



2020 Michigan Design and Build Bridge Challenge Guidelines Grades 11 and 12

Please thoroughly read all sections of this document to insure adherence to the competition guidelines. Rules and specifications change each year.

The Michigan Department of Transportation (MDOT) TRANSPORTATION and CIVIL ENGINEERING (TRAC) Program:

The Purpose of TRAC: The TRAC program is an inventive way of introducing students to the wide variety of career opportunities available in the field of engineering. The program teaches secondary students how to apply a variety of math and science concepts to common engineering problems occurring in transportation systems. The TRAC program is also designed to allow students to identify and evaluate the social and environmental impacts associated with the development of new transportation systems within their communities.

Program Design: TRAC includes electronic components to collect and analyze data, and software programs to graph results and test a series of models. The developed activities are designed to show students how to use software and hands-on tools to solve real-life problems associated with transportation.

The Competition:

This event is designed to allow students the opportunity to develop a **cable-stayed bridge** that will be tested for strength-to-weight ratio. Student teams from grades 11 and 12 will be competing against other TRAC student teams from across Michigan. Interested teams should fill out the attached application and submit it prior to the deadline of Nov. 8, 2019. Only materials included in the kit supplied can be used in the construction of the bridge. The kit will be shipped by Dec. 13, 2019, and will include the following:

- Balsa Wood
- Wood Glue
- String

Other materials needed but not provided in the kit:

- Calculator
- Bentley PowerDraft Student Software (download link below)
 - <http://apps.bentley.com/studentserver/home/index>



TRAC and RIDES

Getting started with Bentley's STUDENTserver:

Faculty and students must first create accounts using the following **School Code** to set up an individual account:

ceUIppmq/CV1ia8npF48K6sfC6t3hqy0JPihQw5FgQ/XzFpJ0krLiA==

Visit STUDENTserver at <http://apps.bentley.com/StudentServer> and click **JOIN NOW**

Create your account:

1. Add your School Code to that field, as requested in the registration form.
2. Add your personal information in the other form fields.
3. Submit the form. An e-mail will be sent to you from Bentley for further verification. (If you do not receive an e-mail within a few minutes, check your spam/junk folder.)

Verify your account:

Click the link in the account verification e-mail to activate your STUDENTserver account.

Once you verify your new account, you can log in and access all that STUDENTserver has to offer.

Download the software:

- Go to the “download” page on STUDENTserver.
- Along the left side of the page are search filters that you can set, including “Product Line,” “Brand,” and “Language.” Click on the Language filter and click on “English” (or your preferred language) from the drop-down menu.
- Click on the “Product Line” filter and select the “Modeling and visualization” option.
- Look to the right and find MicroStation PowerDraft. Click the “All Downloads” text in blue. This will pull down a dropdown menu of versions of PowerDraft to download. Select the version you want and click the green download button on the right.
- Take note of the “site activation key.” This is what you’ll use to activate the product when prompted during the installation process.
- Once the installer is downloaded, open it and follow the instructions. When the product needs to be activated, use the site activation key as described above.
- If you need further explanation of the activation process, click on the blue “How do I activate my Bentley software?” button at the top right-hand side of the page.

Access training:

- Go to the “Leaning” page on [STUDENTserver](#).
- Browse the product categories to find the application for which you want training.
- Click on the blue product name to follow the link to the learning path page on LEARNserver, Bentley's training access point.
- Click on the “find training” below the course you want to open up the course materials for download or viewing.
- Once you have completed a training course, you can view and print out transcripts for that course in the “certificate and transcript” page of STUDENTserver.
- To view a list of learning paths recommended for students, go to Bentley's learning paths Communities page [here](#).

Get connected:

- Join the Academic Programs community on Bentley Communities [here](#) to view information on upcoming events, suggested training opportunities, design competitions, and more.
- Join Bentley's Facebook page [here](#).
- Visit Bentley's [YouTube page](#) to view training views, walkthroughs, and more.
- Bentley's library of on-demand videos can be found [here](#) and can be sorted by product and language.

Bentley step-by-step videos: https://www.Michigan.gov/MDOT/0,4616,7-151-9623_38029_38059_41397-394779--,00.html

After completing the project, each team is required to submit a printed proposal to (electronic copies will not be accepted):

Michigan Department of Transportation
c/o Julie VanPortfliet
1818 Third Ave. North
Escanaba, MI 49829

Do not send the bridge itself. You must include pictures of the bridge (prototype or final). The proposal must be postmarked no later than Feb. 14, 2020. Winners will be notified by March 13, 2020. All entries become the property of MDOT and will not be returned. From the proposals entered, all teams with a complete proposal will be chosen to attend the MDOT TRAC Challenge Competition Finals on April 28, 2020, at the Amway Grand in Grand Rapids. At the Finals, teams will present a 10-minute PowerPoint presentation and structurally test their bridges against teams from across Michigan to determine the winning team.

Who Can Enter?

- Only schools involved in the TRAC program can enter the competition.
- Students must be in grades 11 and 12.
- Teams must be composed of exactly three members. Team member changes will be allowed but must be reported and confirmed by Julie VanPortfliet. Each student can be a member of only one team.

The Problem:

The goal of this competition is to develop a **cable-stayed bridge** that will carry as much weight as possible while weighing as little as possible (strength-to-weight ratio). Each team is to design and conduct experiments to test for strength-to-weight ratio and then design a bridge resulting from those experiments. The teams are to construct a bridge **made only with the materials provided** in the TRAC Challenge Entry Kit. As a part of the Design Competition, the team is required to develop a report portfolio describing the design and testing of the bridge and create design drawings using Bentley PowerDraft CAD software.

The bridges will be weighed and strength tested during the competition to calculate strength-to-weight ratio. Each bridge will be checked for design according to the rules.

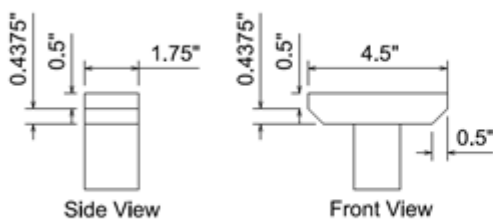
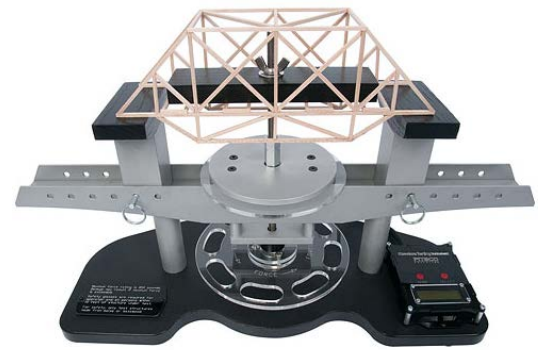
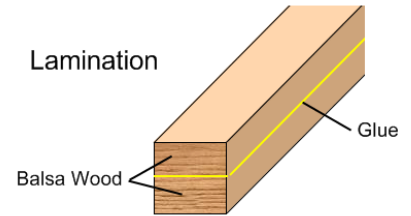
The Challenge:

An engineer's job is to not only design a safe bridge to carry required loads, but also to make sure that it is cost-effective (least amount of materials used to achieve the desired load). To simulate this process, teams will use the following strength-to-weight ratio calculation to develop a bridge that carries a high load relative to the bridge weight. Strength-to-weight ratio is determined by dividing the maximum load carried by the weight of bridge.

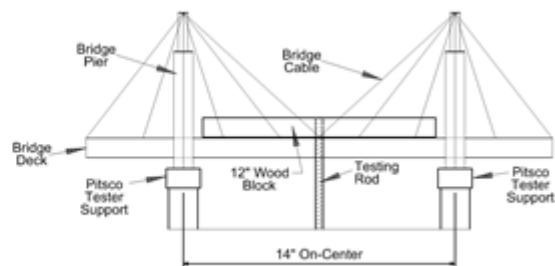
Example: Maximum load = 120 pounds
 Bridge weight = 20 grams
 Ratio = 2,724
 [(120 pounds x 454 grams per pound) / 20 grams]

Specifications for cable-stayed bridge:

- The materials provided in the kit and water are the **only** materials to be used when building the bridge structure. Any modifications to the structural properties of the balsa wood or using different glue than provided will result in judges recording zero weight held.
- All team members must wear the provided Bridge Challenge polo shirt (clearly visible). If the provided Bridge Challenge shirts are not worn, the team will be given a zero weight held and expenses will not be reimbursed.
- The instrument used for testing will be the Pitsco Structure Testing instrument, as seen on the right.
- Lamination shall be permitted one layer thick as shown in the picture on the right. If two laminated members are beside each other there must be a minimum of 1/8 inch gap between them.
- Connections can be butt joints, miter joints, or notched joints. Lap joints are permitted but no greater than 1/4 inch.
- The distance between the center of the piers shall be 14 inches.
- The bridge deck shall be no taller than 2 inches.
- No part of the pier shall overhang the tester supports lengthwise nor touch the bridge deck outside of the support. The bridge deck can freely sit on the pier within the 1.75 inches of the tester support but not touch the tester support. The bridge deck must not be glued to the bridge pier. The piers must be no wider than 4.5 inches at the bottom but can be wider as the towers rise vertically.
- A block of wood that is 12 inches long by 2 inches wide by 1 inch high must be able to be laid across the bridge deck as shown in the diagram below. Therefore, the deck must be wider than 2 inches to accommodate the block.
- Tester supports will be placed at 14 inches on center. Support dimensions are shown below.
- During testing the bridge cables (strings) must be utilized in load transfer to the piers. The bridge shall be designed to work as a whole (deck, piers, and cables).
- The bridge deck must have a 3/4-inch hole to allow a 5/8-inch testing rod to pass through in mid-span and attach to a 12-inch block of wood for strength testing. **The rod must be able to pass through the full height of the bridge as shown in the diagram below.**
- The bridge must meet the **cable-stayed bridge** definition.



Support Detail



Tester Configuration Detail
Not representative of required design.
Use only for dimension reference.

Proposal Format:

I. Bridge Proposal:

To be invited to participate in the bridge challenge, students need to completely fulfill **all** of the criteria for each section below and on the following page.

Students must provide a proposal that is unique to the work that the student team performed. Graphs and charts created in a classroom will not be accepted. Each student team must create their own graphs and charts.

A significant attempt must be made for each section. One or two sentences on a topic is not enough.

- A. Proposal Format: The written proposal should be typed, double-spaced, using a size 12 font of either Arial or Times New Roman on 8.5-inch by 11-inch paper with all pages numbered, 1-inch borders all around. Sections must be labeled and in order of the outline below:
- B. Timeliness: Proposals received after the deadline will not be accepted.
- C. Proposal Presentation: Report portfolio **must** contain all the sections and subsections outlined on the following page and each section must be detailed to show effort from the student teams.

I. Title Page. Include name of challenge (Truss, Deck Arch Truss, Cable-Stayed), team name, team logo (students must create a unique logo – a school or sport logo will not be accepted), name of school or organization, names of students, and name of teacher or advisor.

II. Table of Contents.

III. Summary (abstract). Clearly and concisely stated (at least one-half page, no more than two pages).

IV. Introduction. Indicate the team name and reason for selecting the name, team members, the background of each member, and a background of the local community.

V. Body. The main part of the report. This part must include:

- a) Explain the scientific principles behind your design (at least one-half page).
- b) Describe the challenges you encountered in designing your bridge and how you overcame the challenges.
- c) Include data tables and graphic representation of tests page (at least one full page, no more than six pages; a minimum of three tables or graphs). Students may use computers to create tables and graphs; however, computer programs that evaluate and automatically generate charts and graphs will not be accepted. Student teams must have unique graphs and charts for their team. One class chart used by all or many teams is not acceptable.
- d) Include formulas and supporting calculations. Show the formula, describe what the formula is used for, and work through the calculations. Calculations must support the design or testing of the bridge. Work must be shown (a final answer is not enough).
- e) Include dimensioned, scaled drawings of preliminary and final bridge designs. Bentley MicroStation PowerDraft software must be used to create the CAD drawings. Bentley drawings must be printed using the instructions in the training video (the training video is located on the TRAC website: www.Michigan.gov/MDOT-TRAC). If Bentley MicroStation PowerDraft is not used for the final drawings, the drawing does not have both a scale and dimensions (in a manner that the bridge can be constructed), print directions are not followed, or the print is cropped or “print screen” is used, the proposal will be disqualified.
- f) Include at least five pictures of the bridge during and/or after construction.
- g) Explain how you tested your design and the improvements this led you to make.
- h) Describe the building methods and challenges that you encountered in building your bridge and how you solved these problems.
- i) Explain safety precautions used while building your bridge or prototype.

VI. Conclusions (and Recommendations). How successful is your project? What did you learn by taking part? What would you do different (at least one-half page, no more than two pages)?

VII. Acknowledgments. List the names of the adults who assisted you in the project with a brief description of what they did.

In addition, include the attached completed checklist and certification, signed by all student team members and adults who assisted in this project.

VIII. Bibliography. List all references used, including the Internet, books and magazines.

IX. Appendices.

A. Scheduling. Show on a timeline or similar method how you scheduled your project. Include brief records of meetings telling how you managed the schedule.

B. Daily Journal. Progress reports of day-to-day work on the project, including date, performance and comments from each team member.

BRIDGE COMPETITION FINALS

Teams chosen to attend the 2020 Michigan Design and Build Bridge Challenge will present a PowerPoint presentation to a panel of judges comprised of high-level engineers. Each team will be expected to be able to answer questions from the panel of judges about their entry. **All CAD drawings used in the PowerPoint presentation must have been created using the Bentley Power Draft CAD Software.**

Judges will examine each bridge entry to make sure it meets the specifications given in the rules.

The criteria below outlines the competition fundamentals:

A. Bridge Design and Construction: Prior to testing, the bridge will be checked by the judges for adherence to the specifications on page six of this document. Specification violations will be discussed with the team prior to testing. Any bridge not meeting the specifications on page six will result in a point deduction up to disqualification.

B. Oral Presentation: *Explanation of Project*. Ten minutes maximum. A rubric on page 12 has been provided for the presentation as a guide (50 percent of total team score).

C. Performance: *Achievement of performance goals and stability of construction*. Bridges will be weighed at the beginning of the competition and tested on a Pitsco Structure Tester. Results will be used to calculate strength-to-weight ratio (50 percent of total team score).

Awards:

Teams chosen to attend the Michigan Design and Build Bridge Challenge will compete for Visa gift cards/awards:

- First Place Team: \$300
- Second Place Team: \$225
- Third Place Team: \$150
- Fourth Place Team: \$75

PREPARING FOR COMPETITION

Form a team of interested students or friends. Discuss the challenges and design specifications. Teams are limited to only three students. Each team must have at least one teacher or other adult to help and advise. A single adult may be an advisor to more than one team.

Study the rules. The individual challenge documents and the grading criteria will give important information, which must be followed to achieve the best results. Failure to adhere to the rules could lead to penalties or even disqualification. If any of the information is not clear, please call for additional help.

Plan the timing of the project. Ensure that everyone in the team knows the date for submission of the written report and recognizes that this means that all major development work should be finished before this date.

Carefully keep records of meetings and working drawings and give members of the team responsibility for different sections of the final report.

Notes to adults: TRAC stresses that **the work on all phases of the project is to be done by the students.** Adult assistance is to be limited to:

- Mentoring
- Basic guidance of the students
- Teaching engineering, mathematical and scientific principles applicable to the project
- Guiding students in research
- Assisting in the production of the report and preparation of the drawings
- Overseeing the manufacturing stages of the project

Guidance should be in the form of asking questions (leading questions, if necessary) to promote creative thinking by the students to identify the scientific and engineering principles involved.

Encourage students to consult creditable websites and other resources to help with the project. **Encourage students to test and improve their designs.** A good way to begin is for each student to design and/or construct a rough prototype. Test it and make improvements.

BRIDGE COMPETITION SCHEDULE

- 1) Applications are due Nov. 8, 2019.
- 2) Kits will be shipped to teams by Dec. 13, 2019.
Kits will include:
 - Balsa Wood
 - Wood Glue
 - String
- 3) Proposals are due Feb. 14, 2020 (do not include the bridge). Electronic copies will not be accepted.
- 4) Notification of finalists by March 13, 2020.
- 5) PowerPoint presentations and student waivers must be submitted to the MDOT Bridge Challenge on or before April 14, 2020. **All teams will be required to submit presentations at this time.** Instructions will be provided later.
- 6) The teams will be staying overnight at the Amway Grand in Grand Rapids on April 27, 2020. The Finals will be held at the Amway Grand on April 28, 2020.

For any questions, please contact:

Julie VanPortfliet
Michigan TRAC Program Manager
1818 Third Ave. North
Escanaba, MI 49829
VanPortflietJ@Michigan.gov
906-420-4280

GUIDELINES

2020 TRAC Bridge Competition - Oral PowerPoint Presentation Scoring Rubric

CATEGORY	25	20	15	5
Content	<i>Covers topic in-depth with details and examples. Subject knowledge is excellent.</i>	<i>Includes essential knowledge about the topic. Subject knowledge appears to be good.</i>	<i>Includes essential information about the topic but there are one to two factual errors.</i>	-
Appearance	<i>Content is well organized using headings or bulleted lists to group-related material. Makes excellent use of font, color, graphics, effects, etc., to enhance the presentation. No misspellings or grammatical errors.</i>	<i>Uses headings or bulleted lists to organize, but the overall organization of topics appears flawed. Uses font, color, graphics, effects, etc., to enhance the presentation. Three or fewer misspellings and/or mechanical errors.</i>	<i>No clear or logical organizational structure, just a lot of facts. Use of font, color, graphics, effects, etc., but these often distract from the presentation content. Four misspellings and/or grammatical errors.</i>	-
Oral Presentation	<i>Interesting, well-rehearsed with smooth delivery that holds audience attention.</i>	<i>Relatively interesting, rehearsed with a fairly smooth delivery that usually holds audience attention.</i>	<i>Delivery not smooth, but able to hold audience attention most of the time.</i>	-
Timeliness	<i>Seven to 10 minutes.</i>	<i>Up to one minute under/over.</i>	<i>Up to two minutes under/over.</i>	<i>Up to three minutes under/over.</i>

NOTE: This is a rubric to help with the preparation of the presentation. Oral presentation will count toward 50 percent of the total team score for the competition. This rubric also will be used by the judges to score the presentations. The remaining 50 percent of the team score will be determined by the outcome of the specification measurements and the strength-to-weight ratio calculations.

2020 TRAC BRIDGE COMPETITION

Suggestions and Helpful Hints

1. Students should be prepared for questions at the end of the presentation. These questions may be concentrated in the following topics. However, note that the judges are free to ask any question about any topic. Therefore, each team should be prepared.
 - a) Choice of design
 - b) Civil engineering careers related to bridges
 - c) Safety
 - d) Impacts of bridges
 - e) Lessons learned
2. Stay organized and keep track of time limits.
3. If you have a question, ask. You can contact Julie VanPortfliet at 906-420-4280.
4. Contact your DOT engineers. They will answer many of your questions.
5. Check out other bridges in your area or around the world.
6. Include detailed information in the team portfolio. Remember, your portfolio is what determines if your team is selected to compete in the competition.
7. Research.

FINAL CHECK LIST AND CERTIFICATION

The students' work must be specific to the team and bridge; class work will not be accepted.

Proposals must be assembled in the same order as the checklist below.

- Title Page.** Include name of challenge (Truss, Deck Arch Truss, Cable-Stayed), team name, team logo (students must create a unique logo – a school or sport logo will not be accepted), name of school or organization, names of students, and name of teacher or advisor.
- Table of Contents.**
- Summary (abstract).** Clearly and concisely stated (at least one-half page, no more than two pages).
- Introduction.** Indicate the team name and reasons for selecting the name, team members, a short background of each member, and a background of the local community.
- Body.** This may be divided into several sections (such as design, development, etc.).
- Explain the scientific principles behind your design (at least one-half page).
- Describe the challenges you encountered in designing your bridge and how you overcame the challenges.
- Include data tables and graphic representation of tests page (at least one full page, no more than six pages; a minimum of three tables or graphs). Students may use computers to create tables and graphs; however, computer programs that evaluate and automatically generate charts and graphs will not be accepted. Student teams must have unique graphs and charts for their team. One class chart used by all or many teams is not acceptable.
- Include formulas and supporting calculations. Show the formula, describe what the formula is used for, and work through the calculations. Calculations must support the design or testing of the bridge. Work must be shown (a final answer is not enough).
- Include dimensioned, scaled drawings of preliminary and final bridge designs. Bentley MicroStation PowerDraft software must be used to create the CAD drawings. Bentley drawings must be printed using the instructions in the training video (the training video is located on the TRAC website: www.Michigan.gov/MDOT-TRAC). If Bentley MicroStation PowerDraft is not used for the final drawings, the drawing does not have both a scale and dimensions (in a manner that the bridge can be constructed), print directions are not followed, or the print is cropped or “print screen” is used, the proposal will be disqualified.
- Include at least five pictures of the bridge during and after construction.
- Explain how you tested your design, and the improvements this led you to make.
- Describe the building methods and challenges that you encountered in building your bridge and how you solved these problems.
- Explain safety precautions used while building your bridge or prototype.
- Conclusions (and Recommendations).** How successful is your project? What did you learn by taking part in this challenge? What will you do differently on future projects (at least one-half page, no more than two pages)?

- **Acknowledgments.** List the names of the adults who assisted you in the project with a brief description of what they did. In addition, include the attached completed checklist and certification, signed by all student team members and adults who assisted in this project.
- **Bibliography.** List all references used, including the Internet, books and magazines.
- **Scheduling and Accomplishments.** Show on a timeline, or similar method, how you scheduled your project. Include brief records of meetings telling how you managed the schedule.
- **Daily Journal.** Progress reports of day-to-day work on the project, including date, performance and comments from each team member.
- **Certification.** Team members and advisors must sign the certification on the bottom of this page. Failure to have all signatures will result in disqualification of the proposal.
- Include this completed checklist and the certification in the proposal.

Student/Teacher/Guidance Certification:

“We hereby certify that the majority of the ideas, design, and work was originated and performed by the students, with limited assistance by adults, as described above.”

After each student’s **signature**, please include their shirt size (SS). Shirts are adult sizes.

Team Captain	SS	Team Member	SS	Team Member	SS

Adult advisor **signatures**:

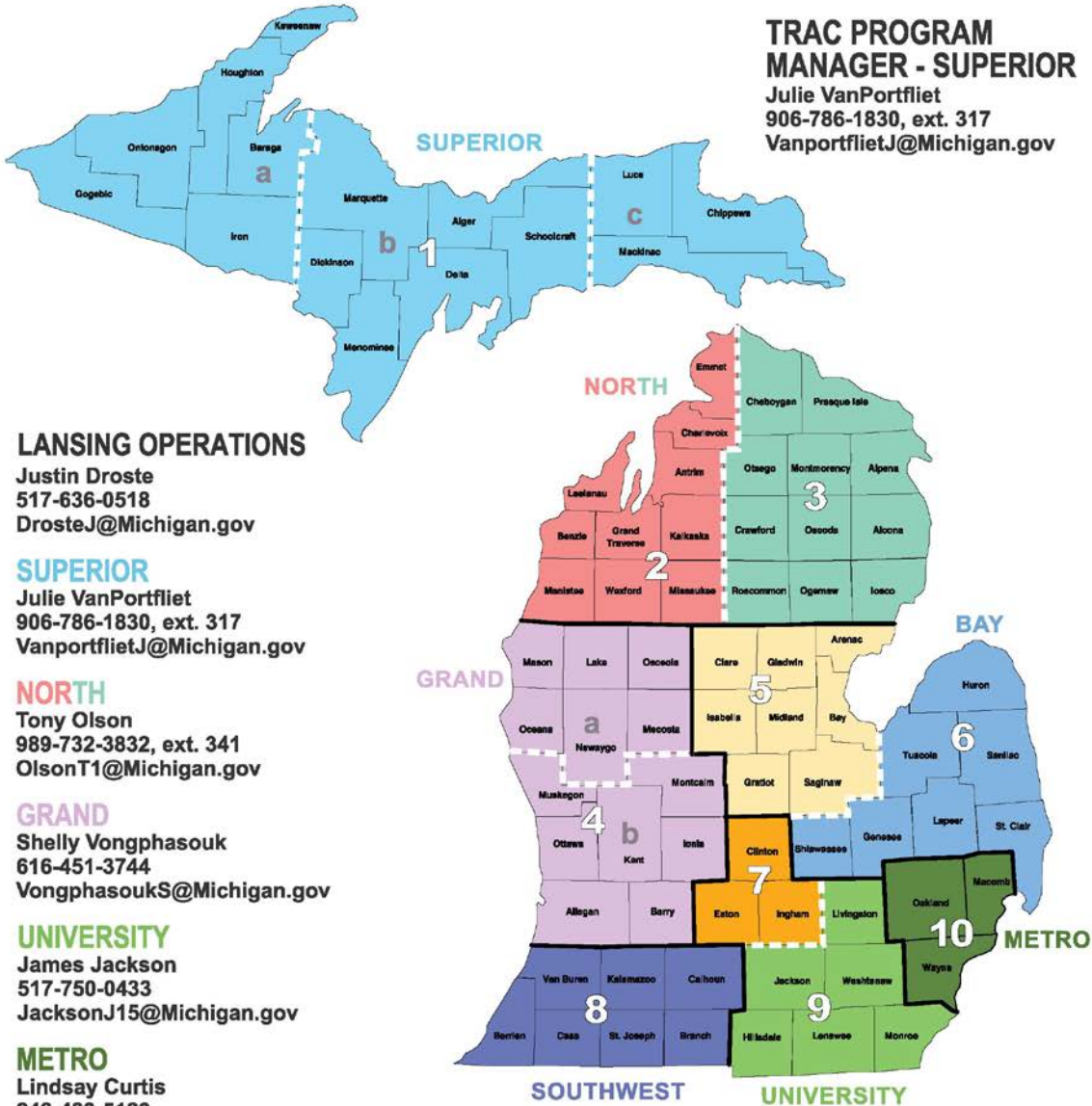
 Advisor/Teacher

 Provided Guidance

 Provided Guidance



TRAC PROGRAM REGION COORDINATORS



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MICHIGAN BRIDGE CHALLENGE APPLICATION

We have read the challenge documents and the guide to entry, and we want to register for the **Michigan Design and Build Bridge Challenge**.

Advisor:	E-mail Address:
Phone Number:	City:
Street Address:	ZIP Code:
School or Group:	Team Name:

Team Member Name	Grade Level	Shirt Size (adult sizes)

Any Michigan school or organization involved with the TRAC Program is eligible to enter. Teams must be composed of three members; no more, no less. Each student can only be a member of one team. (An advisor working with more than one team must send a separate application form for each team.)

This form must be mailed (postmarked), faxed, or e-mailed on or before Nov. 8, 2019, to:

Julie VanPortfliet
 MDOT TRAC Program Manager
 1818 Third Ave. North
 Escanaba, MI 49829
 906-420-4280, 906-789-9775 (fax)
VanPortflietJ@Michigan.gov

Dec. 13, 2019	Bridge Challenge kits will be shipped by this date (when possible, kits will be shipped immediately upon receipt of the application).
Feb. 14, 2020	Report Portfolios are due by this date (do not include bridge) and must be postmarked.
March 13, 2020	Teams with complete Report Portfolios will be notified and invited to attend the 2020 Design and Build Bridge Challenge.
April 14, 2020	Presentations and student waivers are due.
April 27, 2020	Travel to Grand Rapids. Teams will be staying overnight at the Amway Grand Plaza.
April 28, 2020	Design and Build Bridge Challenge at the Amway in Grand Rapids.

For any questions, contact Julie VanPortfliet at 906-420-4280 or VanPortflietJ@Michigan.gov.