST OF INTERSECTION
21) N.E CORNER OF 199/RIVER BY BAKERY
22) 26' NORTH OF P.POLE D5504 ON 199

RIVER ST

23) IN DRIVEWAY OF 218 W.RIVER
24) ACROSS FROM (23) FRONT OF 207 W.RIVER
25) ACROSS FROM INTERSECTION OF KERBY /RIVER BY STOP SIGN
26) PAST 304 W.RIVER NEAR PROPERTY CORNER
27) BY P.POLE 39'EAST OF SAWYER/RIVER INTERSECTION
28) ON W.RIVER 29' EAST OF 414 W.RIVER
29) S.E. CORNER OF KERBY/RIVER * PLUGGED
30) S.E. CORNER OF CAVES AYE/RIVER
31) S.E CORNER OF JUNCTION/RIVER
32) ACROSS FROM INTERSECTION JUNCTION/RIVER
33) S.E CORNER OF DRIVEWAY 317 E.RIVER
34) S.E. CORNER OF SHADOWBROOK/RIVER
35) E.RIVER 32' EAST OF P.POLE D4760 NEAR 150 E.RIVER

PALMER

36) FRONT OF P.POLE D10116
37) ACROSS FROM (36) NEAR LIBRARY

KERBY

38) ON KERBY 149' SOUTH OF RIVER ST INTERSECTION
39) S.E. CORNER OF KERBY/LISTER BEHIND CITY HALL
40) S.W CORNER OF KERBY/LISTER NEAR 108 KERBY

SCHUMACHER

41) N.W. CORNER OF SCHUMACHER/HUSSEY
42) S.W CORNER OF SCHUMACHER/HUSSEY

HUSSEY

43) CROSS FROM INTERSECTION SCHUMACHER/HUSSEY
43B) ON THE CORNER OF STEVENSON/N.HUSSEY
68B) CORNER OF N.SAWYER/STEVENSON

WATKINS

44) S.W CORNER KERBY/WATKINS BY STOP SIGN
45) 57' WEST OF INTERSECTION WATKINS/I99 N.SIDE
46) 57' WEST OF INTERSECTION WATKINS/I99 S/SIDE
47) 152' EAST OF INTERSECTION WATKINS/I99 N.SIDE
48) 152' EAST OF INTERSECTION WATKINS/I99 S.SIDE
49) ON WATKINS/CAVES AVE S.E SIDE

LISTER

50) ON LISTER ACROSS FROM HUSSEY INTERSECTION
51) N.E SIDE OF INTERSECTION HUSSEY/LISTER
51A) ON LISTER 27' WEST OF INTERSECTION
52) N.E CORNER OF CAVES AV

55) CAVES AVE E.SIDE NEAR 143 CAVES AVE
56) CAVES AVE ON PROPERTY LINE OF PLAZA AND CHURCH
57) ON CAVES AVE 36' OF INTERSECTION OF LISTER/CAVES AVE

JUNCTION

58) IN FRONT OF 150 N.JUNCTION 48'S. OF RIVER INTERSECT
58A) IN FIELD 78' FROM CORNER ACROSS 150 JUNCTION
58B) IN FRONT OF 143 N.JUNCTION 58C) IN FRONT OF P.POLE D7915
60) IN PARKING LOT OF L/B SCHOOL
61) S.SIDE OF INTERSECTION JUNCTION/WATKINS
62) S.E CORNER OF CAVES HWY/JUNCTION

WELLS

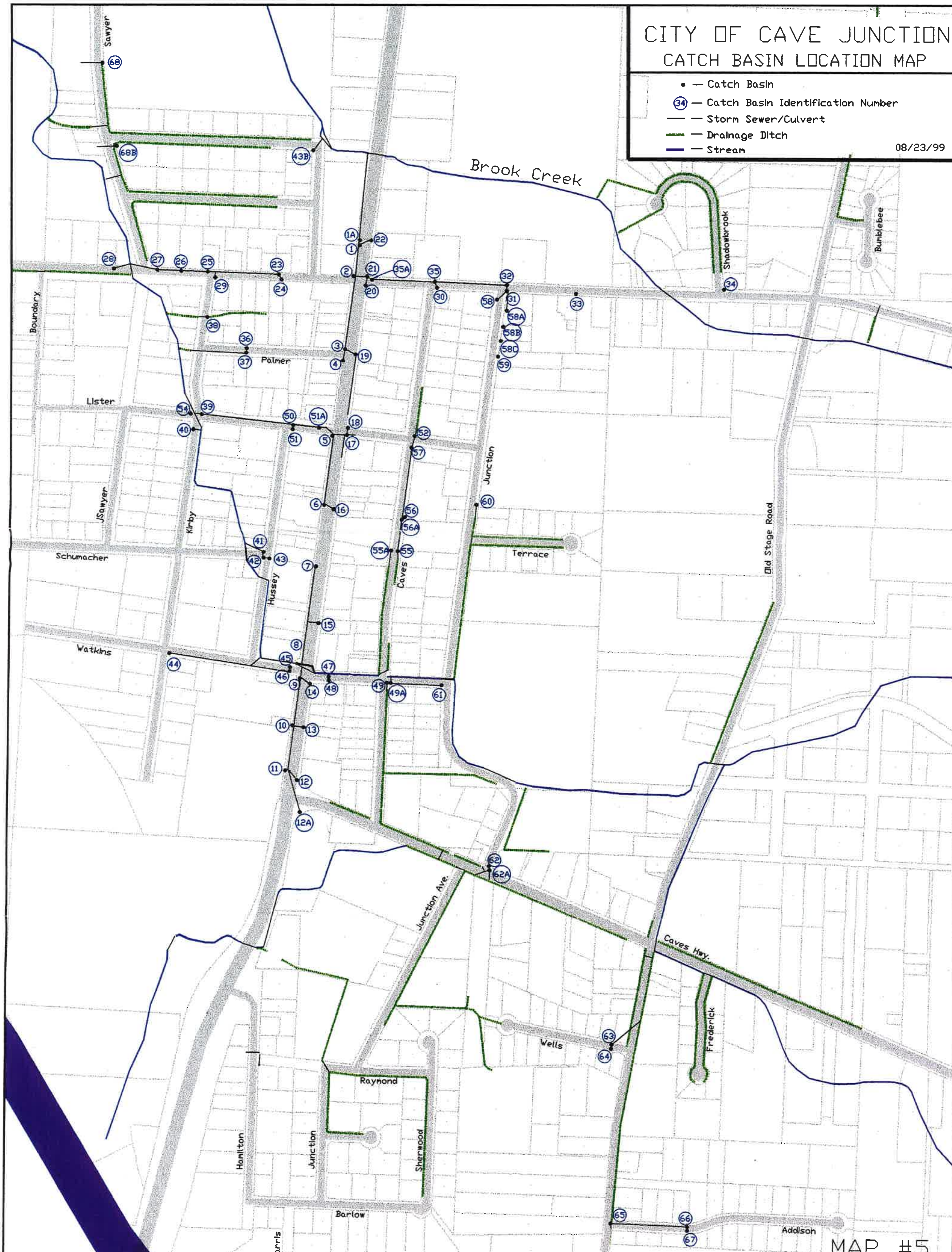
63) ON WELLS 62' EAST OF METER BOX 378 WELLS DRIVE
64) ACROSS FROM (63) NEAR PEDESTAL 2292

ADDISON

65) ON CORNER OF ADDISON/OLD STAGE
66) ON ADDISON 16' FROM M/H 1-3
67) ACROSS FROM (66) 27' FROM M/H 1-3

SAWYER

68) AT BOTTOM OF DIP TOWARD WWTP EAST SIDE OF ROAD



CITY OF CAVE JUNCTION
CATCH BASIN LOCATION MAP
— Catch Basin
— Catch Basin Identification Number
— Storm Sewer/Culvert
— Drainage Ditch
— Stream
08/23/99
Brook Creek
Sawyer
Boundary
Palmer
Lister
JSawyer
Kirby
Schumacher
Hussey
Watkins
Caves
Junction
Terrace
Old Stage Road
Shadowbrook
Bumblebee
Junction Ave.
Caves Hwy.
Wells
Frederick
Raymond
Sherwood
Hamilton
Barlow
Farris
Addison
MAP #5

STORM SEWER MAINTENANCE CHECKLIST

Area of Practice	*Activity*	*Done*
Culvert/Pipe	Inspect at least every 5 years	
	Use long-lasting measures	
	Use rodding for roots	
	Prevent chemical pollution	
	Targe maintenance to area in need	
	Install debris traps before cleaning	
Catchbasin/Inlet	Inspect catchbasin every 6 months	
	Inspect inlets once a year	
	Dispose of debris properly	
Stream Channel	Keep records of problem areas	
	Control pollution sources	
	Stabilize erosion areas	
	Revegetate with native species	
	Dispose of sediments properly	
Deteniton Pond	Inspect once a year	
	Monotor drain times (24-72 hrs)	
	Maintain vegetative buffer	
	Dispose of sediments properly	
Other Facilities	Inspect once a month	
	Monitor sediment build-up	
	Check for clogged filter	
	Dispose of sediments properly	
Retrofit Facilites	Consider retrofit with Water Quality benefits	
	Match retorfits to land use	

ROADWAY MAINTENANCE CHECKLIST

Area of Practice	*Activity*	*Done*
Street Cleaining	Use more effective sweeper	
	Eliminate street flushing	
	Recycle sweeping debris	
	Recycle leaf materila as compost	
	Deal with illegal dumps	
	Create recordkeeping system	
Roadway Repair	Schedule work in dry weather	
	Protect storm drain inlets	
	Protect roadside ditches	
	Avoid using water to clean up	
	Place stockpiles away from streams	
	Contain water and wastes	
	Recycle used asphalt & concrete	
	Use drip pans for leaks	
Surfacing & Resurfacing	Avoid wet weather for paving	
	Protect storm drain inlets	
	Protect roadside ditches	
	Avoid using water for clean up	
	Place stockpiles away from streams	
	Contain water and wastes	
	Recycle used asphalt	
	Use drip pans for leaks	
Pavement Marking	Develop paint handling procedures	
	Protect storm drain inlets	
	Avoid using water to clean up	
	Contain water and wastes	
Snow & Ice Control	Recycle sands and gravels	
	Place stockpiles away from streams	
	Do not use salts	
	Use chemicals sparingly	
Installation of Utilities in Roads	Protect storm drain inlets	
	Avoid using water to clean up	
	Do not discharge dewatering wastes directly	
	Contain water and wastes	
	Place stockpiles away from streams	

MAINTENANCE YARD AUDIT CHECKLIST

Area of Practice	Activity	Done
Prevent Exposure	Provide dead-end sump	
	Wash in a contained area	
	Cover bulk materials	
	Label & store containers properly	
	Disconnect process drains	
Provide Containment	Use drip pans for parked vehicles	
	Drain fluids from vehicles	
	Contain large fuel tanks	
	Contain uncovered bulk materials	
	Store containers on pallets	
	Use dumpsters with lids	
	Clean up Spills promptly	
	Regrade site to divert stormwater	
Remove Pollutants	Provide oil & grease controls	
	Apply erosion control	
	Use sediment controls	
	Install stormwater filters	
	Build stormwater detention	
Other Steps	Don't generate additional water	
	Educate staff	
	Reduce chemical use	
	Recycle wastes	
	Consider alternative products	
	Prepare site drainage map	
	Inspect storm sewers monthly	
	Keep water out of dumpsters	