

# **Needs To Know For Cross-Connection Control System Operators**

Prepared By: The Cross-Connection Control Backflow Prevention Sub-Committee of the  
NC One Water School Committee, In Cooperation with The NC One  
Water Board Of Education and Examiners and The Operator Certification  
Program, North Carolina Division Of Environmental Quality

## References

Rules Governing Public Water Systems, North Carolina Administrative Code Title 15A. Subchapter 18C. March 2000 Reprint.

Rules Governing Water Treatment Facility Operators, North Carolina Administrative Code, Title 15A, Subchapter 18D. Current Through August 1, 2000.

Backflow Prevention and Practice Study Guide. The Backflow Sub-Committee of NC AWWA / WEA School Committee

Backflow Prevention Theory and Practice (Third Edition). University of Florida, Division of Continuing Education, TREEO Center. Gainesville, FL

## **How To Use This Manual**

The outline is not a list of facts, therefore, it, in itself, cannot be studied. From these referenced topics, classes will be taught and examinations given. It is suggested that the operator mark in the manuals with a highlighting pen the sections, which pertain to the certification for which the operator is preparing. The entire manual should then be read and particular attention given to the highlighted sections.

The operator should not expect to study and learn the material necessary to be a cross-connection control system operator or to pass the certification examinations in a short period of time, such as the annual school. The annual school is intended as a review. Techniques continually change and continuous study is required even after certification. Study of the outlined material and on job training is recommended. These manuals are designed as a self-teaching and can be studied at the operator's own rate. If the operator is deficient in basic math skills, it is recommended that courses be taken in the community college system to correct the deficiency.

## **Table Of Contents**

15A NCAC 18C	Rules Governing Public Water Systems	5
15A NCAC 18D	Rules Governing Water Treatment Facility Operators	8
	Backflow Prevention and Practice Study Guide	9
	Backflow Prevention Theory and Practice (Third Edition)	11

<b>Section Number</b>	<b>RULES GOVERNING PUBLIC WATER SYSTEMS Topic</b>	<b>Reference</b>	<b>Need to Know for Examination</b>
	<b>NC Administrative Code Subchapter 18C – Water Supplies</b>	NCAC T15A:18C	<b>X</b>
.0100	<b>A. Section .0100 – Protection Of Public Water Supplies</b>	Section .0100/Page 1	<b>X</b>
.0102	<b>Definitions – Review Carefully</b>	Section .0100/Page 1	<b>X</b>
.0102	Cross-connection	Section .0100/Page 1	<b>X</b>
.0102	Disinfection	Section .0100/Page 1	<b>X</b>
.0102	Fecal Coli form	Section .0100/Page 1	<b>X</b>
.0102	Non-potable Water Supply	Section .0100/Page 2	<b>X</b>
.0102	Water Supply	Section .0100/Page 2	<b>X</b>
.0102	Raw Water Reservoir	Section .0100/Page 2	<b>X</b>
.0102	Service Connection	Section .0100/Page 2	<b>X</b>
.0102	Water Supply Product	Section .0100/Page 2	<b>X</b>
.0102	<i>Adopted by Reference – Review Carefully</i>		
.0102	Maximum contaminant level	Section .0100/Page 2	<b>X</b>
.0102	Public Water System	Section .0100/Page 2	<b>X</b>
.0102	Supplier of Water	Section .0100/Page 3	<b>X</b>
.0102	Non-transient non-community	Section .0100/Page 5	<b>X</b>
.0102	Point of entry	Section .0100/Page 5	<b>X</b>
.0102	Point of use	Section .0100/Page 5	<b>X</b>
.0102	Single Family Structure	Section .0100/Page 6	<b>X</b>
.0102	Transient non-community water system	Section .0100/Page 6	<b>X</b>
.0102	Waterborne Disease Outbreak	Section .0100/Page 6	<b>X</b>

<b>Section Number</b>	<b>RULES GOVERNING PUBLIC WATER SYSTEMS Topic</b>	<b>Reference</b>	<b>Need to Know for Examination</b>
.0300	<b>B. Section .0300 – Submission Of Plans, Specifications, And Reports</b>	T15A:18C.0300	
.0301	Applicability	Section .0300/Page 1	
.0303	Submission Required By Engineer And Water Supplier	Section .0300/Page 1	
.0304	Application For Approval: By Whom Made	Section .0300/Page 2	
.0305	Approval Of Plans Necessary Before Contracting	Section .0300/Page 2	
.0306	Changes In Plans Or Specifications After Approval	Section .0300/Page 2	
.0307	Engineer's Report	Section .0300/Page 2	
.0308	Type And Form Of Exhibits	Section .0300/Page 3	
.0400	<b>C. Section .0400 – Water Supply Design Criteria</b>	T15A:18C.0400	<b>X</b>
.0404(g)	Water Treatment Facilities Prevention Of Backflow And Back - Siphonage	Section .0400/Page 4	<b>X</b>
.0406	Distribution Systems	Section .0400/Page 6	<b>X</b>
.0700	<b>D. Section .0700 – Surface Water Facilities</b>	T15A:18C.0700	
.0709	Prevention Of Backflow And Back – Siphonage	Section .0700/Page 3	

<b>Section Number</b>	<b>RULES GOVERNING PUBLIC WATER SYSTEMS Topic</b>	<b>Reference</b>	<b>Need to Know for Examination</b>
.0900	<b>F. Section .0900 – Distribution Systems</b>	T15A:18C.0900	
.0901	Size of The Water Main	Section .0900/Page 1	
.0902	Number of Residences on a Water Main	Section .0900/Page 1	
.0903	Dead End Water Mains	Section .0900/Page 1	
.0904	Pipe Laying	Section .0900/Page 1	
.0905	Testing New Water Mains	Section .0900/Page 1	X
.0906	Relations of Water Mains to Sewers	Section .0900/Page 2	
.0907	Valves	Section .0900/Page 2	
.1800	<b>G. Section .1800 – Local Plan Approval Programs</b>	T15A:18C.1800	
.1900	<b>L. Section .1900 – Administrative Penalties</b>	T15A:18C.1900	X
.1913	Right Of Entry And Inspection	Section .1900/Page 3	X
.2100	<b>M. Section .2100 – Operating Permits</b>	T15A:18C.2100	
Figure 2	<b>Figure 2 – North Carolina Guidelines, Cross – Connection Control In Water Distribution Systems</b>	T15A:18C.Fig. 2	X

<b>Section Number</b>	<b>RULES GOVERNING WATER TREATMENT FACILITY OPERATORS Topic</b>	<b>Reference</b>	<b>Need to Know for Examination</b>
	<b>NC Administrative Code Subchapter 18D – Water Treatment Facility Operators</b>	NCAC T15A:18D	
.0100	<b>A. Section .0100 – General Policies</b>	T15A:18D.0100	
.0102	Organization	Section .0100/Page 1	
.0103	Meetings Of The Board	Section .0100/Page 1	
.0105	Definitions	Section .0100/Page 1	<b>X</b>
.0200	<b>B. Section .0200 – Qualification Of Applicants And Classification Of Facilities</b>	T15A:18D.0200	<b>X</b>
.0201	Grades Of Certification	Section .0200/Page 3	<b>X</b>
.0202	Examinations	Section .0200/Page 4	<b>X</b>
.0203	Determination Of Various Classes Of Certification	Section .0200/Page 4	<b>X</b>
.0206	Certified Operator Required	Section .0200/Page 7	<b>X</b>
.0300	<b>C. Section .0300 – Applications And Fees</b>	T15A:18D.0300	<b>X</b>
.0301	Application For Exam	Section .0300/Page 9	<b>X</b>
.0302	Application For Reciprocity	Section .0300/Page 9	<b>X</b>
.0303	Application For Temporary Certificate	Section .0300/Page 9	<b>X</b>
.0304	Fee Schedule	Section .0300/Page 10	<b>X</b>
.0305	Waiting Period	Section .0300/Page 10	<b>X</b>
.0307	Revocation Of Certificates	Section .0300/Page 10	<b>X</b>
.0308	Professional Growth Hours	Section .0300/Page 10	<b>X</b>
.0309	Certification Reinstatement	Section .0300/Page 11	<b>X</b>
.0400	<b>D. Section .0400 – Issuance Of Certificate</b>	T15A:18D.0400	
.0401	Notification Of Classification	Section .0400/Page 12	
.0403	Issuance Of Grade Certificate	Section .0400/Page 12	<b>X</b>
.0404	Temporary Certificate	Section .0400/Page 12	
.0405	Reciprocal Certificates	Section .0400/Page 13	
.0500	<b>E. Section .0500 – Rule Making Procedure</b>	T15A:18D.0500	
.0501	Petitions	Section .0500/Page 14	
.0600	<b>F. Section .0600 – Contested Cases</b>	T15A:18D.0600	
.0601	Opportunity For Licensee Or Applicant To Have A Hearing	Section .0600/Page 16	
.0700	<b>G. Section .0700 Operation and Maintenance</b>	T15A:18D.0700	
.0701	Operator in Responsible Charge	Section .0700/Page 17	<b>X</b>

	<b>BACKFLOW PREVENTION AND PRACTICE STUDY GUIDE Topic</b>	<b>Page Number</b>	<b>Need to Know for Examination</b>
	<b>Backflow Prevention and Practice Study Guide</b>		
	Introduction To Backflow Prevention	1	<b>X</b>
	Purpose and Scope	1	<b>X</b>
	Backflow / Cross-Connection	5	<b>X</b>
	Non-Potable Source / Contaminant Pollutant	6	<b>X</b>
	Backflow / Backsiphonage	6	<b>X</b>
	Backflow Prevention	7	<b>X</b>
	Hazards of Backflow	9	<b>X</b>
	Types of Contaminants	9	<b>X</b>
	Biological	9	<b>X</b>
	Chemical	9	<b>X</b>
	Fundamentals of Backflow	10	<b>X</b>
	Cross-Connections	10	<b>X</b>
	Types	10	<b>X</b>
	Temporary	10	<b>X</b>
	Permanent	11	<b>X</b>
	Why Cross Connections are Created	12	<b>X</b>
	Understanding Backflows	13	<b>X</b>
	Pressure Principles	13	<b>X</b>
	Atmospheric Pressure	13	<b>X</b>
	Gauge Pressure	14	<b>X</b>
	Absolute Pressure	14	<b>X</b>
	Water Under Static Conditions	16	<b>X</b>
	Water Movement	16	<b>X</b>
	Backsiphonage	17	<b>X</b>
	Back Pressure	18	<b>X</b>
	Capillary Action	19	<b>X</b>

	<b>BACKFLOW PREVENTION AND PRACTICE STUDY GUIDE Topic</b>	<b>Page Number</b>	<b>Need to Know for Examination</b>
	Summary	20	<b>X</b>
	Methods for Preventing Backflow	21	<b>X</b>
	Backflow Prevention Methods	21	<b>X</b>
	Mechanical Backflow Preventers	23	<b>X</b>
	Approval of Backflow Prevention Devices	24	<b>X</b>
	Pressure Vacuum Breaker	25	<b>X</b>
	Double Check Valve Assembly	27	<b>X</b>
	Reduced Pressure Principle Assembly	28	<b>X</b>
	Unapproved Devices	29	<b>X</b>
	Atmospheric Vacuum Breaker	31	<b>X</b>
	Summary	33	<b>X</b>
	Summary Chart of Backflow Prevention Methods	33	<b>X</b>
	Glossary of Terms	39	<b>X</b>
	North Carolina Section AWWA/WEA Approved Backflow Prevention Assembly Field Test Procedures		<b>X</b>

<b>Chapter Number</b>	<b>BACKFLOW PREVENTION Third Edition Theory and Practice Topic</b>	<b>Reference</b>	<b>Need to Know for Examination</b>
<b>1</b>	<b>Chapter One: Introduction to Backflow Prevention</b>	<b>Page 1</b>	
	<b>Introduction</b>	<b>Page 1</b>	
	Backflow/Cross Connections	Page 1	<b>X</b>
	Non-potable Source/Contaminant/Pollutant	Page 2	<b>X</b>
	Backpressure/Backsiphonage	Page 3	<b>X</b>
	Public Health Significance	Page 4	
	Backflow Prevention	Page 6	<b>X</b>
	<b>Purpose and Scope</b>	<b>Page 8</b>	<b>X</b>
	<b>Summary</b>	<b>Page 8</b>	
	<b>Chapter One Review</b>	<b>Page 9</b>	
<b>2</b>	<b>Chapter Two: The Hazards of Backflow</b>	<b>Page 11</b>	
	Biological Pollution/Contamination	Page 11	<b>X</b>
	Backflows Short-circuit the Water Treatment Process	Page 13	<b>X</b>
	Public Health Significance	Page 14	
	Monetary Cost of Biological Contamination	Page 14	<b>X</b>
	Biological Hazards: Case Histories	Page 15	
	Factors That Affect the Magnitude of a Biological Backflow Incident	Page 16	<b>X</b>
	Chemical Pollution/Contamination	Page 18	<b>X</b>
	Public Health Significance	Page 21	
	Monetary Cost of Chemical Contaminants	Page 21	<b>X</b>
	Chemical Hazards: Case Histories	Page 22	
	Factors That Affect the Magnitude of a Chemical Backflow Incident	Page 26	<b>X</b>
	<b>Summary</b>	<b>Page 27</b>	
	<b>Chapter Two Review</b>	<b>Page 29</b>	
<b>3</b>	<b>Chapter Three: Laws and Responsibility</b>	<b>Page 31</b>	
	<b>Laws</b>	<b>Page 31</b>	<b>X</b>
	Federal Regulations	Page 31	<b>X</b>
	State Regulations	Page 33	
	Regulations in Other States	Page 35	
	Plumbing Codes	Page 35	

<b>Chapter Number</b>	<b>BACKFLOW PREVENTION Third Edition Theory and Practice Topic</b>	<b>Reference</b>	<b>Need to Know for Examination</b>
	<b>Responsibilities and Liabilities</b>	<b>Page 36</b>	<b>X</b>
	Liabilities and Damages	Page 36	<b>X</b>
	<b>Individual Responsibilities</b>	<b>Page 39</b>	
	Water Purveyors	Page 39	<b>X</b>
	Consumer	Page 43	
	Regulatory Officials	Page 44	
	Plumbing Inspector	Page 45	
	Consulting Engineers	Page 45	
	Contractors, Plumbers, and Testers	Page 45	
	Code of Conduct	Page 46	
	Others with Some Level of Responsibility	Page 46	
	<b>Summary</b>	<b>Page 47</b>	
	<b>Chapter Three Review</b>	<b>Page 48</b>	
<b>4</b>	<b>Chapter Four: Fundamentals of Backflow</b>	<b>Page 51</b>	
	<b>Cross-Connections</b>	<b>Page 51</b>	<b>X</b>
	Types of Cross-Connections	Page 51	<b>X</b>
	Why Cross-Connections Are Created	Page 53	<b>X</b>
	<b>Understanding Backflow</b>	<b>Page 59</b>	<b>X</b>
	Pressure Principles	Page 59	
	Water: Under Static Conditions	Page 60	<b>X</b>
	Atmospheric Pressure	Page 64	<b>X</b>
	Water Movement	Page 66	<b>X</b>
	Effects of the Weight of Water	Page 66	<b>X</b>
	Effects of Atmospheric Pressure	Page 68	<b>X</b>
	Effects of Water Temperature	Page 70	<b>X</b>
	Effects of Water Velocity	Page 71	<b>X</b>
	Mechanical Devices	Page 73	<b>X</b>
	Backpressure	Page 74	<b>X</b>
	Backsiphonage	Page 76	<b>X</b>
	<b>Summary</b>	<b>Page 78</b>	<b>X</b>

<b>Chapter Number</b>	<b>BACKFLOW PREVENTION Third Edition Theory and Practice Topic</b>	<b>Reference</b>	<b>Need to Know for Examination</b>
	<b>Chapter Four Review</b>	<b>Page 79</b>	
<b>5</b>	<b>Chapter Five: Methods and Mechanisms for Preventing Backflow</b>	<b>Page 81</b>	
	<b>Devices and Approved Assemblies</b>	<b>Page 81</b>	<b>X</b>
	<b>Mechanical Backflow Preventers</b>	<b>Page 84</b>	<b>X</b>
	Atmospheric Vacuum Breaker	Page 84	<b>X</b>
	Hose Bibb Vacuum Breaker	Page 88	<b>X</b>
	Pressure Vacuum Breaker	Page 88	<b>X</b>
	Backflow Protection for Irrigation Systems	Page 90	
	Spill-resistant Vacuum Breaker Assembly	Page 90	
	Double Check Valve Assembly	Page 94	<b>X</b>
	Reduced Pressure Principle Assembly	Page 97	<b>X</b>
	Air Gap: Approved Non-mechanical Backflow Prevention	Page 106	<b>X</b>
	Summary of Approved Backflow Prevention Methods	Page 109	<b>X</b>
	<b>Other Backflow Preventers</b>	<b>Page 109</b>	<b>X</b>
	Barometric Loop	Page 110	<b>X</b>
	Single Check Valve	Page 111	<b>X</b>
	Dual Check Valve	Page 112	<b>X</b>
	Auxiliary Methods for Preventing Backflow	Page 113	<b>X</b>
	Detector Check	Page 114	<b>X</b>
	Double Check Detector Assembly	Page 114	<b>X</b>
	Reduced Pressure Detector Assembly	Page 115	<b>X</b>
	<b>Commercial Fire Sprinkler Systems</b>	<b>Page 115</b>	<b>X</b>
	Wet Pipe Fire Sprinkler System	Page 116	<b>X</b>
	Deluge Sprinkler System	Page 117	<b>X</b>
	Combined Dry Pipe-Preaction Sprinkler System	Page 117	<b>X</b>
	Dry Pipe Sprinkler System	Page 118	<b>X</b>
	Preaction Sprinkler System	Page 118	<b>X</b>
	Residential Fire Sprinkler System (Single Family)	Page 118	
	<b>Assembly Installation</b>	<b>Page 118</b>	<b>X</b>
	Thermal Expansion	Page 119	<b>X</b>

<b>Chapter Number</b>	<b>BACKFLOW PREVENTION Third Edition Theory and Practice Topic</b>	<b>Reference</b>	<b>Need to Know for Examination</b>
	Temperature and Pressure Valve	Page 120	<b>X</b>
	Freeze Protection	Page 120	<b>X</b>
	<b>Summary</b>	<b>Page 121</b>	<b>X</b>
	<b>Chapter Five Review</b>	<b>Page 123</b>	
<b>6</b>	<b>Chapter Six: Field Testing</b>	<b>Page 127</b>	
	<b>Test Gauges</b>	Page 127	<b>X</b>
	Differential Pressure Gauge	Page 127	<b>X</b>
	Sight Tube	Page 131	
	<b>Testing</b>	<b>Page 132</b>	<b>X</b>
	Testing the Reduced Pressure Principle Assembly	Page 133	
	Step-by-step Testing Procedure for the Reduced Pressure Principle Assembly	Page 135	
	Testing a Reduced Pressure Principle Assembly with a Leaking Outlet Shut-off Valve	Page 143	
	Testing the Reduced Pressure Detector Assembly	Page 143	
	Testing the Double Check Valve Assembly	Page 144	
	Step-by-step Testing Procedures for the DCVA, Differential Pressure Gauge Single-hose Method	Page 144	
	Testing the DCVA with a Leaking Inlet Shut-off Valve, Differential Pressure Gauge Method	Page 146	
	Testing the DCVA with a Leaking Outlet Shut-off Valve, Differential Pressure Gauge Method	Page 147	
	Sight Tube Method	Page 149	
	Step-by-step Testing Procedures for the DCVA, Sight Tube Method	Page 149	
	Testing the DCVA with a Leaking Inlet Shut-off Valve, Sight Tube Method	Page 151	
	Testing the Double Check Detector Assembly	Page 153	
	Testing the Pressure Vacuum Breaker	Page 153	
	Step-by-step Testing Procedures for the Pressure Vacuum Breaker	Page 154	
	Testing the Pressure Vacuum Breaker with a Leaking Inlet Shut-off Valve	Page 157	
	Step-by-step Testing Procedures for the Spill-resistant Vacuum Breaker	Page 158	

<b>Chapter Number</b>	<b>BACKFLOW PREVENTION Third Edition Theory and Practice Topic</b>	<b>Reference</b>	<b>Need to Know for Examination</b>
	Testing the Spill-resistant Vacuum Breaker with a Leaking Inlet Shut-off Valve	Page 160	
	Testing Follow-up	Page 160	
	<b>Summary</b>	<b>Page 162</b>	<b>X</b>
	<b>Chapter Six Review</b>	<b>Page 163</b>	
<b>7</b>	<b>Chapter Seven: Troubleshooting, Maintenance, and Repair</b>	<b>Page 169</b>	
	Troubleshooting Reduced Pressure Principle Assemblies	Page 169	
	Testing a Reduced Pressure Principle Assembly with a Leaking Outlet Shut-off Valve	Page 169	
	<b>Maintenance and Repair</b>	<b>Page 178</b>	<b>X</b>
	Safety	Page 180	<b>X</b>
	Repair	Page 180	<b>X</b>
	<b>Items to Check When the Backflow Preventer Fails</b>	<b>Page 181</b>	
	Reduced Pressure Principle Assembly and Reduced Pressure Detector Assembly	Page 181	<b>X</b>
	Double Check Valve Assembly and Double Check Detector Assembly	Page 182	<b>X</b>
	Pressure Vacuum Breaker and Spill-resistant Vacuum Breaker Assembly	Page 183	<b>X</b>
	Atmospheric Vacuum Breaker Device	Page 183	
	Residential Dual Check Device	Page 184	
	General Items to Check When the Backflow Preventer Fails	Page 184	
	Corrosion	Page 185	
	Water Quality	Page 186	
	<b>Summary</b>	<b>Page 186</b>	
	<b>Chapter Seven Review</b>	<b>Page 187</b>	
<b>8</b>	<b>Chapter Eight: Developing A Cross-Connection Control Program</b>	<b>Page 189</b>	
	<b>Getting Started</b>	<b>Page 189</b>	<b>X</b>
	<b>Administration of the Program</b>	<b>Page 191</b>	<b>X</b>
	An Ordinance	Page 192	<b>X</b>
	Service Contracts	Page 192	<b>X</b>
	Policies and Rules	Page 193	<b>X</b>
	Standard Operating Procedures	Page 194	<b>X</b>
	Administrative Authority	Page 195	<b>X</b>

<b>Chapter Number</b>	<b>BACKFLOW PREVENTION Third Edition Theory and Practice Topic</b>	<b>Reference</b>	<b>Need to Know for Examination</b>
	<b>Seven Elements of a Cross-Connection Control Program</b>	<b>Page 195</b>	<b>X</b>
	Establishing Legal Authority	Page 196	<b>X</b>
	Plan Review of New Construction	Page 197	<b>X</b>
	Using Standards and Specifications to Define “Approved” Assemblies	Page 198	<b>X</b>
	Testing and Maintenance	Page 199	<b>X</b>
	Record Keeping	Page 201	<b>X</b>
	Program for Surveying and Retrofitting Existing Facilities	Page 203	<b>X</b>
	Training and Education	Page 206	<b>X</b>
	<b>Developing a Program for Dealing with Emergencies</b>	<b>Page 209</b>	<b>X</b>
	<b>Program Manual</b>	<b>Page 212</b>	<b>X</b>
	<b>Summary</b>	<b>Page 212</b>	<b>X</b>
	<b>Suggested Supplementary Readings</b>	<b>Page 215</b>	
	<b>Glossary</b>	<b>Page 219</b>	<b>X</b>
	<b>Index</b>	<b>Page 225</b>	
	<b>APPENDIX</b>	<b>Page 227</b>	
Appendix A	AWWA Policy Statement	Page 229	<b>X</b>
Appendix B	Pertinent Sections of FDEP Code	Page 231	
Appendix C	Abbreviations	Page 245/246	
Appendix D	Field Test Procedures	Page 247	
Appendix E	Test and Maintenance Report Forms	Page 253	
Appendix F	Troubleshooting Guide	Page 257	<b>X</b>
Appendix G	Test Kits: Suppliers and Repair Locations	Page 261	
Appendix H	Repair Parts Suppliers	Page 265	
Appendix I	Plumbing Code: Testing and Lawn Irrigation	Page 270	
Appendix J	FCCC & HR Approval Process	Page 271	
Appendix K	Testing the RP Chart	Page 273	
Appendix L	A.S.S.E. Numbers: Approved Assemblies and Devices	Page 275	<b>X</b>
Appendix M	Building a Model Ordinance	Page 277	
Appendix N	Elements of Program Ordinance	Page 279	<b>X</b>
Appendix O	Form Letters: Required Annual Testing, Follow-up, Final, and Repair	Page 283	

<b>Chapter Number</b>	<b>BACKFLOW PREVENTION Third Edition Theory and Practice Topic</b>	<b>Reference</b>	<b>Need to Know for Examination</b>
Appendix P	List of Health Hazard Facilities	Page 289	
Appendix Q	CCC Questionnaire	Page 293	
Appendix R	Survey Inspection Forms	Page 295	
Appendix S	Sample Form Letters: Survey Inspection	Page 299	
Appendix T	List of Common Cross-Connection Locations	Page 303	
Appendix U	Incident Report Form	Page 307	
Appendix V	Selecting Proper Backflow Prevention Discussion	Page 311	
Appendix W	Nomenclature Chart	Page 315	<b>X</b>
Appendix X	Lawn Irrigation Chart	Page 317	
Appendix Y	Article on Reuse Water	Page 319	
Appendix Z	Freeze Protection	Page 333	
	<b>TABLE OF FIGURES</b>		
Figure 2-1	Transmission Route of Giardia Lamblia	Page 13	<b>X</b>
Figure 2-2	Parts per billion Analogy	Page 22	<b>X</b>
Figure 4-1	Tank Truck Creates Cross-Connection	Page 52	<b>X</b>
Figure 4-2	Submerged Bath Tub Inlet Creates a Cross-Connection	Page 53	<b>X</b>
Figure 4-3	Jet Truck Creates a Cross-Connection	Page 54	<b>X</b>
Figure 4-4	Cross-Connection Created at Swimming Pool	Page 55	<b>X</b>
Figure 4-5	“Plumber’s Helper” Creates a Cross-Connection	Page 56	<b>X</b>
Figure 4-6	Siphon Chemical Mixer	Page 56	<b>X</b>
Figure 4-7	A “Bath-to-Shower” Adaptor Creates a Cross-Connection	Page 57	<b>X</b>
Figure 4-8	A Hose Creates a Cross-Connection at a Wastewater Treatment Plant	Page 57	<b>X</b>
Figure 4-9	Common Kitchen Spray Nozzle Creates a Cross-Connection	Page 58	<b>X</b>
Figure 4-10	Comparison between the Weight of Water and the Weight of Air	Page 59	<b>X</b>
Figure 4-11	Comparison of Pressures between Two Blocks of Same Dimensions	Page 60	<b>X</b>
Figure 4-12	The Weight of a 1-foot Column of Water	Page 61	<b>X</b>
Figure 4-13	The Weight of a 2-foot Column of Water: eq 0.866 psi	Page 62	<b>X</b>
Figure 4-14	A Comparison of Water Pressure in Two Different Styles of Water Towers	Page 62	<b>X</b>

<b>Chapter Number</b>	<b>BACKFLOW PREVENTION Third Edition Theory and Practice Topic</b>	<b>Reference</b>	<b>Need to Know for Examination</b>
Figure 4-15	Water Pressure is Dependent on Depth	Page 63	<b>X</b>
Figure 4-16	Determining the Height of a Water Column	Page 63	<b>X</b>
Figure 4-17	The Weight of Atmospheric Pressure on the Earth's Surface	Page 64	<b>X</b>
Figure 4-18	Atmospheric Pressure: Sea Level versus the Mountains	Page 65	<b>X</b>
Figure 4-19	Absolute versus Gauge Pressure	Page 65	<b>X</b>
Figure 4-20	Determining the Direction of Water Movement is a Pipe by Comparing Pressure Gauge Readings	Page 66	<b>X</b>
Figure 4-21	Water Movement in a U-tube	Page 67	<b>X</b>
Figure 4-22	Water Movement through a Siphon	Page 67	<b>X</b>
Figure 4-23	Drinking from a Straw Illustrates the Effects of Negative Pressure	Page 68	<b>X</b>
Figure 4-24	The Creation of a Total Vacuum within a System Theoretically Causes Water to Rise 33.9 Feet	Page 69	<b>X</b>
Figure 4-25	A Graph of the Relationship between Temperature and Pressure at a Constant Volume	Page 70	<b>X</b>
Figure 4-26	How the Effects of the Ideal Gas Law Could Cause Backflow from a Boiler	Page 71	<b>X</b>
Figure 4-27	A Graph of the Relationship between Velocity and Pressure	Page 71	<b>X</b>
Figure 4-28a	An Illustration of How a Venturi Can Cause Backflow	Page 72	<b>X</b>
Figure 4-28b	An Illustration of How the Water Pressure Falls as the System Pressure Drops	Page 72	<b>X</b>
Figure 4-29	An Illustration of How a Pump Can Cause Backpressure-Backflow	Page 73	<b>X</b>
Figure 4-30	An Illustration of How a Pump Can Cause Backsiphonage-Backflow	Page 74	<b>X</b>
Figure 4-31	A Cross-Connection to an Irrigation Well	Page 75	<b>X</b>
Figure 4-32	Backsiphonage at a Restaurant	Page 77	<b>X</b>
Figure 4-33	Backflow in a Laboratory Caused by an Aspirator	Page 78	<b>X</b>
Figure 5-1	Shut-off Valves	Page 82	<b>X</b>
Figure 5-2	Test Cock "Blow-out Proof" Stem	Page 83	<b>X</b>
Figure 5-3	Atmospheric Vacuum Breaker Normal Flow	Page 85	<b>X</b>
Figure 5-4	Atmospheric Vacuum Breaker During Backsiphonage	Page 86	<b>X</b>
Figure 5-5	Atmospheric Vacuum Breaker In-line on an Irrigation System	Page 87	<b>X</b>

<b>Chapter Number</b>	<b>BACKFLOW PREVENTION Third Edition Theory and Practice Topic</b>	<b>Reference</b>	<b>Need to Know for Examination</b>
Figure 5-6	Atmospheric Vacuum Breaker Installed on a Laboratory Sink	Page 87	<b>X</b>
Figure 5-7	Hose Bibb Vacuum Breaker	Page 88	<b>X</b>
Figure 5-8	Pressure Vacuum Breaker	Page 89	<b>X</b>
Figure 5-9	Shut-off Valves Are Allowed Downstream on Pressure Vacuum Breakers	Page 90	<b>X</b>
Figure 5-10	Pop-up Irrigation Heads	Page 91	<b>X</b>
Figure 5-11	Elevated Irrigation Heads	Page 91	<b>X</b>
Figure 5-12	Spill-resistant Vacuum Breaker with No Flow	Page 92	
Figure 5-13	Spill-resistant Vacuum Breaker during Normal Flow Conditions	Page 92	
Figure 5-14	Spill-resistant Vacuum Breaker	Page 93	
Figure 5-15	Spill-resistant Vacuum Breaker during Normal Flow	Page 94	
Figure 5-16	Spill-resistant Vacuum Breaker	Page 94	
Figure 5-17	Double Check Valve Assembly	Page 95	<b>X</b>
Figure 5-18	Double Check Valve Assembly in Parallel	Page 96	<b>X</b>
Figure 5-19	Double Check Valve Assembly Installed in a Vault	Page 96	<b>X</b>
Figure 5-20	Reduced Pressure Principle Assembly	Page 97	<b>X</b>
Figure 5-21	RP: Normal Flow	Page 98	<b>X</b>
Figure 5-22	RP during Backpressure Conditions	Page 99	<b>X</b>
Figure 5-23	RP before Backsiphonage Conditions	Page 100	<b>X</b>
Figure 5-24	RP during Backsiphonage Conditions	Page 100	<b>X</b>
Figure 5-25	RP: Failing Check Valve #2 under Backpressure and Backsiphonage Conditions	Page 102	<b>X</b>
Figure 5-26	Backpressure with a Leaking Check Valve #2	Page 102	<b>X</b>
Figure 5-27	Drain Line Attached to an RP	Page 103	<b>X</b>
Figure 5-28	Spitting: The Relief Valve Opens When the Supply Pressure Drops	Page 104	<b>X</b>
Figure 5-29	The Relief Valve Closes When the Supply Pressure Increases	Page 104	<b>X</b>
Figure 5-30	Dumping	Page 105	<b>X</b>
Figure 5-31	The RP Will Adjust to the Drop in Supply Pressure	Page 106	<b>X</b>
Figure 5-32	Air Gap at a Booster Pump	Page 107	<b>X</b>
Figure 5-33	Absolute Minimum Air Gap Separation	Page 107	<b>X</b>
Figure 5-34	Barometric Loop	Page 110	<b>X</b>
Figure 5-35	Single Check Valve	Page 111	<b>X</b>
Figure 5-36	Dual Check Valve	Page 112	<b>X</b>
Figure 5-37	Double Check Detector Assembly	Page 115	<b>X</b>

<b>Chapter Number</b>	<b>BACKFLOW PREVENTION Third Edition Theory and Practice Topic</b>	<b>Reference</b>	<b>Need to Know for Examination</b>
Figure 5-38	Typical Piping System for a Customer	Page 119	
Figure 5-39	Freeze Protection for Backflow Preventers	Page 121	<b>X</b>
Figure 6-1	Differential Gauge: Diaphragm	Page 128	<b>X</b>
Figure 6-2	Differential Test Kit	Page 129	<b>X</b>
Figure 6-3	Differential Test Kit: Without Separate Bleed Valves	Page 129	<b>X</b>
Figure 6-4	Differential Test Kit: With Pressure Differences Illustrated	Page 130	<b>X</b>
Figure 6-5	Digital Gauge	Page 131	
Figure 6-6	Determining the Pressure Differential across Check Valve #1 on an RP	Page 136	<b>X</b>
Figure 6-7	Determining the Opening Point of the Relief Valve on an RP	Page 137	<b>X</b>
Figure 6-8	Testing an RP with a Leaking Shut-off Valve #2	Page 138	
Figure 6-9	Determining That Check Valve #2 of an RP Will Hold Tight Against Backpressure	Page 139	<b>X</b>
Figure 6-10	Confirm if the Outlet Shut-off Valve Is Not Leaking	Page 141	<b>X</b>
Figure 6-11	Testing the Differential Pressure Across Check Valve #2	Page 142	<b>X</b>
Figure 6-12	Testing Check Valve #1 on a DCVA	Page 145	<b>X</b>
Figure 6-13	Testing Check Valve #2 on a DCVA	Page 146	<b>X</b>
Figure 6-14	Testing Check Valve #2 with Water Flowing to Customer through a Leaking Outlet Check Valve	Page 148	<b>X</b>
Figure 6-15	Testing Check Valve #1 of the DCVA with Sight Tube	Page 149	
Figure 6-16	Testing Check Valve #2 of the DCVA with Sight Tube	Page 150	
Figure 6-17	Testing the Opening Point of the Air Inlet Valve in a PVB with a Five-valve Differential Pressure Gauge	Page 154	<b>X</b>
Figure 6-18	Testing the Opening Point of the Air Inlet Valve in a PVB with a Three-valve Differential Pressure Gauge	Page 156	
Figure 6-19	Verifying That the Single Check of a PVB Will Hold Back 1.0 psi in the Direction of Flow	Page 157	<b>X</b>
Figure 6-20	Testing the Check Valve in a PVB With a Leaking Shut-off Valve	Page 158	<b>X</b>
Figure 6-21	Testing a SVB with a Leaking Inlet Shut-off Valve	Page 160	
Figure 6-22	Approval Tag	Page 161	

<b>Chapter Number</b>	<b>BACKFLOW PREVENTION Third Edition Theory and Practice Topic</b>	<b>Reference</b>	<b>Need to Know for Examination</b>
Figure 6-23	Red Tag	Page 161	
Figure 7-1	Failing Check Valve #1	Page 170	<b>X</b>
Figure 7-2	Failing Check Valve #1	Page 170	<b>X</b>
Figure 7-3	Testing an RP with a Leaking Shut-off Valve	Page 171	
Figure 7-4	RP: Failing Check Valve #2 during Backpressure Conditions	Page 173	<b>X</b>
Figure 7-5	RP: Failing Check Valve #2 under Backpressure and Backsiphonage Conditions	Page 174	<b>X</b>
Figure 7-6	Backpressure with a Leaking Check Valve #2	Page 175	<b>X</b>
Figure 7-7	RP: Clogged Sensing Line under Backpressure Conditions	Page 176	<b>X</b>
Figure 7-8	Clogged Sensing Line with 0 psi in the Sensing Line	Page 177	<b>X</b>
Figure 7-9	Wear on the Plastic Check Valve Guide	Page 179	<b>X</b>
Figure 8-1	Flowchart of Steps to Have Plumbing Plans Approved	Page 194	
Figure 8-2	Suggested Emergency Response Flowchart	Page 211	
	<b>TABLE OF TABLES</b>		
Table 2-1	Common Waterborne Diseases	Page 12	
Table 2-2	Channels of Transmission of Infection	Page 16	
Table 2-3	Secondary Drinking Water Standards	Page 19	
Table 2-4	Maximum Contaminant Levels (“Primary Standards”) for Inorganic Compounds	Page 20	
Table 2-5	Maximum Contaminant Levels for Volatile Organic Contaminants	Page 23	
Table 2-6	Maximum Contaminant Levels for Synthetic Organic Contaminants	Page 24	
Table 5-1	Summary of Requirements for an Approved Assembly	Page 84	<b>X</b>
Table 5-2	Organizations That Establish Standards for Backflow Prevention Assemblies	Page 84	<b>X</b>
Table 5-3	Summary of Backflow Prevention Methods	Page 109	<b>X</b>
Table 6-1	Testing the DCVA – Single Hose Differential Pressure Gauge Method	Page 148	
Table 7-1	Testing an RP with a Leaking Outlet Shut-off Valve	Page 172	
Table 7-2	Troubleshooting the RP	Page 178	<b>X</b>
Table 7-3	Troubleshooting the DCVA	Page 178	<b>X</b>