CHAPTER 5

STRUCTURAL CONDITION DATA EVALUATION

SUMMARY

This chapter provides a brief assessment of the structural condition and data availability of the City of McMinnville collection system, and provides recommendations for maintaining a level of service for the collection system that provides reliability where proactive maintenance is of greater benefit than reactive maintenance.

The goals of this assessment are to: a) summarize known condition deficiencies and develop priorities and strategies to remedy the deficiencies, and b) recommend future activities consistent with the results of the CMOM Gap Analysis in Appendix D, including review of existing condition scoring and data management practices.

These goals were accomplished by reviewing the City's scoring process and making some observations about the methods and consistency of structural ratings in the Hansen system. Results of the review were then integrated with known condition related system deficiencies identified by City staff.

In summary, it is recommended that the City:

- Investigate potential problem areas identified in this chapter for capital improvement funding
- Enhance current best practices and plan for normal system deterioration over time through regular inspection and rating, risk assessment, and funding for condition-related improvements.

DATA CHARACTERISTICS

Information about the City of McMinnville Collection System is stored in different forms: geographical information system (GIS), Hansen computerized maintenance management software (CMMS) database, a video log-book with closed circuit television (CCTV) inspection videos, and AutoCAD files. Collection system inventory data resides in both the GIS and AutoCad files. Condition data is stored in Hansen, which can be accessed indirectly through GIS.

For the database fields of interest, such as material, diameter, and structural rating score, the GIS data were mostly complete, but some pipe segments lacked data in one or more fields.

The City has been using video inspection techniques to assess pipe condition. In general, most of the City's system has been inspected in this manner. Some of these video logs were used as part of the condition assessment. The raw video data is stored on VHS tapes. Each inspected pipe segment shows the pipe entry location (manhole) and some show laterals entering the main line. Not all tapes were preserved at the time of inspection; in some cases a pipe may have defect data and a structural rating score, but no tape is available.

SYSTEM CHARACTERISTICS

The City of McMinnville collection system consists of pipes of a variety of materials. According to the City's database coding list, materials found in the system include:

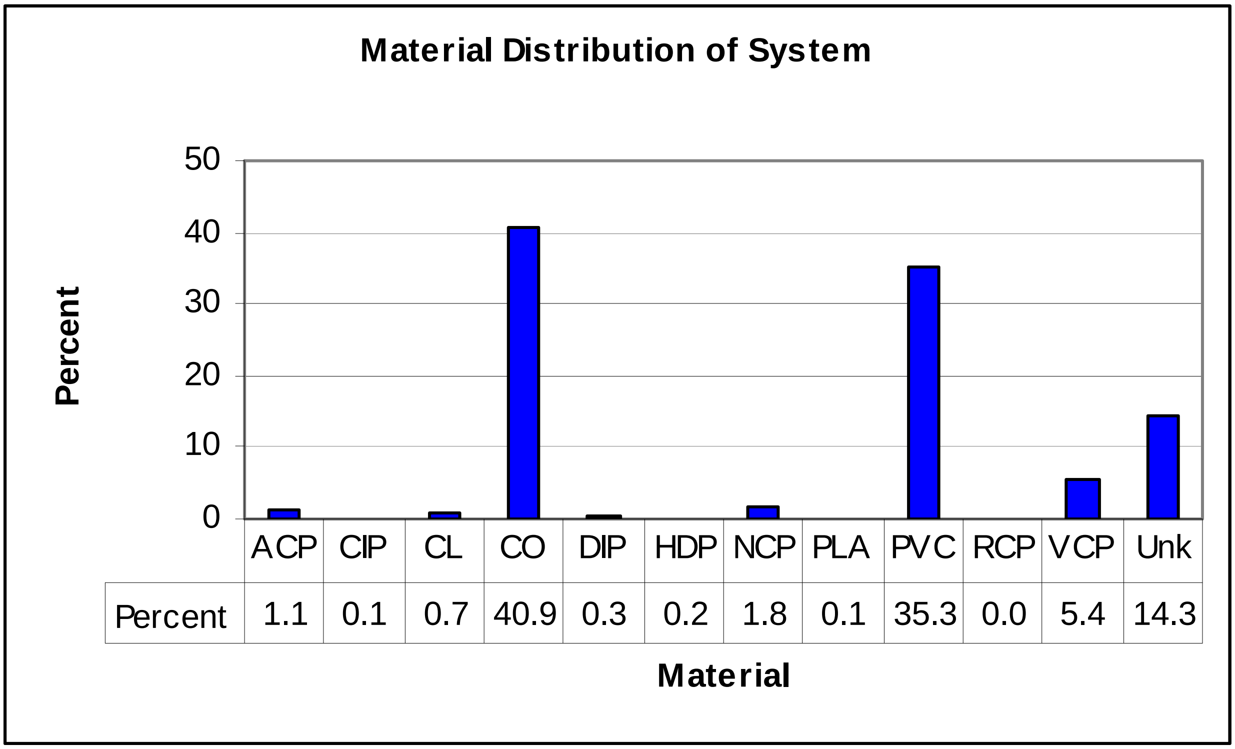
- Concrete (CO)
- Polyvinyl Chloride (PVC)
- Reinforced Concrete Pipe (RCP)
- Vitrified Clay Pipe (VCP)
- Plastic (PLA)
- Non-reinforced Concrete Pipe (NCP)
- High Density Poly Ethylene (HDPE)
- Ductile Iron Pipe (DIP)
- Concrete Lined (CL)
- Cast Iron Pipe (CIP)
- Asbestos Cement Pipe (ACP)

Most of the system is concrete and PVC. Approximately 14% of the pipes do not include data for material type. A summary of pipe material and size is included in Figure 5-1 and Table 5-1.

Table 5-1. Pipe Length Summary Table for Each Diameter Size

Diameter (in)	Total Length (ft)	Percent of Total Length (%)
4	1960	0.3
4 (pressure)	349	0.1
5	276	0.04
6	49,603	7.1
6 (pressure)	823	0.1
8	423,596	60.4
9	98	0.01
10	49,320	7.0
12	29,684	4.2
12 (pressure)	2,793	0.4
15	29,320	4.2
16 (pressure)	3,212	0.5
18	14,347	2.1
21	12,324	1.8
24	5,029	0.7
27	2,546	0.4
30	4,111	0.6
36	3,176	0.5
42	5,274	0.8
48	6,303	0.9
54	1,686	0.2
102	161	0.02
Unknown	35,427	5.1
Unknown (pressure)	19,878	2.8

Figure 5-1. Material Distribution of Collection System



SUMMARY OF KNOWN DEFICIENCIES

The City maintains information about system condition in two ways: field observations by staff, resulting in a list of maintenance-based projects, and condition-based issues from scoring in the Hansen database. Both these sources were consulted to identify known problem areas.

Staff identified both planned maintenance projects (as indicated by an assigned budget) and potential maintenance projects, which do not yet have enough detail to assign costs. These have been summarized in Table 5-2, which describes project locations and descriptions. These areas are also generally shown on Figure 5-2. Only some of the listed potential project locations are shown in the figure, due to limited notes regarding project description and location.

Table 5-2. Planned and Potential City Maintenance Projects

Project	Description	Figure 5-2 ID
PLANNED PROJECTS		
643 NW 6th Place	Mainline T replacement (6ft x 8 in pipe)	1
SE Davis St.& College St.	Mainline repair	2
240 SE Davis St. (at Lincoln St.)	Mainline repair; catch basin repair (combined w/ storm)	3
NE Evans & 4th	Mainline repair (12" clay line); storm mainline repair	4
726 SE Villard Street	Mainline repair (6ft x 8 inch pipe)	5
807 SE Washington Street	Mainline & manhole replacement	6
1155 SW Blaine Street	Mainline repair (broken Y)	7
533 NW 12th & 525 NW 12th	Separate & replace sanitary laterals	8
120 SE Irvine Street	Replace lateral	9
1110 NE 14th Street	Replace lateral	10
1323 NE Kirby Street	Replace lateral	11
1329 NE Kirby Street	Replace lateral	12
1824 NE Ford Street	Repair mainline (backyard)	13
721 NE Davis & 328 NE 8th	Separate & replace laterals	14
906 NE Second Street	Replace lateral	15
918 NE Second Street	Replace lateral	16
838 Shady Street	Separate from 834 Shady St. & install new laterals	17
129 SE Irvine Street	Replace lateral (from mainline to property line)	18
1425 NE 17th Street	Replace mainline (20 ft. x 10 inch pipe)	19
POTENTIAL PROJECTS		
NE Second St.(between Ford & Galloway)	Mainline replacement (185 ft. x 8 inch pipe) & one manhole – downtown mainline	20
NE Third St. (between Ford & Galloway and Galloway & Irvine)	Mainline replacement (2 segments – 435 ft x 8 inch pipe) & one manhole – downtown mainline	21
NE 12th (between Johnson & Kirby)	Mainline replacement (255 ft x 8 inch pipe, plus laterals)	22
135 NE Evans Street	Replace (141 ft x 12 inch pipe) between manhole I-8-41 & I-8-42. Replace mainline between manhole I-8-114E to I-8-152	23
SE Shady Street	Mainline replacement (300 ft. x 8 inch pipe) & lateral replacements	24
High School Basin Sewer Reconstruction II	Galloway area	25
Elm Street	Mainline replacement between NW 11th St. and NW 21st street including 10 manhole replacement.	26

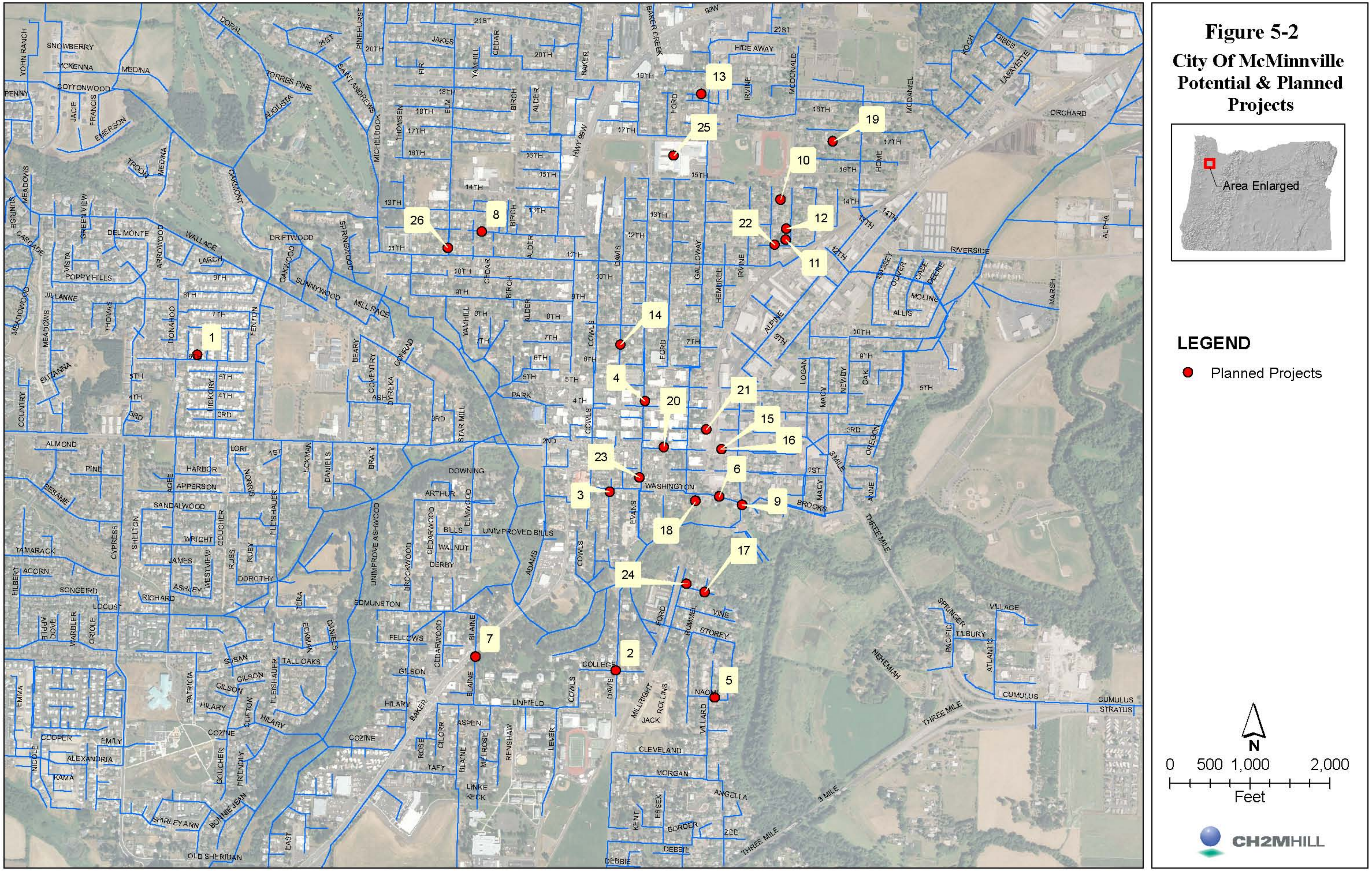


Figure 5-2
City Of McMinnville Potential & Planned Projects

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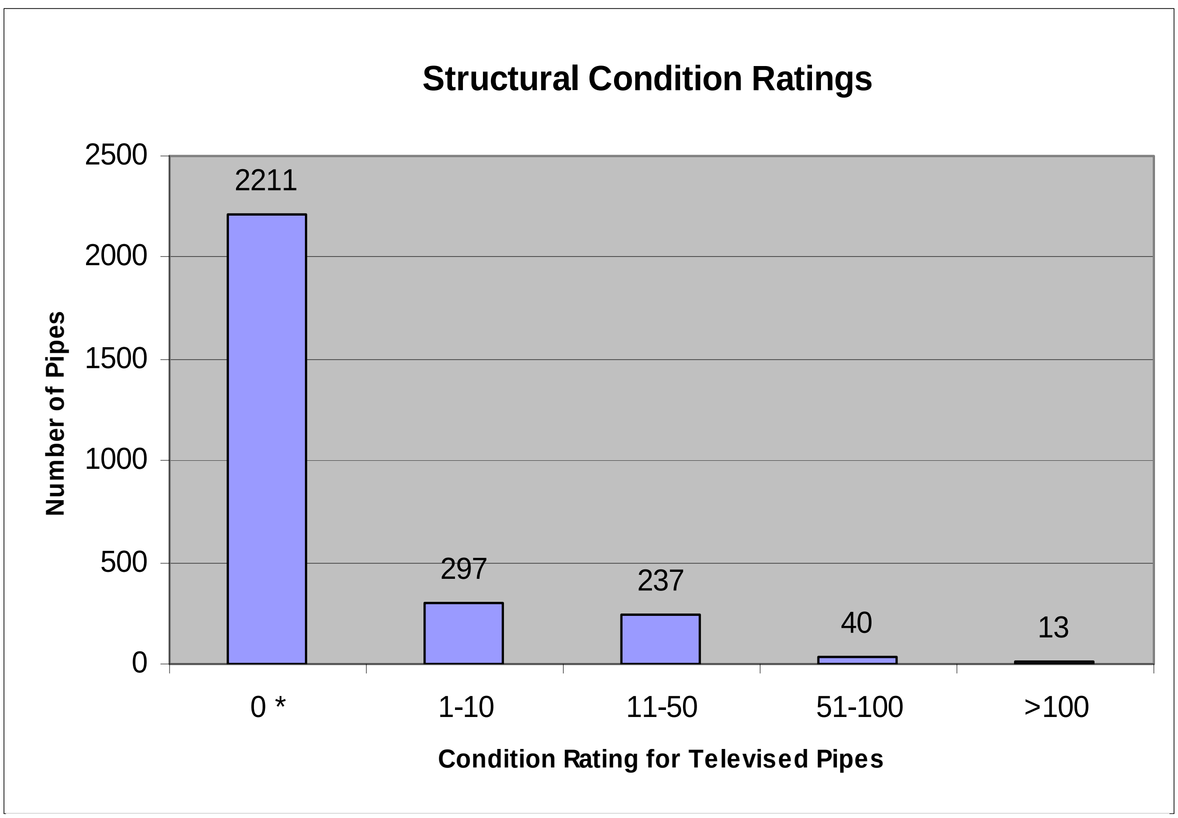
Staff also provided information from the Hansen system, including identifying labels (GIS Compkey) that match the City's geographic information system (GIS). In some cases, minor discrepancies between Hansen and GIS occur, such as pipeline length values. The Hansen data contained a structural rating score that is calculated using a formula derived from reported defects. Each defect is assigned a score based on its relative severity. Multiple defects in a single pipe are additive. The Hansen CMMS reports structural rating scores from 0 to a maximum allowed score of 1,000, where higher scores represent pipes that approach failure, although the highest allowed score does not necessarily represent a specific pipe condition. The City's rated pipes ranged from a score of 0 to 702. Figure 5-3 indicates the rated condition of pipes.

All pipes showing in Figure 5-3 have been inspected. Pipes with a rating score of 0 may be a new pipe, have low spots, dips, misalignments, or other minor defects that are not reported as part of the Hansen structural rating system.

Over 90% of the collection system has been inspected as shown on Figure 5-4. There are less than 300 pipes (less than 10%) that have not been TV inspected. In some cases, a blank database entry may indicate an open work order. In those cases, the pipe has been rated previously and is currently in a repair process. As part of work order development, narrative is recorded describing the known defects and associated repair requested.

Figure 5-3. Hansen Database Structural Rating Scores for McMinnville Collection System



*Pipes with zero rating may possess minor defects that are not registered in the rating system

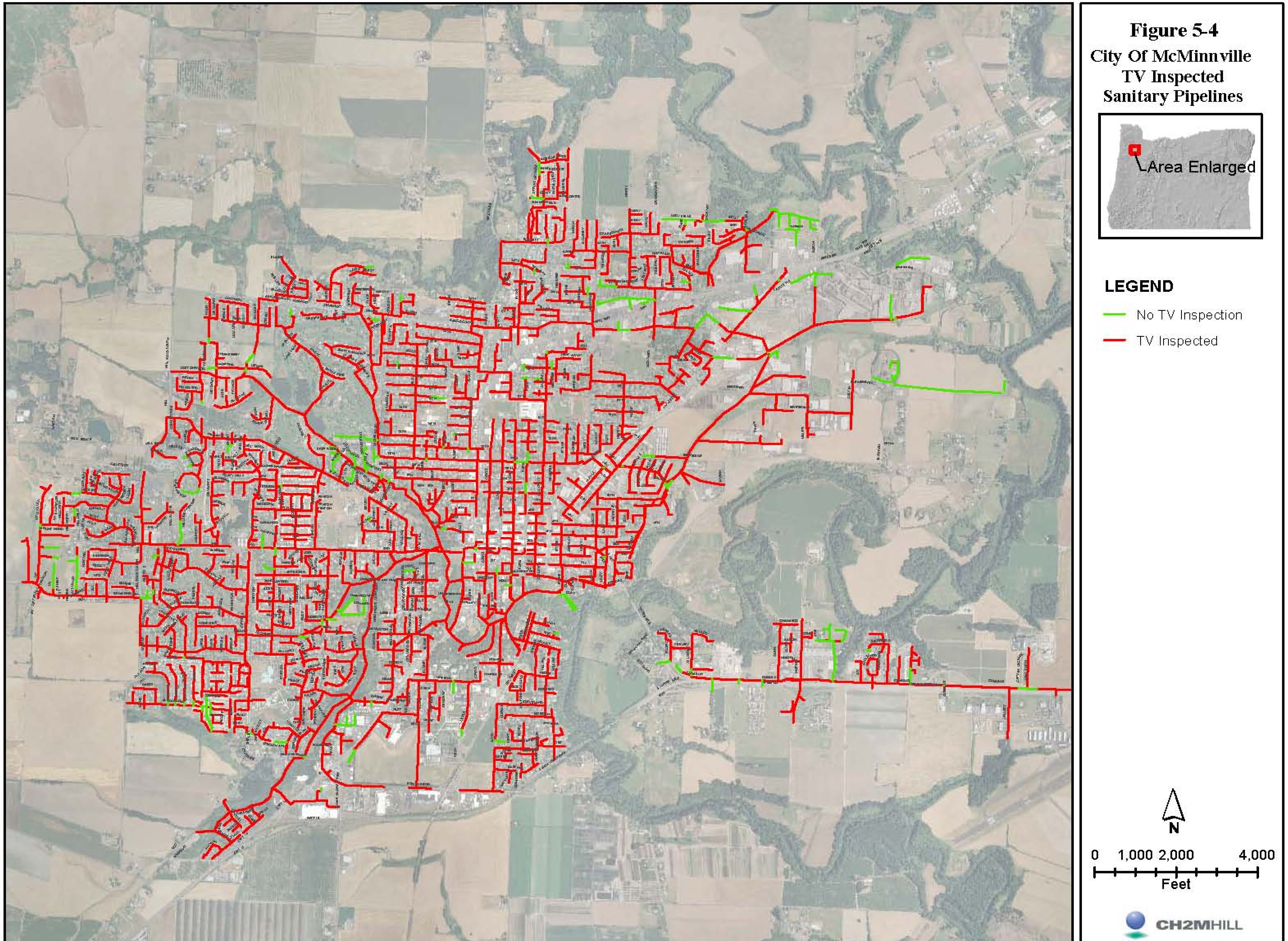


Figure 5-4
City Of McMinnville TV Inspected Sanitary Pipelines

File Path: P:\McminnvilleOrCityOf\355230SWMP\GIS\mxds\Figure5-4_20080603.mxd, Based on discussion with City staff, and our experience in other communities, we have selected a structural rating score of 90 and higher to represent the cut-off for pipes that may be considered for rehabilitation, repair, or replacement, subject to confirmation through more detailed review. For example, the City of Portland uses a Hansen rating of 100 to flag pipe segments for further review and inspection for possible repair. Defects expected to occur in pipes scoring at this level or higher might include severe blockages or misalignment, frequent cracking, spalling, or ovaling, or a high number of lateral connection problems. There were not specific comments in the provided database information to indicate specific problems with each pipe segment. Scores are built up from multiple defects that may be indicated within the Hansen software, or individual pipe registers. Pipe segments with structural rating scores greater than 90 are indicated in Table 5-3.

Table 5-3. Pipe Segments with Structural Rating Score >90

GIS COMPKEY	Upstream Manhole ID	Downstream Manhole ID	Diameter (inches)	Length (feet)	Material	Structural Rating Score
34512	I-8-114EL	I-8-152	8	168	CO	702
28731	H-8-101	H-8-102	36	28	CO	352
36190	H-7-107	H-7-60	8	37	CO	324
5405	I-8-64	I-8-54	6	99	VCP	318
4049	K-6-18	K-6-19	8	224	CO	193
36189	H-7-109	H-7-58	8	43	CO	182
5265	I-6-41	I-6-42	6	148	UNK	160
4970	H-7-82	H-7-112T	8	75	UNK	145
38800	H-7-112T	H-7-123T	8	96	VCP	140
35598	I-5-91	I-5-92	10	71	CO	137
4961	H-7-92	H-7-93	8	280	CO	134
4362	H-8-52	H-8-90	6	235	UNK	107
4048	K-6-19	K-5-13	8	320	CO	105
28759	I-8-107	I-8-129	6	181	VCP	99
29458	H-7-65	I-7-105	8	250	VCP	98
5113	I-7-112EL	I-7-111N	8	98	CO	98
5014	H-7-111EL	H-7-62	6	99	CO	96
5015	H-7-67	H-7-66	8	90	CO	93
5115	I-7-109EL	I-7-52	8	228	VCP	92

Note: UNK – Unknown

When taken in combination, the pipes identified in Tables 5-2 and 5-3 represent potential condition deficiencies. With this information, the City may choose to establish a "watch list" for prioritizing funding for improvement, which might include the "potential" projects from Table 5-2, plus those pipe segments in Table 5-3.

Solutions for condition-related problems vary widely, depending on longitudinal extent and nature of individual defects. For localized areas, point repairs can be effective, while for more extensive problems, applied or slip lining and pipe bursting may be more efficient. Refer to

Table 5-5 for more discussion of improvement methods. If a "watch list" pipe is scheduled for improvement, it is recommended that the listed pipe segments be considered initially as replacements to secure funding. During preliminary design, alternative repair and rehabilitation approaches can be investigated for cost savings opportunities.

In addition to pipeline replacement, the cost of pump station replacement should be budgeted. Table 5-4 summarizes major equipment at the WRF with installation date, expected useful life and resulting expected replacement date. It should be noted that the useful lives shown in the table are based on industry standards. Actual equipment life will vary. A proactive maintenance program like that at the WRF can extend useful life significantly.

Table 5-4. Master Plan Equipment List

Equipment Description	In Service	Estimated Life	Estimated Replacement Date
Pump station: Cozine pump no.1	1996	20	2016
Pump station: Cozine pump no.3	1996	20	2016
Pump station: Cozine pump no.4	1996	20	2016
Pump station: Cozine pump no.6	1996	20	2016
Raw sewage pump no.1	1996	20	2016
Raw sewage pump no.2	1996	20	2016
Raw sewage pump no.3	1996	20	2016
Raw sewage pump no.4	1996	20	2016
Raw sewage pump no.5	1996	20	2016
Pump station: oregon street	1989	30	2019
Pump station: three mile lane no.1	2004	40	2044
Pump station: three mile lane no.3	1973	40	2013
Pump station: cozine	1996	40	2036
Pump station: morgan lane	1997	30	2027
Pump station: cozine woods	1998	30	2028
Pump station: west side	1990	30	2020
Pump station :riverside	1981	30	2011
Pump station :north east	1993	30	2023
Pump station: crestbrook	1994	30	2024
Pump station: autumn ridge	2005	30	2035
Pump station: kathleen manor	1996	30	2026
Pump station: raw sewage	1996	40	2036

SYSTEM REPAIR, REHABILITATION AND REPLACEMENT

It is to be expected that maintenance issues and repairs will increase as the system continues to age and elements reach the end of their design life. It will be necessary to extend the useful life of the system. In addition to replacement, the recommendations below represent prudent measures to extend service life of the collection system. Example repair and rehabilitation methods are shown in Table 5-5.

- Enhance the current routine repair, rehabilitation, and eventual replacement schedule and begin to set aside additional funds for the program. Older installed sanitary sewer pipelines were expected to have a design life of approximately 50 years. As system elements approach their design life, it is prudent to evaluate options to extend useful life, or plan for replacement. A program level budget may wish to focus on the rehabilitation or limited replacement of sewers greater than 40 years old. Age data is not recorded in a GIS database field, but could be estimated from as-built record drawings or observed pace of City growth over the past decades.
- Perform risk assessment of pipes to identify those that exhibit highest vulnerability to failure, either because of location or service area. This increases the likelihood that investment is made in the right parts of the system first.
- Perform a pilot program for repairs and in-situ repairs to evaluate effectiveness and costs for various repair methods. The City may determine that spot repairs more cost effectively extend the useful life of the collection sewers than pipe segment major rehabilitation or replacement.
- Continue with the beneficial lateral inspection and repair program to target problem areas. Review the current assessment process and confirm that it is achieving appropriate lateral replacement needs.
- Include consideration of capacity needs and deficiencies when looking at rehab/replacement projects. A pipe that is both undersized and in poor condition would then have a high priority for action.

Table 5-5. Pipe Rehabilitation Options

Rehabilitation Option	Principal Advantages	Principal Disadvantages	Diameter Range
Pipeline Preparation			
• Cleaning	• Increases effective capacity • May resolve localized problems	• May be costly and cause damage • May become a routine requirement	Up to 36”
• Root Removal	• May increase effective capacity • May resolve localized problems	• Additional maintenance cost • Problem likely to recur	All
Grouting			
• Internal Joint Grouting • Acrylamide Gel • Acrylate Gel • Urethane Gel • Polyurethane Foam	• Seals leaking joints and minor cracks • Prevents soil loss • Low cost and causes minimal disruption • Can reduce infiltration • Can include root inhibitor	• Infiltration may find other routes of entry • Existing sewer must be structurally sound • Considered short-term solution • Requires experienced contractors	Up to 48”
• External Grouting • Cement Grout	• Improves soil conditions surrounding conduit • Can reduce infiltration and soil loss	• Difficult to assess effectiveness • Can be costly • Costly to find point of application	All
Point Repairs			
• Point (Spot) Repairs • Internal • External	• Deals with isolated problems • Many internal and external solutions available	• May require excavation for some defects • May require extensive work on brick sewers	All
Applied Linings			
• Reinforced Concrete Placement	• Variety of cross sections possible • More applicable to odd shaped-sewers	• Requires person entry—may be labor intensive • Lacks corrosion protection • Difficult to determine structural properties	36-inch and larger
• Concrete Placement	• Same as above	• Same as above	36-inch and larger

Rehabilitation Option	Principal Advantages	Principal Disadvantages	Diameter Range
• Spray-on Coatings • Paint-on Coatings	• No excavation • Variety of cross sections possible • Some automated machines for small-diameter applications	• Difficult to verify quality • Full bypass pumping required • May be labor intensive • Control of infiltration required • Does not correct connection problems	36-inch and larger
Sliplining			
• Segmented Linings • VCP (Gladding McBean, Mission Clay) • PVC (Weholite, Permacore, Spirolite) • RCP (Ameron, HydroConduit) • FRP (Hobas)	• High strength-to-weight ratio • Variety of cross sections can be manufactured • Minimal disruption	• Some materials easily damaged during installation • May require temporary support during grouting • Labor intensive • Joint problems on curved pipes • Requires person entry • External lateral connection – trenching • Point repairs required prior to installation • Full bypass pumping required	36-inch and larger
• Continuous Pipe – • Fusion-welded HDPE • (Plexco, Driscopipe) • Polybutylene • Polypropylene	• Quick insertion • Large-radius bends accommodated • Less costly in shallow trenches than other methods • All materials are available now	• Circular cross section only • Insertion/receiving trench disruptive • Large reduction of cross section area in smaller sizes • Less cost-effective where deep • External lateral connection – trenching • Point repairs required prior to installation • Bypass pumping requirements vary for different materials	4-inch and larger

Rehabilitation Option	Principal Advantages	Principal Disadvantages	Diameter Range
• Roll Down (Sewage Lining)	• Same as above • Commonly used for water pipe rehabilitation	• Same as above	3-inch to 24-inch

REVIEW OF SELECTED DATA

The City has an ongoing maintenance program that includes regular CCTV inspection, structural rating (via the Hansen system), cleaning, and repairs.

A brief review was made of the CCTV and structural rating elements of that program, in conjunction with workshops held regarding CMOM activities, to determine if any recommendations could be made to enhance system longevity and the overall management of wastewater assets.

A sample of approximately 40 pipe segments was viewed that had been graded by City staff on the Hansen scale described above. The sample was selected to provide a mix of pipe types, sizes, and locations within the City. The purpose of the review was primarily to observe the inspection and record-keeping processes used by the City to identify condition-related defects.

No specific trends were observed, but the most common defects for pipes that were reviewed were cracks, rough surfaces, and debris/solids deposition. Among the reviewed tapes, there were only two segments with a score above 20 (98 and 107, respectively). These two segments had wide cracks and/or broken pipe or laterals.

Some specific recommendations for CCTV inspection procedures and maintenance activities are described below.

INTEGRATION WITH CMOM FINDINGS

Several findings, recorded in detail in Appendix D, describe program enhancements that meet the intent of CMOM guidelines. A few of these are described below:

Condition Assessment

- Prioritize inspections and condition assessment of all components based on an assessment of criticality and past inspection data.
- Reset inspection frequencies as necessary.
- Review need to outsource inspection to ensure target frequencies are met.

Data Management and Support

- Perform a comprehensive review of current software systems (electronic facility maintenance programs, including both MP2 and Hansen; GIS; customer complaint tracking; hydraulic modeling) and improve as needed to provide a fully linked system for management of a specific asset--upgrade, replace, acquire, or activate unused components and develop custom reports, linkages, or user interfaces. Goal is to have centralized data base with system information (pipe data), work order system (generate and track all maintenance), and map-linked analysis and reporting. Since City software, particularly MP2 and Hansen, do not necessarily manage the same assets, direct linkages are not necessary. Implementation will be case-by-case.

- Design reporting functions to link to Business Plan, providing automatic and timely statistics on meeting specific service goal and performance metric targets.

In light of these suggestions, and review of maintenance and inspection data provided by the City, below are several additional recommendations for consideration.

RECOMMENDATIONS FOR FUTURE ACTIVITIES AND CMOM COMPLIANCE

CCTV Inspection Procedures

- When videotaping the lines, record (by voice or written notation) all visible defects with footage location.
- If part of a pipe segment has standing water, record the cause of flow blockage, if known.
- When videotaping the lines, rotate the camera and focus to the defected area for better viewing and analyzing the condition of the defects.

System Maintenance

- Utilize consistent, documented, and continual assessment grading to track overall system condition.
- Continue and enhance inspection practices and recording of condition assessment in the database system.
- Review video for pipes that were graded higher than 90 for possible repair, rehabilitation, or replacement in the near future.

Level of Service and Repair Prioritization

It can be observed in Figure 5-2 that the correlation between the pipes identified by maintenance staff and those indicated by high structural ratings in the Hansen system is not great. One reason for this inconsistency is the defect types observed are not causing maintenance related problems. Cracks, ovaling, and leaking joint problems, for example, may not cause the blockages or service interruptions that result in maintenance projects.

Many jurisdictions find it challenging to associate Hansen scores with an on-the-ground maintenance program. To be relevant, it is critical that any scoring system make a linkage to expected remaining service life, and consequently allow for programmatic budgets that can be adjusted as the system ages. Hansen alone does not provide the needed linkage. A complementary scoring system, such as described below in Tables 5-6 and 5-7, might provide an approach to comparing pipe conditions across the City. For example, pipes with a Hansen structural rating score over 90 might correspond to grades D, E, and F. Such a system might then allow the City to programmatically budget for repair and replacement costs, consistent with CMOM guidelines. The rating system implies an associated level of service for each grade that can assist the City in evaluating overall system performance.

Table 5-6. Possible Pipe Rating System

Grade	Category	Condition Assessment
A	Very Good	Few minor defects. Anticipated to provide useful service life of 50 or more years.
B	Good	Minor and few moderate defects. May require repairs within the next 21 to 50 years.
C	Fair	Moderate defects that will continue to deteriorate and require repairs within next 10 to 20 years (Master planning horizon)
D	Poor	Severe defects that will soon deteriorate and require repairs within the next 2 to 10 years
E	Very Poor	Sewer requires repairs or improvement in the next two years.
F	Emergency	Requires immediate attention – Possible health hazard, safety hazard, or significant environmental harm

Table 5-7. Common Defects by Grade

Grade	Most Common Defects
A	• No debris or solids deposition • No misalignments
B	• Minor debris or solids deposition (less than 1/2 inch deep)
C	• Roots (frequent and infrequent) • Misalignment of sewer pipe segment (vertically or horizontally)—portions of the sewer line have standing pockets of water • Infrequent small (1/2 inch or less in width) cracks (radial and longitudinal) • Infrequent joint problems (broken and misaligned) • Moderate Debris or solids deposition (1/2 to 2 inches deep) • Minor lateral problems (protrusions common) • Evidence of infiltration (stains at joints or cracks)

Grade	Most Common Defects
D	• Major debris or solids deposition (1/4 of pipe diameter depth) • Misalignment of sewer pipe segment (vertically or horizontally)—1/4 of pipeline length has standing water • Medium frequency of small (1/2 inch or less in width) and large (1/2 inch or greater in width) cracks (radial and longitudinal) • Medium frequency of joint problems (broken and misaligned) • Visible joint gaskets • Minor leaking at pipe joints • Low frequency of structural problems (deterioration and ovaling of < 5%) • Medium frequency of lateral problems • Visible infiltration (less than 1 gpm)
E	• Blockages (greater than 1/4 of pipe diameter in depth) • High frequency of small (1/2 inch or less in width) and large (1/2 inch or greater in width) cracks (radial and longitudinal) • Misalignment of sewer pipe segment (vertically or horizontally)—over 1/4 of pipeline length has standing water • High frequency of joint problems (broken and misaligned) • Missing joint gaskets • High frequency of structural problems (deterioration and ovaling) that are affecting the structural integrity of the pipe • Minor portions of reinforcing steel exposed • Concrete spalling of pipe wall • Higher frequency of lateral problems • Groundwater infiltrating into sewer line at flow rates less than a garden hose flow (garden hose is 2 to 5 gpm)
F	• Full blockage of sewer line from debris or solids deposition • Collapsed section of pipe or section of pipe missing • Major portions of reinforcing steel exposed • Full pipeline length or diameter pipeline large (1/2 inch or greater in width) cracks (radial and longitudinal) • Disconnected or broken lateral • Sewage exfiltrating into adjacent soil • Groundwater infiltrating into sewer line at flow rates greater than 5 gpm (garden hose is 2 to 5 gpm) • Contains an apparent void or opening