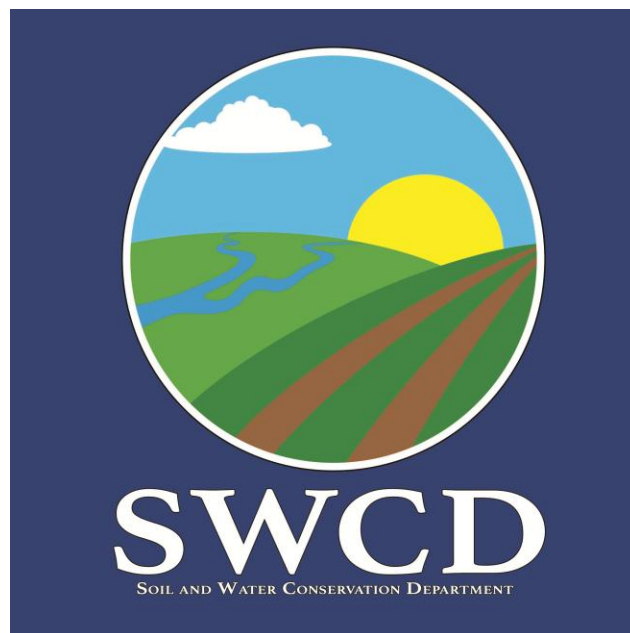
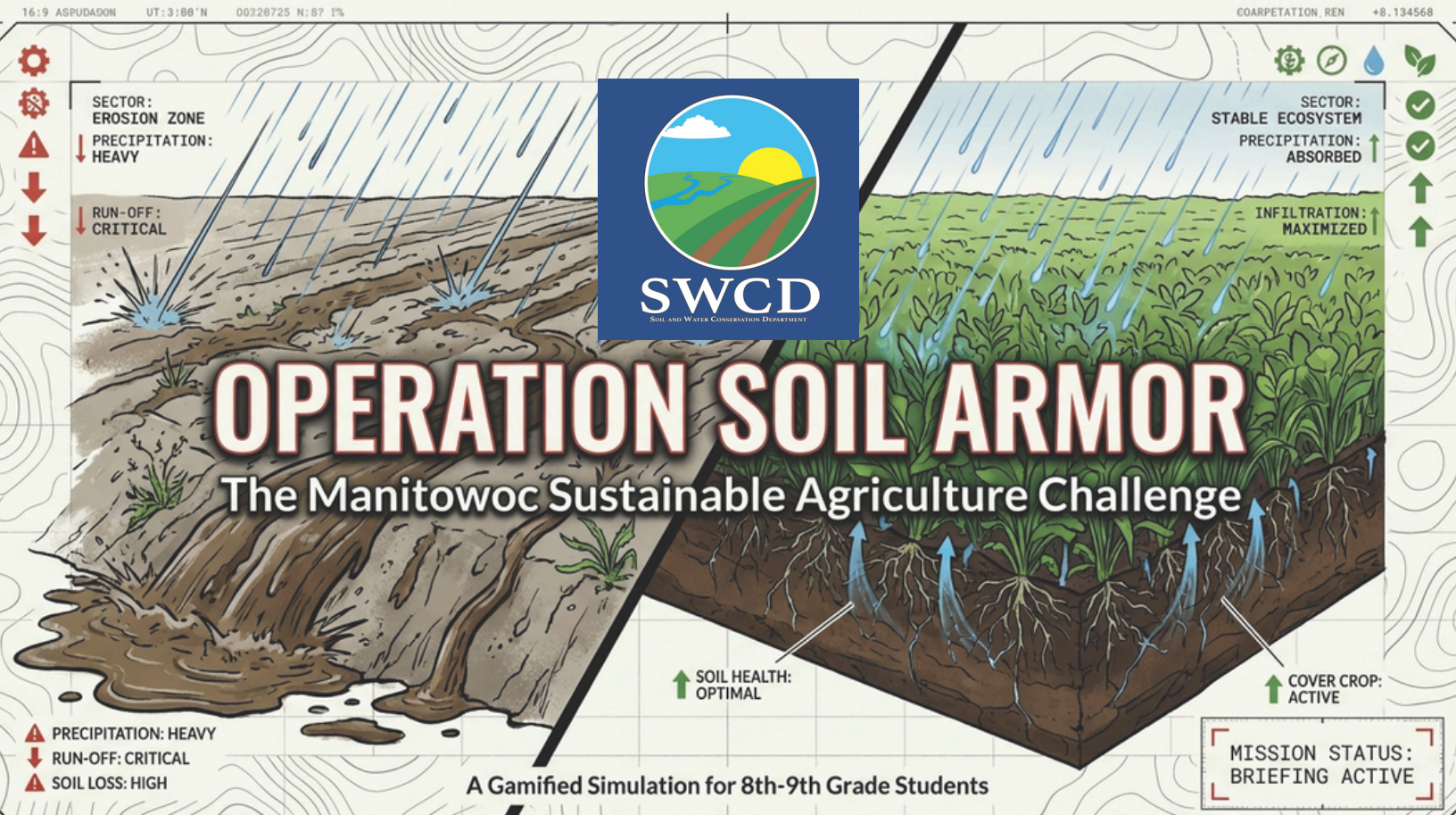


Operation Soil Armor was developed by Manitowoc County Soil and Water Conservation Department as part of North Central SARE Youth Education Grant.



This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under agreement number 2023-38640-39573 through the North Central Region SARE program under project number YENC24-222. USDA is an equal opportunity employer and service provider. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and should not be construed to represent any official USDA or U.S. Government determination or policy.



1. Instructor Overview

This lesson introduces watershed protection through sustainable agriculture using a high-energy, movement-based simulation grounded in Manitowoc County's local landscape.

Instructor Tip: Students learn best when they are decision-makers. Emphasize that their choices directly affect soil and water outcomes.

Target Grade Level: 8th - 9th Grade

Time Needed: 45-60 Minutes

Lesson Context: In Manitowoc County, where 56% of the land is cropland and much of it has steep slopes or heavy clay (C/D hydrology), soil erosion is the number one threat to water quality. This game teaches students how cover crops, reduced tillage, and crop rotations act as "armor" for the earth.

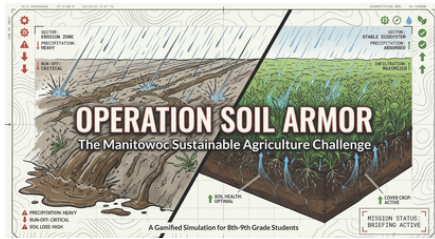
Core Message: The health of the water depends on the armor on the land

2. Learning Goals & Standards Alignment Students will:

- Identify how "keeping it covered" prevents phosphorus and sediment from entering lakes and streams
- Understand the role of living roots in feeding soil microbes and sequestering carbon
- Connect farm management to systems thinking (ELS Standard EX2.A)

Standards Alignment:

ELS EX2.A – Systems Thinking ELS EX4.A – Cycles & Flows ELS EN6.A – Dynamic Balance



One-Page “How to Run This Game” Cheat Sheet OPERATION SOIL ARMOR – QUICK START



Time: 45–60 minutes

Activity Level: High

Space: Gym, hallway, or large room

Supplies:

Colored pinnies or paper
Tape for zones
Tokens (balls, beanbags)

Steps:

Show Rainfall Simulator
Assign roles
Run Round 1 (fail)
Add Cover Crops
Add Reduced Tillage
Add Fertility + Carbon
Debrief

Core Message:

Bare soil loses
Covered soil protects
Management decisions matter

Space: Gym, hallway, or large room

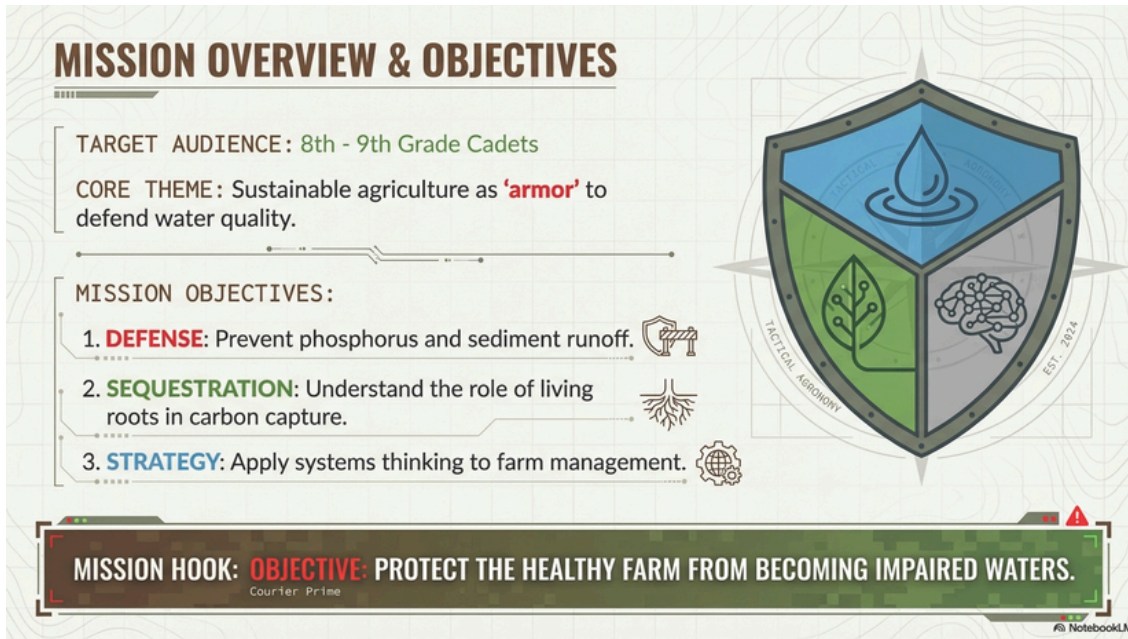
Supplies:

Colored pinnies, paper, arm bands (brown, blue, green)

Tape for zones

Tokens (balls, beanbags)

Whistle



SECTION 1: MISSION BRIEF (5 minutes)

Visual to show:

Slide 1: Operation Soil Armor – Title Image

Slide 2: Mission Overview & Objectives (Shield graphic)

Instructor says (scripted, optional):

“ In Manitowoc County, where 56% of the land is cropland and much of it has steep slopes or heavy clay (C/D hydrology), soil erosion is the number one threat to water quality. Today, you’re going to protect a farm in Manitowoc County. Your mission is to keep soil where it belongs – on the land – and out of our lakes and streams. You’ll see how farming decisions act like armor for the soil.”

Key points to emphasize:

This is Manitowoc County, not a generic farm

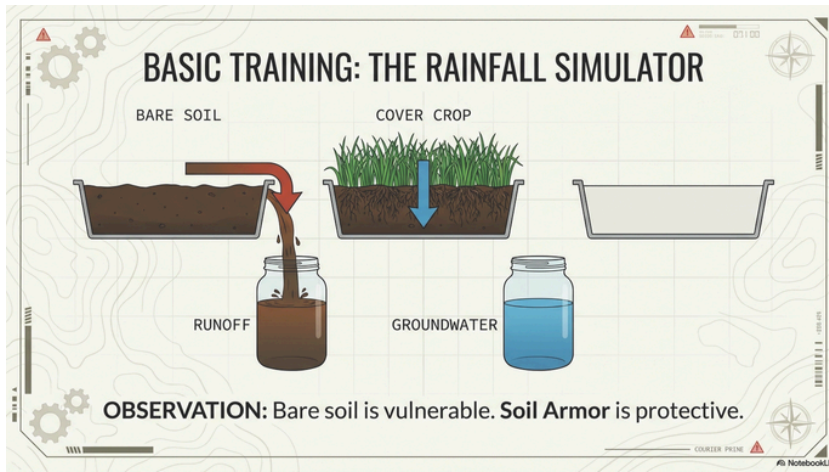
Soil erosion is the main villain

Students are decision-makers, not passive learners

Instructor Tip:

If students are unfamiliar with agriculture, frame this as:

“Soil is the farm’s foundation. If we lose it, everything else fails.”



The Scientific Hook: The Rainfall Simulator

Before starting the game, students observe a Rainfall Simulator demonstration.

- The Setup: Trays of bare soil, soil with crop residue (reduced tillage), and soil with a living cover crop.

- **The Observation:** Students watch as simulated rain falls. They observe how water on bare soil becomes "muddy runoff" (erosion), while water on the cover crop tray infiltrates into the soil, keeping the "groundwater" clear.
- The Lesson: Bare soil is vulnerable; "Soil Armor" (residue/cover) is protective

Alternative: Watch It on YouTube: <https://youtu.be/IOIrUxCeKpg?si=Zs02YhSO4aFvWVeD>

SECTION 2: BASIC TRAINING – THE RAINFALL SIMULATOR (10 minutes)

Visual to show:

Slide 4: Rainfall Simulator – Bare Soil vs Cover Crop

Instructor prompts (ask BEFORE rain):

“Which tray do you think will lose more soil?”

“Where do you think the water will go?”

Instructor prompts (ask AFTER rain):

“Which one would you want next to a river?”

“What did the roots do that bare soil couldn’t?”

Science connection (say plainly):

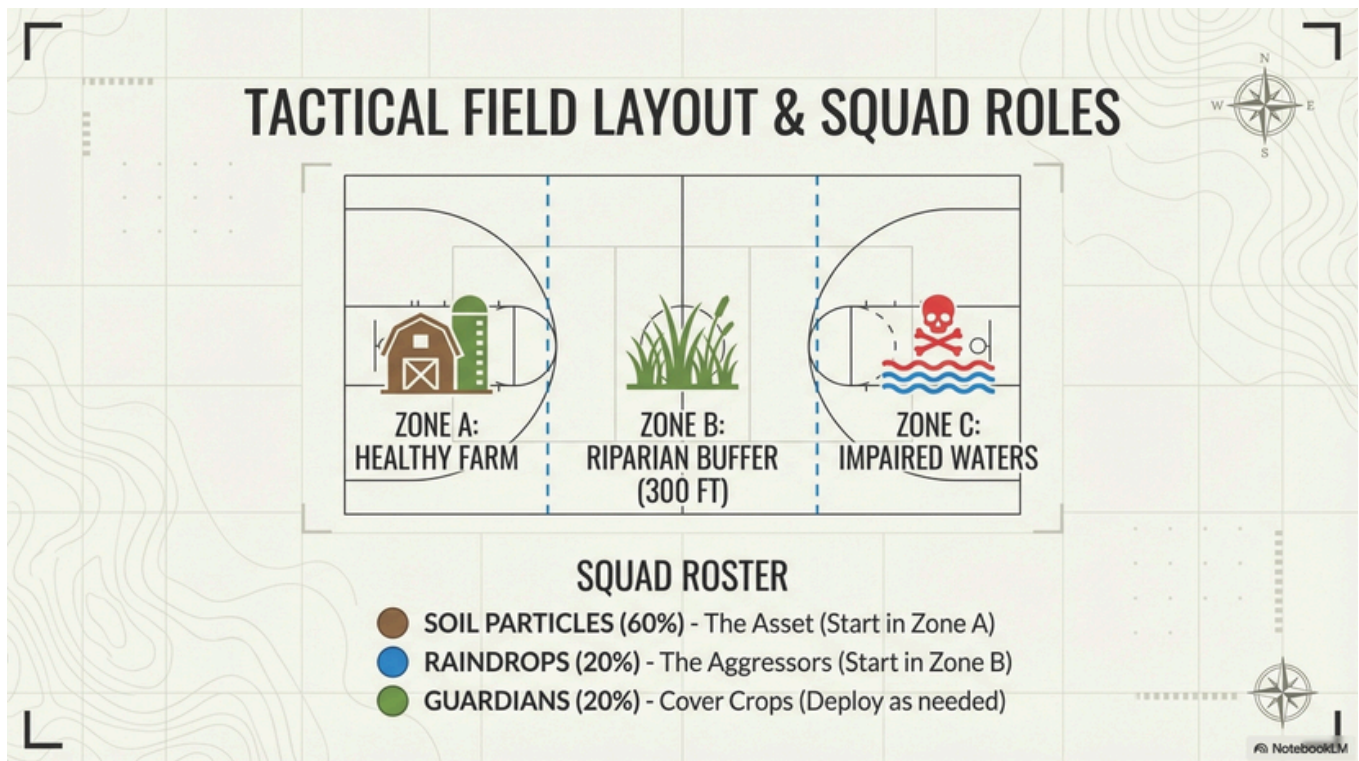
Raindrops break soil apart

Roots hold soil together

Covered soil lets water soak in

Anchor phrase (repeat later):

“Bare soil is vulnerable. Covered soil is protected.”



SECTION 3: FIELD SETUP & ROLES (5 minutes)

Visual to show:

Slide 5: Tactical Field Layout & Squad Roles

Physical setup:

One end = Healthy Farm

Middle zone = 300-ft Riparian Buffer

Far end = Impaired Waters

Role Assignment (quick reference) 60% Brown, 20% Blue, 20% Green

Role	Color	Represents	Starts Where
Soil Particles	Brown	Topsoil + nutrients	Healthy Farm
Raindrops	Blue	Rainfall & runoff	Middle
Soil Guardians	Green	Cover crops / residue	Off-field

Instructor Tip:

Have students say their role out loud when assigned — it locks it in.

Round 1 – Mission Failure

Rules:

Soil Particles try to reach the buffer
Raindrops try to tag them
Tagged soil goes to Impaired Waters

What happens (by design):

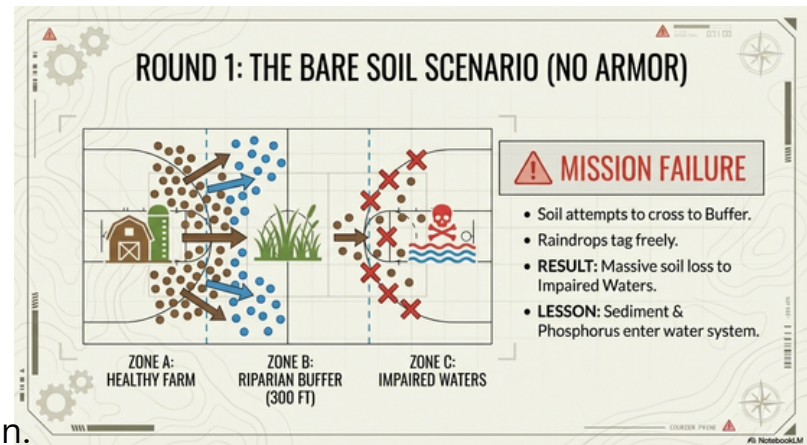
Soil gets tagged quickly
Impaired Waters fills up
Stop early if needed — failure is the lesson.

Debrief question:

“Why couldn’t the soil protect itself?”

Science takeaway:

Sediment and phosphorus move together.

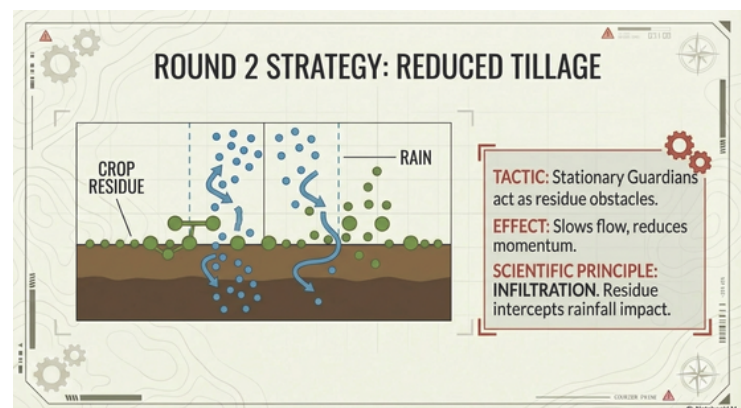
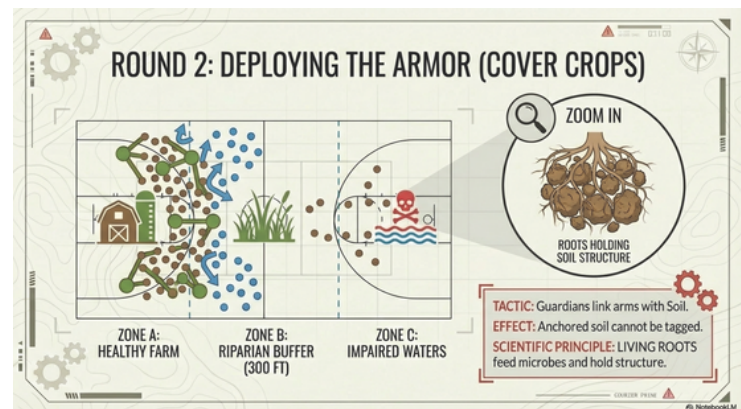


SECTION 5: ROUND 2 – DEPLOYING THE ARMOR

Deploying the Armor & Reduced Tillage

New rule:

- The "Soil Guardians" (Cover Crops) enter the field. They can link arms with "Soil Particles."
- Power-Up: If a Soil Particle is holding hands with a Cover Crop, they are "anchored" by living roots and cannot be tagged by Raindrops.
- Reduced Tillage Rule: Some Soil Guardians act as "Crop Residue" by standing still and creating "obstacles" that Raindrops must run around, slowing them down.
- Outcome: Most Soil Particles stay on the farm. Reflection: Armor intercepts raindrops and promotes infiltration

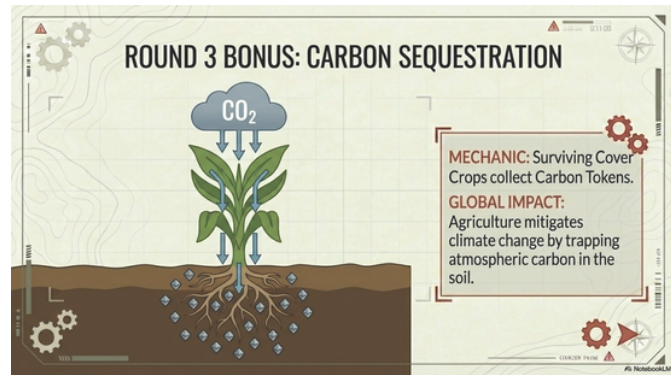


Instructor language:

“Those roots act like anchors.”

Science connection:

Living roots feed microbes and stabilize soil structure.



SECTION 6: ROUND 3 – FERTILITY, PESTS & CARBON

Visual to show:

Slide 9: Fertility Challenge

Slide 10: Carbon Sequestration Bonus

Add Balls:

- Round 3: The Carbon & Fertility Bonus (Crop Rotations)
- Add Nutrient Tokens (balls) to the field.
- Soil Particles must collect these tokens to "grow crops."
- The Challenge: If a Soil Particle stays in one spot too long (no rotation), a "Pest" (teacher) takes their token.
- The Solution: Students must "rotate" to different parts of the field to represent Crop Rotation, which manages pests and improves organic matter.
- Carbon Sequestration: Every time a Cover Crop "survives" a round, they "trap" a Carbon Token, representing how plants sequester carbon to mitigate climate change

Rules:

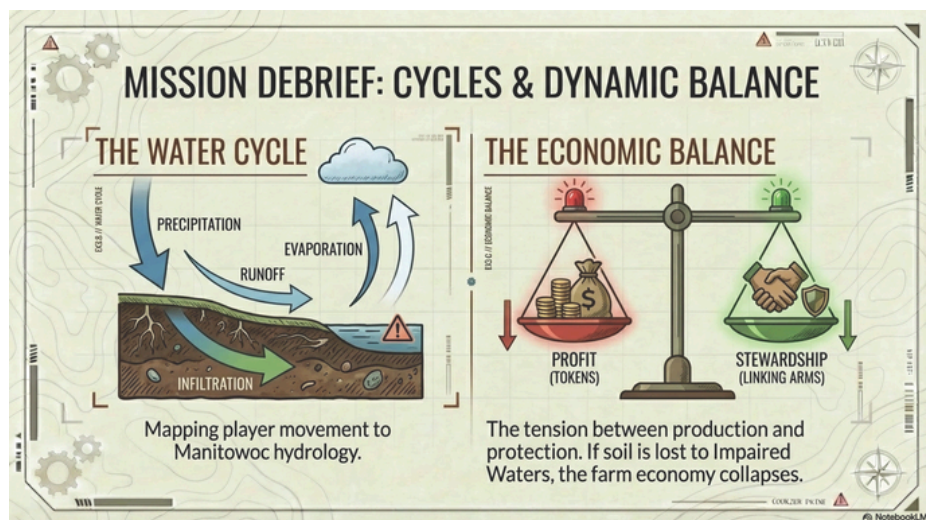
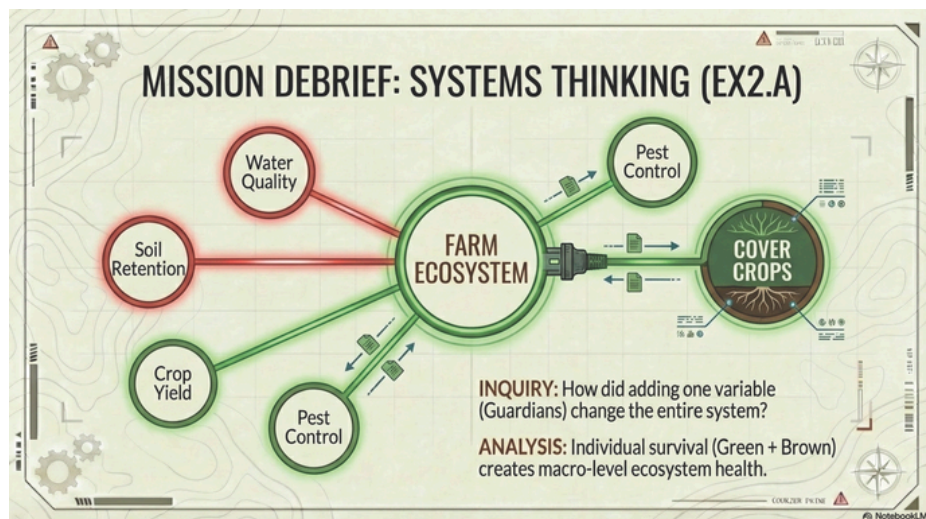
Staying in one place = pest risk

Movement = crop rotation

Surviving Guardians earn carbon tokens

Big idea:

Healthy soil supports food, water, and climate.



Discussion & Reflection (ELS Standards Alignment)

1. Systems Thinking (EX2.A): In the game, how did the "Cover Crop" players change the outcome for the "Soil" and "Water" players?.
2. Cycles & Flows (EX4.A): How does the movement of "Raindrops" in the game represent the Water Cycle in Manitowoc County?.
3. Dynamic Balance (EN6.A): Why do farmers need to balance making a profit with protecting the soil? What happens to the farm if all the "Soil Particles" end up in the "Impaired Waters"?

Guided reflection questions:

- “What changed when we added armor?”
- “What happens if farmers ignore soil health?”
- “Where do you see tradeoffs?”

Closing message:

“The health of the water depends on the armor on the land.”

C00 99.2023



SECTOR:
EROSION ZONE

PRECIPITATION:
HEAVY

RUN-OFF:
CRITICAL



SECTOR:
STABLE ECOSYSTEM

PRECIPITATION:
ABSORBED

INFILTRATION:
MAXIMIZED

OPERATION SOIL ARMOR

The Manitowoc Sustainable Agriculture Challenge

- PRECIPITATION: HEAVY
- RUN-OFF: CRITICAL
- SOIL LOSS: HIGH

SOIL HEALTH:
OPTIMAL

COVER CROP:
ACTIVE

MISSION STATUS:
BRIEFING ACTIVE

A Gamified Simulation for 8th-9th Grade Students

MISSION OVERVIEW & OBJECTIVES

TARGET AUDIENCE: 8th - 9th Grade Cadets

CORE THEME: Sustainable agriculture as **'armor'** to defend water quality.

MISSION OBJECTIVES:

1. **DEFENSE**: Prevent phosphorus and sediment runoff. 
2. **SEQUESTRATION**: Understand the role of living roots in carbon capture. 
3. **STRATEGY**: Apply systems thinking to farm management. 



MISSION HOOK: **OBJECTIVE:** PROTECT THE HEALTHY FARM FROM BECOMING IMPAIRED WATERS.

Courier Prime

THREAT ASSESSMENT: MANITOWOC COUNTY SECTOR

INTEL

- **TERRAIN:** 56% Cropland. Steep slopes. Heavy clay hydrology.
- **THE VILLAIN:** Soil Erosion.
- **THREAT LEVEL:** Critical.



PROTECTION ZONES:

- 1,000-ft Lake WQMA
- 300-ft Stream WQMA

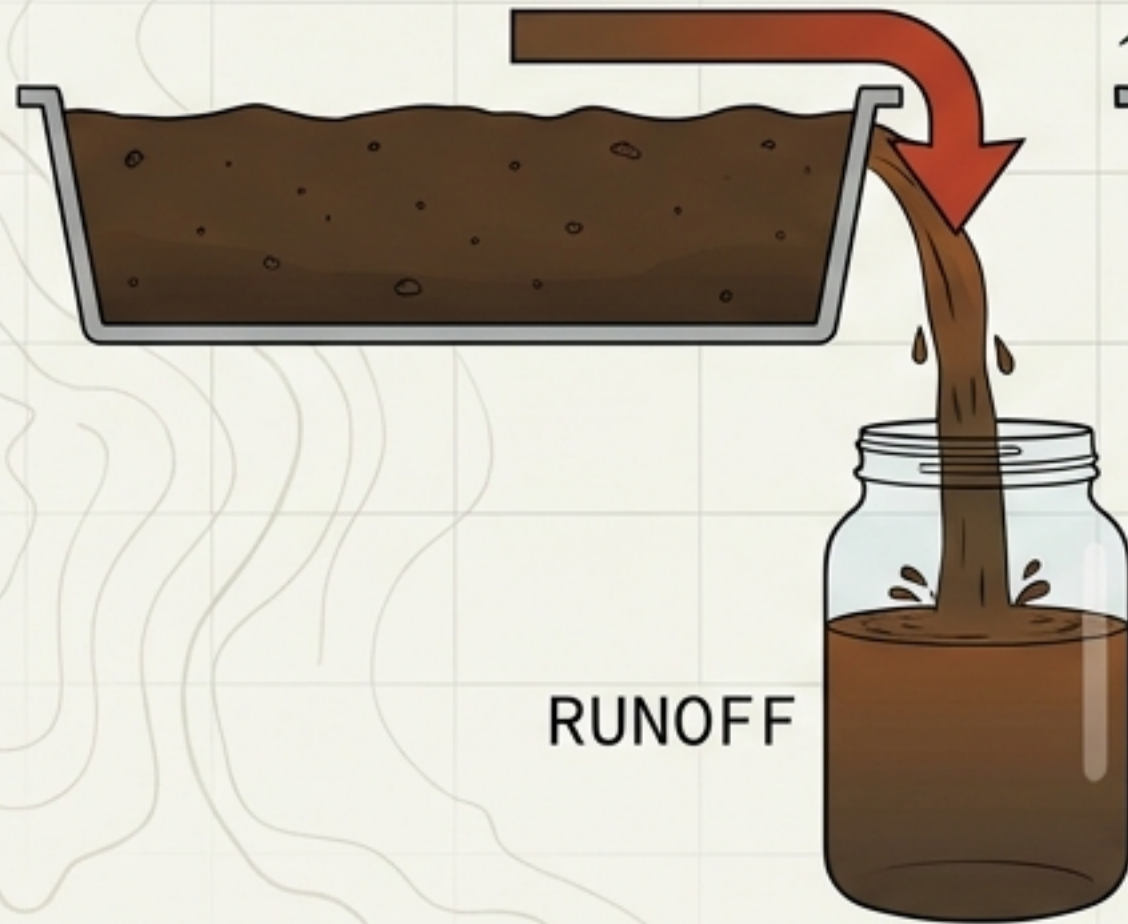
MISSION HOOK: OBJECTIVE: PROTECT THE HEALTHY FARM FROM BECOMING IMPAIRED.

Courter Prime

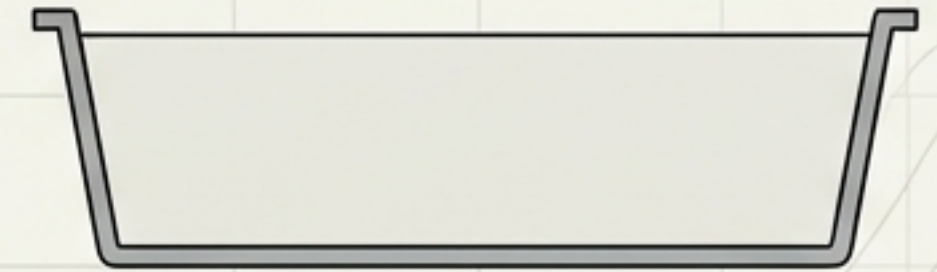
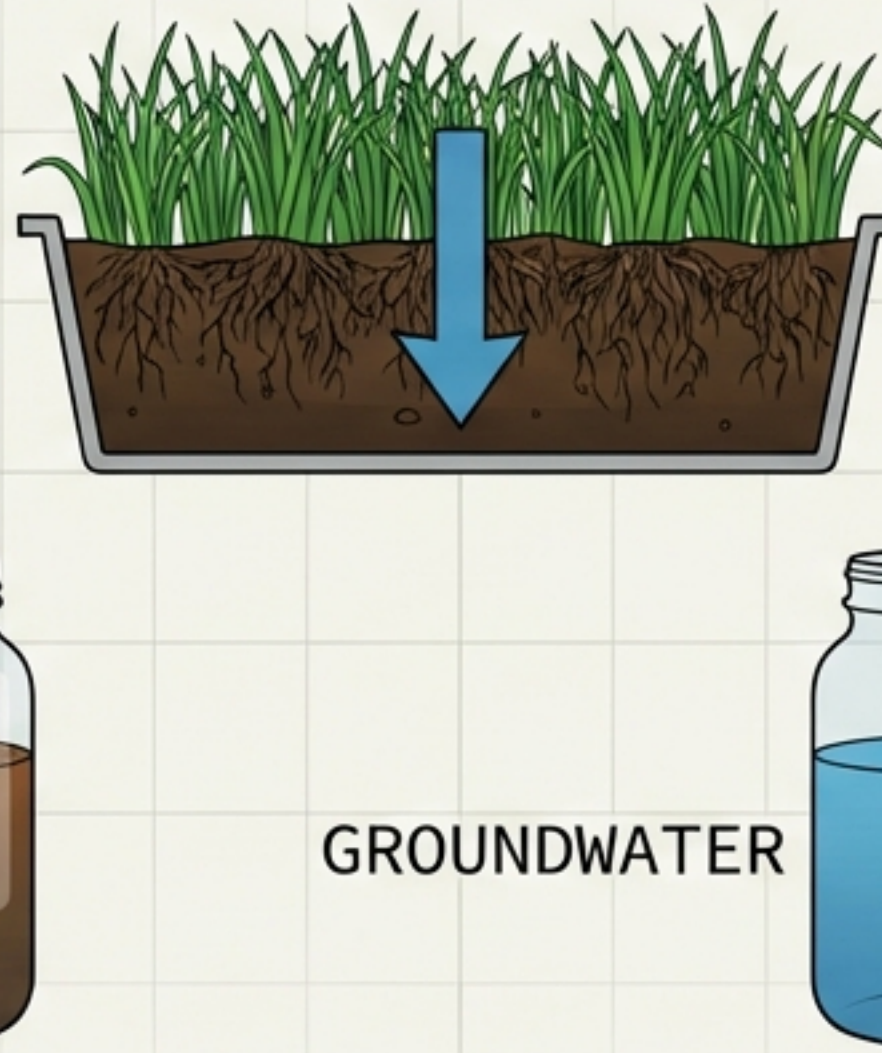


BASIC TRAINING: THE RAINFALL SIMULATOR

BARE SOIL

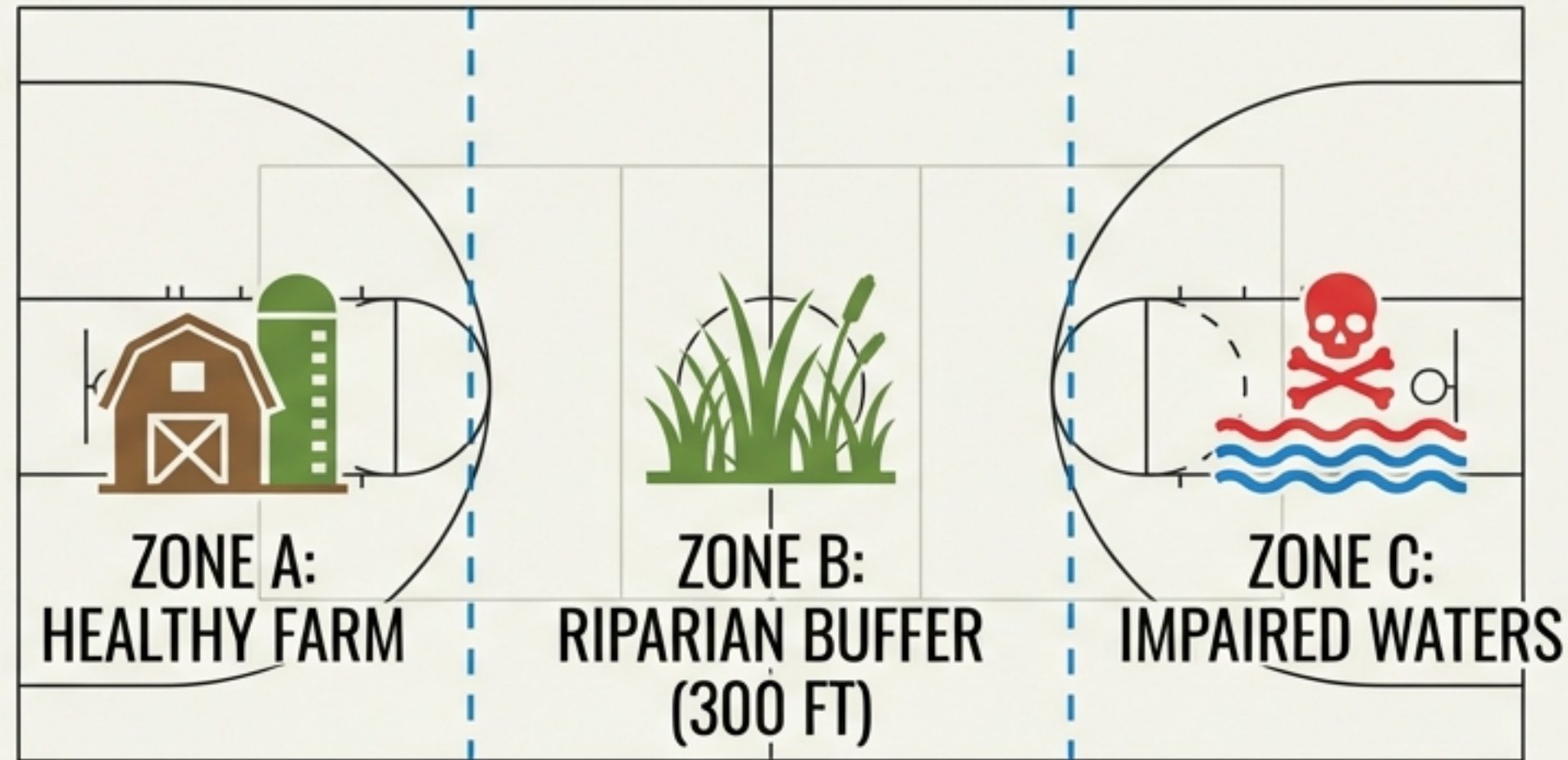


COVER CROP



OBSERVATION: Bare soil is vulnerable. Soil Armor is protective.

TACTICAL FIELD LAYOUT & SQUAD ROLES

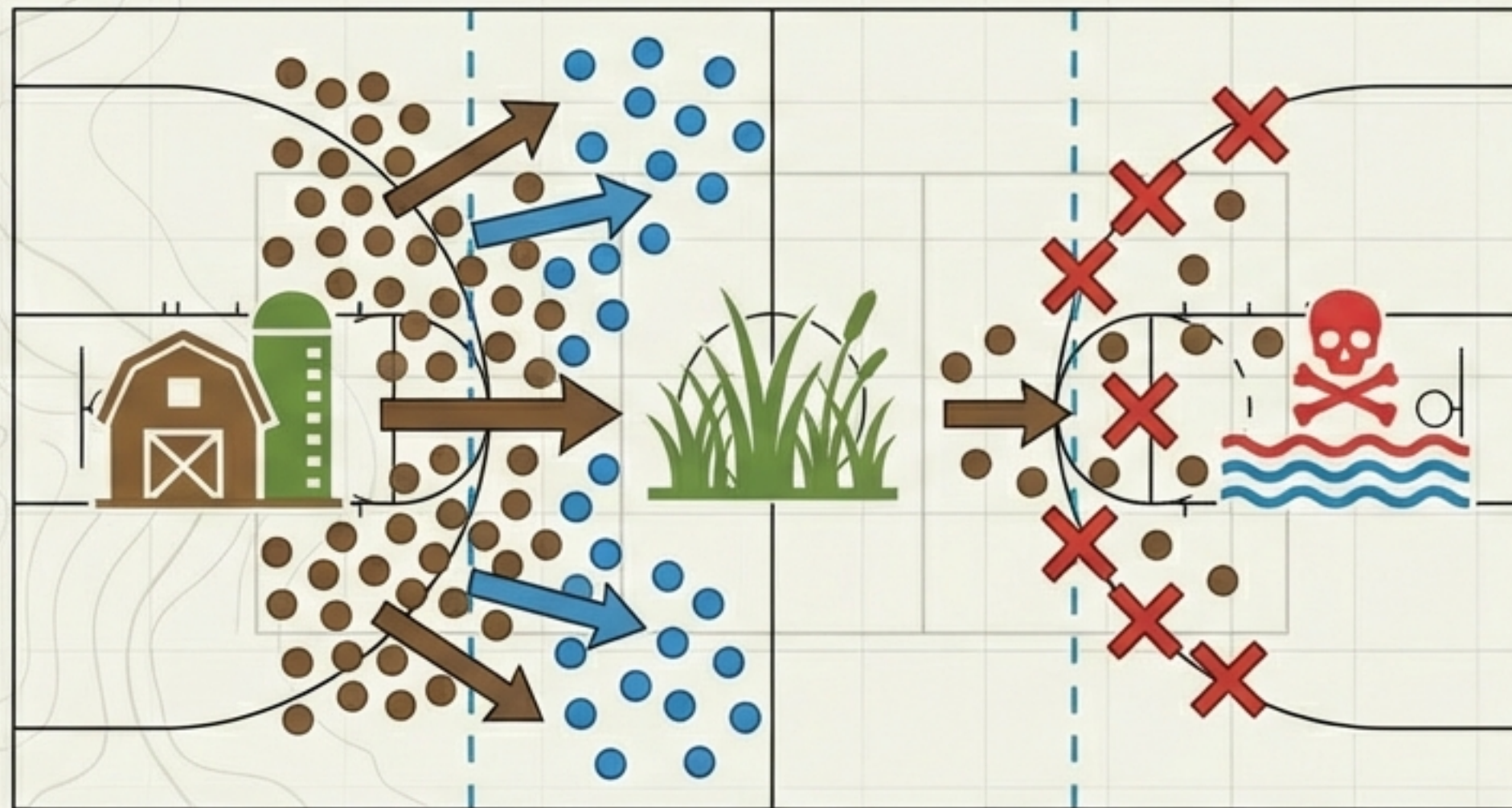


SQUAD ROSTER

-  **SOIL PARTICLES (60%)** - The Asset (Start in Zone A)
-  **RAINDROPS (20%)** - The Aggressors (Start in Zone B)
-  **GUARDIANS (20%)** - Cover Crops (Deploy as needed)



ROUND 1: THE BARE SOIL SCENARIO (NO ARMOR)



ZONE A:
HEALTHY FARM

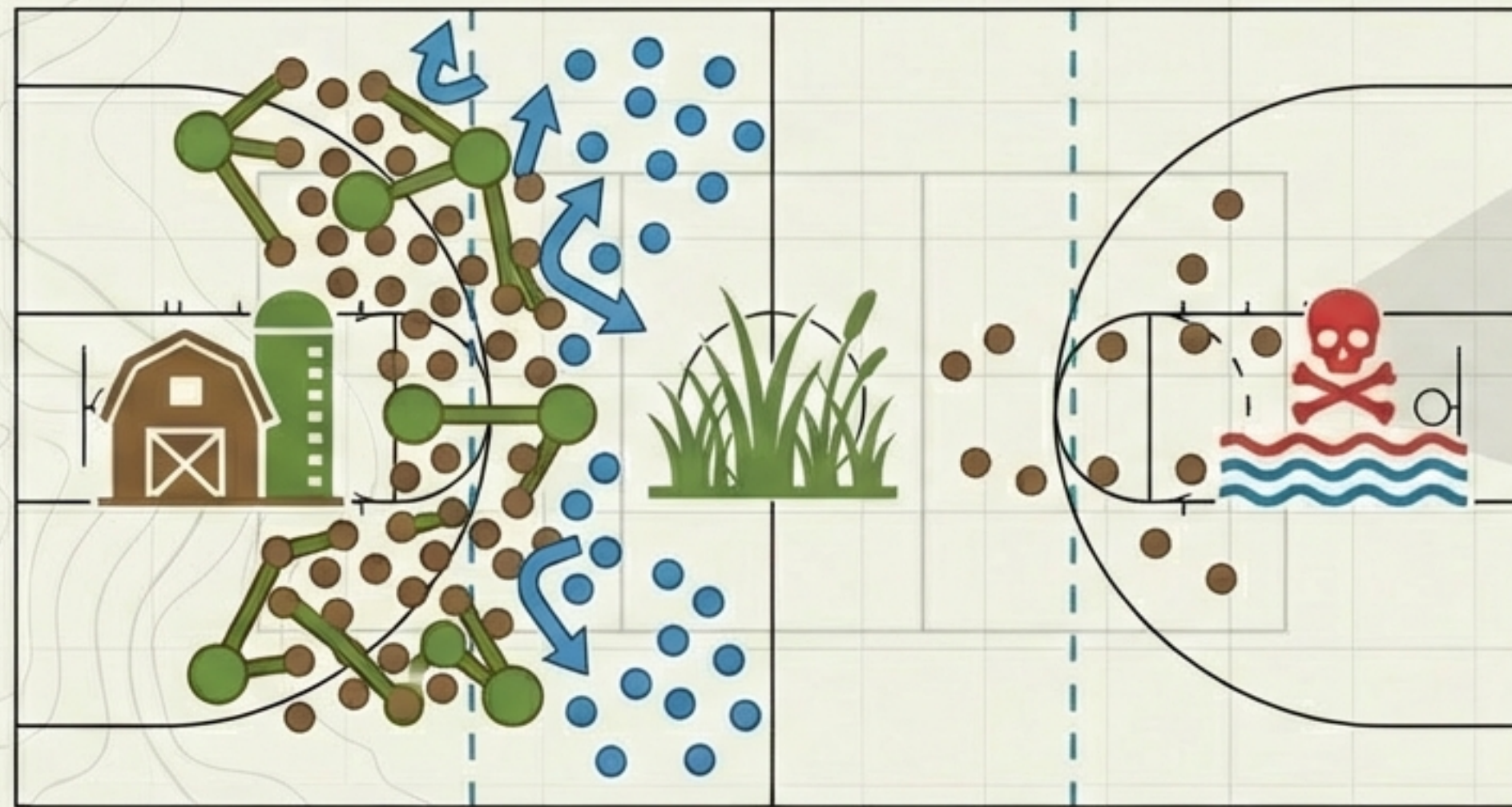
ZONE B:
RIPARIAN BUFFER
(300 FT)

ZONE C:
IMPAIRED WATERS

 **MISSION FAILURE**

- Soil attempts to cross to Buffer.
- Raindrops tag freely.
- **RESULT:** Massive soil loss to Impaired Waters.
- **LESSON:** Sediment & Phosphorus enter water system.

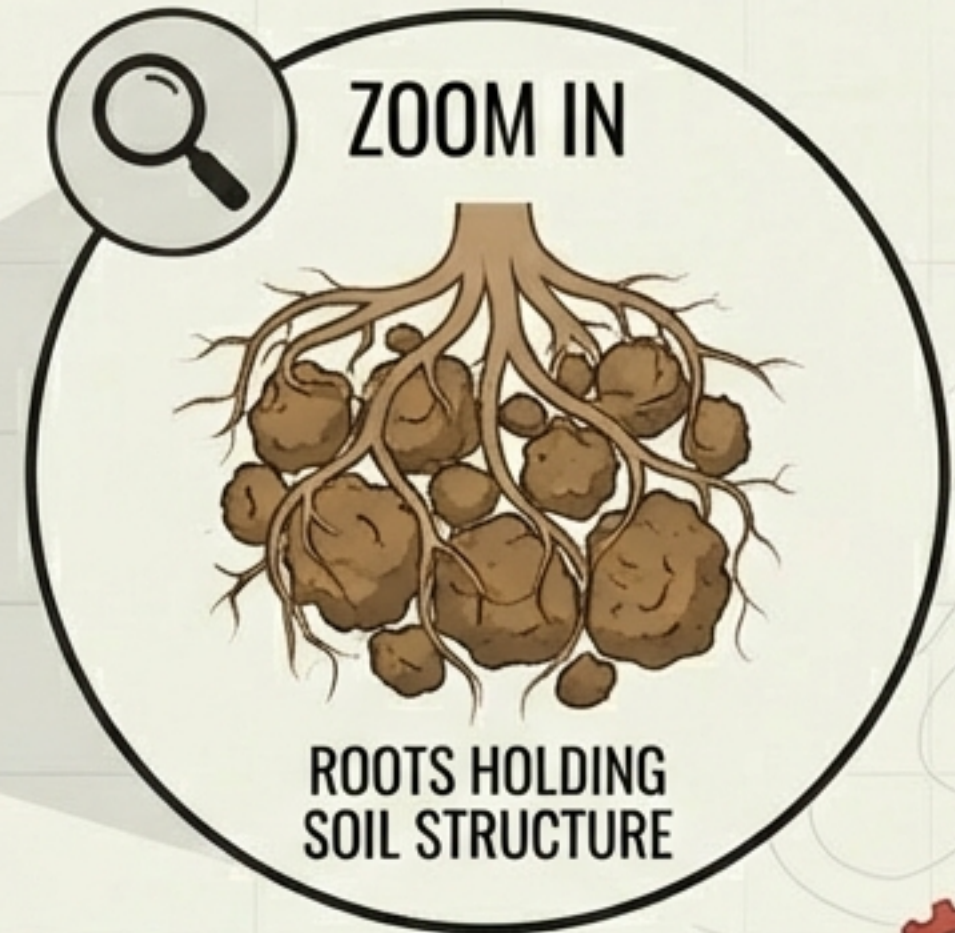
ROUND 2: DEPLOYING THE ARMOR (COVER CROPS)



ZONE A:
HEALTHY FARM

ZONE B:
RIPARIAN BUFFER
(300 FT)

ZONE C:
IMPAIRED WATERS

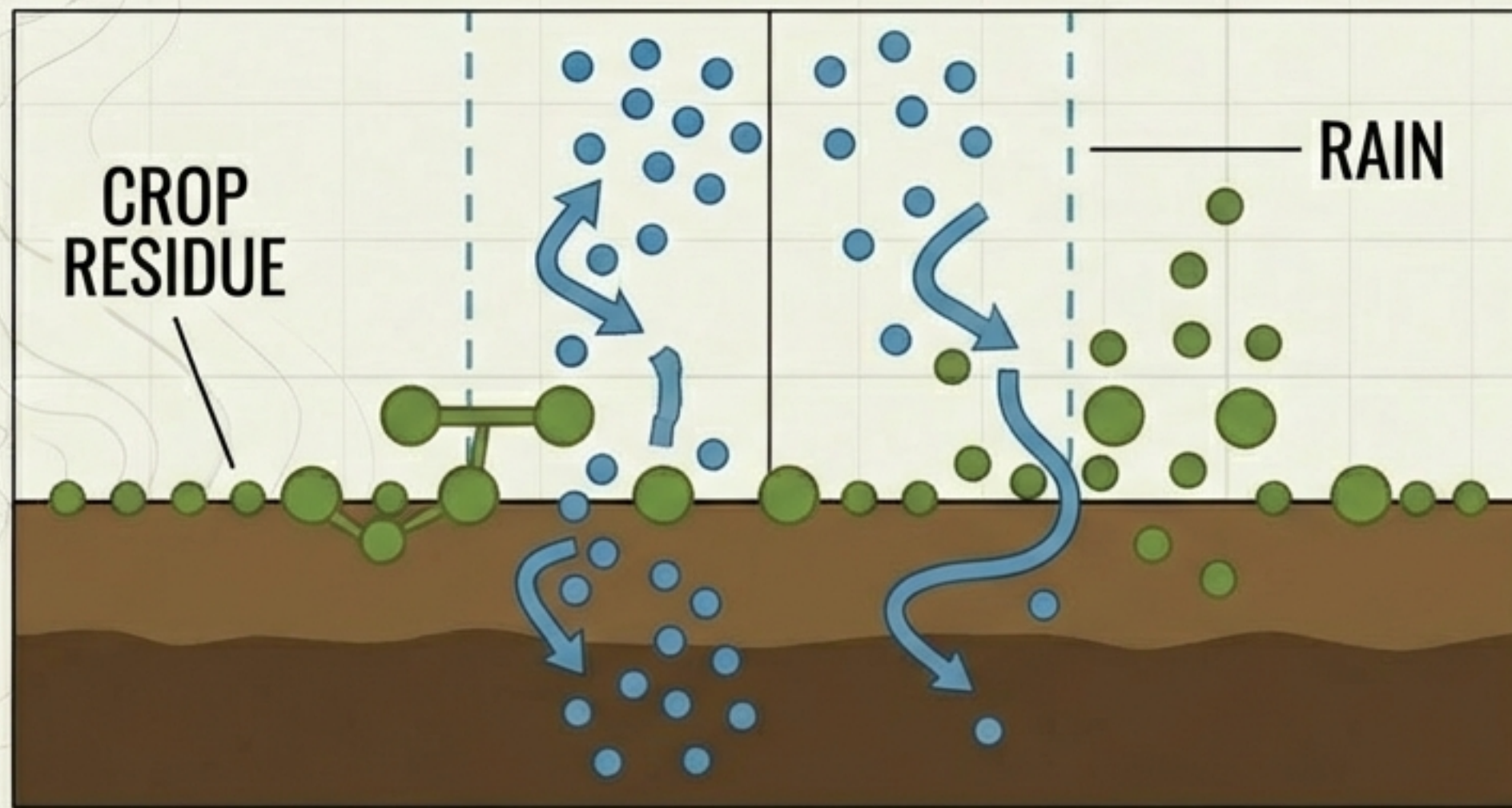


ZOOM IN

ROOTS HOLDING
SOIL STRUCTURE

TACTIC: Guardians link arms with Soil.
EFFECT: Anchored soil cannot be tagged.
SCIENTIFIC PRINCIPLE: LIVING ROOTS
feed microbes and hold structure.

ROUND 2 STRATEGY: REDUCED TILLAGE

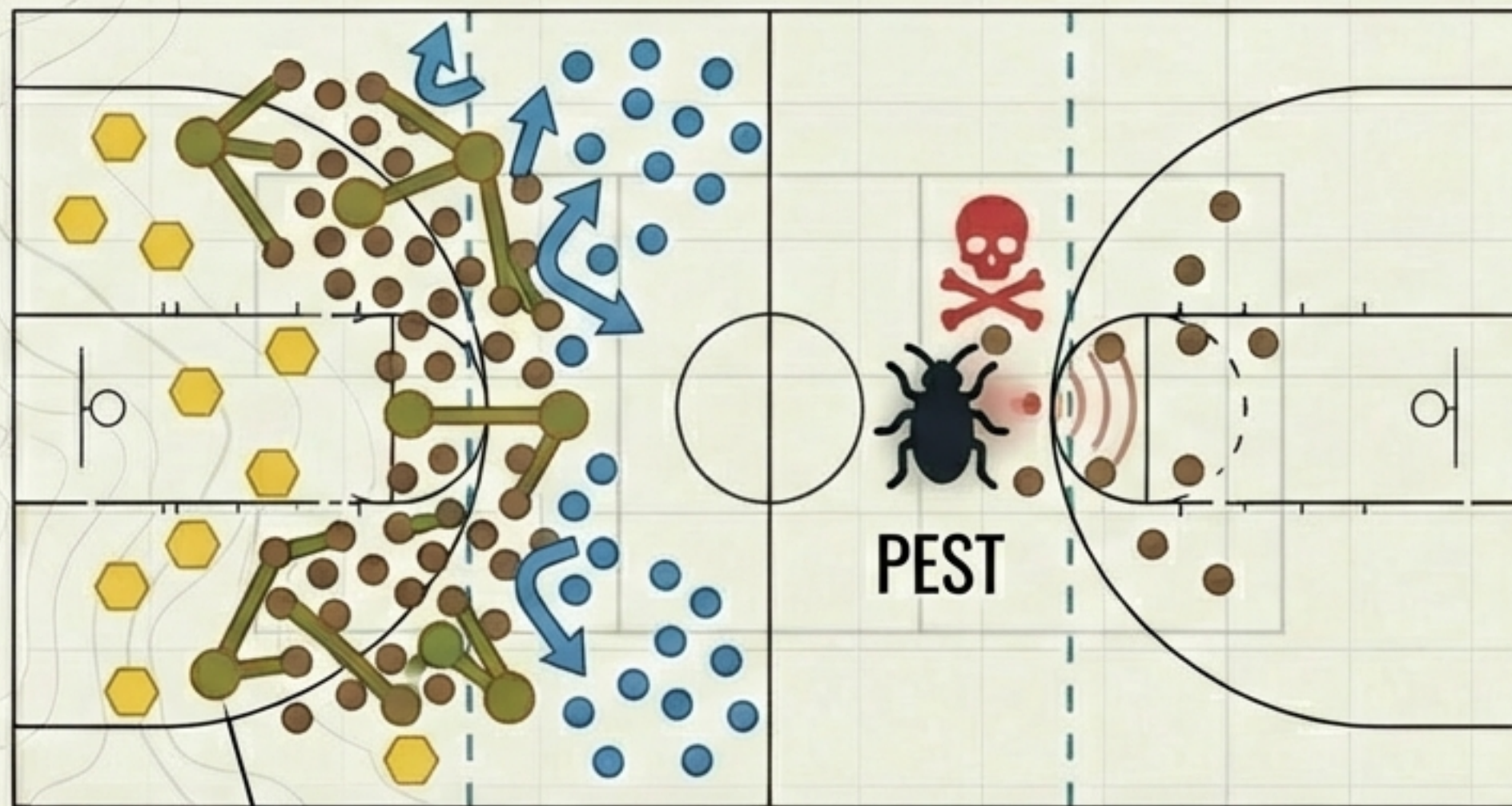


TACTIC: Stationary Guardians act as residue obstacles.

EFFECT: Slows flow, reduces momentum.

SCIENTIFIC PRINCIPLE: INFILTRATION. Residue intercepts rainfall impact.

ROUND 3: THE FERTILITY CHALLENGE



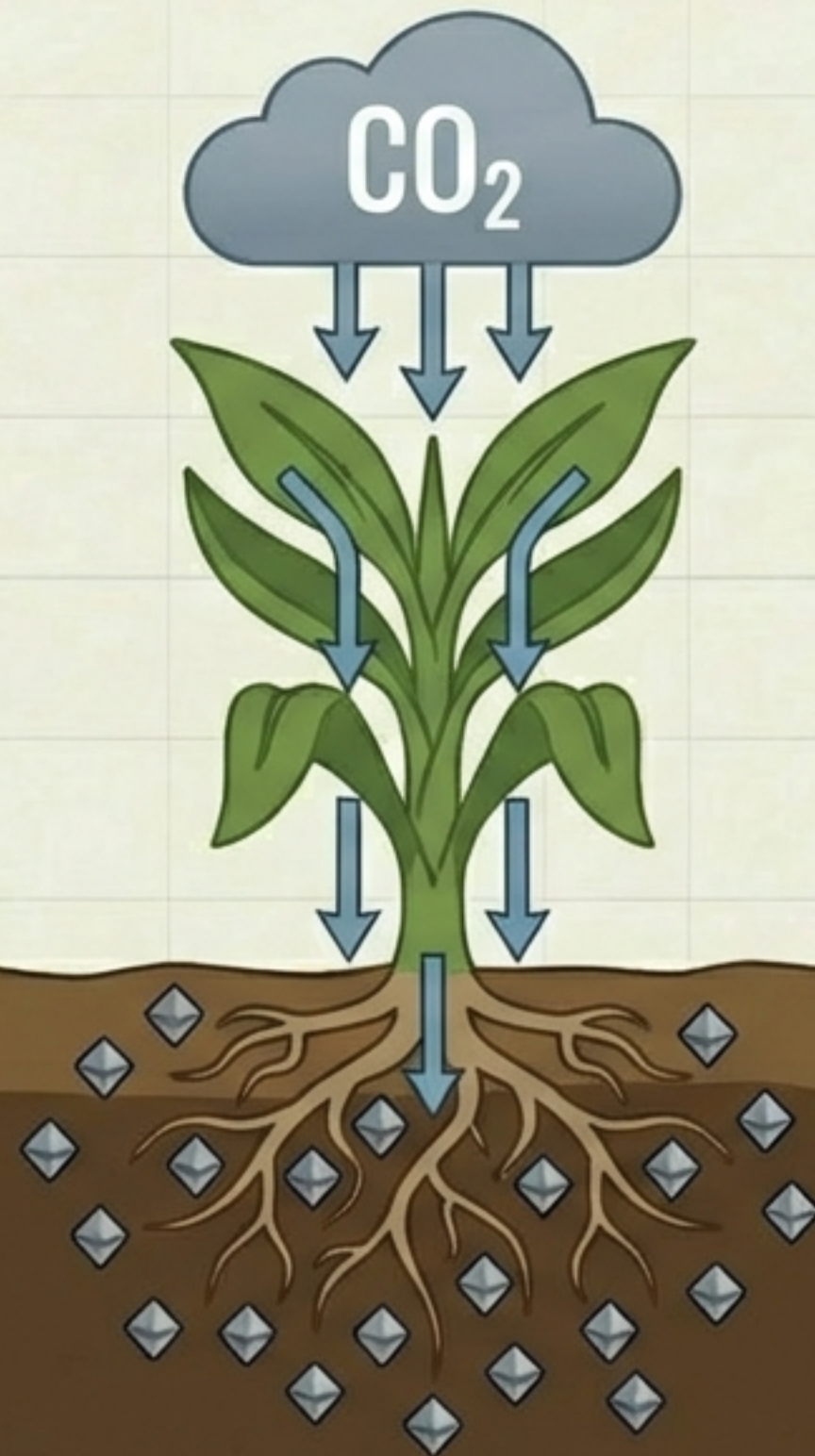
 NUTRIENTS

OBJECTIVE: Collect Nutrient Tokens to grow.

THREAT: Pests attack stationary targets.

SOLUTION: CROP ROTATION. Moving breaks pest cycles and improves soil biology.

ROUND 3 BONUS: CARBON SEQUESTRATION



MECHANIC: Surviving Cover Crops collect Carbon Tokens.

GLOBAL IMPACT:

Agriculture mitigates climate change by trapping atmospheric carbon in the soil.

INTEL DATABASE: COVER CROP PROTOCOLS

PRACTICE



Planting Winter Rye immediately after harvest.

BENEFITS

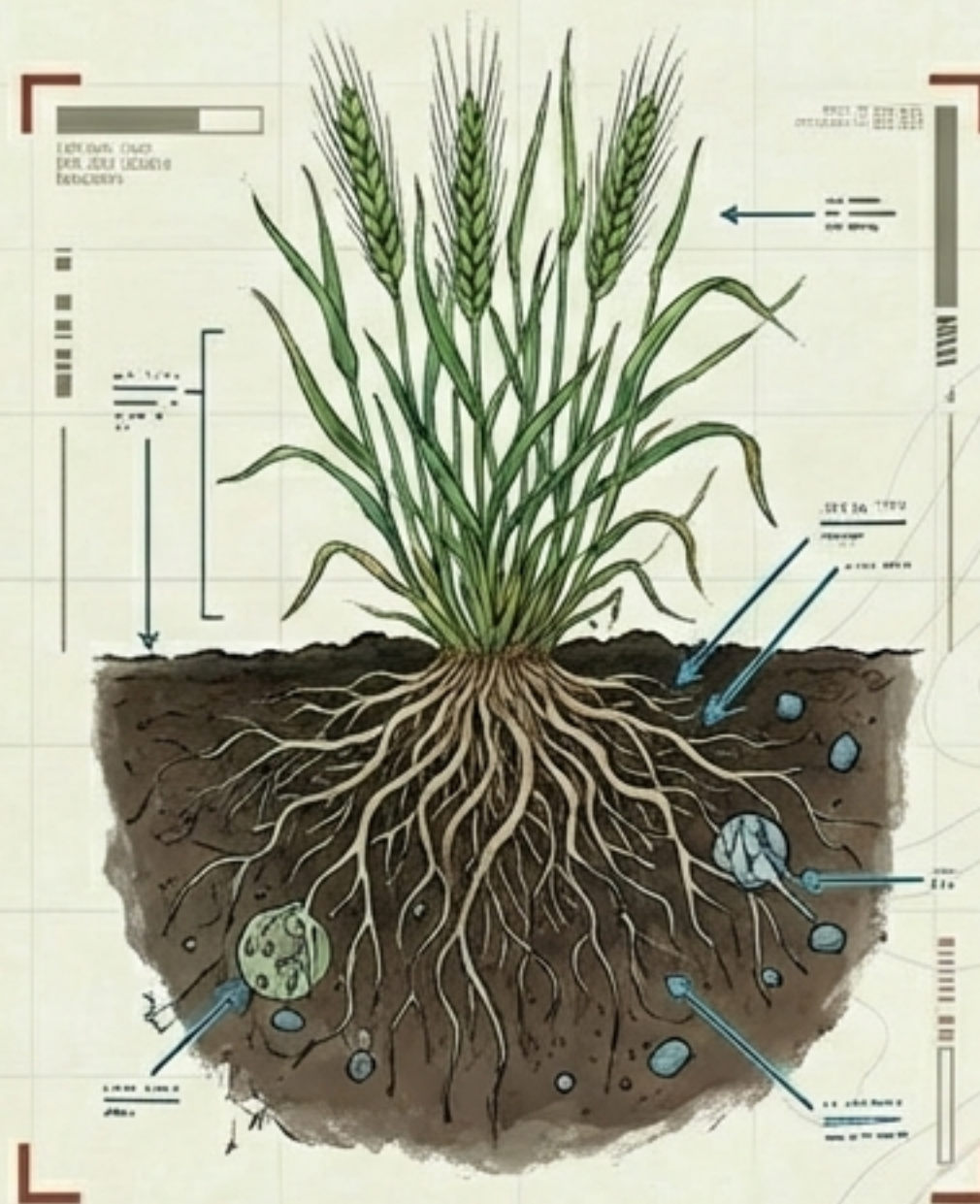


WATER QUALITY

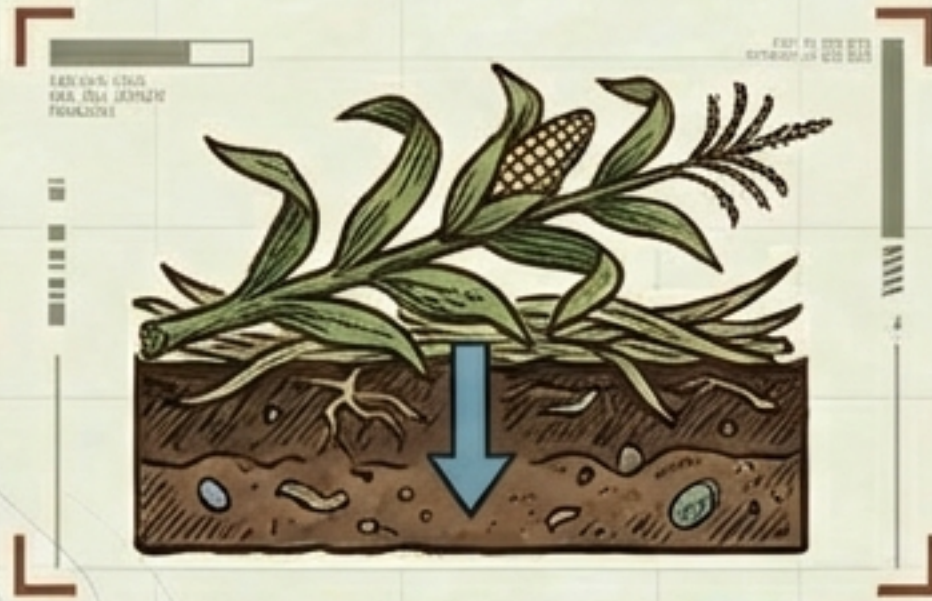
Traps Phosphorus and Nitrogen before they leach into groundwater.

SOIL HEALTH

LIVING ROOTS feed fungi and soil microbes, maintaining the biological engine.

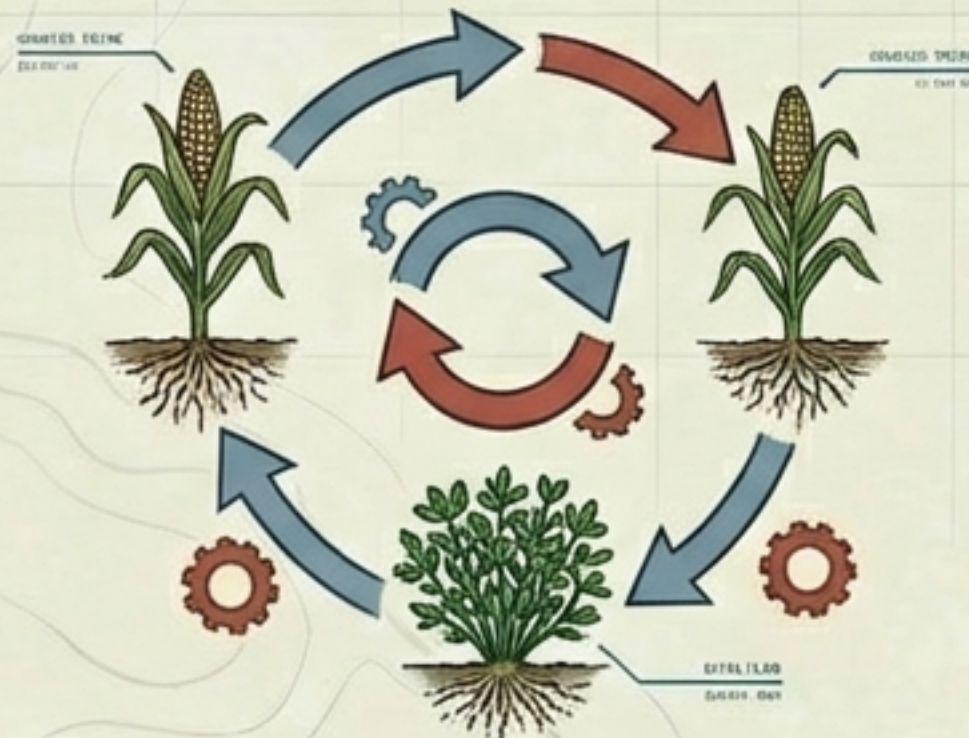


INTEL DATABASE: TILLAGE & ROTATION PROTOCOLS



REDUCED TILLAGE

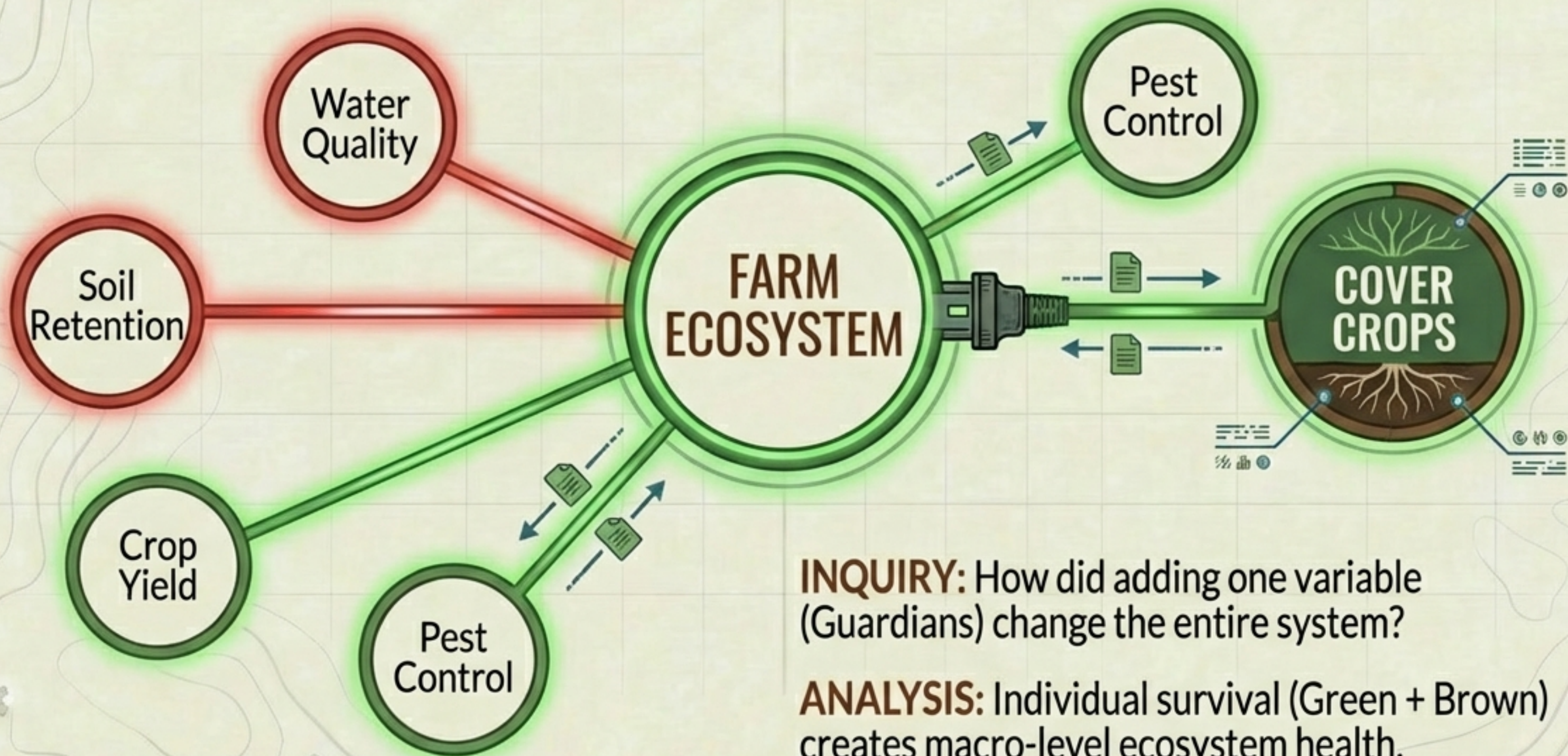
Action: Leave stalks/leaves on surface.
Benefit: Shields against impact, increases Organic Matter.



CROP ROTATION

Action: Switch crops annually.
Benefit: Breaks pest cycles, reduces synthetic fertilizer needs.

MISSION DEBRIEF: SYSTEMS THINKING (EX2.A)

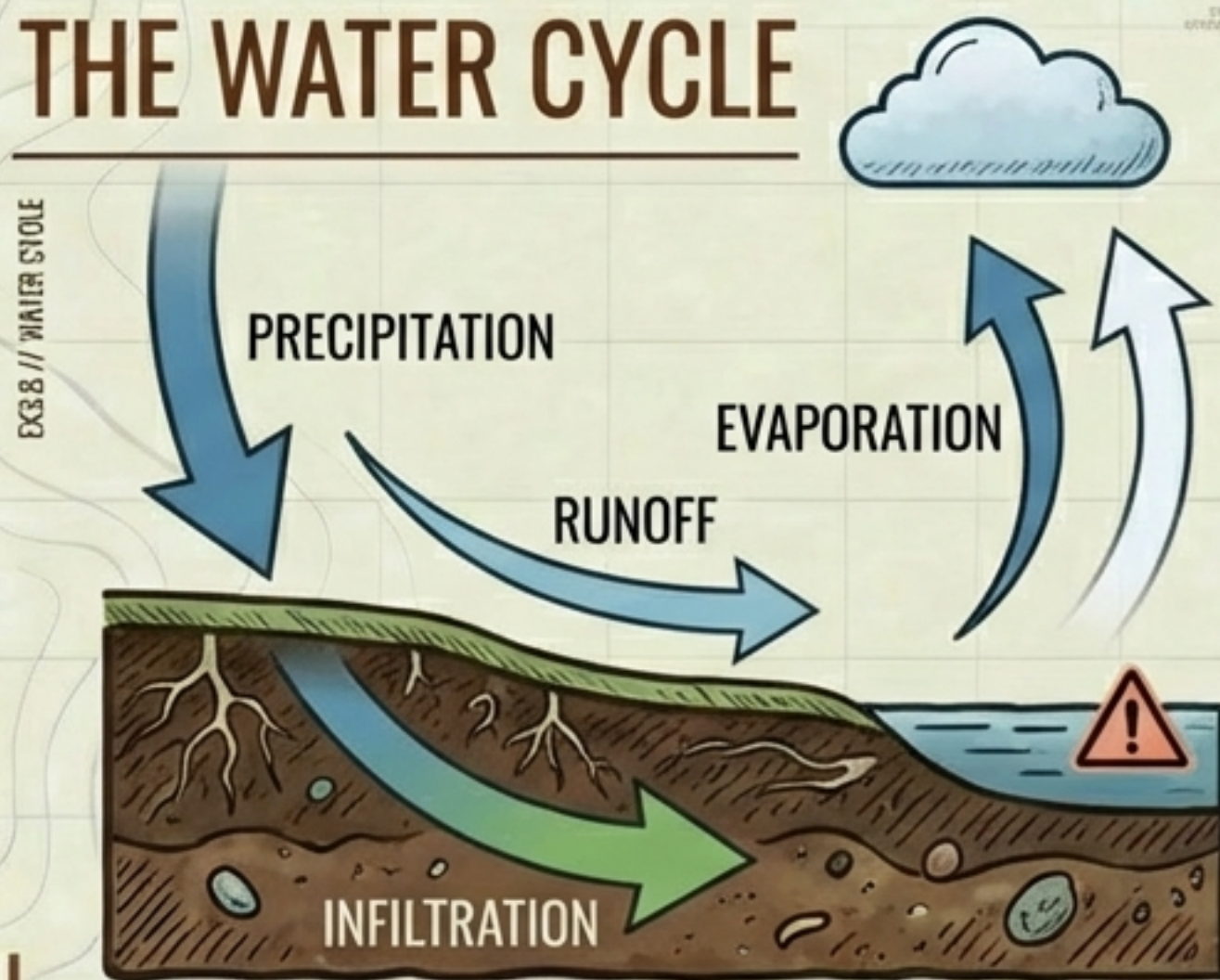


INQUIRY: How did adding one variable (Guardians) change the entire system?

ANALYSIS: Individual survival (Green + Brown) creates macro-level ecosystem health.

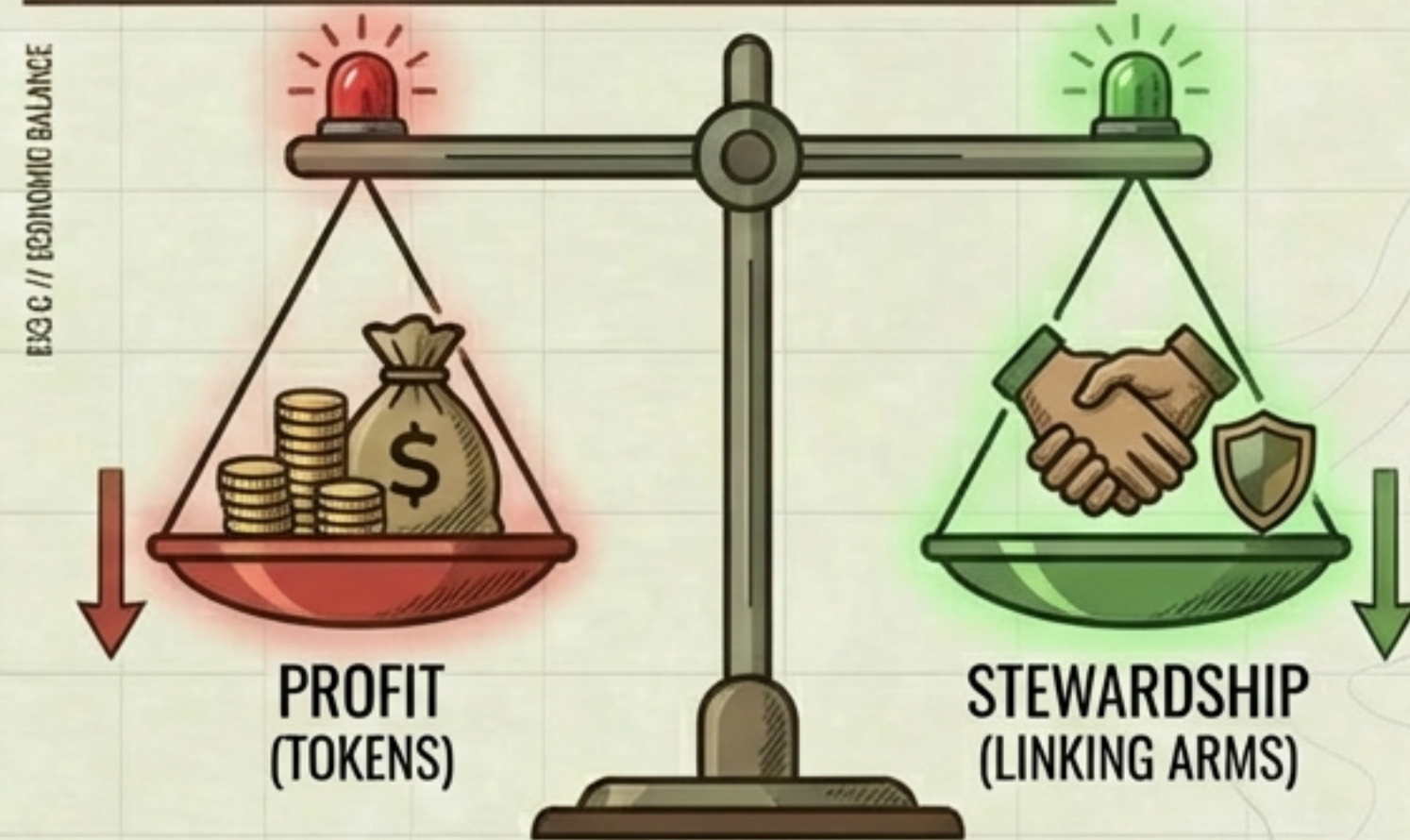
MISSION DEBRIEF: CYCLES & DYNAMIC BALANCE

THE WATER CYCLE



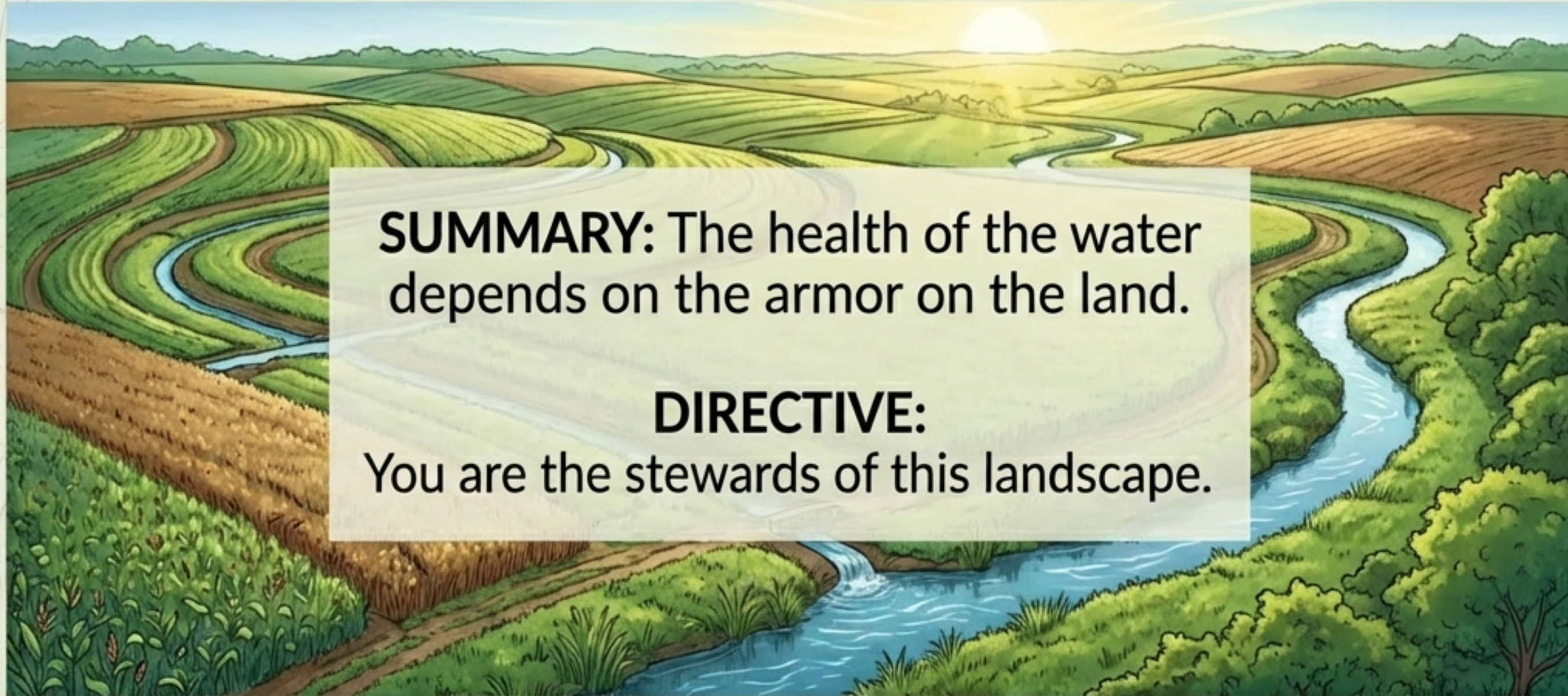
Mapping player movement to Manitowoc hydrology.

THE ECONOMIC BALANCE



The tension between production and protection. If soil is lost to Impaired Waters, the farm economy collapses.

MISSION STATUS: ONGOING



SUMMARY: The health of the water depends on the armor on the land.

DIRECTIVE:
You are the stewards of this landscape.

CALL TO ACTION: KEEP IT COVERED.