

AGRICULTURAL STRUCTURES

Writers:

Claude Busby, Brad King, and James C. Graham
Instructional Materials Laboratory
University of Missouri-Columbia

Consulting Editor:

Jim Riley
Agricultural Education
University of Missouri-Columbia

Sherry Mahnken, Editor

Instructional Materials Laboratory
University of Missouri-Columbia

Produced by:

Instructional Materials Laboratory
University of Missouri-Columbia
10 London Hall
Columbia, Missouri 65211

Volume 31

Number 1

Catalog Number 10-7103-I

June 1999

Available from:
Instructional Materials Laboratory
University of Missouri-Columbia
10 London Hall
Columbia, MO 65211
573-882-2883

**©1999 the Curators of the University of Missouri on behalf of the Missouri Department of
Elementary and Secondary Education. All rights reserved.**

The activity that is the subject of this report was supported in whole or in part by funds from the Department of Elementary and Secondary Education, Division of Vocational and Adult Education. However, the opinions expressed herein do not necessarily reflect the position or policies of the Missouri Department of Elementary and Secondary Education or the Division of Vocational and Adult Education, and no official endorsement should be inferred.

ACKNOWLEDGMENTS

Recognition is given to advisory committee members for providing their valuable time and suggestions in developing this agricultural structures curriculum. The committee consisted of Gale Hodges, Doyle Justus, Keith Mueller, Mike Pollard, Alan Slayton, Kirk Lawson, Lance Massey, Joseph Zulovich, and Charles Parkes.

Information for this project was supplied by individuals at J&B Construction in Gallatin, Missouri; Weston Drilling and Pump Co. in New Franklin, Missouri; and Ballenger's Propane Service in Columbia, Missouri.

Appreciation is expressed to the following staff members of the Instructional Materials Laboratory for their efforts in producing this material: Dana Tannehill, Director; Dan Stapleton, Associate Director; Veronica Feilner, Project Coordinator; Bonnie Painter, Assistant Editor; Cheryl Unterschultz, Graphic Designer; Kevin Gamble, Graphic Artist; Chris Casey, Graphic Artist; and Jill Clark, Jamie Keith, and Allison Cadle, Editorial Assistants.

Sherry Mahnken, Editor
Instructional Materials Laboratory
University of Missouri-Columbia

Jim Riley, Instructor
Agricultural Education
University of Missouri-Columbia

FOREWORD

The development of the *Agricultural Structures* curriculum guide is the result of suggestions by the MVATA Teaching Aids Committee. The Agricultural Structures Advisory Committee suggested the topics to be included and reviewed the materials.

This curriculum contains seven units. The instructor guide includes: objectives, competencies, motivational techniques, teaching procedures, other activities, activity sheets, transparency masters, evaluations, answers to evaluations and activity sheets, references and teaching aids, and materials and equipment. Topics include working with plans, home and farmstead planning, building construction, concrete, electricity, plumbing, and fencing. One copy of the student reference is packaged with the instructor guide. Additional copies of the student reference can be purchased separately.

During the summer of 1981, the Missouri State Board of Education formally adopted the concept of "Instructional Management Systems" (IMS) as a priority for the 1981-82 school year. The Missouri Commissioner of Education described the IMS concept as a practical way of "organizing for excellence" in education. To meet the demand for greater productivity and accountability, the director of Vocational Education applied the elements of IMS to form the Vocational Instructional Management System (VIMS). The VIMS process provides a framework to use in planning and organizing to assure excellence in Missouri's vocational education system by focusing greater attention on the management of teaching and learning.

This guide incorporates the needed components to aid agriculture teachers in the implementation of VIMS.

For ease of use, performance objectives and competencies have been included at the beginning of the guide as well as incorporated within each lesson. A competency profile has been provided in the front of the guide for convenient record keeping. A table is included to show how the competencies in *Agricultural Structures* relate to the Show-Me Standards and Curriculum Frameworks. *Agricultural Structures* is in the Natural Resources career path.

Jim Riley, Instructor
Agricultural Education
University of Missouri-Columbia

Terry Heiman, Director
Agricultural Education
Department of Elementary and
Secondary Education

AGRICULTURAL STRUCTURES

TABLE OF CONTENTS

ACKNOWLEDGMENTS.....	iii
FOREWORD	iv
COMPETENCIES/OBJECTIVES	viii
REFERENCES AND MATERIALS	ix
MATERIALS AND EQUIPMENT FOR ACTIVITIES.....	xii
AGRICULTURAL STRUCTURES COMPETENCY CROSSWALK	xvii
TEACHING CALENDAR	xxv
COMPETENCY PROFILE.....	xxvii
UNIT I - WORKING WITH PLANS	
Lesson 1--Preparing a Plan	I-1
TM 1.1: Architect's Scale.....	I-11
TM 1.2: Labeling.....	I-13
TM 1.3: Symbols.....	I-15
TM 1.4: Lines.....	I-19
TM 1.5: Elevation Drawings	I-21
AS 1.1: Reading a Plan.....	I-23
AS 1.2: Drawing a Plan (Instructor).....	I-25
AS 1.2: Drawing a Plan (Student)	I-27
Lesson 2--Understanding a Plan of Procedure	I-29
AS 2.1: Preparing a Plan of Procedure.....	I-37
UNIT II - HOME AND FARMSTEAD PLANNING	
Lesson 1--Home Site Selection	II-1
AS 1.1: Evaluating Home Sites	II-11
Lesson 2--Arranging a Farmstead	II-13
AS 2.1: Farmstead Planning	II-23
AS 2.2: Planning a Farmstead	II-25
Lesson 3--Livestock Manure Management Systems	II-27
AS 3.1: Resources for Manure Management.....	II-35
UNIT III - BUILDING CONSTRUCTION	
Lesson 1--Construction Safety	III-1
AS 1.1: Safety on the Construction Site.....	III-9
Lesson 2--Building Designs	III-11
AS 2.1: Identifying Building Designs	III-19
Lesson 3--Building Materials	III-21
TM 3.1: Typical APA Plywood Grade-Trademark.....	III-29
AS 3.1: Construction Materials.....	III-31
Lesson 4--Fasteners and Fastening Systems	III-33
TM 4.1: Nails	III-41
TM 4.2: Nail Sizes	III-43

TM 4.3:	Screws.....	III-45
TM 4.4:	Framing Anchors	III-47
AS 4.1:	Identifying Fasteners.....	III-49
Lesson 5--Floors and Subfloors		III-51
TM 5.1:	Parts of a Floor.....	III-59
TM 5.2:	Bridging	III-61
AS 5.1:	Diagramming Flooring	III-63
JS 5.1:	Joist Layout	III-65
Lesson 6--Walls		III-67
TM 6.1:	Pole Frame Construction.....	III-75
TM 6.2:	Stud Frame Construction	III-77
TM 6.3:	Components of a Frame Wall.....	III-79
AS 6.1:	Wall Construction	III-81
Lesson 7--Roof Support Systems.....		III-83
TM 7.1:	Sample Truss	III-93
TM 7.2:	Rafters.....	III-95
TM 7.3:	Pitch	III-97
TM 7.4:	Parts of a Rafter	III-99
TM 7.5:	Rafter Table.....	III-101
TM 7.6:	Rafter Cuts	III-103
TM 7.7:	Roof Styles.....	III-105
JS 7.1:	Rafter Layout.....	III-107
Lesson 8--Roofing Materials		III-109
TM 8.1:	Structural Components of Roofs	III-117
TM 8.2:	Applying the Starter Course	III-119
TM 8.3:	Three-Tab Shingle Application.....	III-121
TM 8.4:	Applying Cap Shingles	III-123
AS 8.1:	Applying Roofing Materials.....	III-125
Lesson 9--Heating, Cooling, and Ventilation		III-129
AS 9.1:	Heating, Cooling, and Ventilation Needs	III-137
 UNIT IV - CONCRETE		
Lesson 1--Safety in Working with Concrete		IV-1
AS 1.1:	Concrete Safety.....	IV-7
Lesson 2--Factors Affecting the Quality of Fresh Concrete.....		IV-9
TM 2.1:	Slump Test.....	IV-19
AS 2.1:	Mixing Concrete	IV-21
Lesson 3--Site Preparation		IV-23
TM 3.1:	Footing	IV-31
TM 3.2:	Equal and Unequal Diagonals.....	IV-33
TM 3.3:	Batter Boards	IV-35
AS 3.1:	Subgrade Preparation	IV-37
AS 3.2:	Laying Out a Building	IV-39
Lesson 4--Pouring a Concrete Slab.....		IV-41
AS 4.1:	Reinforcing Concrete.....	IV-51
Lesson 5--Ordering, Pouring, and Finishing Concrete.....		IV-53
JS 5.1:	Pouring a Concrete Curb.....	IV-61
Lesson 6--Curing Concrete		IV-63
AS 6.1:	Curing Concrete	IV-73
Lesson 7--Pouring Concrete Walls.....		IV-75
TM 7.1:	Plywood Forms.....	IV-83
TM 7.2:	Parts of a Form.....	IV-85
JS 7.1:	Preparing Forms for a Concrete Wall.....	IV-87

UNIT V - ELECTRICITY

Lesson 1--Electrical Safety	V-1
AS 1.1: Electricity on the Internet	V-9
Lesson 2--Electrical Terminology	V-11
AS 2.1: Electrical Terms	V-19
Lesson 3--Wire Types and Uses	V-21
TM 3.1: Service Wire	V-31
TM 3.2: Cable	V-33
TM 3.3: Wire Sizes	V-35
TM 3.4: Wiring Tables	V-37
TM 3.5: Feeder Wires	V-39
AS 3.1: Calculating Feeder Wire Size	V-41
Lesson 4--Grounding and GFCI Protection	V-43
TM 4.1: A GFCI at Work	V-51
TM 4.2: Types of GFCIs	V-53
AS 4.1: Grounding and GFCIs	V-55
Lesson 5--Lights, Outlets, Switches, and Circuit Protection	V-57
AS 5.1: Evaluating Lights, Outlets, Switches, and Circuit Protection	V-65
Lesson 6--Electrical Symbols in Wiring Plans	V-67
TM 6.1: Electrical Wiring Symbols	V-75
AS 6.1: Diagraming Electrical Wiring	V-81
Lesson 7--Running Electrical Wiring	V-83
TM 7.1: Wire Stacking at the Pole	V-91
TM 7.2: Installation of the Service Entrance	V-93
AS 7.1: Diagraming the Service Stack	V-95
Lesson 8--Connecting to the SEP	V-97
TM 8.1: SEP Parts	V-105
TM 8.2: Ground System	V-107
TM 8.3: Wired 120/240 V Panel	V-109
AS 8.1: Identifying SEP Components	V-111
Lesson 9--Running Wire from the SEP	V-113
TM 9.1: Wiring Diagram	V-123
TM 9.2: Labeling Receptacles	V-125
TM 9.3: Ceiling Runs	V-127
TM 9.4: Wall Runs	V-129
TM 9.5: Junction Box	V-131
TM 9.6: Connectors	V-133
TM 9.7: Wiring a Switch and Light	V-135
TM 9.8: Wiring a Switch Loop	V-137
TM 9.9: Wiring a Three-Way Switch and Light	V-139
TM 9.10: Series and Parallel Wiring	V-141
TM 9.11: Wiring a Convenience Outlet	V-143
JS 9.1: Wiring a Three-Way Switch	V-145
Lesson 10--Cost and Electrical Power Use	V-147
TM 10.1: Formulas	V-155
TM 10.2: Measuring Electricity	V-157
AS 10.1: Calculating Electrical Costs	V-159
Lesson 11--Lightning Protection	V-161
TM 11.1: When Lightning Strikes	V-169
TM 11.2: Components of a Lightning Protection System	V-171
TM 11.3: Grounding Practices	V-173
AS 11.1: Assessing Lightning Protection	V-175
Lesson 12--Detecting Problems	V-177
TM 12.1: Types of Electrical Testers	V-183
AS 12.1: Using Testing Devices	V-185

UNIT VI - PLUMBING

Lesson 1--Water Needs	VI-1
TM 1.1: Water Needs Table	VI-9
AS 1.1: Determining Water Needs	VI-11
Lesson 2--Plumbing Safety	VI-13
TM 2.1: Cutting Tools for Copper Pipe	VI-21
TM 2.2: Flaring and Bending Tools	VI-23
AS 2.1: Working with Plumbing Safely.....	VI-25
Lesson 3--Pipe Types and Size Requirements	VI-27
TM 3.1: Plastic Pipe Fittings.....	VI-35
TM 3.2: Copper Pipe Fittings.....	VI-37
TM 3.3: PVC Pipe Size Table.....	VI-39
AS 3.1: Pipe Usage.....	VI-41
Lesson 4--Measuring, Cutting, and Connecting Pipes	VI-43
AS 4.1: Cutting and Joining Plastic Pipe.....	VI-51
JS 4.1: Sweating Copper Pipe	VI-53
Lesson 5--Protecting Water Pipes from Freezing	VI-55
TM 5.1: Electric Heat Tape.....	VI-61
AS 5.1: Water Pipes and Freezing Temperatures	VI-63

UNIT VII -FENCING

Lesson 1--Fencing Basics	VII-1
AS 1.1: Building Legal Fences	VII-9
Lesson 2--Setting and Bracing Posts	VII-11
TM 2.1: Anchor-and-Brace Assemblies.....	VII-19
TM 2.2: H-Brace	VII-21
TM 2.3: Metal Corner Post and Braces	VII-23
AS 2.1: Constructing Model Brace Assemblies	VII-25
Lesson 3--Barbed and Woven Wire Fences	VII-27
TM 3.1: Staple Positioning	VII-35
JS 3.1: Constructing Barbed Wire Fencing	VII-37
Lesson 4--High Tensile and Electric Fences	VII-39
TM 4.1: Electric Fencing Components	VII-47
AS 4.1: Tensioning Fences	VII-49
Lesson 5--Fence Mending Techniques	VII-51
TM 5.1: Using a Compression Sleeve.....	VII-57
TM 5.2: Splicing Woven Wire	VII-59
AS 5.1: Splicing Wire	VII-61

COMPETENCIES/OBJECTIVES

UNIT I - WORKING WITH PLANS

1. Read and create a simple construction drawing.
2. Develop a plan of procedure and a bill of materials for a construction project.

UNIT II - FARMSTEAD PLANNING

1. Evaluate a site for a home.
2. Arrange a farmstead.
3. Describe characteristics of disposal systems for managing livestock manure.

UNIT III - BUILDING CONSTRUCTION

1. Describe safety practices associated with building construction.
2. Identify types and designs of buildings and their methods of construction.
3. Identify and select building materials.
4. Identify the uses of different fasteners and fastening systems.
5. Describe how to construct a floor and subfloor.

6. Describe the purposes of walls, types of walls, supports, and siding used in agricultural buildings.
7. Select a roof support system.
8. Select roofing materials.
9. Identify factors affecting the heating, cooling, and ventilation of agricultural structures.

UNIT IV - CONCRETE

1. Discuss safety in working with concrete.
2. Identify factors that affect the quality of fresh concrete.
3. Identify site preparation requirements.
4. Describe the procedure for preparing to pour a concrete slab.
5. Explain the procedure for ordering, pouring, and finishing concrete.
6. Identify factors affecting the quality of cured concrete.
7. Describe the procedure for pouring a concrete wall.

UNIT V - ELECTRICITY

1. Identify the terms, dangers, and safety practices associated with electrical work.
2. Identify the terms associated with electrical work.
3. Match types and sizes of wire with their uses.
4. Identify the importance of grounding and GFCI protection.
5. Locate lights, outlets, and switches, and identify circuit protection needs.
6. Identify the symbols used in agricultural wiring plans.
7. Describe practices for running wire to an agricultural structure and wiring within the building safely.
8. Identify procedures for connecting the drop wires and branch circuit wires to the SEP.
9. Describe how to run wiring from the SEP to a junction box, lights, and receptacles.
10. Calculate cost and electrical power using Ohm's Law.
11. Describe procedures for planning and installing lightning protection.
12. Identify problems in electrical systems.

UNIT VI - PLUMBING

1. Calculate how much water is needed for a farmstead.
2. Discuss safety practices for plumbing.
3. Identify pipe types and determine size requirements.
4. Measure, cut, and connect pipes and tubing.
5. Identify methods of protecting water pipes against freezing.

UNIT VII - FENCING

1. Discuss the terminology, dangers, and safety practices associated with building fences.
2. Describe how to set and brace wood and steel posts.
3. Describe techniques for building barbed and woven wire fences.
4. Describe techniques for building high tensile and electric fences.
5. Identify fence mending techniques.

EVALUATION

1. Give short, objective tests following each lesson and a more in-depth objective test at the conclusion of the unit.
2. Observe the changes in behavior as evidence of the improved ability of students to deal with problems in this unit using background information acquired from earlier units.
3. Observe students' attempts to solve similar problems in their supervised agricultural experience programs.

REFERENCES AND MATERIALS

1. Student Reference

Agricultural Structures (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1999.

2. Teacher References

a. Books

- 1) Ahrens, Donald L. *Concrete and Concrete Masonry.* St. Paul, Minn.: Hobar Publications, 1976.
- 2) Annis, William H. *Basic Plumbing Skills.* Athens, Ga.: American Association for Vocational Instructional Materials (AAVIM), 1989.
- 3) Ball, John E. *Tools, Steel Square, and Joinery.* Vol. 1 of *Carpenters and Builders Library*, Revised by John Leeke. New York: Macmillan Publishing Co., Inc., 1991.
- 4) Boyd, James S. *Buildings for Small Acreages.* Revised by Carl L. Reynolds. Danville, Ill.: Interstate Publishers, Inc., 1996.
- 5) Boyd, James S. *Practical Farm Buildings.* 3rd ed. Revised by Joshua L. Reynolds. Danville, Ill.: Interstate Publishers, Inc., 1993.
- 6) Brunk, Art. *Building Maintenance.* Module III, *Plumbing.* University of Missouri--Columbia: Instructional Materials Laboratory, 1990.
- 7) Burch, Monte. *How to Build Small Barns and Outbuildings.* Pownal, Vt.: Garden Way Publishing, 1992.
- 8) Cooper, Elmer L. *Agricultural Mechanics: Fundamentals and Applications.* Albany, N.Y.: Delmar Publishers, 1997.
- 9) Duelm, Brian L. *Computer-Aided Drafting.* Holland, Ill.: Goodheart-Wilcox Company, Inc., 1989.
- 10) Ensminger, M.E. *The Stockman's Handbook.* 7th ed. Danville, Ill.: Interstate Publishers, 1992.
- 11) Hiatt, Richard S., ed. *Agricultural Wiring Handbook.* 11th ed. Columbia, Mo.: National Food And Energy Council. 1996.
- 12) Holzman, H.N. *Modern Residential Wiring.* South Holland, Ill.: Goodheart-Wilcox Company, Inc., 1996.

- 13) Huth, Mark W. *Construction Technology*. 2nd ed. Albany, N.Y.: Delmar Publishers, Inc., 1989.
- 14) Kicklighter, Clois E. et al. *Architecture: Residential Drawing and Design*. Tinley Park, Ill.: Goodheart-Willcox Company, 1995.
- 15) Jordan, Cora. *Neighbor Law: Fences, Trees, Boundaries, and Noise*. Berkeley, Calif.: Nolo Press, 1991.
- 16) Lindley, James A., and James H. Whitaker. *Agricultural Buildings and Structures*. Rev. ed. St. Joseph, Mich.: American Society of Agricultural Engineers. 1996.
- 17) McClain, Gerald R. *Basic Drafting*. 3rd ed. Stillwater, Okla.: MAVCC, 1997.
- 18) McConnell, Charles. *Plumbers and Pipe Fitters Library*. Vol 3, *Water Supply - Drainage - Calculations*. New York: Macmillan, 1989.
- 19) Mix, Floyd M. *House Wiring Simplified*. Tinley Park, Ill.: Goodheart-Willcox Company, Inc., 1996.
- 20) National Plan Service. *UCANDO Design #B2042*. 1994.
- 21) Phillips, Richard E. *Farm Buildings: From Planning to Completion*. St. Louis: Doane-Western, 1981.
- 22) Phipps, Lloyd J., and Carl L. Reynolds. *Mechanics in Agriculture*. 4th ed. Danville, Ill.: Interstate Publishers, 1990.
- 23) Ramsey, Dan. *The Complete Book of Fences*. Blue Ridge Summit, Pa.: TAB Books, Inc., 1983.
- 24) Richter, H.P., and W.C. Schwann. *Wiring Simplified*. 38th ed. Somerset, Wis.: Park Publishing, Inc., 1996.
- 25) Steele, Kenneth. *Animal Waste and Land Water Interface*. Boca Raton: Lewis Publishers, 1995.
- 26) Taylor, Robert L. *Builders Estimating Databook*. Blue Ridge Summit, Pa.: Tab Books, 1990.
- 27) Time-Life Editors. *Insulation & Weatherproofing*. Alexandria, Va.: Time-Life Books, 1996.
- 28) Wagner, Willis H. *Modern Carpentry*. South Holland, Ill.: Goodheart-Wilcox Co., Inc., 1987.

b. Extension publications

- 1) *Animal Waste Regulations for Livestock Producers in Missouri (WQ200)*. University Extension Agricultural Publications, 1993.
- 2) *Constructing Electric Fences for Cattle (G1190)*. University Extension Agricultural Publications, 1993.

- 3) Constructing Wire Fences (G1192). University Extension Agricultural Publications. University of Missouri-Columbia.
- 4) How to Size a Farm and Home Water System (G1801). University Extension Agricultural Publications. University of Missouri-Columbia.
- 5) *Lightning Protection for Missouri Farms and Homes (G1020)*. University Extension Agricultural Publications, 1993.
- 6) Missouri Fencing and Boundary Laws (G810). University Extension Agricultural Publications, 1993.
- 7) *Selecting Wire Fencing Materials (G1191)*. University Extension Agricultural Publications, 1993.
- 8) *Sources for Farm and Home Water Supply (G1800)*. University Extension Agricultural Publications. University of Missouri-Columbia.

c. Internet resources

- 1) Bucklin, R. A., W. E. Kunkle, and R. S. Sand. "Construction of High Tensile Wire Fences." <http://gnv.ifas.ufl.edu/~fairsweb/text/ae/ae017.html> (9 September 1998).
- 2) Consumer Information Center. "A Home Electrical Safety Check." From the National Electrical Safety Foundation, 1995. http://www.pueblo.gsa.gov/cic_text/housing/home-elec/homeelec.txt (1 September 1998).
- 3) "Electrical Code." <http://anna.texoma.net/Nonprofit/City/Code/Index.htm> (22 January 1999).
- 4) Electricians Toolbox Etc. "Lightning Protection." <http://www.elec-toolbox.com/usefulinfo/lightprot.htm> (8 February 1999).
- 5) Environmental Protection Agency. "Office of Enforcement and Compliance Assurance." <http://es.epa.gov/oeca/> (31 August 1998).

- 6) Granite Rock Company. "Concrete Surface Defects - Causes, Prevention and Repair." <http://www.graniterock.com/tn.htm> (12 December 1998).
- 7) Kardon, Redwood. "Code Check: Help with Building Codes." <http://www.codecheck.com/frame.htm> (22 January 1999).
- 8) Kidwell, Boyd. "Choosing a Charger." *Progressive Farmer.com* <http://progressivefarmer.com/equipment/1098/fence/choose.html> (20 May 1999).
- 8) Materials Science and Technology (MAST) Teacher's Workshop. "Concrete." Produced by the Department of Materials Science and Engineering at the University of Illinois, Urbana/Champaign. <http://mach-pc66.mse.uiuc.edu/~tw/concrete/concrete.html> (29 August 1998).
- 9) Mississippi State University Extension Service. *Frozen Pipes: Causes and Cures*. <http://www.ext.msstate.edu/pubs/is1438.htm> (25 September 1998).
- 10) Missouri Department of Natural Resources. "Division of Energy." <http://www.dnr.state.mo.us/de> (25 January 1999).
- 11) Missouri Department of Natural Resources. "Soil and Water Conservation Service Program." <http://www.dnr.state.mo.us/deq/swcp/faqswwcp/htm> (17 August 1998).
- 12) State Farm Educational Materials. "Lightning Protection." <http://www5.statefarm.com/educate/lightnin.htm> (8 Feb. 1999).
- 13) The Concrete Pages. "Control Joints for Concrete Slabs." <http://www.concretepages.com/tcjts.html> (19 October 1998).

MATERIALS AND EQUIPMENT FOR ACTIVITIES

1. Unit 1, Lesson 1: Drawing a Plan

Computer with CAD software and printer (if possible)
 Paper, either plain white copy paper or high rag content drawing paper (if professional hand drawing instruments are available)
 No. 2 lead pencil
 Ruler or architect's scale

2. Unit 3, Lesson 5: Joist Layout

10 8-foot 2" × 8" boards
 2 10-foot 2" × 8" boards
 16d duplex head nails
 Circular or radial arm saw
 Hammer
 Tape measure

3. Unit 3, Lesson 7: Rafter Layout

Pencil and paper

Carpenter's framing square
Boards, strips of construction paper, cardboard, or rolls of fax paper

4. Unit 3, Lesson 8: Applying Roofing Materials

Classroom or shop tables
Paper models of shingles

5. Unit 4, Lesson 3: Laying Out a Building

4 stakes
2 tape measures
Twine

6. Unit 4, Lesson 4: Reinforcing Concrete

1 8-foot 1" × 6" board
20 16d duplex-head nails
½" welding wire
Wax paper or plastic wrap
Latex gloves
Eye protection
Concrete mix

7. Unit 4, Lesson 5: Pouring a Concrete Curb

Wood and duplex nails for forms
Tape measure
Concrete
2 1" pipes, 1' long
Wire
Rebar
Wire for rebar supports
Shovel or spade
Oil
Hand trowel
Board for screed
Latex gloves
Eye protection

8. Unit 4, Lesson 6: Curing Concrete

Mixed concrete
15 3" pieces of PVC pipe, 6" long
Hydraulic press
Oil (new motor oil)
¼" steel rod, 8" long
4' × 4' piece of plywood or sheet metal
Buckets
Oven
Freezer
Sand

9. Unit 4, Lesson 7: Preparing Forms for a Concrete Wall

Plywood

- 16d duplex-head nails
- 4 snap ties
- 8 snap tie holders
- 2 8-foot 2" × 4" boards for wales and braces
- 1 4-foot 1" × 4" board for ties
- Wire for wire ties
- 2" × 4" scraps for spreaders
- Electric drill and bits
- Level

10. Unit 5, Lesson 9: Wiring a Three-Way Switch

- Mock wall with two switch boxes and one light fixture already attached
- 1 12-2 NMC cable, 16 inches long
- 2 12-3 NMC cables, 30 inches long
- 2 three-way switches
- Light fixture
- Solderless connectors
- Three-prong plug
- Screw driver set
- Wire strippers
- Cable rippers

11. Unit 5, Lesson 12: Using Testing Devices

- Neon tester
- Voltage tester
- VOM meter

12. Unit 6, Lesson 4: Cutting and Joining Plastic Pipe

- 1" PVC pipe, 4 feet in length
- 4 1-inch 90-degree PVC elbows
- 1 1-inch PVC T
- 1 1-inch PVC cap
- Tape measure
- Hacksaw
- PVC primer and glue (optional)
- Sandpaper

13. Unit 6, Lesson 4: Sweating Copper Pipe

- 1 1" copper pipe, 4 inches in length
- 1 1" cap
- Flux
- Brush
- Propane torch
- Stationary vise
- Steel wool or sandpaper

14. Unit 7, Lesson 2: Constructing Model Brace Assemblies

- 1 8-foot 2" × 4"
- 1 4-foot ½" dowel
- Hacksaw
- ½-inch drill bit
- Drill

Wood glue
Wood chisel
1 12d nail
2 feet of thin wire (.035 MIG wire)

15. Unit 7, Lesson 3: Constructing Barbed Wire Fencing

Barbed wire
Fence stretchers
Metal fence posts
Metal post driver
Wire clips
Fencing pliers
Standard screwdriver
Claw hammer
Fencing staples

16. Unit 7, Lesson 4: Tensioning Fences

14-gauge soft wire
Strainer
Wire cutters

17. Unit 7, Lesson 5: Splicing Wire

14-gauge soft electric wire, cut into four 2-foot pieces
Compression sleeve
Sleeve compressor or fencing pliers

Agricultural Structures - Competency Crosswalk

Duty Band and Task Statement	SHOW-ME STANDARDS		CURRICULUM FRAMEWORKS					
	Knowledge (Content)	Performance (Goals)	Math	Communication Arts	Science	Social Studies	Health/ Physical Education	Fine Arts
A-1	FA-4 CA-3 MA-2	1.4, 1.5, 1.6, 1.8, 2.1, 2.5, 4.1	MA/VI/9-12/3a, 3b	CA/I/9-12/3b CA/II/9-12/2c CA/II/9-12/3c CA/II/9-12/4i CA/III/9-12/1j				FA/IV-A/9-12/6a
A-2	MA-1 CA-1	1.4, 1.6, 2.1, 3.2	MA/V/9-12/1a MA/IV/9-12/3a, 3b, 3c, 3d	CA/II/9-12/1a, 1b				
xvii B-1	SC-4, SC-8 SS-5, SS-6, SS-7 CA-3	1.1, 1.2, 1.4, 1.10, 2.3, 3.1, 3.8, 4.1, 4.2		CA/IV/9-12/1a, 1b, 1c, 1d, 1e, 1f, 1g, 1h, 1i	SC/VIII-A/9-12/2a SC/VIII-B/9-12/2a	SS/IV-A/9-12/3a, 3b, 3c, 3d, 3e, 3f, 3g, 3h, 3i SS/IV-B/9-12/1a, 1b, 1c, 1d, 1e, 1f, 1g, 1h, 1i		
B-2	SC-1,SC-2, SC-5,SC-8 SS-5	1.2, 1.4, 2.3, 3.1, 3.2, 3.3, 3.5, 3.6, 3.7, 3.8			SC/II-A/9-12/2a SC/VIII-A/9-12/2b SC/VIII-B/9-12/2a, 2b, 2c	SS/IV-A/9-12/3a, 3b, 3c, 3d, 3e, 3f, 3g, 3h, 3i SS/IV-B/9-12/1a, 1b, 1c, 1d, 1e, 1f, 1g, 1h, 1i		
B-3	SC-8 CA-3	1.4, 1.5, 3.1, 3.2, 3.3, 3.5, 3.6, 3.7, 4.7		CA/I/9-12/1b, 1d CA/I/9-12/2a, 2b, 2c, 2d, 2e CA/1/9-12/3a, 3b, 3c, 3d, 3e	SC/VIII-B/9-12/1a			
C-1	HPE-6 CA-3	1.2, 1.10, 3.2, 3.3, 4.7	CA/IV/9-12/1c, 1d, 1e, 1f, 1g, 1h				HPE/III-B/9-12/5a	
C-2	CA-3 MA-2	1.2, 1.7, 2.5 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8	MA/VI/9-12/2a	CA/I/9-12/1b CA/IV/9-12/1a, 1b, 1c, 1d, 1e, 1f, 1g, 1h				

Duty Band and Task Statement	SHOW-ME STANDARDS		CURRICULUM FRAMEWORKS					
	Knowledge (Content)	Performance (Goals)	Math	Communication Arts	Science	Social Studies	Health/ Physical Education	Fine Arts
xviii C-3	CA-3	1.1, 1.4, 1.8, 1.10, 3.1, 3.5, 3.8		CA/IV/9-12/1c, 1d, 1e, 1f, 1g, 1h				
C-4	SC-2	1.2			SC/IV-C/9-12/1a			
C-5	MA-1	1.3, 1.10, 2.5, 3.1, 3.2, 4.6, 4.7	MA/IV/9-12/3a, 3b, 3c, 3d, 3e					
C-6	MA-2	1.3, 1.5, 2.5, 3.5	MA/IV/9-12/3a, 3b, 3c, 3d, 3e MA/VI/9-12/1b, 1d, 1i, 1k, 1l, 2b, 2d, 2i, 2k, 2l, 3b, 3d, 3i, 3k, 3l					
C-7	MA-2	1.3, 1.5, 2.5, 3.5	MA/IV/9-12/3a, 3b, 3c, 3d, 3e MA/VI/9-12/1b, 1d, 1i, 1k, 1l, 2b, 2d, 2i, 2k, 2l, 3b, 3d, 3i, 3k, 3l					
C-8	CA-3 SC-1	1.2, 1.3, 1.5, 3.5, 4.1		CA/I/9-12/1b	SC/II-A/9-12/1c			
C-9	SC-8 CA-3	1.1, 1.2, 1.3, 1.4, 1.8, 2.5, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7		CA/I/9-12/1b CA/I/9-12/2c	SC/III-B/9-12/2a SC/III-C/9-12/4a			
D-1	CA-3 HPE-6	1.2, 1.4, 3.2, 3.3, 4.7		CA/I/9-12/1b CA/II/9-12/1c CA/IV/9-12/1c, 1d, 1e, 1h			HPE/III-B/9-12/5a	
D-2	SC-8 MA-1	1.2, 1.3, 1.4, 1.6, 1.8, 2.5, 3.1, 3.2, 3.3,	MA/IV/9-12/2b, 2c, 2d, 3b, 3c, 3d		SC/III-B/9-12/1a			

Duty Band and Task Statement	SHOW-ME STANDARDS		CURRICULUM FRAMEWORKS					
	Knowledge (Content)	Performance (Goals)	Math	Communication Arts	Science	Social Studies	Health/ Physical Education	Fine Arts
		3.4, 3.5, 3.6, 3.7, 3.8						
D-3	CA-3 MA-1, 2		MA/IV/9-12/2a, 2b, 2d, 3a, 3b, 3d	CA/I/9-12/1b CA/II/9-12/1c				
D-4	CA-3	1.2, 1.4, 1.5, 1.7, 1.8, 3.2, 3.3, 3.5, 3.7, 3.8		CA/1/9-12/1b CA/II/9-12/1c CA/IV/9-12/1c, 1d, 1e, 1f, 1g, 1h				
D-5	SC-8 CA-3 MA-1, 2	1.2, 1.3, 1.5, 1.8, 1.10, 2.5, 2.6, 3.2, 3.3, 3.7, 3.8	MA/I/9-12/4a, 4b, 4c, 4d, 4e MA/III/9-12/1a, 1b, 1c, 1d, 2a, 2b, 2c, 2d, 4a, 4b, 4c, 4d, 5a, 5b, 5c, 5d MA/IV/9-12/2a, 2b, 2c, 2d, 2e, 3a, 3b, 3c, 3d, 3e MA/VI/9-12/1a, 1b, 1c, 1d, 2a, 2b, 2c, 2d, 3a, 3b, 3c, 3d	CA/IV/9-12/1c, 1d, 1e, 1f, 1g, 1h, 2c, 2d, 2e, 2f, 2g, 2h, 3c, 3d, 3e, 3f, 3g, 3h	SC/III-B/9-12/1a			
xix D-6	SC-8	1.2, 1.3, 1.5, 1.8, 1.10, 2.5, 2.6, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8			SC/III-B/9-12/1a			
D-7	SC-8 CA-3 MA-1, 2	1.2, 1.3, 1.5, 1.8, 1.10, 2.5, 2.6, 3.2, 3.3, 3.7, 3.8	MA/I/9-12/4a, 4b, 4c, 4d, 4e MA/III/9-12/1a, 1b, 1c, 1d, 2a, 2b, 2c, 2d, 4a, 4b, 4c, 4d, 5a, 5b, 5c, 5d MA/IV/9-12/2a, 2b, 2c, 2d, 2e, 3a, 3b, 3c, 3d, 3e MA/VI/9-12/1a, 1b,	CA/IV/9-12/1c, 1d, 1e, 1f, 1g, 1h, 2c, 2d, 2e, 2f, 2g, 2h, 3c, 3d, 3e, 3f, 3g, 3h	SC/III-B/9-12/1a			

Duty Band and Task Statement	SHOW-ME STANDARDS		CURRICULUM FRAMEWORKS					
	Knowledge (Content)	Performance (Goals)	Math	Communication Arts	Science	Social Studies	Health/ Physical Education	Fine Arts
			1c, 1d, 2a, 2b, 2c, 2d, 3a, 3b, 3c, 3d					
E-1	HPE-6	1.1, 1.2, 1.3, 1.4, 1.5, 1.8, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7					HPE/III-D/9-12/1a, 1b	
E-2	CA-3			CA/I/9-12/1b CA/I/9-12/2c				
E-3	SC-8 CA-3	1.2, 1.3, 1.4, 1.8, 2.5, 2.6, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7		CA/IV/9-12/1c, 1d, 1e, 1f, 1g, 1h	SC/III-B/9-12/1a			
E-4	HPE-6	1.2, 1.4, 1.8, 2.6, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 4.7					HPE/III-D/9-12/1a, 1b	
xx E-5	CA-3 HPE-6	1.2, 1.3, 1.4, 1.8, 2.5, 2.6, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 4.7		CA/IV/9-12/1c, 1d, 1e, 1f, 1g, 1h CA/IV/9-12/2c			HPE/III-D/9-12/1a, 1b	
E-6	CA-3	1.2, 1.4, 1.8, 2.6, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7		CA/IV/9-12/1c, 1d, 1e, 1f, 1g, 1h CA/IV/9-12/2c				
E-7	HPE-6 SC-8 CA-3	1.2, 1.3, 1.4, 1.7, 1.8, 2.6, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 4.7		CA/IV/9-12/1c, 1d, 1e, 1f, 1g, 1h	SC/III-B/9-12/1a		HPE/III-D/9-12/1a, 1b	

Duty Band and Task Statement	SHOW-ME STANDARDS		CURRICULUM FRAMEWORKS					
	Knowledge (Content)	Performance (Goals)	Math	Communication Arts	Science	Social Studies	Health/ Physical Education	Fine Arts
E-8	HPE-6 SC-8 CA-3	1.2, 1.3, 1.4, 1.7, 1.8, 2.6, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 4.7		CA/IV/9-12/1c, 1d, 1e, 1f, 1g, 1h	SC/III-B/1a		HPE/III-D/9-12/1a, 1b	
E-9	HPE-6 SC-8 CA-3	1.2, 1.3, 1.4, 1.7, 1.8, 2.6, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 4.7		CA/IV/9-12/1c, 1d, 1e, 1f, 1g, 1h	SC/III-B/9-12/1a		HPE/III-D/9-12/1a, 1b	
E-10	MA-1,3 HPE-6 SC-8	1.1, 1.2, 1.4, 1.8, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 4.7	MA/IV/9-12/2a, 2b, 2c, 2d, 3a, 3b, 3c, 3d MA/V/9-12/1a, 1b, 1c, 2a, 2b, 2c		SC/III-B/9-12/1a		HPE/III-D/9-12/1a	
xxi E-11	HPE-6 SC-8 CA-3	1.2, 1.3, 1.4, 1.7, 1.8, 2.6, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 4.7		CA/IV/9-12/1c, 1d, 1e, 1f, 1g, 1h	SC/III-B/9-12/1a		HPE/III-D/9-12/1a, 1b	
E-12	CA-3 SC-1 HPE-6	1.1, 1.2, 1.4, 1.8, 1.10, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 4.7		CA/IV/9-12/1c, 1d, 1e, 1f, 1g, 1h	SC/III-B/9-12/4a		HPE/III-D/9-12/1a	
F-1	MA-1 SC-8	1.2, 1.4, 1.8, 1.10, 3.2, 3.3, 3.5, 3.6, 3.7	MA/V/9-12/1a		SC/VIII-A/9-12/3b			
F-2	HPE-6 CA-3	1.2, 1.3, 1.7, 1.8, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7		CA/IV/9-12/1c, 1d, 1e, 1f, 1g, 1h			HPE/III-D/9-12/1a, 1b	

Duty Band and Task Statement	SHOW-ME STANDARDS		CURRICULUM FRAMEWORKS					
	Knowledge (Content)	Performance (Goals)	Math	Communication Arts	Science	Social Studies	Health/ Physical Education	Fine Arts
F-3	CA-3 MA-1, 2	1.2, 1.4, 1.8, 2.5, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7	MA/V/9-12/1a MA/VI/9-12/1b, 1c, 1d, 2b, 2c, 2d, 3b, 3c, 3d	CA/IV/9-12/1c, 1d, 1e, 1f, 1g, 1h				
F-4	HPE-6 CA-3 MA-1	1.2, 1.3, 1.4, 1.8, 2.5, 2.6, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 4.7	MA/I/9-12/1a, 1b, 1c, 1d, 1e, 2a, 2b, 2c, 2d, 2e, 3a, 3b, 3c, 3d, 3e, 4a, 4b, 4c, 4d, 4e	CA/IV/9-12/1c, 1d, 1e, 1f, 1g, 1h			HPE/III-D/9-12/1a, 1b	
F-5	CA-3	1.2, 1.4, 1.8, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7	CA/I/9-12/1b CA/III/9-12/1a, 1b, 1c, 1d, 1e, 1f, 1g, 1h, 1i, 1j					
G-1	HPE-6 CA-3	1.2, 1.3, 1.7, 1.8, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7		CA/I/9-12/1b CA/III/9-12/1a, 1b, 1c, 1d, 1e, 1f, 1g, 1h, 1i, 1j			HPE/III-D/9-12/1a, 1b	
xxii G-2	MA-1	1.2, 1.3, 1.4, 1.8, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7	MA/IV/9-12/3a, 3b, 3c, 3d, 3e MA/I/9-12/1a, 1b, 1c, 1d, 1e, 2a, 2b, 2c, 2d, 2e, 3a, 3b, 3c, 3d, 3e, 4a, 4b, 4c, 4d, 4e	CA/I/9-12/1b				
G-3	MA-1	1.2, 1.3, 1.4, 1.8, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7	MA/IV/9-12/3a, 3b, 3c, 3d, 3e MA/I/9-12/1a, 1b, 1c, 1d, 1e, 2a, 2b, 2c, 2d, 2e, 3a, 3b, 3c, 3d, 3e, 4a, 4b, 4c, 4d, 4e	CA/I/9-12/1b				
G-4	MA-1	1.2, 1.3, 1.4, 1.8, 3.1, 3.2, 3.3, 3.4, 3.5,	MA/IV/9-12/ 3a, 3b, 3c, 3d, 3e MA/I/9-12/ 1a, 1b,	CA/I/9-12/1b				

Duty Band and Task Statement	SHOW-ME STANDARDS		CURRICULUM FRAMEWORKS					
	Knowledge (Content)	Performance (Goals)	Math	Communication Arts	Science	Social Studies	Health/ Physical Education	Fine Arts
		3.6, 3.7	1c, 1d, 1e, 2a, 2b, 2c, 2d, 2e, 3a, 3b, 3c, 3d, 3e, 4a, 4b, 4c, 4d, 4e					
xxiii G-5	CA-3	1.2, 1.3, 1.4, 1.5, 2.5, 2.6, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7		CA/I/9-12/1b CA/III/9-12/1a, 1b, 1c, 1d, 1e, 1f, 1g, 1h, 1i, 1j				

AGRICULTURAL STRUCTURES

TEACHING CALENDAR

	Periods for Classroom Instruction/Activities	Length for Activity Sheets (AS)
Unit I, Lesson 1	6	AS 1.1 30 min.
		AS 1.2 1 class period
Unit I, Lesson 2	5	AS 2.1 30 min.
Unit II, Lesson 1	6	AS 1.1 1 class period
Unit II, Lesson 2	15	AS 2.1 1 class period
		AS 2.2 2 class periods
Unit II, Lesson 3	2	AS 3.1 1 class period
Unit III, Lesson 1	1	AS 1.1 30 min.
Unit III, Lesson 2	2	AS 2.1 1 class period
Unit III, Lesson 3	3	AS 3.1 1 class period
Unit III, Lesson 4	4	AS 4.1 1 class period
Unit III, Lesson 5	5	AS 5.1 30 min.
		AS 5.2 1 class period
Unit III, Lesson 6	5	AS 6.1 30 min.
Unit III, Lesson 7	6	AS 7.1 1 class period
Unit III, Lesson 8	4	AS 8.1 1 class period
Unit III, Lesson 9	2	AS 9.1 1 class period
Unit IV, Lesson 1	2	AS 1.1 1 class period
Unit IV, Lesson 2	3	AS 2.1 30 min.
Unit IV, Lesson 3	3	AS 3.1 1 class period
		AS 3.2 30 min.
Unit IV, Lesson 4	5	AS 4.1 2 class periods
Unit IV, Lesson 5	10	AS 5.1 2 class periods
Unit IV, Lesson 6	4	AS 6.1 1 class period
Unit IV, Lesson 7	5	AS 7.1 1 class period
Unit V, Lesson 1	2	AS 1.1 1 class period
Unit V, Lesson 2	2	AS 2.1 30 min.
Unit V, Lesson 3	5	AS 3.1 30 min.

	Periods for Classroom Instruction/Activities	Length for Activity Sheets (AS)
Unit V, Lesson 4	3	AS 4.1 30 min.
Unit V, Lesson 5	3	AS 5.1 1 class period
Unit V, Lesson 6	1	AS 6.1 30 min.
Unit V, Lesson 7	3	AS 7.1 30 min.
Unit V, Lesson 8	7	AS 8.1 30 min.
Unit V, Lesson 9	8	AS 9.1 1 class period
Unit V, Lesson 10	2	AS 10.1 30 min.
Unit V, Lesson 11	2	AS 11.1 30 min.
Unit V, Lesson 12	3	AS 12.1 30 min.
Unit VI, Lesson 1	3	AS 1.1 30 min.
Unit VI, Lesson 2	1	AS 2.1 15 min.
Unit VI, Lesson 3	3	AS 3.1 1 class period
Unit VI, Lesson 4	5	AS 4.1 1 class period
		AS 4.2 30 min.
Unit VI, Lesson 5	2	AS 5.1 30 min.
Unit VII, Lesson 1	2	AS 1.1 30 min.
Unit VII, Lesson 2	3	AS 2.1 1 class period
Unit VII, Lesson 3	5	AS 3.1 1 class period
Unit VII, Lesson 4	5	AS 4.1 30 min.
Unit VII, Lesson 5	2	AS 5.1 15 min.

x
 x
 v
 i
 i

3	2	1	N

3	2	1	N

Other: _____

Other: _____

3	2	1	N

Other: _____

[illegible]

1. Discuss safety in working with concrete
2. Identify factors that affect the quality of

9. Describe how to run wiring from the SEP to

10. Calculate cost and electrical power using

12. Identify problems in electrical systems

11. Describe procedures for planning and

F. Plumbing

1. Calculate how much water is needed for a
2. Discuss safety practices for plumbing
3. Identify pipe types and determine size
4. Measure, cut, and connect pipes and tubing
5. Identify methods of protecting water pipes

4. Describe techniques for building high

5. Identify fence mending techniques

G. Fencing

1. Discuss the terminology, dangers, and
2. Describe how to set and brace wood and
3. Describe techniques for building barbed

AGRICULTURAL STRUCTURES

[illegible]

[illegible]

- requirements.
4. Measure, cut, and connect pipes and tubing.
5. Identify methods of protecting water pipes against freezing.

UNIT VII -FENCING

1. Discuss the terminology, dangers, and safety practices associated with building fences.
2. Describe how to set and brace wood and steel posts.
3. Describe techniques for building barbed and woven wire fences.
4. Describe techniques for building high tensile and electric fences.
5. Identify fence mending techniques.