Maple Career Development Event
A Guide for Career and Technical Centers of Vermont

A Project Sponsored by:
Shelburne Farms
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Introduction

On May 7th, 2019 the first ever FFA Maple Career Development Event (CDE) was held at Shelburne Farms in Shelburne, Vermont. A CDE is a competition that is designed to test skill development and prepare students for careers in the particular area of focus. CDEs are held for many different disciplines such as forestry, tractor driving, and dairy handling. The CDE's are often used by high school career and technical centers as a way to assess students' knowledge and compare results between schools that are teaching similar material. Additionally, CDE's serve as a way for students to build their credentials, with students often including their CDE experience on their resumes.

The maple industry in Vermont has grown more than threefold in the last twenty years. Such growth in an already established industry demonstrates that individuals can join a successful business or start their own. Students who understand the latest research on sap and syrup production will be better prepared and effective sugar makers, bringing this traditional product and skill into the next generation.

The Maple CDE was designed through a collaboration between Vermont high school agriculture/natural resources instructors, UVM Extension Maple Specialist, Mark Isselhardt, and UVM graduate student, Lynn Wolfe. Additionally, a maple manual designed to provide up-to-date, science-based information on maple syrup production and serve as a reference to prepare students for the Maple CDE was created. Shelburne Farms and UVM Extension sponsored Lynn Wolfe to develop the Maple CDE and associated materials as her graduate project for the UVM Field Naturalist and Ecological Planning Graduate Program.

Event description

The purpose of the Maple CDE was to illustrate the wide range and complexity of subjects required to produce high quality maple syrup. The CDE assessed students' knowledge through hands-on exercises and traditional test questions. Students from schools around Vermont competed in both individual and team events during the 2 ½ hour Maple CDE. The individual competition included four separate stations: (1) tools and materials, (2) syrup grading, (3) tapping skills, and (4) general knowledge. The tools and materials section required students to identify the name and use of a variety of tools related to sap and syrup production. The syrup grading portion required students to correctly grade several samples of syrup and determine if they meet the standard for pure maple syrup in terms of color, clarity, density, and flavor. The tapping skills section asked students to determine if proper tapping guidelines were followed on a select number of trees. The general knowledge section tested students' knowledge of maple production from tree identification to syrup sales. The 2019 Maple CDE exam can be viewed in Appendix A. The team event required groups of four students to work together to install a lateral line from a tree to a preinstalled section of mainline.

Tools and materials

The tools and materials station included 17 numbered items that students had to identified by name or function.

Tools and materials used in 2019 Maple CDE

1. One-handed tubing tool
2. Two-handed tubing tool
3. Mainline tubing tool
4. Tapping drill bit vs. carpenters drill bit
5. Tapping hammer
6. 5/16 tubing

7. 1” mainline
8. Sight level
9. Check valve spout
10. Non-check valve spout
11. Lateral line straight connector
12. Lateral line Tee
13. Mainline saddle entrance fitting
14. Manual wire twister
15. Wire tensioning device
16. Hose clamp
17. Pressure gauge

Complete list of tools and materials that could be used in future Maple CDEs

Maple educators and industry professionals collaborated to create a list of the most commonly used sugaring tools and materials that would be appropriate to use in future Maple CDEs. A photo guide of this list can be viewed in Appendix B.

1. One-handed tubing tool
2. Two-handed tubing tool
3. Mainline tubing tool
4. Mainline punch
5. Drill
6. Tapping drill bit vs. carpenters drill bit
7. Tapping hammer
8. DBH tape
9. 3/16 tubing
10. 5/16 tubing
11. 1” mainline
12. 1.5” mainline
13. 12.5-gauge wire (support mainline)
14. 14-gauge wire (side tie)
15. Sight level
16. Hydrometer
17. Hydrometer cup
18. Digital refractometer
19. Optical refractometer
20. Check valve spout
21. Non-check valve spout
22. Spout remover
23. Lateral line straight connector
24. Lateral line slide fitting
25. Lateral line end line hook
26. Lateral line tee
27. Right dead-end tee
28. Left dead-end tee
29. End ring
30. Mainline saddle entrance fitting
31. Mainline plug
32. Mainline plastic coupling
33. Mainline plastic tee
34. Mainline quick coupler
35. Wire tie
36. Manual wire twister
37. Wire tensioning device
38. Cable grip tubbing puller
39. Wire cutter
40. Filter press
41. Diaphragm pump
42. Gravity filter (cone)
43. Vacuum pump
44. Releaser
45. Hose clamp
46. Nut driver
47. Pressure gauge
48. Tubing cutter
49. Temporary maple syrup grading comparator kit
50. Permanent maple grading comparator kit

Syrup grading

The syrup grading station included five syrup samples that had to be correctly graded for color, clarity, flavor, and density. Students were required to use a variety of instruments (hydrometer, optical refractometer and digital refractometer) to determine if the sample density was within acceptable limits. Students had to determine the color grade of the syrup using a Vermont temporary grading kit

and check for clarity visually. Students were also asked to determine if the flavor was acceptable Grade A syrup or if it fit the definition of Processing Grade syrup.

Figure 1- Syrup grading
Students participating in the 2019 syrup grading station at the Maple CDE
(Image source Silva, 2019 (left) Isselhardt, 2019 (right))

Tapping skills

The tapping skills station included four pre-tapped sugar maple logs. Each sugar maple log had a tap hole, seated spout, dropline, tee, and previous years tap hole scars (artificially made). Students were asked to determine if each stem had been tapped correctly based on relation to other tap holes, how the spout was seated, the angle of the tap hole, and the length of the drop line. If the student determined that the stem was not correctly tapped, they were asked to identify what mistakes were made. In addition to the questions, students were able to see an educational display of tapping provided by sugar maker Dave Folino from Hillsboro Sugarworks of Starksboro, Vermont. The display was a 4-foot section of sugar maple stem with a history of tapping that had been turned on a lathe to expose the tap hole stain. This display allows students to see the importance of promoting good stem growth and of spacing tap holes.

Figure 2- Tapping skills
Image of educational tapping display (left) and students filling out exams at tapping skills station (right)
(Image source Isselhardt, 2019)

General knowledge

The general knowledge station included 33 multiple choice questions. The questions covered a wide variety and complexity of subjects ranging from tree identification and sugarbush management to maple syrup production and syrup sales.

Figure 3- General knowledge
(Image source Isselhardt, 2019 (left) Silva, 2019 (right))

Team event

The team event required each team of four students to install a 5/16" lateral line from a designated tree and connect the tubing to a preinstalled section of 3/4"mainline. Each team was given a selection of tubing, fittings, and tools. They were allotted a maximum of 45-minutes to accomplish this task. The tubing system was tested by introducing "sap" (water) at the top of the lateral line to a designated collection point. The system was scored based on the quality of tubing installation (Tight-Straight-Downhill), quality of connections (appropriate fittings selected and properly connected), and the system's ability to conduct "sap". The team event score sheet used by judges can be viewed in Appendix C.

Figure 4- Team event
Student installing mainline saddle entrance fitting (left) and introducing "sap" to a bucket attached to a sugar maple tree connected to the top of the lateral line (right)
(Image source Isselhardt, 2019 (left) Silva, 2019 (right))

Maple CDE development

The Maple CDE was developed through a collaboration between Vermont career and technical center high school agriculture/natural resources educators, UVM Extension Maple Specialist Mark Isselahardt, and UVM graduate student Lynn Wolfe. Seventeen career and technical center educators were interviewed to learn about their current maple curriculum, what skills/knowledge they believe are important for students to gain, if they would participate in the Maple CDE, what resources they would need to prepare students for the CDE, and if their students express interest in working in the sugaring industry. A list of teachers interviewed for the project can be viewed in Appendix D. Five classrooms were visited to observe students participating in their agriculture/natural resources class, talk to students about maple syrup production, view the schools sugaring operation/access to resources, and further discuss the development of a Maple CDE and associated resources with educators. Additionally, 16 maple professionals were interviewed to discuss what they feel are essential skills young people seeking jobs in the sugaring industry should have after completing a sugaring unit at a career and technical center.

In order to develop a pool of questions for the general knowledge section of the Maple CDE that represented a range and complexity of topics, I contacted maple educators, researchers, extension specialists, and industry professionals in the United States and Canada. 24 people submitted multiple choice questions generating a total of 104 possible questions for the general knowledge category.

On March 15, 2019 a working group meeting was held at the UVM Proctor Maple Research Center. A total of nine people participated including career and technical center educators, UVM Extension staff, and an academic program coordinator from Saint Michael's College. Together we edited and narrowed the pool of questions to make them appropriate for the selected student body.

Results

Forty-two students from eight schools participated in the Maple CDE. Teachers provided feedback regarding the layout and content of the CDE. They described the event as running smoothly, being fair, and recommended that it could be a little longer and more challenging next year. One teacher stated, "Each question is simple and straightforward, but the range of questions (tested) students' understanding of the process". Exams were graded immediately after the event was completed using a Scantron machine.

Individual exam results

Student scores ranged from 55.9 to 94.9. The average score was a 79.1. The score distribution for the individual exam can be viewed in Figure 5.

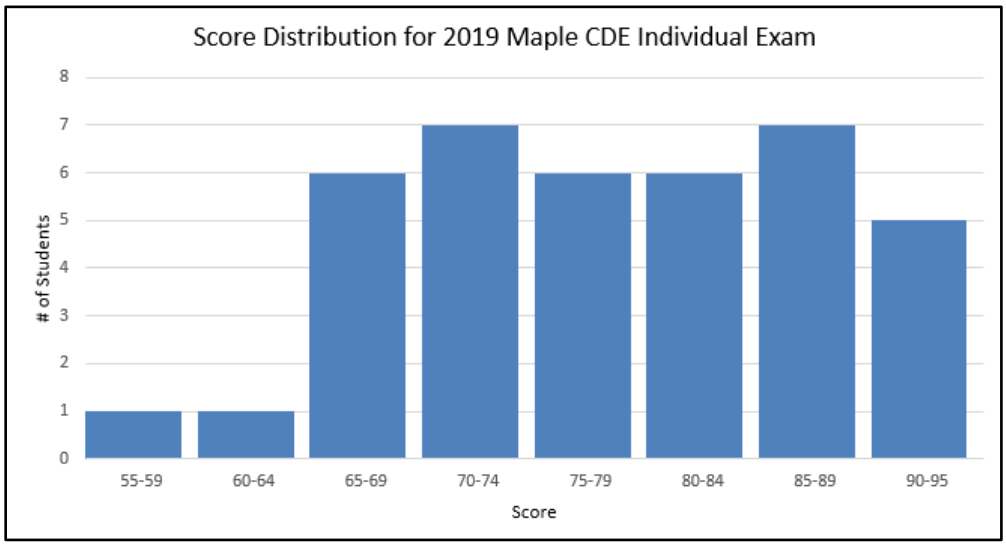


Figure 5 - Score distribution for 2019 Maple CDE individual exam

Each question was reviewed to determine the frequency at which students answered individual questions correctly and which topic areas were considered most difficult. After reviewing the exams, it was determined that the syrup grading portion was most difficult with 52% of students answering the questions correctly. The syrup grading judge stated that the students did not all have the same level of experience. Some students were not familiar with how to use the grading instruments, while others were very proficient. When one student was grading the "buddy" syrup she simply had to smell the syrup and realized it was clearly Processing Grade syrup. With confidence she tossed the sample cup in the trash without even tasting it and recorded the correct answer on her exam. Exam results separated by topic can be viewed in Table 1. Exam results by individual question can be viewed in Table 2.

Table 1- 2019 Individual exam results by topic

Individual exam topic	**Percent answered correctly**
Tools and Materials	88%
Tapping Skills	87%
General Knowledge	78%
Syrup Grading	52%

Table 2- Individual exam results by question

Question Number	Percent Answered Correctly	Individual Exam Topic
1	97%	Tools and Materials
2	95%	Tools and Materials
3	97%	Tools and Materials
4	90%	Tools and Materials
5	72%	Tools and Materials
6	82%	Tools and Materials
7	97%	Tools and Materials
8	77%	Tools and Materials
9	82%	Tools and Materials
10	79%	Tools and Materials
11	87%	Tools and Materials
12	79%	Tools and Materials
13	95%	Tools and Materials
14	82%	Tools and Materials
15	92%	Tools and Materials
16	95%	Tools and Materials
17	100%	Tools and Materials
18	90%	Tapping Skills
19	97%	Tapping Skills
20	62%	Tapping Skills
21	100%	Tapping Skills
22	100%	General Knowledge
23	100%	General Knowledge
24	100%	General Knowledge
25	100%	General Knowledge
26	100%	General Knowledge
27	100%	General Knowledge
28	100%	General Knowledge
29	100%	General Knowledge
30	82%	General Knowledge
31	36%	General Knowledge
32	69%	General Knowledge
33	82%	General Knowledge
34	59%	General Knowledge
35	36%	General Knowledge
36	74%	General Knowledge
37	77%	General Knowledge
38	79%	General Knowledge
39	95%	General Knowledge
40	95%	General Knowledge
41	90%	General Knowledge
42	87%	General Knowledge
43	67%	General Knowledge
44	54%	General Knowledge
45	74%	General Knowledge
46	69%	General Knowledge
47	74%	General Knowledge
48	28%	General Knowledge
49	90%	General Knowledge
50	46%	General Knowledge
51	69%	General Knowledge
52	85%	General Knowledge
53	82%	General Knowledge
54	79%	General Knowledge
55	44%	Syrup Grading
56	51%	Syrup Grading
57	38%	Syrup Grading
58	74%	Syrup Grading
59	33%	Syrup Grading

Team event results

Eight teams competed in the team event portion of the Maple CDE. Scores ranged from 60 to 100. All teams were able to successfully install a functional system that conducted "sap" from the top of the lateral line to the designated collection point. The separation in scores resulted from deductions that were given due to differences in the quality of the tubing installation. Seven teams received deductions because the wire ties were not installed on the mainline entrance saddle fitting. Four teams received deductions because the fittings were not installed correctly. Three teams received deductions because the lateral tubing was not tight. Three teams received deductions because they did not use a straight connector to take the tension off the saddle fitting. Two teams received deductions because the gasket on the saddle was folded.

Recommendations for future Maple CDE

Immediately after the Maple CDE ten of the event organizers, teachers, and volunteers (listed in Appendix D) met to discuss the event and improvements that could be made for 2020. Discussion mostly focused on the team event, but recommendations were also made for the individual exam.

Individual exam recommendations

- Syrup grading
    - Advise teachers to spend more time instructing students on syrup grading techniques.
    - Have temperature readings and temperature conversion charts for the syrup samples.
    - Display a sign that instructs students to read hydrometer as a hot test.
- Tapping skills
    - Structure the exam so students have to tap their own stump and seat a spout. This will make it more difficult for the event organizers and graders, but it is worth the effort to have students physically demonstrate the skill of tapping.
    - A measuring device needs to be provided so students can measure drop length.
- General knowledge
    - Students should have access to calculators for the maple math portion of the exam.
    - In 2019 students were tested on the Jones Rule of 86. In future years students should be required to know the revised rule of 88.2. The original Rule of 86 is no longer accurate. The rule was developed when everyone boiled raw sap. Today many producers boil sap that has been concentrated through reverse osmosis machines. The original Rule of 86 underestimates production of syrup for concentrate. The revised rule also accounts for the updated legal standard of syrup which has been changed to from 65.5° brix at the time when the Rule of 86 was created to 66.9° brix in Vermont.
    - Questions that require students to stand up and view displays (e.g. twig identification and questions that have them look at the evaporator) should be clustered together to prevent students from repeatedly standing up and moving to stations and then sitting back down at a table.
    - Pages numbers should be included on the exam.

Team event recommendations

- Allow more than one team per school so every student has the option of participating in the team event.

- It is estimated that with the current structure of two judges and using the same area of the sugarbush the Maple CDE has the capacity to host a total of 12 teams.
- It could be longer and include more complex activities. In 2019, 45 minutes were allotted to complete the team event, but on average teams only needed 20 minutes to complete the task.
- In addition to installing lateral lines students should be required to make some repairs.
- In 2019, event organizers selected the trees that students connected a lateral line to. In future years students should be required to select their own tree. This would allow students to demonstrate tree identification and measurement skills.
- Due to the timing of the event students can not actually tap a tree for the team event. However, they could insert a push pin into the bark to indicate where the tap hole should be placed. This would require students to demonstrate knowledge of tap hole placement in relation to previous years tap holes and ability to look at the whole tree from crown to ground.
- A measuring device should be provided so students can install drop lines that are the correct length (approximately 30").
- Add more lateral lines.
- Increase the number of lateral lines that teams need to install.
- The team event score sheet gave every team 100 points if they successfully got "sap" to travel from the bucket attached to the sugar maple tree through the lateral line and to flow out the mainline. Eight common mistakes were described on the judges score sheet. Judges deducted 10 points for each mistake. It is recommended that the scoring system change in future Maple CDEs so all deductions are not weighted evenly. For example, if a team installs a lateral line that is not tight more points should be deducted than if a team does not use wire ties on the saddle.
- Additional deductions that should be added to the score sheet include: 1) trash (pieces of tubing, fittings, etc.) not picked up after team event completed, 2) all members of the team did not participate in the event, 3) drops were not pre-made at the edge of the sugarbush before installing the other components of the tubing system

General recommendations for Maple CDE

- Include page numbers on the exam.
- Secure Scantron sheets the day before the event.
- CDE superintendent needs to make sure that all students have officially registered for the event with Executive Director of Vermont FFA prior to the event.
- Improve parking area signs so bus drivers park in the correct location.

Alternative team event topics

The team event task should change every year to test different skills, especially since it is likely that some students will compete in the Maple CDE for multiple years in a row. For the 2020 Maple CDE exam, reviewers recommend keeping the same tubing installation task but altering it to make the task more challenging. Below are descriptions of other team event tasks that could be used in future years.

Sugarbush installation quote: Each team is provided with a topographic map and basic forest stand information. Teams are also provided with the number and length of mainlines, lateral lines, taps, and a list of material prices. With the information provided students are required to produce an itemized quote and map that shows where the mainlines and lateral lines would be installed.

Invoice preparation sap: Teams are provided with a scenario where they are in charge of purchasing sap and creating an invoice for the sap sale. Teams are provided with number of gallons of sap, and a table from the *Maple Syrup Digest* that states sap prices based on the sugar concentration of the sap.

Cost analysis of sap: Teams are given a partially completed data table showing sap buying records. Teams are required to fill in the missing information.

Example: You manage a sugarhouse that purchases additional sap from other producers. You have agreed to pay the sap supplier 50% of the value of syrup produced from their sap. With the information provided in the table below calculate the missing information to determine how much money will be generated from making syrup from purchased sap and how much the sap supplier needs to be paid. Note: Calculations should be completed using the rule of 88.2. One gallon of sap weighs 11.15 lbs.

Bulk syrup prices

Grade	Grade abbreviation	Price per pound
Golden/Delicate	GD	$2.80
Amber/Rich	AR	$2.70
Dark/Robust	DR	$2.60
Very Dark/Strong	VDS	$2.40

Date	Gal. of sap	Sap sugar content	Grade of syrup produced	Price of syrup produced per gal.	Gal. of sap needed to produce 1 gal. of syrup	Lb. of syrup produced	Total gallons of syrup produced from the sap	Total price of the sap	Price per gallon of the sap
1-Mar	200	1.8	AR	$2.70	49	45.5	4.08	$61.41	$0.31
4-Mar	378	2.1	GD	$2.80	42	100.35	9.0	$140.49	$0.37

*Teams should be able to calculate the highlighted information. This is a sample table; more delivery dates could be added for the actual Maple CDE team event. See calculations below.

Calculations for 1-Mar:
88.2 ÷ 1.8 = 49 gal sap to make 1 gal syrup
200 ÷ 49 = 4.08 gal syrup produced from purchased sap
Convert to lbs. of syrup = 4.08 gal x 11.15 lb = 45.5 lb syrup produced from purchased sap
45.5 lb x $2.70 = $122.83 syrup produced
$122.83 ÷ 2 = $61.41 total price of sap (to be paid to supplier)
$61.41 ÷ 200 gal = $0.31 price per gal of sap

Calculations for 4-Mar:
88.2 ÷ 2.1 = 42 gal sap to make 1 gal syrup
378 ÷ 41 = 9 gal syrup produced from purchased sap
Convert to lbs. of syrup = 9 gal x 11.15 lb = 100.35 lb syrup produced from purchased sap
100.35 lb x $2.80 = $280.98 syrup produced
$280.98 ÷ 2 = $140.49 total price of sap (to be paid to supplier)
$140.49 ÷ 378 gal = $0.37 price per gal of sap

Invoice preparation syrup: Each team is provided with a scenario that states the quantity of syrup that was made, quantity of grades, price per pound, and price per container. Teams are required to create an invoice comparing bulk sales to retail sales.

Value added products: Students are supplied with all tools, materials, and recipes necessary for activity. Each team is required to test the invert sugar level of syrup and make molded sugar candy by following a provided recipe. Molded sugar candy will be judged on taste, texture, color, and shape.

Materials inventory and contacts

The Maple CDE would not have been possible without the generosity of industry representatives that donated tools, materials, prizes, and their time to assist with development and execution of the event. The companies that contributed donations include: CDL USA, H_2O Innovations, Lapierre USA, Leader Evaporator, Shelburne Farms and UVM Extension. An inventory of materials that were donated for the event can be viewed in Appendix E. Donor contact information can be viewed in Appendix F.

A wonderful team of volunteers made the event happen and run smoothly. Volunteers included Dana Bishop (Shelburne Farms), George Cook (UVM Extension-Retired), Cyrus Grennon (H_2O Innovations), Liz Kenton (UVM Extension) David Lalanne (CDL USA), and Marshall Webb (Shelburne Farms), and Mark Isselhart (UVM Extension). Contact information for volunteers can be viewed in Appendix G.

Appendix A: 2019 Maple Career Development Event exam

Tools and Materials

1. What is this tool?
    a. Two-handed tubing tool
    b. Mainline punch
    c. One-handed tubing tool
    d. Mainline tubing tool

2. What is this tool?
    a. Two-handed tubing tool
    b. Mainline punch
    c. One-handed tubing tool
    d. Mainline tubing tool

3. What is this tool used for? (Tool = Mainline tubing tool)
    a. To clean soot from a drop flue pan
    b. To drill a hole in a mainline and install a saddle fitting
    c. To strip tubing from 5/16" barbed fittings
    d. To repair mainline tubing

4. Which drill bit is a tapping drill bit? (Display a tapping bit and carpenters bit label A and B)
    a. Bit A is a tapping bit
    b. Bit B is a tapping bit

5. Why is it important to use this type of hammer when tapping? (Tool =Tapping hammer)
    a. Provides more force when hammering
    b. Light weight
    c. Helps prevent breaking spouts and damaging trees
    d. Both B and C

6. Name this material. (Display a ruler with the tubing so students can measure it)
    a. 3/16" tubing
    b. 5/8" tubing
    c. 5/16" tubing
    d. 7/16" tubing

7. Name this material. (Display a ruler with the tubing so students can measure it)
    a. 3/4" lateral line
    b. 1" mainline
    c. 1 1/2" lateral
    d. 2" mainline

8. What is this tool used for? (Tool = Sight level)
    a. To measure the percent of light that passes through syrup
    b. To measure slope when installing a mainline
    c. To measure tree canopy size
    d. To measure the refractive index of a solution

9. What is this fitting?
    a. Check valve spout
    b. Tee with plug
    c. Non-check valve spout
    d. Stub spout

10. What is this fitting?
    a. Check valve spout
    b. Tee with plug
    c. Non-check valve spout
    d. Stub spout

11. What is this fitting?
    a. Lateral line slide fitting
    b. Lateral line straight connector
    c. Plastic quick disconnect for lateral line tubing
    d. Lateral line tee

12. What is this fitting?
    a. End Y barbed plastic tubing fitting
    b. Y plastic barbed tubing fitting
    c. Lateral line tee
    d. End ring for lateral line

13. What is this fitting used for? (Fitting = Mainline saddle entrance fitting)
    a. To join and tension mainline
    b. To hold mainline tubing to aerial wires
    c. To connect lateral line to mainline
    d. To inject air into a sap ladder

14. What is this tool?
    a. Wire tie
    b. Gripple
    c. Cable grip tubing puller
    d. Manual wire twister

15. What is this tool?
    a. Wire tensioning device

b. Tubing spooler
c. Quick clamp
d. Automatic wire tying tool

16. What is this tool?
    a. Entrance fitting
    b. Hose clamp
    c. Quick coupler
    d. Quick clamp

17. What is this tool?
    a. Pop-on adapter
    b. Pressure gauge
    c. Dial thermometer
    d. Stack thermometer

Tapping Skills

18. This stump is tapped… (Directly below a previous years tap hole)
    a. Correctly
    b. Incorrectly, the tap is too close to a previous year tap hole
    c. Incorrectly, the spout is hammered in too far
    d. Incorrectly, the tap hole does not have the correct angle
    e. Incorrectly, the drop line is not the right length

19. This stump is tapped… (Spout hammered in too far)
    a. Correctly
    b. Incorrectly, the tap is too close to a previous year tap hole
    c. Incorrectly, the spout is hammered in too far
    d. Incorrectly, the tap hole does not have the correct angle
    e. Incorrectly, the drop line is not the right length

20. This stump is tapped… (Correctly!)
    a. Correctly
    b. Incorrectly, the tap is too close to a previous year tap hole
    c. Incorrectly, the spout is hammered in too far
    d. Incorrectly, the tap hole does not have the correct angle
    e. Incorrectly, the drop line is not the right length

21. This stump is tapped… (Tap hole angled incorrectly)
    a. Correctly
    b. Incorrectly, the tap is too close to a previous year tap hole
    c. Incorrectly, the spout is hammered in too far
    d. Incorrectly, the tap hole does not have the correct angle

e. Incorrectly, the drop line is not the right length

General Knowledge

22. Which twig is a sugar maple? (Label twigs A and B)
    a. A is a sugar maple
    b. B is a sugar maple

23. Which leaf is a red maple? (Label leaves A and B)
    a. A is a red maple
    b. B is a red maple

24. Most of the evaporation happens in the _____ of the evaporator
    a. Back pan (also called sap or flue pan)
    b. Front pan (also called syrup pan)
    c. Back float box
    d. Front float box

25. The mineral deposits that form in unfiltered syrup and bond to the evaporator pan is called
    a. Silica
    b. Gradient
    c. Diatomaceous
    d. Sugar sand and niter

26. Find the part of the evaporator labeled A. What is it? (Label float box A)
    a. Draw off spout
    b. Smoke stack
    c. Float box
    d. Flues

27. Small trees give the same amount of sap as large trees
    a. True
    b. False

28. The **average** sugar content of raw sugar maple sap is:
    a. 4-6 percent
    b. 0-1 percent
    c. 1-3 percent
    d. 6-8 percent

29. Sugar maple is considered shade tolerant and small trees can survive in the understory for many years before being released.
    a. True
    b. False

30. Maple trees should never be cut in a sugarbush.
    a. True
    b. False

31. What species of tree does the forest tent caterpillar **NOT** feed on?
    a. Sugar maple
    b. Aspen
    c. Red oak
    d. Red maple

32. Which of the following plants are invasive and cause harm in the sugarbush?
    a. Honeysuckle
    b. Buckthorn
    c. Barberry
    d. Amur maple
    e. All of the above

33. Why is removing non-native and invasive plant species desirable in the sugarbush?
    a. They are unsightly to look at
    b. They can outcompete regeneration of native trees and shrubs
    c. It's not important to remove them
    d. They lower the % sugar in maple sap

34. When using a 5/16" spout, what is the recommended a tap hole depth?
    a. 0.5"
    b. 1"
    c. 1.5"
    d. 2"
    e. 2.5"

35. When using **traditional** tapping guidelines what is the minimum diameter tree that you should tap?
    a. 8"
    b. 10"
    c. 6"
    d. 4"

36. When should taps be removed from the tree?
    a. After leaf out
    b. Before leaf out
    c. As a sugarmaker's time permits
    d. They shouldn't. Leave them in year-round.

37. What is an advantage of using a new spout every year?

a. Less bacteria
b. Longer flow and season
c. Less leaks
d. All of the above

38. Why do some maple producers use a wet-dry mainline system?
    a. It creates better vacuum at the taphole
    b. It is easier to install
    c. It requires less maintenance than a single mainline system

39. Reverse osmosis uses membranes to concentrate sap by separating the sugar from the _____ in the sap
    a. Minerals
    b. Water
    c. Gas
    d. Starch

40. The glass instrument used to measure syrup density and consists of a calibrated weight and graduated scale is called a _____.
    a. Pressure gauge
    b. Sight level
    c. Hydrometer
    d. Diaphragm

41. Knowing the syrup temperature is critical for using a hydrometer correctly.
    a. True
    b. False

42. If sap is 2% sugar how many gallons of sap are needed to make 1 gallon of syrup? (Use the Rule of 86)
    a. 43
    b. 54
    c. 27
    d. 22

43. If you have 6000 gallons of 2.2% sap, how much syrup would you make? (Use the Rule of 86)
    a. 170.3 gal
    b. 155.7 gal
    c. 153.5 gal
    d. 157.8 gal

44. If you have a 40-gallon barrel of syrup and syrup is selling for $2.75/lb, how much is the barrel worth? (Syrup weight is 11.15 lbs)
    a. $1,226.50

b. $986.50
c. $106.65
d. $394.60

45. Every batch of maple syrup must meet the legal standard in four areas: _____, -
_____, _____ and _____ .
    a. Color, weight, viscosity and flavor
    b. Clarity, sugar sand, flavor and color
    c. Color, flavor, glucose and DE
    d. Color, clarity, flavor and density

46. At sea level, maple syrup boils at about what temperature?
    a. 180 F
    b. 300 F
    c. 212 F
    d. 219 F

47. In Vermont, finished maple syrup must legally have a Brix of at least
    a. 50.8
    b. 66.9
    c. 75.2
    d. 100

48. Dark maple syrup is thicker than light maple syrup.
    a. True
    b. False

49. What is the best time to filter syrup?
    a. When it is hot
    b. When it is cold
    c. When it is lukewarm
    d. Anytime

50. If you have moldy syrup you should
    a. Skim it off and reuse
    b. Reheat
    c. Throw out
    d. Give it to the dog
    e. Both a and b

51. What is the **minimum** temperature required to hot pack syrup?
    a. 150°F
    b. 173°F
    c. 180°F

d. 204°F

52. A _____ is a device that allows sap to dump out of the tubing system without breaking the vacuum.
    a. Mainline quick coupler
    b. Releaser
    c. Diaphragm pump
    d. Filter press

53. Vacuum is measured in inches of mercury (Hg).
    a. True
    b. False

54. Syrup can only be produced from the sap of sugar maple trees.
    a. True
    b. False

Syrup Grading

See flow chart titled Maple Syrup Grading Exercise.

55. What grade is the syrup? (Low Density, Brix 64)
    a. Golden Color/Delicate Taste
    b. Amber Color/Rich Taste
    c. Dark Color/Robust Taste
    d. Very Dark Color/Strong Taste
    e. Processing Grade

56. What grade is the syrup?
    a. Golden Color/Delicate Taste
    b. Amber Color/Rich Taste
    c. Dark Color/Robust Taste
    d. Very Dark Color/Strong Taste
    e. Processing Grade

57. What grade is the syrup? (Buddy Syrup)
    a. Golden Color/Delicate Taste
    b. Amber Color/Rich Taste
    c. Dark Color/Robust Taste
    d. Very Dark Color/Strong Taste
    e. Processing Grade

58. What grade is the syrup?
    a. Golden Color/Delicate Taste
    b. Amber Color/Rich Taste

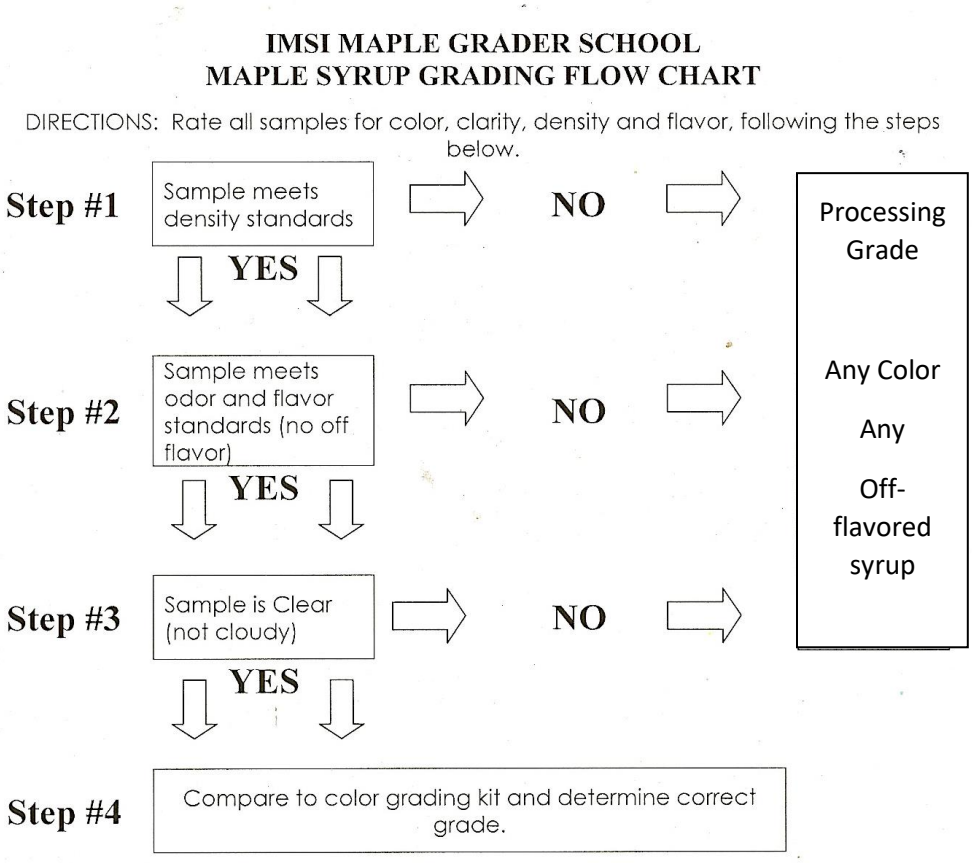
c. Dark Color/Robust Taste
d. Very Dark Color/Strong Taste
e. Processing Grade

59. What grade is the syrup?
    a. Golden Color/Delicate Taste
    b. Amber Color/Rich Taste
    c. Dark Color/Robust Taste
    d. Very Dark Color/Strong Taste
    e. Processing Grade

Maple syrup grading exercise

Directions:
1. Grade each sample using the steps in the table below.
2. Record (y/n) results in the corresponding box for each sample.
3. If the sample does not meet the standard in any one step it becomes ***processing grade***.

		Sample #				
Step	Does Sample…	1	2	3	4	5
1	Meet density standards (y/n)?					
2	Meet odor and flavor standards (y/n)?					
3	Look clear (y) or cloudy (n)?					
4	Determine correct grade using the color kit:					
	Golden Color/Delicate Taste (answer A)					
	Amber Color/Rich Taste (answer B)					
	Dark Color/Robust Taste (answer C)					
	Very Dark Color/Strong Taste (answer D)					
	Processing Grade (answer E)					

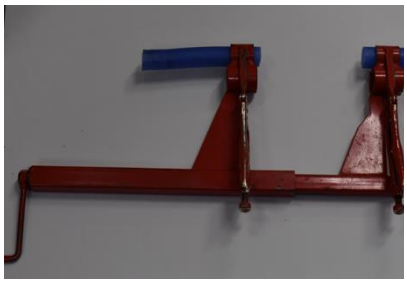


Appendix B: Tools and materials photo guide

A maple tools and materials photo guide was developed as a reference to be used in preparation for the Maple CDE. It is also available in *Maple: A Sap to Syrup Guide* a manual for career and technical centers of Vermont. This photo is intended to provide a quick visual image of the most common tools and materials used in sugaring. (Image source Isslehardt, 2019)

One-handed tubing tool

Two-handed tubing tool



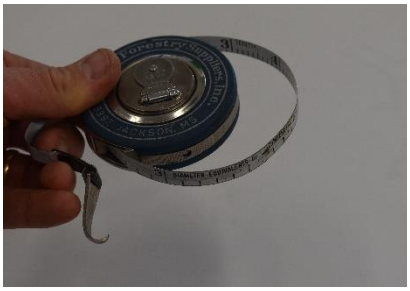
Mainline tubing tool

Mainline punch

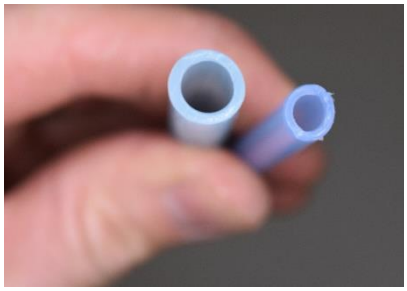
Drill

Tapping bit (L) carpenters bit (R)

Tapping hammer



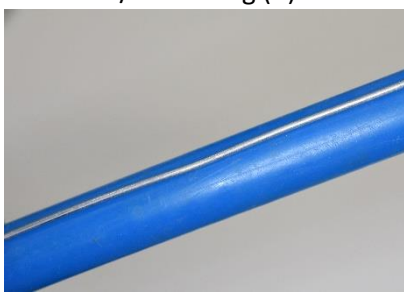
DBH tape



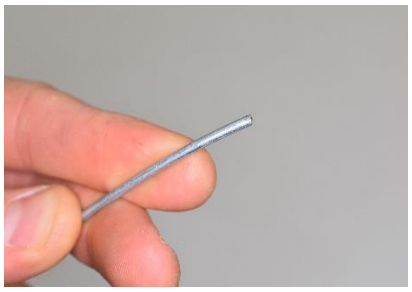
5/16” tubing (L) vs.
3/16” tubing (R)

1” mainline

1.5” mainline

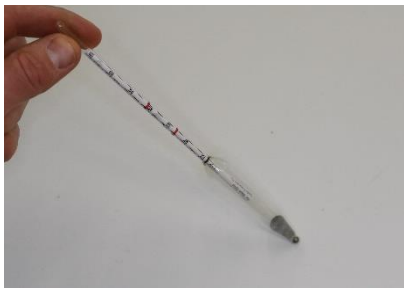


12.5-gauge wire (support mainline)



14-gauge wire (side tie)

Sight level

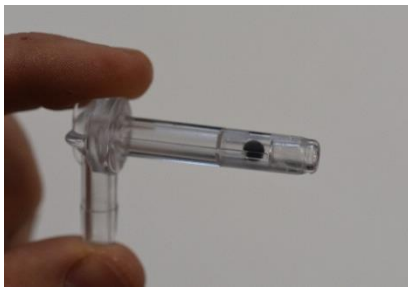


Hydrometer

Hydrometer cup

Digital refractometer

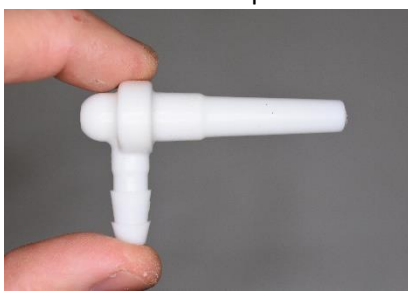
Optical refractometer



Check-valve spout

Black spout

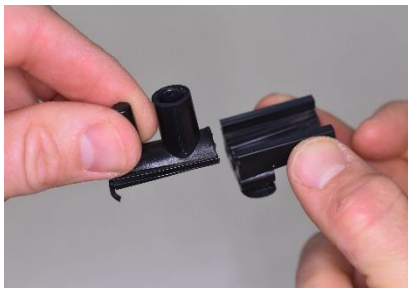
Clear spout



White spout

Spout remover

Lateral line straight connector



Lateral line slide fitting

Lateral line end line hook

Lateral line tee

Dead end tee (right)

Dead end tee (left)

End ring

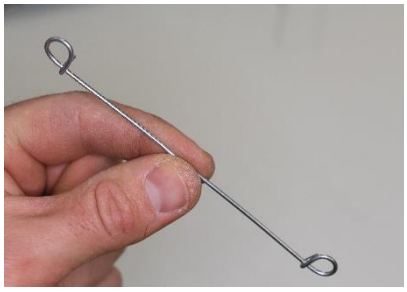
Mainline saddle entrance fitting

Mainline plug

Mainline plastic coupling

Mainline plastic tee

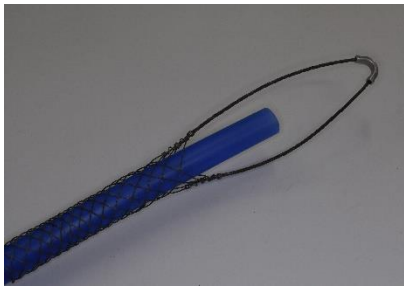
Mainline quick coupler



Wire tie

Manual wire twister

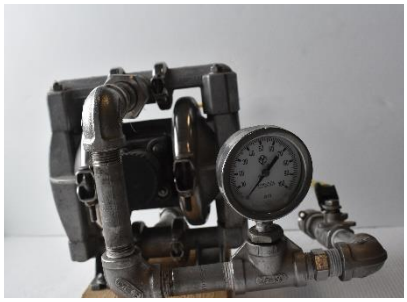
Wire tensioning device



Cable grip tubing puller

Wire cutter

Filter press



Diaphram pump

Gravity filter (cone)

Vacuum pump

Releaser

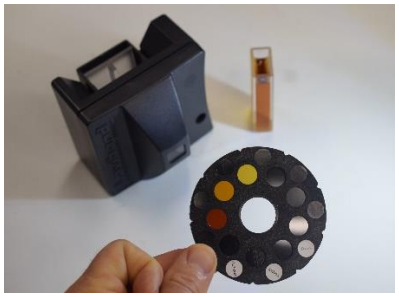
Hose clamp

Nut driver

Pressure guage

Tubing cutter

Temporary maple syrup grading comparator kit



Permanent maple syrup grading comparator kit

Appendix C: 2019 Team event score sheet

School: _____

Team members' names:	**1.**	**2.**
	3.	**4.**
	5.	**6.**

Event description: Install a functioning model tubing system. A section of ¾" mainline is set up in the sugarbush. Students need to install a mainline saddle, 5/16" lateral line, tee fitting, dropline, spout and end fitting. The system will be scored on quality of installation (Tight-Straight-Downhill), quality of connections (fittings installed correctly without damage to the tubing) and the system's ability to conduct "sap" (water) from the simulated tree (a bucket of water hanging from a tree) to a designated collection point. The installation must be completed within 45 minutes.

Every team gets 100 points if they successfully get water to travel from the bucket attached to the maple tree through the lateral line and to flow out the mainline.

Each deduction is -10 points.

Description	Deduction	Comments
Tubing not tight		
Tubing not straight		
Tubing not downhill		
Fittings not installed correctly		
Gasket on saddle folded		
Wire ties (3) not installed on saddle		
Straight connector not used to take tension off the saddle		
Dropline obviously not the correct length (should be ~30")		
Total deductions		
TOTAL SCORE		

Judged by:_____

Appendix D: Career and technical center teachers

Name	School	Address	Email	Attended 2019 Maple CDE	Attended working group meeting
Errold Nelson	Windham Regional Career Ctr	80 Atwood St, Brattleboro, VT	enelson@wsesu.org	No	No
David Dence	SW VT Career Dev Ctr	321 Park St, Bennington, VT	ddence@svcdc.org	No	No
Mark Raishart	Stafford Technical Center	8 Stratton Rd, Rutland, VT	Mark.Raishart@rcpsvt.org	No	Yes
John Harmer	River Valley Technical Center	307 South St, Springfield, VT	jharmer@rvtc.org	No	No
Max Van Houten	Randolph Technical Center	17 Forest St, Randolph, VT	mvanhouten@orangesouthwest.org	Yes	Yes
Aaron Townshend	Patricia Hannaford Career Ctr	51 Charles Ave, Middlebury, VT	atownshend@pahcc.org	Yes	Yes
Sam Nijensohn	North Country Career Ctr.	209 Veterans Ave, Newport, VT	samuel.nijensohn@ncsuvt.org	No	No
Chris Masson	Canaan - NCCC	209 Veterans Ave, Newport, VT	cmasson@canaanschools.org	Yes	No
Mark Wilde	Missisquoi Valley UHSD #7	175 Thunderbird Drive, Swanton, VT	mwilde@fnwsu.org	Yes	Yes

Jerry Leonard	Lyndon Institute	168 Institute Cir, Lyndon Center, VT	jerry.leonard@lyndoninstitute.org	Yes	No
Tom Ostler	Hartford Career & Tech. Ctr.	1 Gifford Rd, White River Junction, VT	ostlert@hartfordschools.net	No	No
Ben Nottermann	Green Mtn Tech. & Career Ctr	Forestry Program at Union High School Hardwick 738 VT-15, Hyde Park, VT	bnottermann@gmtcc.net	Yes	No
Tyler (Robert) Siddens	Essex, Center for Technology	2 Educational Dr, Essex Junction, VT	rsiddens@ccsuvt.org	No	No
Peter Falby	Essex, Center for Technology	2 Educational Dr, Essex Junction, VT	pfalby@ewsd.org pfalby@ccsuvt.org	No	Yes
Brian Japp	Essex, Center for Technology	2 Educational Dr, Essex Junction, VT	bjapp@ewsd.org	Yes	No
Andrew (Drew) Shatzer	Essex, Center for Technology	2 Educational Dr, Essex Junction, VT	ashatzer@ewsd.org	Yes	No
Josh Goss	Cold Hollow Career Center	184 Missisquoi St, Enosburg Falls, VT	jgoss@chccvt.net	Yes	No
Suzanne Buck	VT FFA	4351 Crown Point Rd. Bridport VT	suzannesbuck@gmail.com	Yes	No

Appendix E: Materials inventory

2019 Maple CDE Material Inventory			
Item	**Quantity required**	**Inventory**	**CDE Topic**
Mainline tubing tool	1	0	tools/materials
Two-handed tubing tool	5	4	1 for tools/materials, 4 for team event
Mainline punch	4	3 (2 small bits, 1 large bit)	team event
One-handed tubing tool	1	0	tools/materials
5/16" tubing	1 roll (500 ft)	1 roll (500 ft)	team event
Mainline (3/4")	200 ft	200 ft	team event
Sight level	1	3	tools/materials (1 fancy, 2 standard hand level
Wire cutter	1	3	team event set up
Tapping hammer	1	1	tools/materials
Tension grip/cable grip tubing puller/monkey grip	2	9	team event set up
Wire tensioning device	2	2	tools/materials, team event set up
Wire tensioning handle	1	1	tools/materials
Gripple (medium)	1	4	team event set up
Vacuum pressure gauge	1	1	tools/materials
Channel lock pliers	4	4	team event
Tubing cutter for lateral line	4	3	team event
Mainline support wire (12.5 ga)	200 ft	1 roll (2000 ft)	team event set up
Rapifix strapping	100 ft	2 rolls (400 ft)	team event set up
Nut driver	1	1	team event set up
Wire ties (6")	1 coil	1 coil (1000)	team event set up, 64 team event

Manual wire twister	5	3	1 tools/materials, 4 team event
Mainline quick coupler (1")	1	1	tools/materials
5/16" tapping drill bit	1	4	tools/materials
Mainline saddle entrance fitting (3/4")	17	1 bag (universal adjustable)	1 tools/materials, 16 team event
Check valve spout (5/16")	1	14 (clear)	tools/materials
Non-check valve spout (5/16")	6	1 bag (clear), 4 (diff colors)	1 tools/materials, 5 tapping
Lateral line straight connector (5/16")	1	3	tools/materials
Dead end Lateral line tee (5/16")	8	16	team event
Lateral line tee (5/16)	13	16	5 tapping, 8 team event
End ring	8	8	team event
Hose clamp (for 3/4" mainline)	3	3	1 tools/materials, 2 team event set up
Mainline plug (3/4")	5	8	team event
Flagging tape	8 (diff colors)	8	team event
Square bucket with fitting	4	4	team event
Water bucket with lid	4	4	team event
Hat - ball cap	7	19	Prize
Hat – winter		4	Prize
Book, *Maple Syrup an Introduction to the Science of a Forest Treasure*	15	19	for teachers
Temporary grading kits		6	Prize
Maple syrup (quart)	7	7	Prize

Appendix F: Donor contact information

Name	Title	Organization	Email	Address	Notes
Amanda Voyer		VT Maple Sugar Makers Association	amandav@vermontmaple.org	189 VT Rt 15, Jericho, VT 05465	Donated
David Lalanne	Operations Manager	CDL USA	david.lalanne@cdlinc.ca	3 Lemnah Dr. St. Albans VT 05478	Donated & Volunteered
Bruce Gillian	Vice President	Leader Evaporator	Bruce@leaderevaporator.com	49 Jonergin Dr Swanton VT 05488	Donated
Bradly Gillian	President	Leader Evaporator	Bradley@leaderevaporator.com	49 Jonergin Dr Swanton VT 05488	Donated
Cyrus Grennon	Sales & Service Rep/Former student	H20 Innovation	cyrus.grennon@h2oinnovation.com	127 Grand Ave Swanton VT 05488	Donated & Volunteered
Nyoka Bertrand	Office Manager	Lapierre	nyoka.bertrand@elapierre.com	102 Airport Rd Swanton VT 05488	Donated
Mike Rechlin	Maple educator	WV Department of Agriculture	mike.rechlin@future.edu	2519 Montaineer Dr. Franklin, WV 26807	Donated
Dave Folino	Sugarmaker	Hillsboro Sugarworks	dffolino@gmavt.net	270 Rounds Rd Bristol VT 05443	Loaned tapped maple stump

Appendix G: 2019 Volunteers and event organizers

Name	Title	Email	Role
Lynn Wolfe	Grad student/Sugarmaker, Shelburne Farms	lwolfe@shelburnefarms.org	Coordinator, set up May 6th, set up May 7th, clean up, attend banquet
Mark Isselhardt	Maple Specialist, UVM Extension	Mark.Isselhardt@uvm.edu	Coordinator, set up May 6th, clean up, attend banquet
Mark Wilde	Teacher, Missisquoi Valley UHSD	mwilde@fnwsu.org	Event superintendent, grader
George Cook	Retired UVM Extension Maple Specialist	george.cook@uvm.edu	Judge - Maple grading
Dana Bishop	Sugarmaker, Shelburne Farms	dbishop@shelburnefarms.org	Judge - Tapping/general knowledge
Cyrus Grennon	H2O/Former Missisquoi Valley student	Cyrus.grennon@h2oinnovation.com	Judge - Team event
Marshall Webb	Sugarmaker, Shelburne Farms	mwebb@shelburnefarms.org	Judge - Tools and materials
Liz Kenton	Youth Agricultural Individual Development Account Coordinator, UVM Extension	liz.kenton@uvm.edu	Review exam, set up May 7th, registration, pick up lunch
Aaron Townshend	Teacher, Patricia Hannaford Career Ctr	atownshend@pahcc.org	Grader
David Lalanne	CDL Operations Manager	david.lalanne@cdlinc.ca	Judge - Team event