

# 2024 4-H ROBOTICS ENGINEERING CHALLENGE

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# "MINE" YOUR OWN BUSINESS!

## **1 Maryland 4-H Robotics Engineering Challenge**

The Maryland 4-H Robotics Engineering Challenge (REC) provides an opportunity for 4-H members interested in STEM (Science, Technology, Engineering, Math) to participate in a hands-on, team-based activity where they build robots and program them to complete specific tasks. Successful teams will display technical excellence in robot design, engineering, and programming, as well as a high level of skill on the field in competition. The REC theme changes every year and integrates hot topic issues plus 4-H and University of Maryland priorities to bridge connections between youth, UMD, and industry.

Please direct questions and/or concerns to Willie Lantz, 4-H Robotics Superintendent, at [wlantz@umd.edu](mailto:wlantz@umd.edu) or Mark DeMorra, 4-H STEM Specialist, at [mdemorra@umd.edu](mailto:mdemorra@umd.edu).

## **2 The Essence of the Game**

The 2024 Maryland 4-H Robotics Engineering Challenge has youth getting back to nature... and hopefully not destroying it in the process! Youth will be challenged to determine the best means through which some critical resources can be attained from our forests, while not destroying them, thus allowing us to help maintain the vital role trees play on Earth and in humanity's existence. Teams will have several means to score points, including collecting various stones and ore (diamond, coal, redstone), but will get bonus points if they have careful maneuvering so as to not damage the surrounding forests too much in the process. Further, to support the regrowth of forests that humans may have impacted, teams will also have the ability to plant "Saplings" in damaged areas, to ensure the forests can thrive and support wildlife for generations to come.

To collect the ores and score the biggest points, however, requires specific maneuvering in the game. First, not all of the ores in the game are in demand all of the time. Each team can only collect *one* of the ores from each of their mining regions per game to score points. Trying to collect the other ores will result in significant "waste" generated, and thus no points will be scored. Further, not all ores can be "mined" the same way, so each team has to design their robot so that a separate component or attachment on it is designed specifically to collect that specific ore. So one designated robot component (and only one component) can be used to collect diamond, a separate designated robot component can only be used to collect coal, etc. To determine the ore that should be collected from each of a team's two mining regions, each will have a color indicator (a notecard) that with use of a robot camera or other sensor, will show what ore they need to collect from that mining region. The team scores points for collecting the correct ore and returning it to base, and can score significant bonus points by not knocking down many trees on the edge of the mining region in the process.

Success in this game requires driver precision to navigate some of the tight areas, excellent planning to determine strategies and sequences of movements, good time management, and innovative engineering solutions. Well-considered strategies and pre-game planning for various situations that might occur will be vital to a team's success.

Following is an image of the 2024 REC field with field elements. Each team is assigned a side of the field, either blue or red. Each team's side of the field has two "Mining Regions" which present numerous opportunities to score points, with a large diamond in the field center called the "Canyon." The Canyon is considered a "neutral zone." However, teams are NOT allowed to cross the field's center white line, besides entering and exiting the Canyon on their side of the field **only**. Therefore, teams are also not allowed to cross through the Canyon to enter their opponent's side of the field.

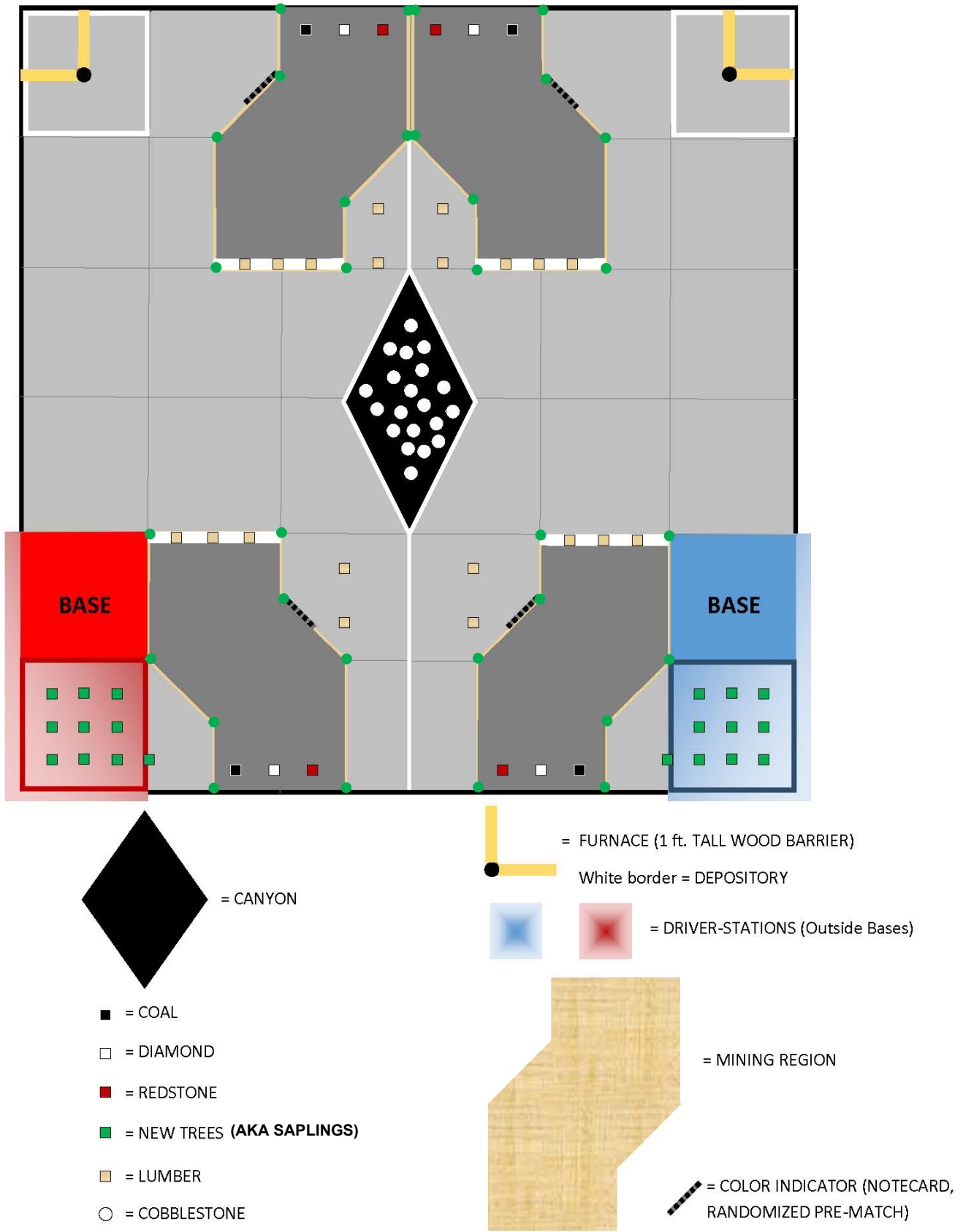
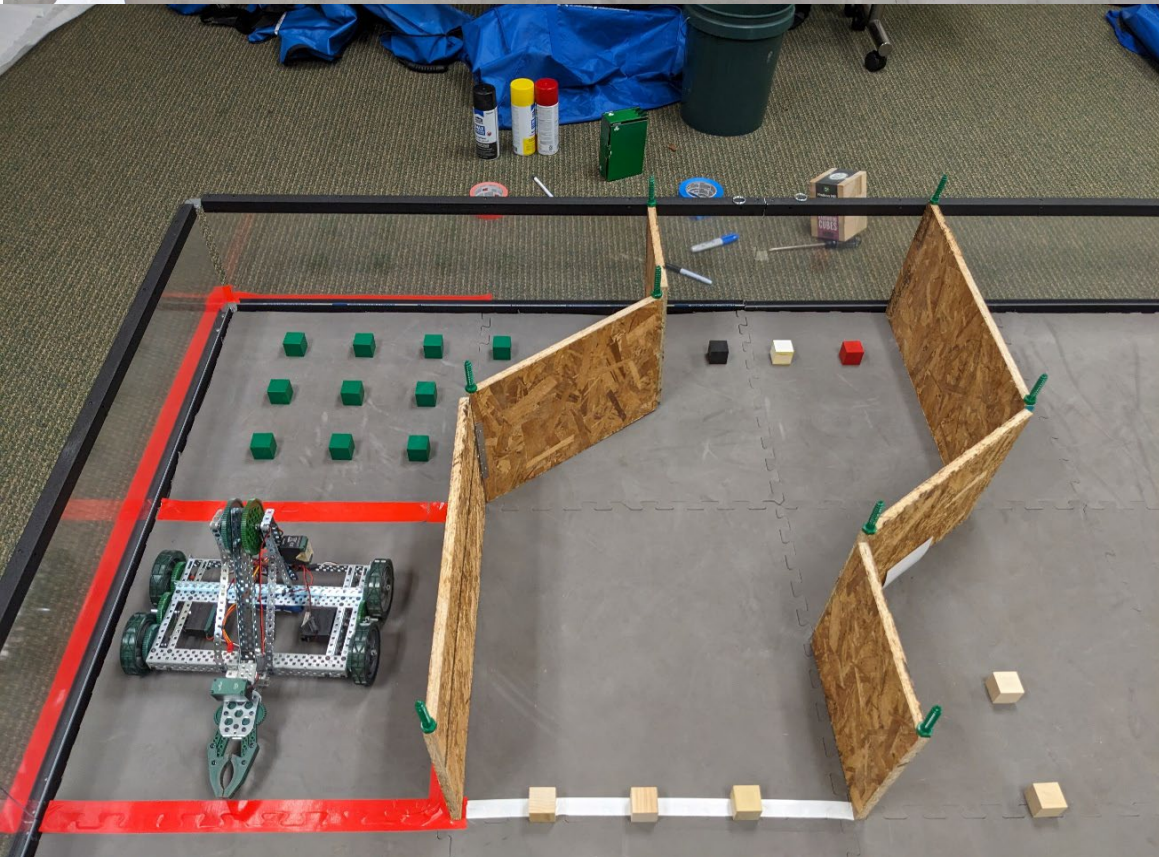
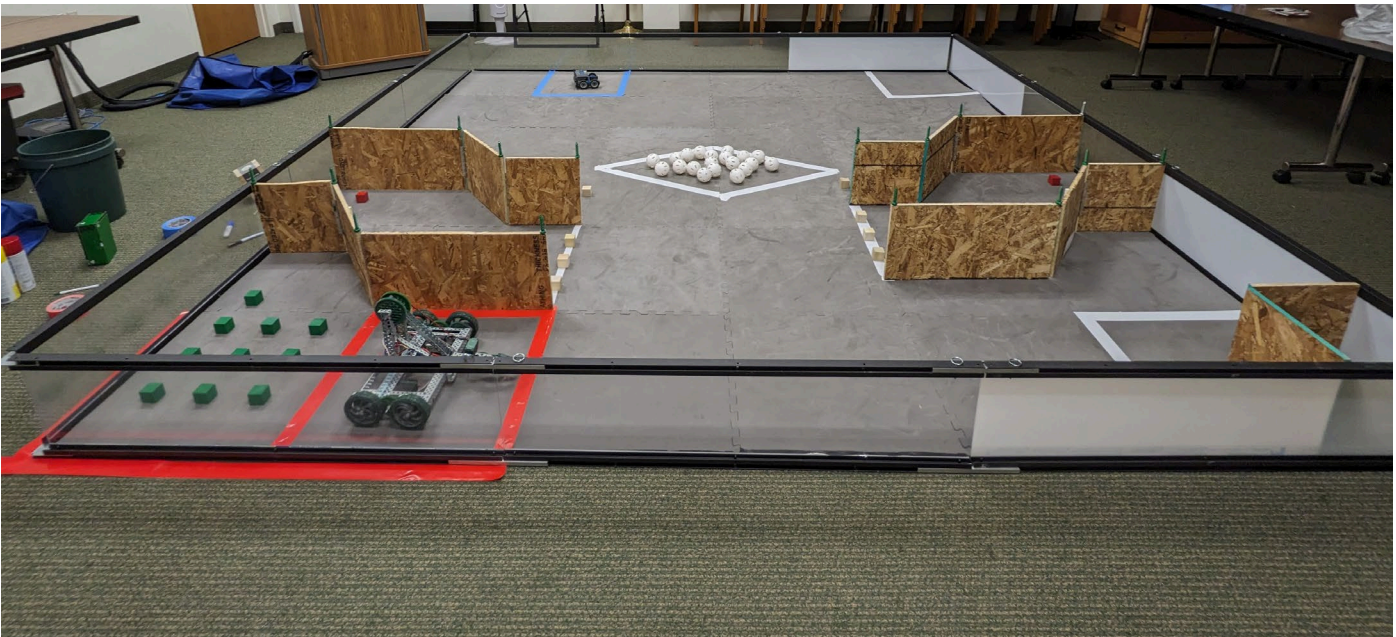


Figure 1: 2024 REC Field







## Gameplay Overview

4-H REC matches are played on a 12ft x12ft *Field* surrounded by a 1ft tall *Field Perimeter*. Two teams play on the *Field* during a match, designated as the “red team” or “blue team,” with their *Starting Tile* colored red or blue in accordance. Each team will play at least one match on the red side of the field, and one match on the blue side of the field. The object of the game is for teams to score the most points during each 2.5-minute match they compete in, by performing missions as explained below.

Each Match starts with a 30-second *Autonomous Period*, where robots can operate only via pre-programmed instructions teams create before the contest. Team members can complete missions on the field to score points during this time, provided they are still adhering to the game’s overall *Item Control Limit* and not incurring *Penalties*, but cannot use remote controls during this time. The team with the most points after the *Autonomous Period*, as scored at the end of its 30 second period, will earn a 15-point *Autonomous Bonus*. If teams are tied, no bonus will be awarded.

**Note:** A team’s score at the end of the *Autonomous Period* is calculated solely for the purpose of awarding the *Autonomous Bonus*. **Only** a team’s final score, at the end of a full 2.5-minute match, is used to determine their overall Robot Game score. A team’s score may increase or decrease after the *Autonomous period*, depending on what events transpire during the *TeleOperation* period. In effect, a team’s “Autonomous score” should only be viewed as their score at that particular moment of the match, and not an indicator of their final score at the end of the match.

During the *Autonomous Period*, robots can score points by performing the following:

1. Bringing *Lumber* to base (Both *Autonomous* and *TeleOp*)
2. Delivering *Saplings* to *Mining Regions* (Both *Autonomous* and *TeleOp*)
3. Bringing the correct *Ore* from a *Mining Region* to base while keeping as many *Trees* standing as possible. (Both *Autonomous* and *TeleOp*)
4. Delivering *Cobblestone* to their team’s *Depository* or *Furnace* (Both *Autonomous* and *TeleOp*)
5. Successfully maneuvering so the robot itself is at least 50% within the *Canyon*, to achieve *Parking* points, as determined by the position of the robot at the **end** of the *Autonomous Period* (Autonomous ONLY)

After the *Autonomous Period*, the 2-minute *TeleOperation* period begins after the referees' signal. Teams can earn points during this period mostly the same way as during the *Autonomous period*, **except for parking**. Teams can earn an additional 20 points by maneuvering at least 50% of the robot into their *Base*, as scored by the position of the robot at the **end** of the *TeleOperation Period*.

### **3 Terms and Definitions**

**Autonomous Period:** The first 30 seconds of a REC match is called the *Autonomous Period*. As opposed to the *Driver-Controlled Period*, this is when a team's robot must operate on its own without the use of human input through a controller. A team will have to write an autonomous code before competing, and can have multiple autonomous codes created, but can only run one per match.

**Blocking:** This is defined as inhibiting a robot's access to scoring elements. Temporary blocking while in congested areas is expected, but strategic blocking to limit opponent's ability to score is not allowed.

**Border Trees:** Represented as green screws standing on their heads, 8 of these are placed on specific spots on the border of each *Mining Region*, on the edge of the plywood boards that are facing upwards. If a team successfully mines and delivers the correct *Ore* from one of their *Mining Regions* back to their base, they'll earn 30 points for the *Ore*, plus an additional 5 points for every *Border Tree* still standing on that *Mining Region's* border (on top of the wood) at the end of the match. **NOTE:** *Border Trees* may shift during the game but will still count for full points, as long as they are still standing in the same orientation on the plywood boards (4 on each side) at the end of the match. Due to the size of the screws, teams should also take precautions to ensure they design and control their robots in such a way to minimize potential effects from the lag screws falling onto or around their robots during a match.

**Canyon:** This diamond shaped area, 4' wide by 2' long, is located at the center of the REC field and is where 20 scorable *Cobblestone* (represented by whiffle balls) are located at the start of the match. This is the **only** area of the field where **both** teams' robots are allowed to enter and may interact. The area is marked with 2" wide white duct tape (part of the *Canyon*). *Cobblestone* are scattered at random in the *Canyon* at the start of each match.

**Cobblestone:** Represented by standard white whiffle balls located at the state of a match in the *Canyon*, teams may collect *Cobblestone* to deposit in their *Depository* and/or *Furnace*. 20 *Cobblestone* start in the *Canyon*, placed randomly at the start of a match. Teams may score points with *Cobblestone*, provided they are following the *Item Control Limit*, by depositing them into the *Depository* and/or *Furnace*. At the end of a match, each *Cobblestone* located in a team's *Depository* is worth 5 points, while each *Cobblestone* located in a team's *Furnace* is worth 10 points.

**Color Indicator:** Represented by a black, white, or red notecard (3" x 5"), each team has one of these attached to the outer perimeter of the diagonal section of each of their *Mining Regions* (2 color indicators per team). The color of each notecard will be randomly selected by a referee before a match, and the robot, using sensors or other devices it has equipped, must determine the color of the notecard to determine which of the 3 *Ores* it must collect from that specific mining region during that match. A team's notecards (and thus scorable colors) will not be visible to team members while a match is in play. A team's two mining regions, however, will have different color notecards between them during a game, and the notecards will be re-randomized every match.

**Control/Controlling:** Items are considered to be Controlled by a team's robot if the item(s) is/are following the movement of the team's robot. Examples include but may not be limited to: Pushing an item in any form, holding or carrying an item, grabbing and/or releasing an item.

**Depository:** 2ft x 2ft x 2ft area represented by the white tape at the opposite corner of each team's base, teams can score points here for every *Cobblestone* they fully place successfully within the

Depository, as scored at the end of a match. The *Furnace* is fully located entirely within the Depository, represented by an L-shaped wood perimeter 1 foot in height. Each *Cobblestone* fully within the Depository at the end of a match (but NOT within the *Furnace*) is worth 5 points apiece.

Designated Ore Collector (“Collector”): This is part of a team’s robot, which is designated as the component that will collect a specific *Ore* from a *Mining Region*. When robot inspection occurs, the robot’s “Collectors” will all need to be attached to the robot at that time and will be considered when determining if a robot passes inspection. Each of the robot’s “Collectors” must be clearly indicated as to which of the three ores it is intended to collect. This is done by having a significant portion of the “Collector” to be colored the same as the ore it is intended to collect (**Coal-black, Diamond-white, Redstone-red**). At least 50% of each “Collector” must be painted or other present as the same color as its corresponding *Ore* block, though if possible, it is recommended as much of the “Collector” matches the corresponding *Ore* block color as possible. A team can only score points for *Ore* collection if it uses the correct “Collector” to attain the correct ore in a mining region, and use it to return it to the team’s base. Using any of the other “Collectors” a team may have to collect and deliver an *Ore* will result in points not being scored for the team for that mission.

Driver-Controlled Period: The Driver-Controlled Period follows the 30-second *Autonomous Period* and lasts 2 minutes. Teams control their robots directly using remote controls that remotely communicate with the robot’s electronics to operate. The end of the Driver-Controlled Period constitutes the end of a match.

Driver-Station: The area where drivers are required to stand during matches. These areas are represented on the prior REC field image by the colored shadows on the exterior around each team’s base and will be marked at the contest with red or blue tape. This area will extend back three feet from the *Field Perimeter*. Drive-teams must remain here for the entirety of a match. If a drive-team member leaves this area during a match, they may forfeit points scored, as determined by the referees.

Drive-Team: Up to three youth team members may be active “at” the field for any one match. This is the active Drive Team. These members must stay in the Driver Station area for the duration of the match, and they are the only people able to handle the robot controls or provide any coaching during the match.

Event Official: Any individual who is leading or assisting with the operation and execution of refereeing, judging, scoring, and officiating a REC tournament is considered an Event Official. Decisions made by them are believed to be unbiased and done using their best judgment. These individuals have been asked to assist in some manner with a REC tournament by, and report to, the 4-H Robotics Superintendent and 4-H STEM Specialist. Questions about decisions made by robot game referees must be brought to their attention immediately following a match when a referee asks a team to review and sign-off on their score sheet. After a match’s scoring has been posted, it is considered final and CANNOT be changed.

Field: The 12ft x 12ft playing area for the REC game. The field consists of a 6 x 6 grid of 24” foam tiles and all game elements which are located within the *Field Perimeter*.

Field Perimeter: The 1ft tall black aluminum and clear acrylic border of a REC Field, whose purpose is to keep all *Field* elements contained within its borders throughout the game. The Field Perimeter is 12ft in length on each side and can be a VEX VRC Field Perimeter or FTC Field Perimeter from Andymark.

Furnace: Located fully within the *Depository*, this area is represented by an L-shaped wood barrier comprised of two 1ft x 1ft boards angled at 90 degrees from each other (made from the same plywood as the *Mining Region* - 19/32” depth). Teams can score points by successfully placing *Cobblestone* within the Furnace, provided they are following the *Item Control Limit*. Every *Cobblestone* fully placed within a team’s Furnace (fully within the furnace boundary in length, width, and height), as determined at the end of the match, is worth 10 points to the team.

Item Control Limit: A robot can only *Control a maximum of 2 items at any one time* during a REC



match. This rule is meant to replicate constraints miners and lumberers face when collecting resources, but also allow both teams the chance to collect *Cobblestone* from the Canyon. This challenges teams to plan their strategies and manage time well during matches. If a team does not follow the *Item Control Limit*, they will be assessed a *Minor Penalty* of 10 points for each item above the limit their robot controls, with additional *Minor Penalties* every 3 seconds this continues for every item above the limit.

- Example 1: If a robot *Controls* 3 items for 5 seconds while trying to score in the *Depository*, they'll be assessed two *Minor Penalties* totaling 20 points. They are assessed the first 10-point penalty for controlling 3 items at the onset, then an additional 10-point penalty for having this situation continue for at least 3 seconds.
- Example 2: If a robot *Controls* 5 items for 2 seconds while trying to score with the lumber, they'll be assessed three *Minor Penalties* totaling 30 points. The team is assessed a 10-point penalty for each of the items above the 2-Item Control Limit at the onset of this specific situation. Because this situation did not last longer than 3 seconds, the *Minor Penalty* for each item over 2 is assessed only once.

Lumber: These are scorable objects represented by unpainted 1.5" x 1.5" blocks on the field (10 per team). 3 are located at the entrance of each of a team's two *Mining Regions*. 2 each are located between each of a team's two *Mining Regions* and the *Canyon*. Teams score 5 points apiece for each piece of lumber they return to their base using their robot, as scored at the end of the match, and provided the team follows the *Item Control Limit*.

Mining Region: Each team has two of these on their side of the field. Each is the region whose perimeter includes the plywood border comprised of three plywood boards (1' high) on each side, a 2-foot-long strip of white tape on the field on one end, and the field perimeter on the other end, creating a concave octagon resembling a stretched letter z. Within the Mining Region are 3 colored blocks representing *Ores*, which a team can score points with if they correctly and successfully collect the correct *Ore* while the robot is entirely contained within that Mining Region. Placed on the border of the Mining Region at the top of the plywood boards are a series of *Border Trees*, represented by green upside-down screws, which can earn the team bonus points if they are still standing at the end of a match, and their robot has successfully mined and delivered the correct *Ore* from that Mining Region. A team is **required** to indicate to referees before a match begins if they intend to enter the Mining Region to attempt to score points by collecting the correct *Ore* located there.

Minor Penalty: A Minor Penalty is assessed when certain infractions of game rules are broken. Minor penalties issued to a team subtract 10 points from the final score at the end of a match. These penalties are designed so that even though teams may have broken a core rule of the 2024 4-H REC game, they are still able to continue playing.

Ore (Red, White, or Black): Scorable items that robots must determine which is to be mined, then bring back to their base to score points. Correctly obtained and delivered *Ore* are worth 30 points each, plus a 5 point bonus for each *Border Tree* still standing on the edge of that *Mining Region* at the end of the match. *Ore* can only be collected successfully when a robot is **entirely** enclosed in the *Mining Region* when attempting this mission. *Ore* is represented by 3 color blocks located in each of the four *Mining Regions* on a field. Each team's side of the field features two of each color of these blocks. Each block is 1.5" by 1.5", made a standard 2x4 pine board that can be purchased at home improvement stores. Pre-cut blocks can be purchased at Lowes or online: <https://www.lowes.com/pd/Madison-Mill-1-5-Hardwood-Cubes-27-PKG/5001880823>

- Black Ore: Coal
- White Ore: Diamond
- Red Ore: Redstone

Parking: Term used to describe scorable “missions” where a robot can maneuver to a specific location on the REC field to score points. In 2024’s game, teams can score parking points twice during a match:

- 10 Points if a team’s robot is at least 50% within the *Canyon* when time is called at the end of the *Autonomous Period* (as defined by the number of fully positioned wheels OR length of treads within the taped canyon region).
- 20 Points if a teams’ robot is entirely back within their team base when time is called at the end of the *Driver-Controlled Period*.

Penalties: Penalties will be assessed for behavior which typically provides an unfair advantage or prevents an opponent from actively attempting to score. Penalties are defined throughout this document, and when applied will be added to the opponent’s score.

Pinning: This is defined as contact with an opposing robot, not allowing it to move. This typically applies to holding an opponent against the *Field Perimeter* or another field element. **It is not allowed.**

Saplings (Newly Grown Trees): Represented by 10 green blocks on each team’s side of the field, located behind their base, a team can score points for each one placed by the robot completely within one of the team’s two *Mining Regions*. Each Sapling in a team’s *Mining Region* at the game’s end is worth 5 points.

Starting Tile: The designated tile, colored red or blue, which a team’s robot must start in at the beginning of every REC match. The starting tile also has one black block on it at the start of the match that can be scored during the *Autonomous period*.

Teleoperation (TeleOp): **See Driver-Controlled Period.**

## **4 Challenge Overview**

### ***4.1 Robot Game Structure***

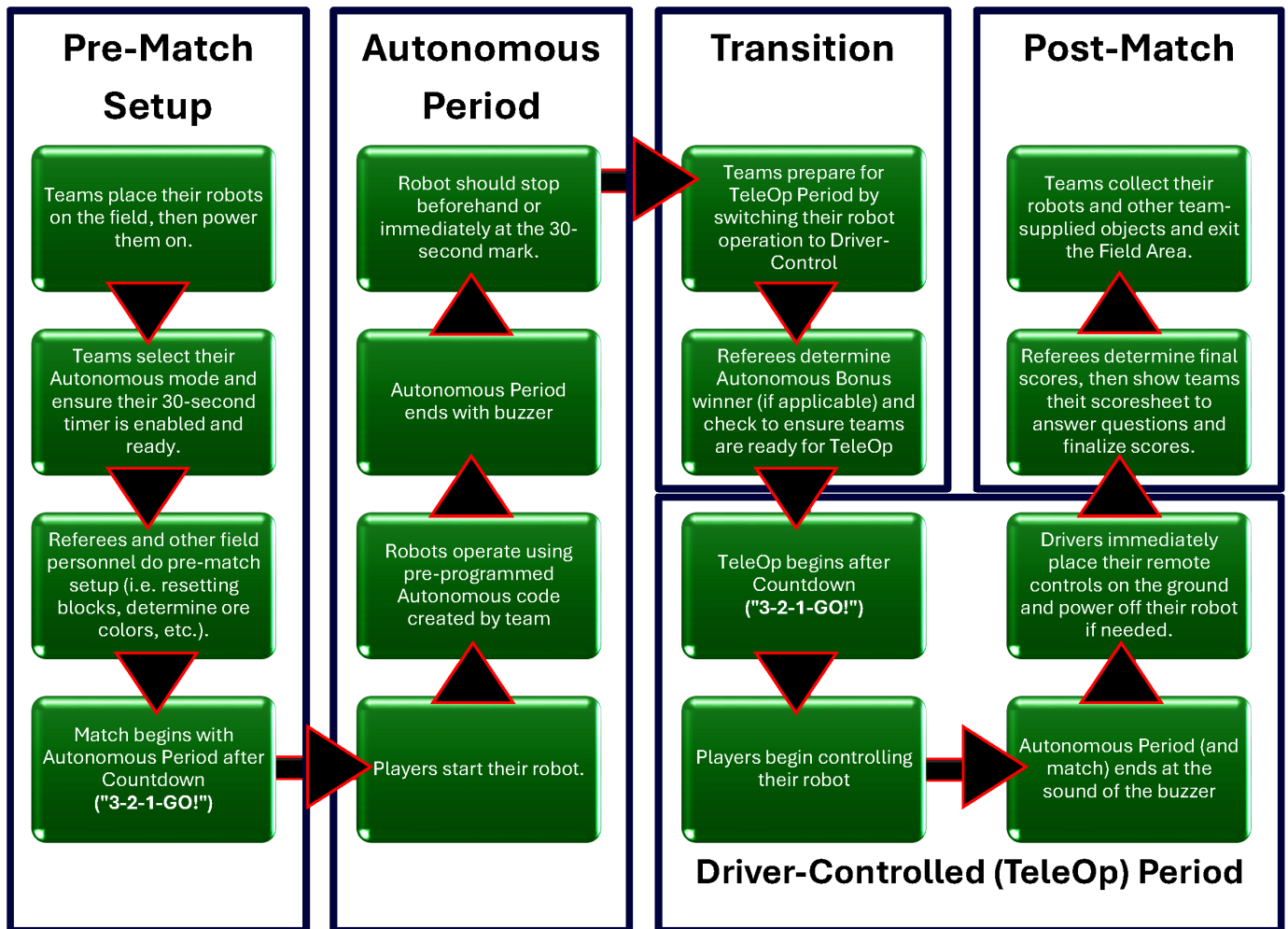
During each match, two teams will compete head-to-head, and teams will be competing in multiple matches throughout the day. The objective is for a team to score the most points by completing game tasks. Points are primarily scored by delivering objects to specifically designated areas of the field, and by collecting ores while not knocking down trees in the Mining Region. Other scoring mechanisms also exist, and missions have a range in their difficulty, intended to challenge veteran teams while also allowing for new teams to have a chance to compete.

Each match will last for a total of 2 minutes 30 seconds, and will be divided into two separate timed periods, as follows.

1. The Autonomous period: Teams will have 30 seconds to score points with their robot using only code previously installed on their robot, without any direct operator control. Remote controls must be out of the drivers’ hands during this period. The robot must remain in its final resting position at the end of the Autonomous period and cannot be moved until the start of the Driver Control period.
2. The Driver Control (Teleoperation) period: Shortly after the conclusion of the Autonomous period, Teams will have 2 minutes to operate their robot by remote control.

Scores will be tallied by referees and other event officials at the end of the Driver Control period. Scores may not immediately be revealed to teams, but will be posted shortly after a match’s conclusion, after scoring officials have verified and entered them into the system. Following is a flowchart that may

be helpful for teams to review to understand the processes and flow of 4-H REC games.



## 4.2 Judging and Engineering Notebook

During the season, teams should document their work in an Engineering Notebook, which should summarize the team's entire process of designing, building, programming, and testing their robot. It is expected that teams update their Engineering Notebook *every meeting*. At State Fair, on the morning of the REC Tournament, each team must submit their Engineering Notebook when they check-in that morning. The judges will *not* review Engineering Notebooks before judging rounds begin.

During the day of the REC tournament, each team will have a scheduled time to give a presentation about their work during the season, both technical and non-technical, to a panel of judges. These sessions will last approximately 10 minutes, **but teams must leave time for judges to ask questions at the end**. It is recommended teams aim to have their presentations last approximately 5 minutes with 5 minutes left for questions. If the judges feel a team's presentation is running too long, they reserve the right to stop the team at whatever point deemed necessary, and the judges will score the team on what they heard and what questions they're able to ask with the time left. The team's Engineering Notebook and their presentation will determine their final judging score. The rubric used by judges to score notebooks and presentations can be found in the appendix of this document.

A team should use their Engineering Notebook to document the team's design process in building the robot from its initial design concepts to finished product. Team members should document their work in

the journal each time they meet to work on the robot. Items that can be included are, but not limited to, prototype & CAD drawings, obstacles encountered, lessons learned, coding used and development process, failures & successes of designs, testing procedures and results, and any relevant community outreach or club efforts. Any format may be used for the journal.

### 4.3 State Fair Competition Structure

There are two components that combine equally to form a team's overall tournament score and subsequent ranking: Robot Performance and the Engineering Presentation/Notebook. The percentage score for these two components is added and the resulting sum is used to rank the teams.

During the State REC Tournament, REC teams will compete in at least 3 matches. A team's overall Robot Performance is the average score of all their scheduled matches. If a team does not participate in a scheduled match, or if it is disqualified from a match, it will receive zero points for that match, which will reduce their average score. A team's average score will then be turned into a percentage of the competition's highest top score.

## 5 The Field and Field Elements

### 5.1 The Field

Matches are played on a standard 12' x 12' VEX/FTC field, with perimeter walls 12" high, and a field surface of standard foam VEX or AndyMark FTC tiles approximately measuring 24" x 24". There are two colored starting tiles on opposite sides of the field. One red, one blue. Field tiles are installed with their smooth side up.

### 5.2 Field & Scoring Elements

Blocks: Some scoring elements for this game include 26 1.5" cubes/blocks of various colors on each team's side of their field. 10 are painted green (located next to a team's base), representing *Saplings*. 10 unpainted/natural blocks are placed in various spots around a team's side of the field, representing *Lumber*. 2 blocks each of red, white, and black are located in a team's *Mining Regions*, representing the *Ores* redstone, diamond, and coal respectively. Teams can score points by moving these blocks various places around their side of the field. Blocks follow the *Item Control Limit* rule of the game.

Canyon: This diamond shaped area, 4' wide by 2' long, is located at the center of the REC field and is where 20 scorable *Cobblestone* (represented by whiffle balls) are located at the start of the match. This is the **only** area of the field where **both** teams' robots are allowed to enter and may interact. The area is marked with 2" wide white duct tape (part of the *Canyon*). *Cobblestone* are scattered at random in the *Canyon* at the start of each match.

Cobblestone (Whiffle Balls): 20 of these standard-size Whiffle Balls are randomly distributed within the diamond-shaped *Canyon* at the start of a match. A team can transport these to their *Depository* and/or *Furnace* to score points.

Depository & Furnace: Located on a team's side of the field opposite their base, teams can score points by having their robot transfer *Cobblestone* (Whiffle Balls) here during the match, worth 5 points each. The *Depository* is a 2' x 2' square bounded by 1" white tape. Within the *Depository* at its corner that includes two sides of the field perimeter, the *Furnace* is a 1' x 1' square bounded by the field perimeter and a 1' high plywood perimeter, comprised of two 1' high boards positioned at 90 degrees from each other. Whiffle Balls located within a team's *Furnace* at the end of a match score 10 points each.

Mining Region Perimeter: There are two mining regions on each team's side of the field. These regions are each comprised of a 2 ft-long strip of white tape and two plywood-constructed walls one foot high. Each plywood wall is comprised of a 1'x1' piece and 2'x1' piece, connected at a 45 degree angle by a 17"x1' plywood piece.

Starting Tile: Each team has one 24" by 24" foam tile (colored red or blue) where their robot must be placed completely inside when the match begins. The Starting tiles are located towards the rear wall of the field one tile over from each corner. Next to each starting tile in the corner, itself, are 10 green blocks that they can score points with by placing them in their *Mining Regions* by the end of the match.

Trees (Screws): On each plywood side of a *Mining Region*, 4 screws (1/2" x 2.5" Zinc lag screws, [available at Lowe's](#) individually or in packs of 25) represent trees, which sit on their head on the edge of plywood and can score bonus points for the team if they're still standing at the end of the match if they successfully collected *Ore*. The 2' plywood panels of these walls have one tree on each end of their 2' length, the 17" length board has one tree on the end of the board farthest from the two-foot board, and the 1' length board has a tree on its end at that corner of the full *Mining Region*. This means each *Mining Region* has 8 associated trees surrounding it. If the predetermined ore is correctly collected and returned to a team's base, each of those trees still standing on the edge of the plywood of that *Mining Region* is worth an additional 5 points to the team. These bonus points are ONLY calculated and based from the final field situation and positions of the screws at that end of the match.

More information on the materials used to build the REC game field components can be found in the REC Build Guide on the [MD 4-H STEM Website](#), including websites where items can be purchased.

## **6 Challenge & Game Rules**

### **6.1 Robot Rules**

1. Robots can weigh a maximum of 20 lbs. (including batteries). A scale may be used at inspection to ensure the robot meets this requirement.
2. Robots may be constructed using a wide variety of materials. Creativity is encouraged! Legos, VEX robotics parts, FIRST components, plastic, cardboard, duct tape, fasteners of various types, etc. are all permitted.
3. Components that pose risk of harm to an opponent's robot are not permitted, even if the risk is unintentional or rare. This includes, but is not limited to, sharp, explosive, radioactive, or liquid components. Robot inspectors, judges, and referees all will be monitoring for these potential risks and have the authority to disqualify a robot from competing until identified issues are fixed.
4. At the beginning of a match, robots must be able to fit inside a 18"x18"x18" sizing box. Robots identified as being too large will be required to reduce their size before being able to compete.
5. Once a match begins, a robot may expand in size. Teams are urged to use common sense when designing their robot expansions.
6. No component of a robot may be intentionally detached during a match. This can present a safety hazard.
7. The robot's power source CANNOT exceed a total of 12 nominal volts.
8. The total capacity of the robot's power source CANNOT exceed 6000 mAh.
9. During a match, robots MUST be controlled wirelessly. No tethered or wired connections are allowed.
10. A robot's Autonomous program, if it has one, MUST be able to be started remotely by a team. After being placed in its starting position on the field, touching the robot or its components in any way to start it, change its programming or operation, or otherwise physically control it by hand in some manner, is not allowed until after event officials signal it is clear for robots to be removed. Starting and/or controlling robots by hand in this manner could present safety hazards.
11. Any microprocessor may be used in the robot's design.

12. Any wireless controller may be used, as long as the setup allows for the robot's operation in Autonomous and Driver Control to be done remotely, in accordance with Robot Rule 10 above.
13. A robot can have a MAXIMUM of 10 motors and/or servos total.
14. On Challenge Day, all robots must be inspected before they will be permitted to compete in any match. Any issues the inspection judges find with a robot design or setup must be rectified first before it is allowed to compete.

## 6.2 Participation Requirements

1. 4-H REC Teams may consist of between 3-8 4-H youth members.
2. All team members MUST be enrolled in 4-H Online by July 15, 2023 in order to participate in REC at State Fair. Failure to be an enrolled 4-H member, paid in full, and in good standing will result in those individuals not being able to participate in the challenge in any form.
3. Each group of youth must have two certified 4-H volunteers established to compete and remain in compliance with established 4-H program rules and protocols.
4. Coaches and Mentors **are** allowed to run, assist, and/or oversee more than one 4-H REC team.
5. The 4-H division a REC team competes in is determined by the oldest member of the team. The 4-H age divisions are as follows (Note: 4-H age is determined by a child's age as of 1/1/2023)
  - Senior Division 14+ years
  - Intermediate Division 11 through 13 years
  - Junior Division 8 through 10 years

## 6.3 Safety Rules

1. Each team in the pit areas and/or at the field during a match must wear safety glasses. NO EXCEPTIONS!
2. If a robot becomes disabled or behaves erratically, an event official may authorize a team member to enter the field of play and shut off the robot. This is the ONLY time a team member may be allowed to enter the field while play is ongoing. Penalties may be applied if team members enter the field without permission by an event official, while a match is ongoing.
3. Robots that repeatedly or purposefully damage other robots and/or the field or field elements may be removed from the tournament by an event official.

## 6.4 General Robot Round Rules

1. All decisions regarding scoring and rules violations are made by event officials. Every effort will be made to ensure matches are fairly and evenly officiated. Concerns about match scoring, penalties, and violations must be brought to the attention of event officials at the end of the match in question, and before the robots are removed from the playing field.
2. Unless given explicit permission by an event official, team members must remain in the designated driver station area for the duration of a match.
3. At no point during a match may anyone other than an active drive-team member give coaching or instruction.
4. Each match will last a total of 2 minutes and 30 seconds: 30 seconds for Autonomous and 2 minutes for Driver Control.
5. After robots have been set up on the field and event officials have given the "ready" signal, team members CANNOT enter the field or change the position of their robots without explicit permission from the officials.
6. During each match, a countdown timer will be clearly visible to all teams competing in the current match.
7. Event officials may be encouraged, but are not required, to give a countdown in the closing seconds of each match.
8. A buzzer sound plus a signal from an event official will indicate time has expired for each match.

At this point, teams must IMMEDIATELY set down their controller to make it obvious they are no longer operating their robot. Any missions completed after the 2.5 minute period will not count towards the scoring.

9. If a robot malfunctions at the conclusion of a match such that the robot continues to operate, teams must receive an "OK" from the event official before manually disabling their robot
10. If a team continues to operate their robot after time has expired, an event official will give a **Warning** for the first violation. Additional violations may result in a team being disqualified from the current match and subsequent matches.
11. If and only if extreme circumstances arise that compromise the integrity of the game, as decided by event officials, the decision to replay a match or a portion of it may be made.
12. Egregious and Unsportsmanlike Conduct: If the referee determines that a team's behavior or actions, on or off the field, is meant to damage another team's robot or is unsportsmanlike conduct, the team will be issued a warning. The referee will explain the warning to the team. If the behaviors or actions continue, the referee may disqualify the team from the competition.

## 6.5 *Autonomous Period*

1. The Autonomous period will last for the first 30 seconds of the match.
2. Teams are recommended to use a VEXNET match controller or the FTC Robot Controller app to stop their Autonomous program or must have another pre-approved method to stop their robot's Autonomous function immediately upon expiration of the 30-second Autonomous period.
3. **Incidental** contact between robots will be excused during the Autonomous period. **Intentional** contact is not permitted in any form and may result in penalties being applied.
4. During the Autonomous period, a team must not handle their remote control.
5. Once the Autonomous period has begun, teams may not touch their robot for any reason unless they have received explicit approval from an event official.
6. If a robot continues operation past the end of the Autonomous period, any missions it completes after the 30-second time will NOT be counted for points. The first time a team's robot does this, they will be given a Warning. At the 2<sup>nd</sup> instance, their robot will be disqualified from scoring in the Autonomous portion of matches for the rest of the competition.
7. At the conclusion of the Autonomous period, event officials will calculate the score of each team.
  - It is during this time that teams may ask permission to enter the field if manual switching from Autonomous to Driver Control modes, if required. **Teams must declare this requirement to the event official prior to the start of the match.** After Autonomous has concluded, those teams may not enter the field to perform this switch until permission is granted. The teams may not reposition the robot or touch any other game piece.

## 6.6 *Driver Control (Teleoperation) Period*

1. The Driver Control period will last for 2 minutes.
2. During Driver Control, each team must control their robot exclusively through wireless controllers.
3. Controlling the robot using wired or tethered means is not permitted.
4. During the Driver Control period, teams may not touch their robot for any reason unless the team has received explicit permission from an event official to do so.
5. During Driver Control, incidental contact between robots is expected, but this is not *Battle-Bots*, so behavior which causes damage to another robot (either intentional or accidental) will be penalized.
6. On the first violation of rules regarding robot contact and/or damage, the referee will issue the offending team a **Warning**. Subsequent infractions by the same team will result in disqualification from a match.
7. At the conclusion of Driver Control, teams may not touch, move, or otherwise handle their robot until granted permission from an event official. This is to ensure final scoring is done accurately.

## 7 Match Scoring

### 7.1 Scoring Summary Table

Mission/Action	Auto Score	TeleOp Score
Correct Ore in base from Mining Region	25	25
Trees left standing IF Correct Ore Mined	5 each	5 each
Whiffle ball (Cobblestone) fully in Depository	5	5
Whiffle ball (Cobblestone) fully in Furnace	10	10
Fallen Trees (Lumber) fully in Team Base	5	5
Saplings fully in Mining Region	5	5
Parking in Canyon (Autonomous End)	10	
Parking in Base (TeleOp End)		20
Bonus for leader at end of Autonomous	15	
<b>Any Minor Penalty</b>	<b>-10</b>	<b>-10</b>

### 7.2 General Scoring Rules

1. Teams are REQUIRED to declare to referees that they'll be attempting the Ore Collection missions in the Mining Regions before a match begins. If needed, referees will ask for clarification on the "Ore Collector" attachments and may require the team to take actions to help make Designated Ore Collectors more obvious for which block they are designated to collect (by color).
2. Once the signal is given for robots to be removed from the field, all scoring decisions are **final**.
3. Teams may ask for scoring or rules clarification before removing their robot from the field of play.
4. Teams are NOT allowed to cross into their opponent's side of the field. Incidental crossing while attempting to collect lumber or cobblestone may (at the referee's discretion) not be penalized if determined as accidental and inconsequential by referees. **Intentional** crossing into the opponent's field will result in penalties, at least minor and potentially major, as determined by referees depending on the severity.
5. Parking: For parking missions, the robot must be at least 50% contained within the region that it is supposed to be in, as determined by the number of wheels or length of treads on the robot.

### 7.3 Penalties

1. A robot may NOT exceed the Item Control Limit. Attempting to control more than the allowed number of blocks will result in an item per block over the limit for each 3 seconds the robot controls the blocks. Controlling an item will include pushing any colored block in an intentional direction either for scoring or for moving blocks out of the path of the robot.
2. A Minor Penalty will be issued if the referee determines a robot is in control of more than 2 items at the same time, for every object over the 2 Item Control Limit, with additional Minor Penalties issued every 3 seconds this continues for every item above the limit.
3. Penalties will be applied for intentional and/or repeated crossing into opponents' side of the field. The only area where both teams' robots are allowed is in the Canyon area in the center of the field. Crossing into the opponents' side of the field will result in at least a minor penalty and potentially a major penalty if the robot disturbs their opponents' scoring elements, damages or moves field components, and/or attempts to block or disrupt the motion of their opponents' robot.

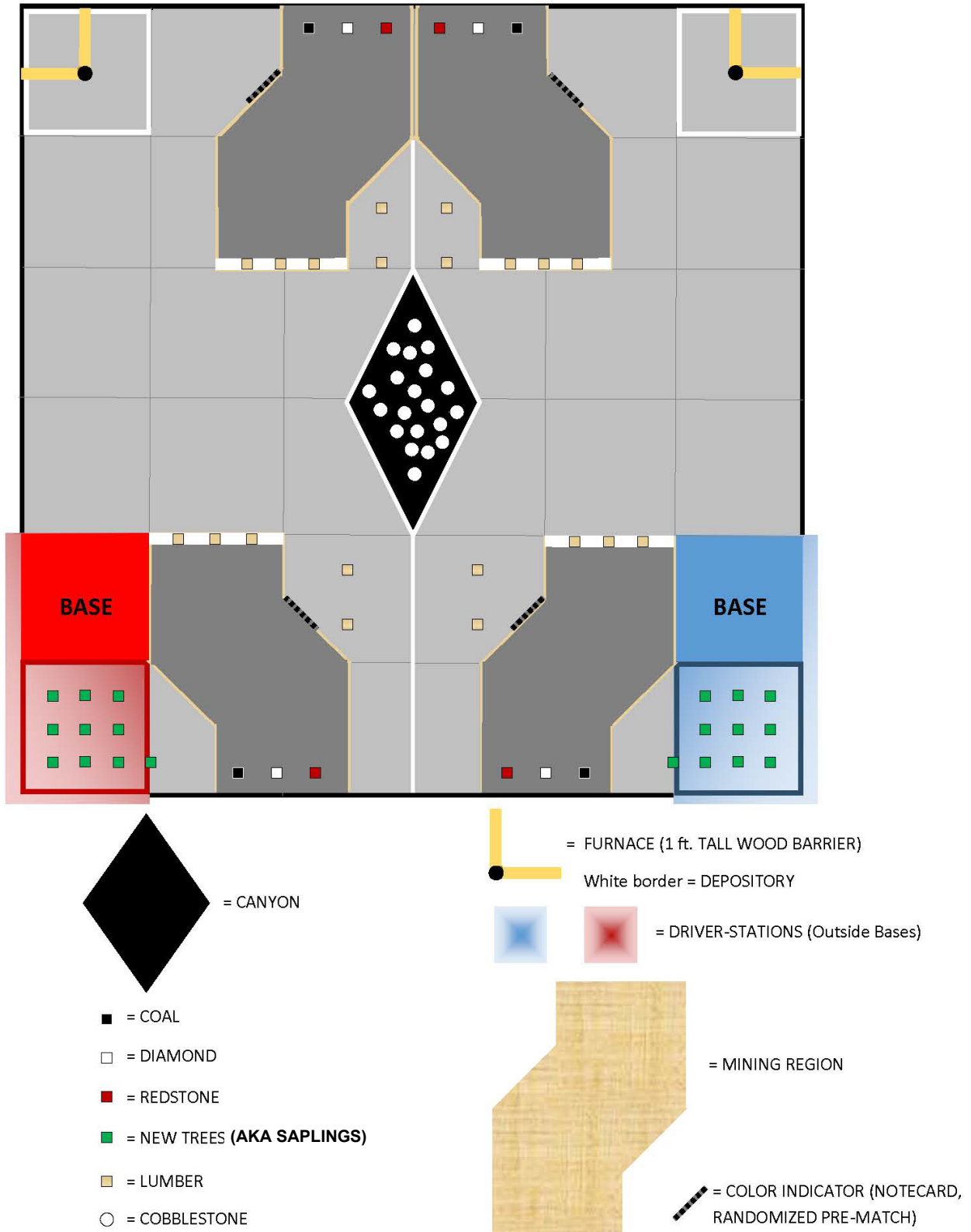


# Appendix A TENTATIVE Referee Scoring Sheet

TEAM NAME		MATCH NUMBER		RED or BLUE?		
MISSION	QUANTITY (IF APPLICABLE)	POINTS FOR EACH	POINTS +/-		TOTAL	OUT OF (MAX)
			AUTO	TELEOP		
<b>COBBLESTONE (WHIFFLE BALLS) IN DEPOSITORY/FURANCE</b>						
In Depository (0-20)		X 5				/100
Furnace (0-20)		X 10				/200
<b>LUMBER (NATURAL/UNPAINTED BLOCKS) IN BASE</b>						
Lumber in Base (0-10)		X 5				/50
<b>CORRECT ORE MINED FROM MINING REGION USING CORRECT DESIGNATED ARM ON ROBOT</b>						
Correct Ore in Base (0, 1, or 2)		X 25				/50
Scorable Trees Left Standing (0-16)		X 5				/80
<b>SAPLING CORRECTLY PLANTED IN MINING REGION</b>						
Green Blocks in Mining Region (0-10)		X 5				/50
<b>ROBOT PARKING</b>						
Robot in Canyon at end of Autonomous		X 10				/10
Robot in Base at end of Teleoperation		X 20				/20
<b>AUTONOMOUS BONUS</b>						
Team in lead at the end of Autonomous?		X 15				/15
<b>Penalties?</b>						
Minor Penalties		X 10				-
<b>TEAM MEMBER INITIALS</b>		<b>TOTALS:</b>				<b>/475 (MAX)</b>

# Appendix B 2023 REC Field Layout

Plywood boards are 19/32" depth. Mined blocks (red, white, black) are all 6 inches from field perimeter. Red blocks are 4.5 inches away from nearest plywood edge, the white block 4.5 inches from the red block, and the black block 4.5 inches from the white block. Each team's 3 Lumber blocks at the entrance to the mining region are spaced the same way. Lumber blocks outside of mining region are centered between the field's middle line (white) and the nearest plywood edge. "Partnered" lumber blocks on each team's side are 6 inches from each other.



## Appendix C Presentation & Notebook Judging Rubric

		Awarded Points	Possible Points
<b>Quality of Display Elements</b>			
	Visual elements were well organized.		5
	Visual elements were helpful (i.e. not just "eye candy").		5
	<b>SECTION TOTAL:</b>		<b>/ 10</b>
<b>Quality of Presentation</b>			
	Each team member spoke, and information presented matches what is recorded in Engineering Notebook.		5
	Team clearly presented overview and technical information on major subsystems of robot (scoring mechanisms, drivetrain, battery/power supply, choice of materials, gear ratios, etc.).		10
	Team provided clear and detailed explanation of code and programming.		10
	Team provided an explanation of design process, problem solving process.		10
	Clearly demonstrated understanding of game, rules, and strategy.		5
	<b>SECTION TOTAL:</b>		<b>/ 40</b>
<b>Quality of Engineering Notebook</b>			
	Each team member has a brief biography in notebook.		5
	The team includes information, matching what is in their presentation, about their service projects throughout the year that align with the goals & priorities of 4-H and REC.		10
	The team clearly demonstrates & records their process of robot design, building, programming, and testing, including goals, important milestones, significant changes, evaluation and testing methods, etc.		20
	The team clearly demonstrates the problems they identified, the work they did to solve each particular problem, the testing methods used to verify the solutions, and adequately explained the resolutions.		15
	<b>SECTION TOTAL:</b>		<b>/ 50</b>
	<b>GRAND TOTAL</b>		<b>/ 100</b>