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MICHIGAN SOIL HEALTH APPRAISAL PILOT OVERVIEW

FALL 2024

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EXECUTIVE SUMMARY

The purpose of a farm real estate appraisal is to determine the fair market value of farm property. The valuation process is crucial for stakeholders in the agricultural sector, including farmers, landowners, lenders, investors, and government agencies. For example, real estate market participants use appraisals to negotiate fair prices when buying or selling farm properties. Lenders use appraisals to assess the value of the farm property as collateral for loans or mortgages. Appraisals assist in estate planning by providing an accurate valuation of farm properties for inheritance and tax purposes. Investors utilize farm real estate appraisals to evaluate potential returns and risks associated with investing in agricultural properties. Government authorities may employ appraisals to assess property taxes on farm properties based on their fair market value. Taken as a whole, farm real estate appraisals play a critical role in ensuring fair and accurate valuations of agricultural properties, which in turn supports informed decision-making and the functioning of the agricultural real estate market.

Michigan farmers may improve their soil health and protect local water quality by adopting Soil Health Management Systems (SHMS), such as cover crops or no-till. However, prior stages of work by Delta Institute have shown that despite evidence that suggests improved soil health may create more profitable farming operations (American Farmland Trust, 2019; American Farmland Trust, 2020; Soil Health Institute, 2021), Michigan farmers require greater financial incentives to adopt SHMS.

Farmers may be incentivized to adopt SHMS if building soil health can demonstrably increase the value of their land, helping to provide a clear value proposition to undertake soil health- and water quality- focused efforts. To do so, soil health must be valued as a property characteristic and a replicable process to incorporate soil health into commonly accepted appraisal practices must be created. However, in Michigan (and more broadly in the Midwest), no real estate appraisal approaches currently exist to empirically assess the value ($/acre) of soil health. Instead, land values are closely tied to productivity index scores, which are derived from measurements of inherent soil properties (e.g., texture and drainage). In other words, the condition (or health) of the soil is not considered due to a lack of commonly accepted metrics by real estate professionals.

Through generous support from the Fred and Barbara Erb Family Foundation, a project team comprised of Delta Institute, Douglas Hodge (Capstone Realty), and Rob Malcomnson (Certified Crop Advisor)—i.e. the Project Team—tested a proof-of-concept approach to incorporating measurements of soil health into the farm real estate appraisal process in Michigan. The Project Team piloted this approach on 4 subject properties in southeastern Michigan in 2024 that were viewed to be reasonably indicative of many Midwestern farm properties.

Briefly, the Project Team implemented the following modified appraisal approach, which filtered information into a transferable system that can be replicated in other agricultural real estate markets:

1. Foundational, widely recognized metrics of the subject properties and comparable land sales in the defined market area were collected.
2. Soil health data of the subject cohort and comparable properties was collected and analyzed to observe trends specific to soil health indicators. Land management history data collected

via farm owner/tenant interviews was used for qualitative bracketing.

3. A simple and replicable “Soil Health Index” score was created specific to each subject for comparison among peers, determine the extent of any value influence, and attempt to form an opinion as to how these ultimately influence property value.
4. The subject cohort was analyzed and any trends specific to the soil health indicators were observed. The association between assessed value ($/acre) and soil health was then assessed by regression analysis.
5. Finally, the appraiser incorporated the Soil Health Index specific to the subject to attempt to form an opinion as to how/whether these ultimately influence property value.

The scope of the appraisal encompassed the Income Approach and Sales Comparison Approach. A comparable sale search was conducted within Lenawee and Hillsdale Counties for vacant row cropland sales that have transacted within the last three years.

It was the appraisers' opinion that as of the effective date there was insufficient empirical evidence available in the marketplace to be able to utilize a “Soil Health Index” in a meaningful valuation approach. While soil health was able to be analyzed as a potential adjustment within the Sales Comparison Approach on all four properties, a review of the individual Soil Health Index scores among pilot participant farms did not warrant an adjustment simply due to lack of market evidence. In other words, at the moment, appraisers lack the baseline data required to identify and isolate any quantifiable market reactions to soil health.

The Project Team not only successfully created a replicable soil sampling methodology and “Soil Health Index” to be utilized in future appraisals but also determined that the Sales Comparison approach may be best suited for incorporating soil health into the land valuation process at scale. However, through this process, the Project Team has found that major barriers, such as limited information and high transaction costs preventing the institutional adoption of this novel appraisal methodology have created a “missing market” for soil health in land valuation.

The results of this Pilot Program also contribute empirical evidence that suggests land management has a significant effect on soil health. The soil health indicator values among management types were markedly different - with the idle CRP land having overall highest soil health, farms that adopted SHMS having above average soil health and conventionally managed farms having the lowest soil health. These results suggest that tillage and conventional agricultural management may decrease soil health. This is valuable towards the incorporation of soil health into land appraisals because it not only shows that soil health can be measured and compared among sites, but also that reference sites provide a ceiling for improvement for farmers to achieve by adopting SHMS.

The next steps of our work will be to fill the gaps of this “missing market” by further building market evidence of the value of soil health and lowering the prohibitive costs/time of soil health testing. Therefore, Delta seeks to further compile baseline data and test the soil health appraisal approach in similar Midwestern markets, such as Iowa and Indiana. Delta also has identified loan officers as crucial partners needed to catalyze the creation of a soil health market. For example, if building soil health can be tied to greater land values and deliver more equity to farmers, then farmers may adopt soil conservation practices to secure lower interest rate

operating loans. The Project Team will test this modified Sales Comparison approach in new regions and refine to identify the emerging market pathways and platforms in which the appraised value of soil health may be traded.

The novel approach outlined in this document has not been officially approved or adopted by any governing organizations or regulatory bodies within the appraisal industry. The effectiveness and reliability of this approach may vary depending on specific circumstances, local regulations, and market conditions. Therefore, it is recommended to consult with certified appraisers or relevant authorities for guidance on conducting farm real estate appraisals in compliance with established standards and best practices. This document is provided for informational purposes only and does not constitute professional appraisal advice or endorsement of the approach described herein.

About Delta Institute

Delta Institute collaborates with communities to solve complex environmental challenges throughout the Midwest. Delta exists because environmental, economic, and climate issues hit communities—urban and rural—through disinvestment, systemic inequity, and policy decisions. We collaborate at the community level to solve our home region's new and legacy issues, by focusing on the self-defined goals and needs of our partners.

Delta Institute improves the living conditions of more than five million Midwesterners by transitioning one million acres to more resilient, conservation-focused practices, and by improving water quality and reducing flooding by capturing 100 million stormwater gallons. By 2025 we will achieve these goals through our agriculture, climate, water, and community development projects.

This is what a more resilient, equitable, and innovative Midwest looks like. Visit us online at www.delta-institute.org.

Acknowledgements

This project was produced with generous support from the **Fred and Barbara Erb Family Foundation**, who envisions a flourishing, healthy, and resilient Great Lakes ecosystem and a culturally vibrant, sustainable Southeast Michigan. Toward this end, we strengthen the cultural and environmental organizations that share our vision to make this a reality for generations to come. Learn more at https://www.erbff.org/.

Douglas Hodge, ARA, MAI, has been involved in the valuation of agricultural assets since 1983 and has prepared appraisal reports and appraisal reviews globally. Doug graduated from Ferris State University in 1983 with a BS – Finance with a concentration in real estate. He formerly held the position of VP – Chief Appraiser at International Farming Corporation where he was responsible for valuation of farmland investments and appraisal review for the global agricultural assets held by IFC. He also held the position of VP of Appraisal Services for Nuveen Global Asset Management and Sr. Director for TIAA-CREF and was responsible for the appraisal review of Nuveen/TIAA's global agricultural portfolio. Prior to joining Nuveen, he was the regional appraisal manager for the eastern US for Farmers National Co. Before joining FNC in 2007 he owned his own valuation firm in Lapeer, Michigan. He is currently a certified general appraiser in Michigan. Doug has served recently as the District III VP for the American Society

of Farm Managers and Rural Appraisers (ASFMRA) and is the current immediate past president of ASFMRA and has held other positions with ASFMRA and the Great Lakes Chapter of the Appraisal Institute. Throughout his career he has prepared appraisal reports for many purposes including lending, litigation, eminent domain, business valuations and others. Having grown up on a dairy farm in Sanilac County, Michigan he has a strong background in agriculture. In addition to his appraisal practice he and his wife, June, operate Stony Croft Farms, a producer and processor of heritage grains and flour.

Rob Malcomnson holds a Bachelor's Degree in Resource Development from Michigan State University. He has managed Marsh Haven Farms, a diverse, organic/regenerative farm, for 30 years near Flint, MI. He has worked as the Urban Agriculture Technician for MSU Extension in Genesee County, and for the Lapeer Conservation District assisting landowners in earning verification in the Michigan Agriculture Environmental Assurance Program. He has served his region through various Boards of Directors and has taught classes through the local Community Education program. For 35 years, Rob has used and/or serviced residential alternative energy systems. Rob is a Certified Crop Advisor and has a 30-year history of mentoring/teaching farmers and homesteaders as an independent consultant.

This document and the tools provided aim to be action oriented and to provide the most current, correct, and clear information possible, but some information may have changed since publication. We encourage practitioners to reach out to us at delta@delta-institute.org with questions, corrections, or to discuss implementation challenges.

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AN OVERVIEW OF THE MICHIGAN SOIL HEALTH APPRAISAL PILOT PROGRAM

Program Basics

The Project Team partnered to implement a Soil Health Appraisal Pilot Program (the Pilot Program) to test a proof-of-concept appraisal approach towards factoring soil health in the land valuation process on 4 Michigan farms in Summer 2024.

The goals of the Pilot Program were to:

- Determine the extent to which measures of soil health can be incorporated into the farmland appraisal process.
- Create a quantifiable metric for soil health that can be incorporated into the farmland appraisal process.
- Analyze the effect of soil health on sales price of farmland parcels and test the methods on the pilot study data set.
- Provide a framework to track soil health and create awareness for producers who may want to adopt conservation practices such as cover crops or no-till.

The Pilot Program was a partnership between 4 Michigan farmers (the Farm Cohort) and Delta Institute (Delta), which included an agreement to permit the Project Team access to each subject property to conduct soil health testing and to gather land management history data. In total, 9 subject properties were analyzed. By collecting soil health measurements and land management history data, the Project Team created a database of ranked participating farms using a novel Soil Health Index. In return, each member of the Farm Cohort received a free appraisal, soil health testing, and a personalized Soil Health Report, which included recommendations to improve their soil health through best practices in SHMS.

Timeline

The following timeline demonstrates the sequential order of each milestone of the Pilot Program:

Milestone	Winter 2023	Spring 2024	Summer 2024	Fall 2024
Identify Pilot Program Geography				
Farm Cohort Recruitment				
Data Collection: Soil Samples & Land MGMT History				
Appraisals & Soil Health Analyses				
Evaluation & Reporting				

Partners and Roles

- Delta Institute facilitated the Pilot Program, managed agreements with pilot participants, supported project partners, synthesized and reported results.
- Capstone Realty and Douglas Hodge, ARA, MAI performed and advised property owner/farmer outreach, performed market research and provided expert analysis, assisted in the creation and implementation of novel appraisal approach.
- Rob Malcomnson, CCA performed and advised property owner/farmer outreach, advised subject parcel selection based on soil and physiographic conditions, selected and sampled site(s) within farms, send samples to applicable soil testing laboratory, analyzed and reported soil health results, provide recommendations to subject parcel owners to improve soil health conditions.

Delta Institute and Rob Malcomnson shared responsibility for establishing soil health as a metric. Capstone Realty was responsible for integrating this metric into the appraisal process.

Program Geography

The Project Team determined that subject properties should be selected from the most dominant Soil Health Sampling Group (SHSG) within the three Major Land Resource Areas (MLRA) of southeastern Michigan (Figures 1, 2, and 3). A SHSG represents an area with similar soil texture and drainage while an MLRA represents a specific geographic area of constrained parent material and climate. In other words, several SHGS can be found within the same MLRA. Loamy soils are the most dominant SHSG in the three MLRAs of southeastern Michigan. Therefore, subject properties with high proportions of loamy soils were selected for the Pilot Program.

Major Land Resource Areas

The following information comes directly from the USDA Agriculture Handbook 296 (USDA, 2022). The Handbook is a collective effort by the National Soil Survey Center and regional natural resource managers to subdivide land into resource units with similar soils, climate, and vegetation or crop types.

MLRA 98: Southern Michigan and Northern Indiana Drift Plains

MLRA 98 is located within Land Resource Region L - Lake States Fruit, Truck Crop, and Dairy Region and covers about 16,747 square miles (Figure 1). Here, fertile cropland is superimposed on calcareous glacial till of the Great Lakes region. Region L is dominated by Alfisols (broadleaf deciduous forests) – as opposed to the Mollisols of the Corn Belt – but also has small portions of sandy soils from remnant Ice Age lake shorelines. The soils of MLRA 98 are generally characterized by fine-loamy till and sandy outwash from the Great Lakes.

Despite large swaths of deciduous forest, nearly half of MLRA 98 is devoted to cropland for Corn, Soybeans and Hay/feed grains for dairy cattle (Figure 2). The major resource concerns are preserving water quality from sediment and pesticides as well as protecting soil health.

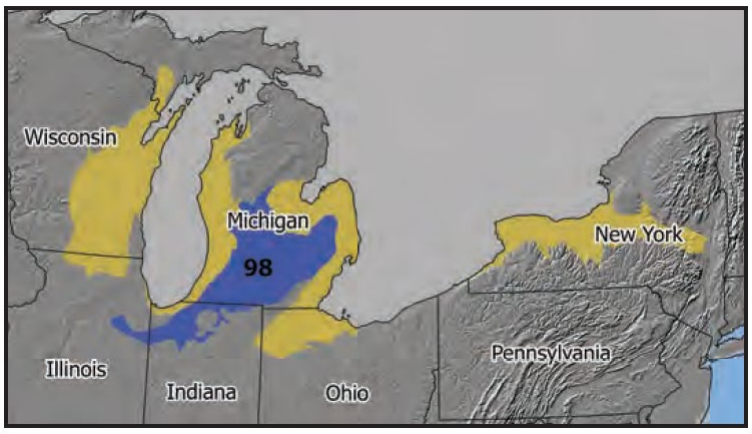

Figure 1: Location of MLRA 98, which covers 16,747 miles^2. Source: USDA Agriculture Handbook 296, 2022.

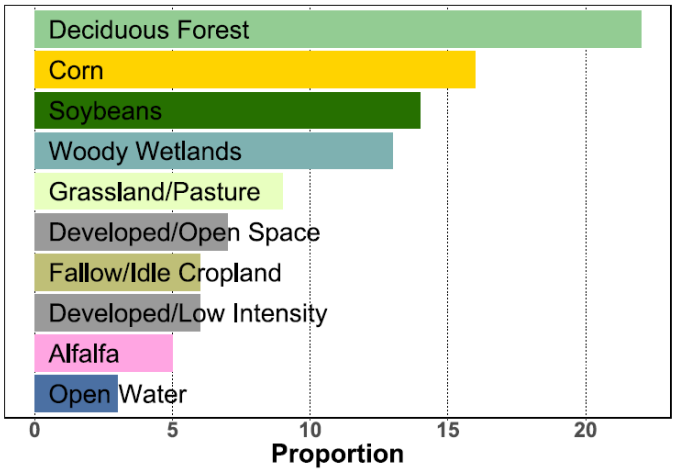

Figure 2: Relative proportions (percentages) of land use in MLRA 98. Source: USDA Agriculture Handbook 296, 2022.

MLRA 99: Erie-Huron Lake Plain

MLRA 99 is also located within Land Resource Region L - Lake States Fruit, Truck Crop, and Dairy Region. MLRA 99 covers 13,161 square miles (Figure 3).

Here, glacial deposits of till, lake sediments and outwash support beech-maple forests and lake plain oak savannas as well as productive croplands for the production of Corn, Soybeans, and Sugar Beets. The soils of MLRA 99 are generally characterized by Alfisols (forests), Inceptisols (steep slopes), and Mollisols (grasslands/prairies).

Nearly three-fourths of the land area of MLRA 99 is devoted to farmland, with about three-fifths of the farmland used as cropland (Figure 4). Soybeans, hay, corn, winter wheat and sugar beets are the dominant cash crops. Coarse textured soils are used to grow fruit. The major resource concerns are protecting water quality from agricultural runoff and soil erosion.

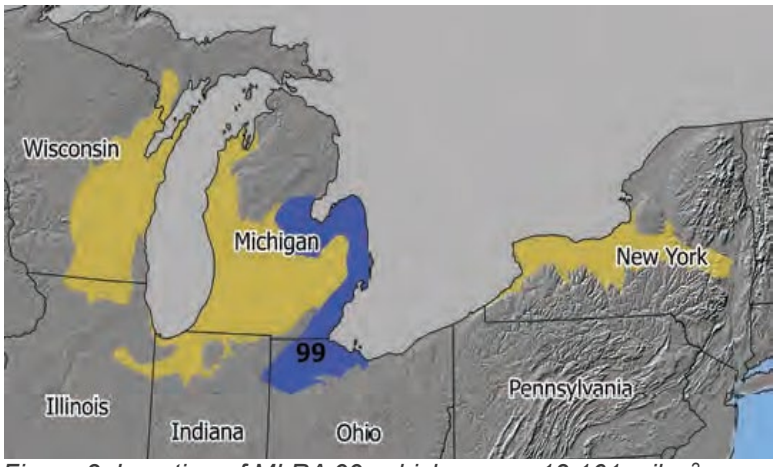

Figure 3: Location of MLRA 99, which covers 13,161 miles², within Region L. Source: USDA Agriculture Handbook 296, 2022.

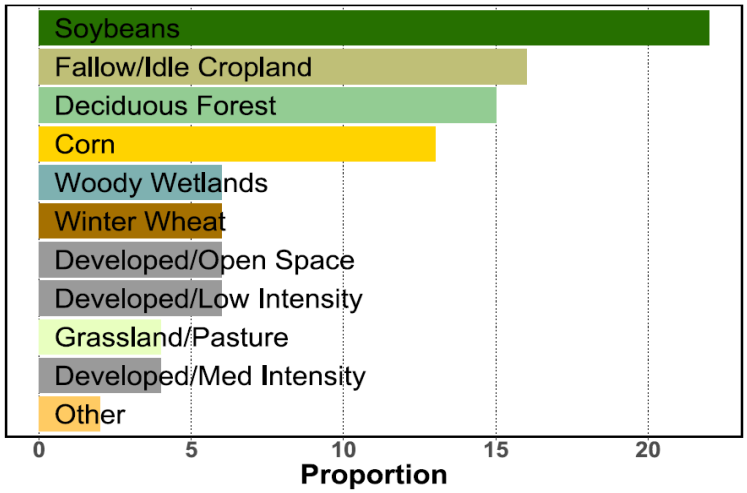

Figure 4: Relative proportions (percentages) of land use in MLRA 99. Source: USDA Agriculture Handbook 296, 2022.

MLRA 111: Indiana and Ohio Till Plain

MLRA 111 is located within Land Resource Region M - Central Feed Grains and Livestock Region. The productive croplands of Region M are the result of Pleistocene (“Ice Age”, 2.58M – 11.7KYA) glacial deposits of loess and till, which produced native tallgrass prairies (Mollisols) in the western portion and deciduous forests (Alfisols) in the eastern and southern portions.

MLRA 111 covers 34,294 square miles (Figure 5). It’s croplands mostly produce cash crops, feed grain, and hay for livestock. The soils of MLRA 111 are characterized as very deep, very poorly drained to well drained, and silty, loamy, or clayey.

Most of MLRA 111 is farmland devoted to producing corn, soybeans, hay/feed grains for livestock (Figure 6). As such, the major resource concerns are soil erosion and preserving water quality.

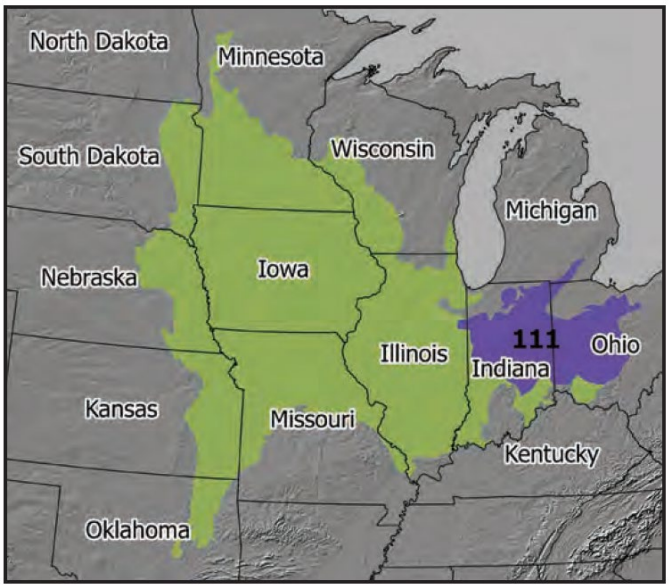

Figure 5: Location of MLRA 111, which covers 34,294 miles^2. Source: USDA Agriculture Handbook 296, 2022.

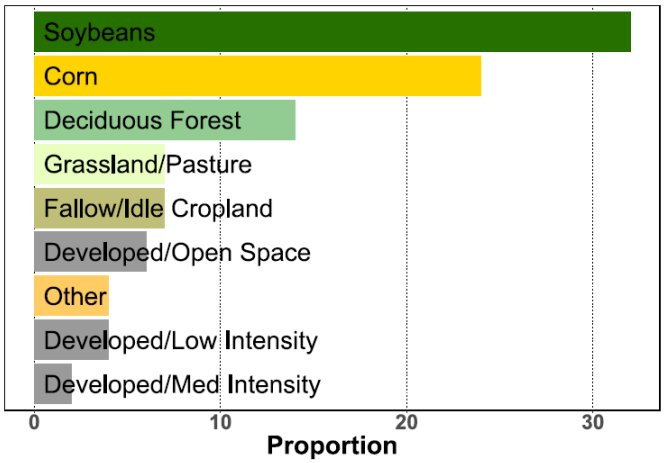

Figure 6: Relative proportions (percentages) of land use in MLRA 111. Source: USDA Agriculture Handbook 296, 2022.

Soil Health Sampling Group – Southeastern Michigan

The Project Team determined that the market area of the Pilot Program should be Hillsdale, Lenawee, Washtenaw, and Monroe counties, in Southeast Michigan (Figure 7). This Pilot Program’s primary focus was Lenawee and Hillsdale Counties for their central location, relative availability of sales data, and the uniformity of soils types and topography within the region. One of the main watersheds in this region is predominantly characterized by Ziegenfuss clay loam (45% land area) and closely followed by Blount and Glynwood loams. These soil types extend into neighboring watersheds and counties (Figure 7). These soil types are significant in southeast Michigan for their agricultural importance and suitability for commodity crops.

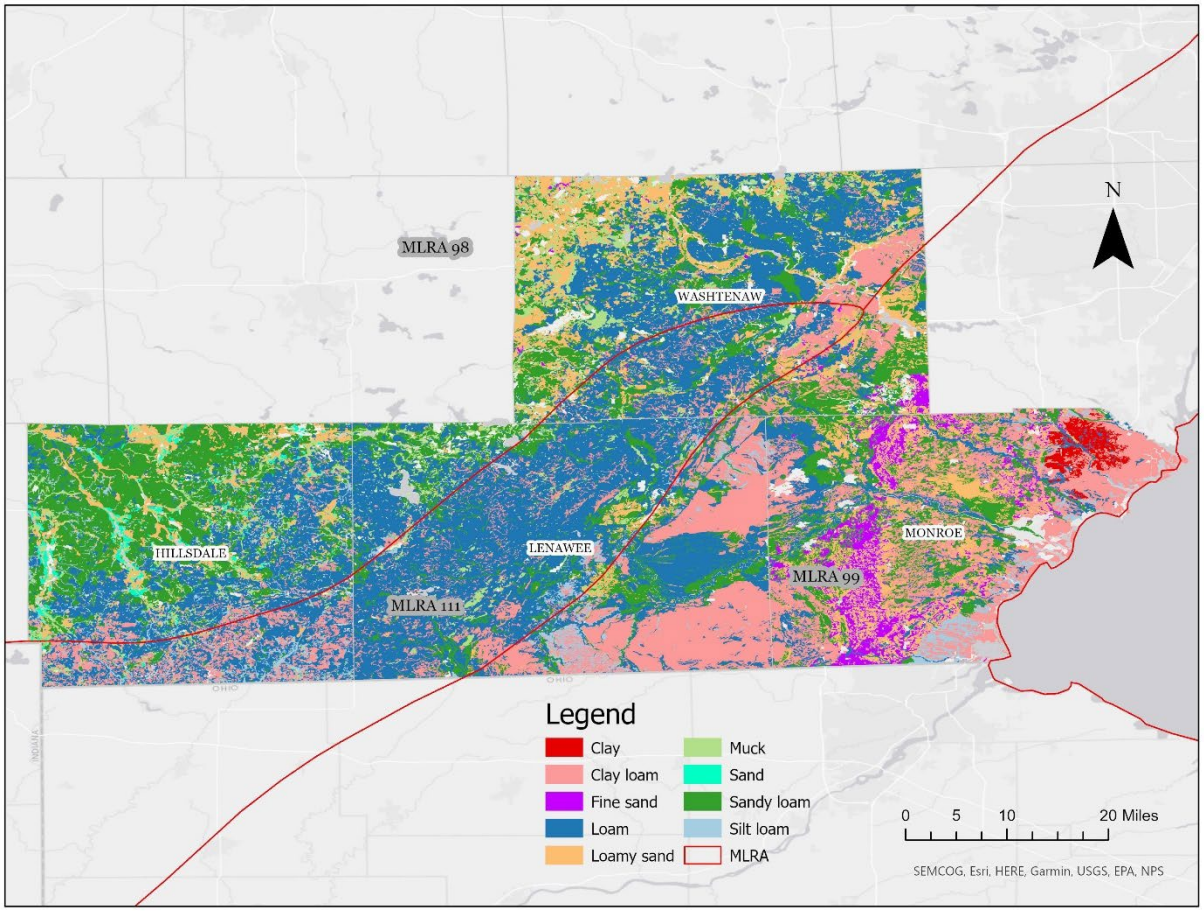

Figure 7: Map of Southeastern Michigan showing Hillsdale, Lenawee, Washtenaw, and Monroe counties. MLRAs 98, 99 and 111 are superimposed over the dominant Soil Health Sampling Groups of the region. Source: Delta Institute.

Pilot Program Participant Eligibility

In order for comparisons among parcels to be made, participating farm sites were chosen that shared the following eligibility criteria:

- Similar size range acreage (40 – 320 acres)
- Comparable slope, Class and erosion susceptibility
- Shared underlying soil types and National Commodity Crop Productivity Index scores
- Similar % tillable acreage
- Arms-length transactions (sales that were publicly advertised and typically sold by realtor or auctioneer)
- Vacant (Unimproved)
- Within a 25 +/- mile range
- Signed agreement with Project Team regarding confidentiality of property information and appraisal results publishing.

Four farms were chosen to be “subject properties” for full appraisal and soil health analysis.

These four farms establish a benchmark representing top management for soil health (e.g., a diverse crop rotation (at least corn-soybean-small grain), extensive use of cover crops, and reduced or no tillage systems). Rob Malcomnson was responsible for verifying the adoption of soil health practices by the subject properties.

An additional three farms were selected for soil health analysis that had recently experienced an agricultural appraisal. Management practices were assumed to be variable in this group. A mix of benchmark farms and several non-benchmark farms were chosen to increase the likelihood that the soil health for each farm management category would be reasonably representative. Capstone Realty was responsible for identifying the comparable, recently appraised properties.

One idle farm field enrolled in the Conservation Reserve Program (CRP) was included for soil health analysis to represent the highest soil health for the region. Further in this document, this idle farm field is referred to as the "reference site".

In total, four subject properties were appraised, and eight properties were analyzed for soil health for the Pilot Program. Subject properties ranged in size from approximately 40 acres to approximately 122 acres and ranged in average NCCPI scores from 57.7 to 64.4.

Expected Outcomes

- Increased understanding of the relationship, if any, between soil health and land value in Michigan's agricultural real estate market.
- Development of a "proof of concept" place-based appraisal approach for factoring soil health in the land valuation process that can be applied to other regions.
- Increased awareness and adoption of best practices in soil health management systems among Michigan farmers.

MODIFIED APPRAISAL APPROACH METHODOLOGY

Property Information

The first step was to define the extent to which the subject property is identified, including: the property's street address; legal description; plat of survey; deed plot survey; plat book; aerial map; soils map and soils analysis; county aerial map; deed; title commitment; assessor's parcel identification number (PIN #); County / Township zoning map; and Michigan real estate transfer declaration. Capstone Realty collected factual information regarding each subject property from FarmWorth and USDA NRCS, local County records, public courthouses, and interviews with the property owner and/or tenant.

Comparable Sales Data

Next, Capstone Realty gathered comparable sales data via the county's equalization department, published data from the USDA National Agriculture Statistics Services (NASS) (USDA National Agriculture Statistics Services, 2022), as well as conversations with loan officers, appraisers, and other real estate professionals. Where possible, Capstone Realty sought to verify data via transfer documents filed at the county courthouse and conversations with buyer, seller, or knowledgeable parties close to the transaction with access to transfer records and a perspective on motivations of the parties, such as a sales agent, broker, or escrow agent. Sales were selected for their reasonableness in representing a sound basis for value conclusions.

Cash rent data was also collected from both the subject farms and the comparable sales data to determine what impact soil ratings may have on income levels. Cash rents offer a heuristic for net farm income and are valuable to collect as this eliminates the possibility of having management and/or marketing practices influence the profitability of a particular farm operation.

Agricultural production, or yield, data was gathered during interviews with the property owners or tenants. Yield data is dependent upon the accuracy of a yield monitor, harvest records, and is not typically marketed in the advertisement of a property.

A soils and topography map was included in the analysis of each comparable sale to provide an indication of the National Commodity Crop Productivity Index (NCCPI) rating for each subject property.

Market Trends / Economic Indicators

Comparable sales data were then analyzed to determine the contributory value of different land classes (e.g., tillable cropland, irrigated cropland, woodlands) and a resulting price per acre, price per NCCPI rating point and if possible, land management practices. Qualitative factors (e.g., drainage and utility) were included in the analysis at the discretion of the appraiser. By conducting this market survey, the appraiser was able to identify regional and neighborhood market transactions that may quantify a market response to the subject property.

Soil Health Data Collection

In parallel to the above appraisal steps, the Project Team sampled soils at the four subject properties, three recently sold properties, and one “reference site”. The Soil Health Institute recommends the use of reference sites to compare against “business-as-usual” – management practices (e.g., conventional corn/soybean rotation with no SHMS) to bridge gaps in soil health testing availability, establish benchmarks for land management decisions, and be scaled up from site-specific to regional (Maharjan et al., 2020).

The reference site – an idle farm field enrolled in the Conservation Reserve Program – was chosen to maximize the local potential expression of soil health principles (minimize disturbance, maximize soil cover, maximize presence of living roots, maximize biodiversity) within a SHSG. The reference site was chosen because the soil has been largely undisturbed in the last several years and perennial plants are growing.

Figure 8: Collection of soil samples from a wheat field using a soil probe for use in one of Delta Institute’s Soil Health Appraisal Pilot Programs. Source: Delta Institute.

Soil health data collection via sampling occurred on all sites on May 1, 2024. All site and sampling criteria were chosen to eliminate as many variables as possible so that soil health scores represent features that are under the farmers’ control, and valid soil health comparisons could be made between management strategies. For each site selected, a field representing the average conditions for the farm was sampled.

About a dozen cores were taken by a standard soil probe at 3-5” depth (because of soil compaction and dryness) randomly about the field (Figure 9). Cores were homogenized and bagged for shipping to Midwest Laboratories to be tested. A complete nutrient analysis and a soil health assessment were performed. The soil health indicators measured were as follows:

- **H3A Soil Extractant**: This extract is designed to mimic organic acids produced by living plant root systems. These organic acids increase nutrient availability in the root zone (Haney et al., 2010).
- **Water Soluble Extract** provides a snapshot of nutrients that are immediately available to the plants.
- **CO2 Burst** measures the amount of CO2 naturally released from the soil due to the activity of the soil microbes through microbial respiration. This test is very dependent on the amount of carbon that is available to soil microbes and the form that the carbon is in. As the available carbon increases in soils, microbial respiration will increase.
- **Organic Carbon** is the available total water extractable organic carbon from your soil. This

pool of carbon is roughly 80 times smaller than the Soil Organic Matter. The organic carbon pool reflects the energy/food source that is driving the soil microbes.

- **Organic Nitrogen** is replenished by fresh plant residues, manure, composts, and dying soil microbes.
- **Organic C/N ratio** is a critical component of the nutrient cycle. A soil C/N ratio above 20 generally indicates that Nitrogen will be tied up and not available.

Midwest Laboratories merges these soil health indicators to generate a "**Soil Health Calculation**", which represented the overall soil health of a parcel. This number is calculated as "1-day CO2C divided by the organic C:N ratio plus water extractable organic carbon/100 + water extractable organic nitrogen/10 to include a weighted contribution of water extractable organic carbon and organic nitrogen" (Midwest Laboratories, 2025).

The Project Team also requested **Bulk Density** (grams/cm^3) to be measured for all property samples. Bulk density provides insights into soil structure, compaction, porosity, and fertility. It is an important parameter for understanding soil structure, compaction, and porosity, all of which are critical factors influencing soil health. Monitoring changes in bulk density over time can help inform soil management decisions and practices aimed at maintaining or improving soil health for sustainable agriculture and environmental conservation (Soil Health Institute, 2024).

Land Management History Data Collection

No two farm sites are managed identically, and soil health is assumed to be greater on properties where SHMS have been adopted for longer (Bender et al., 2016; Krupek et al., 2022). Therefore, the Project Team attempted to collect land management history data of each subject property, to evaluate differences among the cohort in terms of crop rotation, soil physical disturbance, and cover cropping.

Table 1: Land Management History Data collected by the Project Team for the four subject properties to be used for qualitative bracketing by the appraiser.

Property ID	2022 Crop	2022 Cover Crop	2023 Crop	2023 Cover Crop	2024 Crop	2024 Cover Crop	2025 Crop
1	Soybean	Wheat	Wheat	Clover	Soybean	Triticale, Rapeseed, Rye, Buckwheat	Corn and Soybean
2	Soybean	Wheat	Wheat	Rapeseed	Soybean	Wheat	Wheat
3	Corn	Rye, Rapeseed, Buckwheat	Soybean	Rye, Rapeseed, Buckwheat	Corn	Rye, Clover, Vetch	Soybean
4	Soybean	Wheat	Wheat	Sunflower, Oats,Triticale, Buckwheat	Soybean	Wheat	Wheat

Table 1 on the prior page shows the recorded land management history data for each of the four subject properties. Field and practice data were collected for the 2022-2024 seasons as well as intentions for 2025. All four farms utilized no-till and used various cover crop regiments. All 4 were row crop or row crop/small grain rotations. None of the four subject properties used manure for fertilizer. The land management history was unknown for the three recently appraised fields. Observations and surface conditions were noted by the Project Team.

Soil Health Index Creation

Appraisers compare properties and estimate the value of improvements or features to make valuation adjustments. In the modified approach described in this document, given the time and costs associated with the adoption of soil conservation practices, soil health may be seen as an improvement. However, appraisers require benchmarks to inform comparisons and resulting valuation adjustments.

Currently, there is no widely accepted holistic metric by the agricultural real estate market as it pertains to soil health. For the purposes of this Pilot Program, the soil health of each of the 8 properties was first determined by their individual "Soil Health Calculation" value provided by Midwest Laboratories. While this score tells us about the soil health of an individual property, it does not provide parameters, or a ceiling, for which soil health among properties can be compared in their regional context. Nor does it quantify how healthy a particular soil can be – and if efforts to improve soil health are succeeding. In other words, for appraisers to make valuation adjustments based on soil health, a benchmark, or ceiling, for soil health in the market area must be created.

Table 2: Soil Health Calculation scores and the relativized Soil Health Index scores (0:1) of each of the 8 Pilot Program properties. Soil Health Index scores were determined by dividing each Property's Soil Health Calculation score by the Reference Sites.

Property ID	Soil Health Index Score (0:1)	Soil Health Calculation Score
Subject Property 1	0.57	21.9
Subject Property 2	0.78	29.7
Subject Property 3	0.62	23.5
Subject Property 4	0.61	23.1
Reference Site (Idle, CRP field)	1.00	38.1
Recently Appraised 1	0.31	11.9
Recently Appraised 2	0.50	19
Recently Appraised 3	0.57	21.7
Average	**0.57**	**23.6**

The collection of soil samples from the reference site – where the soil is minimally disturbed with continuing living roots – was done to estimate the absolute highest potential for soil health in the loam-dominated soils of Hillsdale and Lenawee County, Michigan. As previously mentioned, it is assumed that no active farmland (even with the adoption of soil conservation practices) is able to achieve the same degree of soil health as the reference site because of the negative effects

of disturbance inherent in farming.

Therefore, a simple "Soil Health Index" score (0:1) was created for each property by dividing the Soil Health Calculation score of each property by the Soil Health Calculation score of the reference site. In doing so, each subject property's Soil Health Index score is able to be ranked and contextualized for the region's possible expression of soil health. The Table below shows each property's initial Soil Health Calculation score from Midwest Laboratories and then the relativized Soil Health Index score for use in appraisals.

Recommended Soil Health Indicators for Standardized Soil Health Index Creation

A Soil Health Index can be created using any number of soil health indicator values. However, we found that simplifying the process and emphasizing the three above indicators met our soil health assessment needs and recommend the following standardized and streamlined approach moving forward. A standardized method ensures that soil health assessments are comparable across regions, time, and different laboratories, reducing variability caused by differing proprietary techniques. This standardized soil health assessment methodology was designed to be applied across diverse soil types and agricultural systems and has achieved broad consensus among soil scientists. Furthermore, adherence to a standardized methodology may facilitate participation in government and conservation programs that require alignment with standardized soil health metrics for funding.

To quickly and simply assess the soil health of a farm field or subject property, Delta Institute and the Soil Health Institute recommend measuring the following three soil health indicators:

- **Organic C Concentration:** Soil organic Carbon is an essential component of high–functioning soils, as it builds soil structure, thereby improving water and nutrient cycling and retention as well as sequestration of atmospheric carbon. Management that increases organic carbon content promotes greater soil structure, microbial activity, available water, and available nutrients. The Soil Health Institute's standard operating procedure for measuring Organic C concentration can be found here.
- **Carbon Mineralization Potential (Burst of CO2):** Soil nutrient cycling depends on a vibrant soil microbial community. Quantifying Carbon mineralization (e.g., the breakdown of organic matter by soil microbes) provides insight into the soil's microbial activity. This method measures the abundance of carbon dioxide (CO2) produced by soil microbes (metabolic activity/decomposition) following a 24-hour incubation period. The Soil Health Institute's standard operating procedure for this method can be found here.
- **Aggregate Stability:** Soil aggregates are formed through physical and chemical interactions between mineral particles and organic matter. Improved aggregation reduces erodibility, enhances water retention, and provides better habitat for microbes and larger soil organisms. Aggregates also play a role in carbon sequestration by physically protecting organic matter. Aggregate stability is measured by Image Quantification using a smartphone. The Soil Health Institute's standard operating procedure for this method can be found here.

More detailed information about these soil health indicators and how to interpret their values can be found in Delta Institute's Soil Testing Guide as well as Soil Health Institute's Soil Health Measurements Fact Sheet.

The creation of a Soil Health Index using the three recommended soil health indicators listed above is as follows:

Divide each subject property's soil health indicator value by the reference site's value. Then, average the subject property's values to reach a final index score between 0 and 1. The subject property's final Soil Health Index score demonstrates the subject property's relative soil health to the reference site (assumed to be the highest soil health in the area) and its peers. Table 3 below shows each property's soil health indicator value relativized against the reference site to create a simple, replicable Soil Health Index score for use in appraisals.

Table 3: Example of the use of Soil Health Institute's recommended soil health indicators to create a standardized Soil Health Index for use in appraisals on hypothetical subject properties.

Property ID	Organic Carbon	% of Reference Value	Carbon Mineralization Potential	% of Reference Value	Aggregate Stability	% of Reference Value	Average of 3 Indicators	Soil Health Index (0:1)
Subject 1	2.25	56%	31.52	64%	0.34	72%	64%	0.64
Subject 2	1.66	42%	33.6	68%	0.28	60%	57%	0.57
Subject 3	1.69	43%	26.92	54%	0.3	64%	54%	0.54
Reference	3.98	N/A	49.52	N/A	0.47	N/A	N/A	1.0

In summary, despite the success of using Midwest Laboratories' Soil Health Calculation to create a Soil Health Index in this Pilot Program, Delta Institute recommends the standardized approach created by the Soil Health Institute to measure soil organic carbon, potentially mineralizable carbon, and aggregate stability of the subject properties and a reference site and then divide each subject property's soil health indicator value by the reference site's value. Finally, average the subject property's values to reach a final index score between 0 and 1 to create a Soil Health Index for use in the modified appraisal approach described in this document.

Valuation Approaches

After relevant appraisal data was collected, Capstone Realty identified the extent and type of analysis applied by the appraisers to reach the final value conclusion. The real estate appraiser does not set the market but rather interprets the market from the market data available. In a professional real estate appraisal, three approaches to value are considered and typically applied: (1) Cost Approach (2) Income Capitalization Approach and (3) Sales Comparison Approach. All approaches apply data derived from the market and are applicable to the subject.

Cost Approach

The Cost Approach adds the depreciated reproduction or replacement cost of improvements to the value of the vacant land. The approach emphasizes the premise that an informed buyer would pay no more than the cost of producing a substitute with similar utility - presuming no undue or costly delays. Use of the approach to value is best when land values are well supported, which is typically the case in agricultural assignments. Due to the 4 subject properties being vacant, the cost approach was not conducted.

Income Capitalization Approach

The Income Capitalization Approach analyzes the subject's capacity to generate benefits and converts them into an indication of present value. This approach presumes that no prudent buyer will pay more for a property than the present value of these anticipated future benefits. The steps in the process are as follows: (1) determine market Potential Gross Income (2) analyze Vacancy and Collection Loss (3) determine market Operating Expenses (4) summarize Net Operating Income and (5) select a Capitalization Rate. Given agricultural properties are purchased based on their ability to provide income, the Income Capitalization Approach is a market value indicator.

This approach is a set of procedures through which an appraiser derives a value indication for an income-producing property by converting its anticipated benefits (cash flows and reversion) into property value. This conversion can be accomplished in two ways.

One year's income expectancy can be capitalized at a market-derived capitalization rate or at a capitalization rate that reflects a specified income pattern, return on investment, and change in the value of the investment. Alternatively, the annual cash flows for the holding period and the reversion can be discounted at a specified yield rate. This approach to value involves an analysis of the property in terms of its ability to produce an income stream. The net income is then capitalized at a rate commensurate with relative certainty of its continuance and the risk involved in ownership. Net operating income is derived after deducting annual operating expenses from gross income prior to debt service payments. This approach assumes that competent management is necessary to produce the income stream upon which the present value is predicted. There are various methods of capitalization available to the appraiser to convert the future benefits of ownership to a present value. The two methods of capitalization are direct capitalization and yield capitalization. Each method is based on different measures of anticipated earnings and has different assumptions regarding the relationship between earnings and value.

Direct capitalization is a method which converts an estimate of a year's income into an indication of value by either dividing the income estimate by an appropriate rate or by multiplying the income estimate by an appropriate factor or multiplier.

Yield capitalization is a valuation method which converts future benefits to a present value by applying an appropriate yield rate. The basis for the income approach sustains an indication of value from the investor's perspective by estimating what a typical investor would pay to capture an income stream resulting from the operation of the subject property.

The estimated gross income (cash rent per acre) is derived from the National Commodity Crop Productivity Index attributed to the subject property, and a complementary/corresponding rental

rate is assigned to the subject property farm based on a per acre basis. The rental data used in the report is supported by actual market rents throughout the county area, and also through surveys and studies conducted by Capstone Realty.

The sales used in the Income Capitalization Approach are those also used in the Sales Comparison approach. The sales selected are comparable because of their proximity, timeliness, and consistency of soil composition. The capitalization rates developed are determined by dividing the estimated net incomes by the sales price of the sale property.

An appropriate capitalization rate is then applied to the subject property's net income, which develops the opinion of value for the income capitalization approach.

Sales Comparison Approach

The Sales Comparison Approach involves market analysis of comparable properties that have been sold. This approach is based on the economic principle of substitution, which states an informed buyer will not pay more for an item than for another item of equal utility. Reliability of this approach is dependent upon: (1) the degree of comparability of the sales to the subject (2) the date of sale in relation to the effective date and capturing market condition changes (3) reliability of the sales data and (4) appropriate adjustments for any unusual conditions. The Sales Comparison Approach is typically used on vacant or minimally improved agricultural properties.

The Sales Comparison Approach is based upon the principle of substitution which implies that an informed purchaser would not pay more for a property than the cost of acquiring a similar property with equal utility. The Dictionary of Real Estate Appraisal, Fourth Edition defines the Sales Comparison Approach as “A set of procedures in which a value indication is derived by comparing the property being appraised to similar properties that have been sold recently, then applying appropriate units of comparison, and making adjustments to the sale prices of the comparables based on the elements of comparison.”

The process involves gathering sales data of recent bona fide arm's length sales of comparable properties and comparing their most important characteristics to the subject property. After acquiring sales that the appraiser feels are justifiably comparable, adjustments are made from the comparable sales toward the subject property for any significant difference. The value of the subject property by the Sales Comparison Approach is derived after a comparison with similar sales. The subject property is the base of comparison, superior characteristics of the comparable sales are adjusted downward and inferior characteristics of the comparable sale are adjusted upward toward the subject property. This process results in an indication of what the comparable sales would have sold for on the appraisal date had they possessed all of the important characteristics of the subject property. The adjusted sale price of all the comparables is then reconciled to arrive at an indication of the market value of the subject property.

Final Valuation

The final step in the appraisal process is the reconciliation or correlation of the value indications, and places major emphasis on one or more of the approaches which appear to be the most reliable and applicable solution to the specific appraisal problem. Here, the Sales Comparison Approach and Income Approach were both given consideration in determining the final value

opinion of the subject properties. The holistic Soil Health Index scores of the subject properties were compared to traditional appraisal metrics (Cropland A; $/Acre; $/NCCPI Point; & $/Tillable Acre.) to form an opinion of market value on the effective date of this appraisal.

The Soil Health Index scores were also assessed in the context of land management data. The first evaluation of the soil health indicators was to compare the reference sites to the cropped fields. This comparison gave the Project Team an estimate of the “innovation space”, or the difference between soils in their current state compared to their potential. If there were meaningful differences in the management history among fields, the Project Team also evaluated how the indicators have responded to soil health practices. The Project Team did not expect cropped soils to have identical soil health indicator values to the references, but this sampling approach allowed the Project Team to determine how different they are and if there are opportunities to improve with the adoption of SHMS. The association between assessed value ($/acre) and soil health was then assessed by regression analysis.

SUMMARY OF RESULTS

Soil Health

Soil health differed among properties. The idle, undisturbed reference site was shown to have the highest Soil Health Index score (*Figure 10*). The Soil Health Index scores of the four subject properties, who have adopted soil conservation practices, were all above average. The Soil Health Index scores of the three recently appraised properties, whose land management was assumed to be conventional, were average or below average.

Microbial activity (Soil CO2 Burst) was shown to be highest at the idle, undisturbed reference site, followed by the four subject properties, who have adopted soil conservation practices, and then the three recently appraised, conventionally managed properties (*Figure 11*).

Bulk Density was the lowest at the idle, undisturbed reference site (*Figure 12*). Low bulk density suggests the site has well-structured soil and low compaction, which translates to improved water holding capacity and resilience to erosion. Bulk density among the farmed properties was mixed.

Finally, Carbon to Nitrogen ratios, which reflect the soil's nutrient cycling abilities, were mixed among the cohort of properties (*Figure 13*, next page). The idle, undisturbed reference site and the majority of the subject properties who have adopted soil conservation practices had above average C/N ratios.

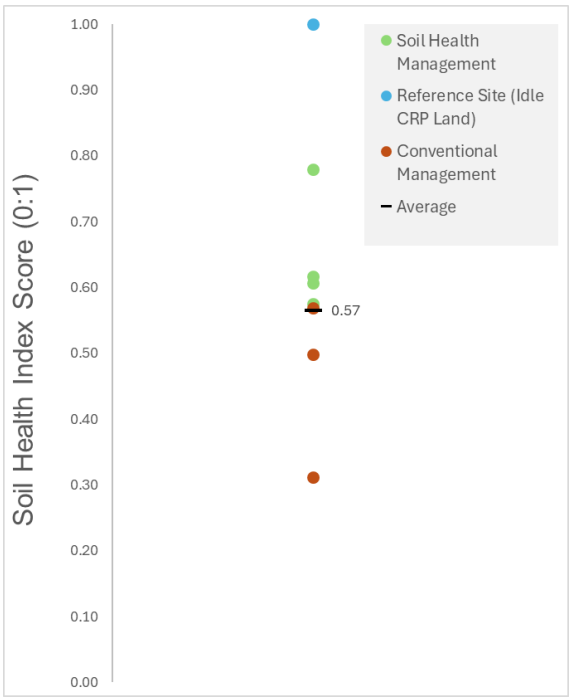

Figure 9: Soil Health Index scores among properties.

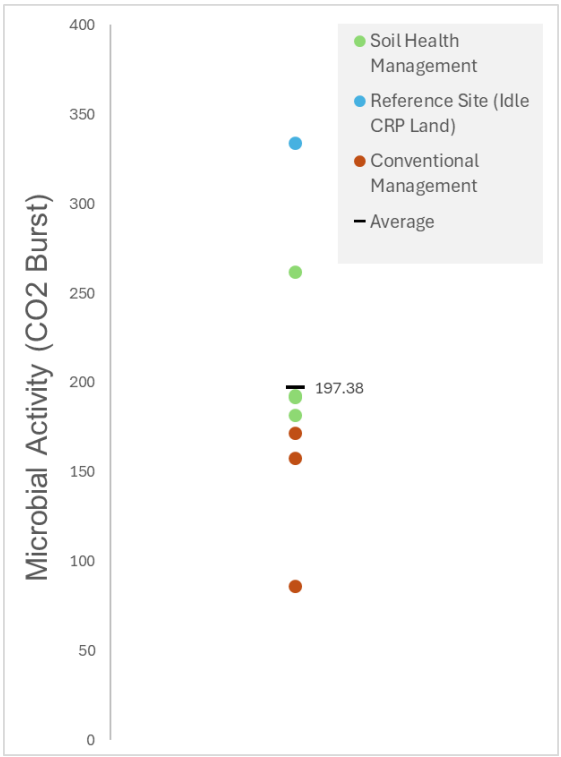

Figure 10: Microbial Activity among properties.

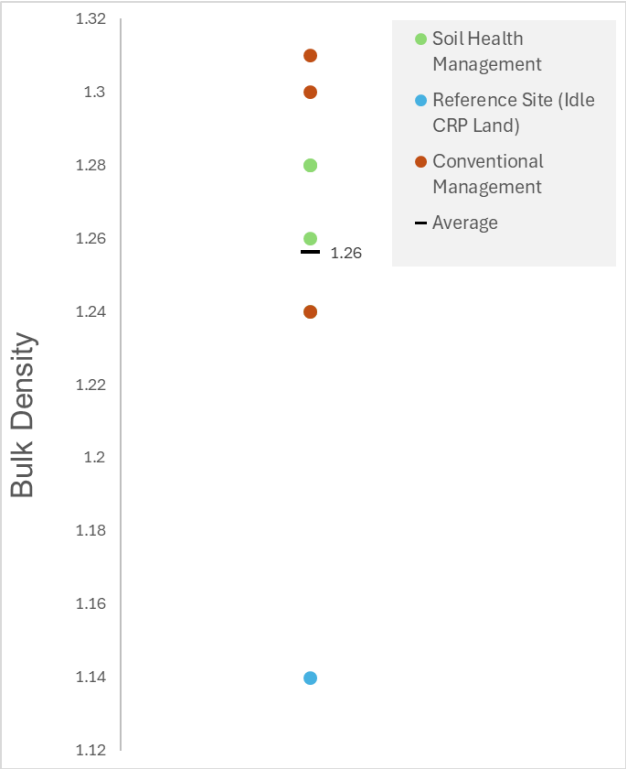

Figure 12: Bulk Density among properties.

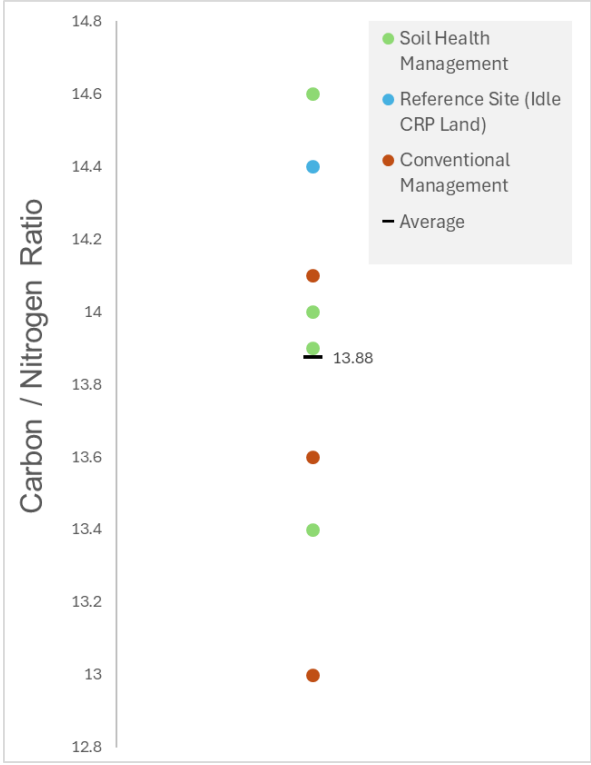

Figure 11: Carbon to Nitrogen Ratio among properties.

Overall, these findings suggest that differences in soil health values among sites may be related to differences in management. The values and dynamics of soil health indicators are closely linked to management practices (Liu et al., 2021). Given that overall soil health was highest at the idle, undisturbed reference site followed by the four subject properties, who have adopted soil conservation practices, it follows that management decisions may have delivered greater soil health benefits.

However, given the small sample size of subject properties (n=4) and unknown land management history of the three recently appraised properties, it wasn't possible to fully evaluate the role of land management history on soil health. In general, land management across the four subject properties was similar – a corn, soybean, and wheat crop rotation with regular use of cover crops. Interviews with the Project Team also provided anecdotal differences among the subject properties in the manner of cover crop planting, with some using aerial application and others using a "highboy" – a specialized, high-clearance vehicle often used to apply herbicides or other chemicals to tall crops without damaging them. From this, we see a need for more baseline land management history data.

Table 4 below shows the soil health indicator values of each of the properties from this Pilot Program.

Table 4: Summary of soil health indicator values of all properties and their relativized Soil Health Index scores.

Property ID	Soil Health Index (0:1)	Soil Health Calculation Score (Midwest Laboratories)	Bulk Density	Microbial Activity (CO2 Burst)	Carbon / Nitrogen Ratio
Subject Property 1	0.57	21.9	1.24	182	13.9
Subject Property 2	0.78	29.7	1.26	262	14
Subject Property 3	0.62	23.5	1.28	192	13.4
Subject Property 4	0.61	23.1	1.28	193	14.6
Reference Site (Idle CRP Land)	1.00	38.1	1.14	334	14.4
Recently Appraised 1	0.31	11.9	1.31	86	13
Recently Appraised 2	0.50	19	1.3	158	14.1
Recently Appraised 3	0.57	21.7	1.24	172	13.6
Average	**0.56**	**23.6**	**1.26**	**197.38**	**13.88**

Final Valuation

To determine the value of the subject properties as row cropland, the income approach and sales comparison approach were used within the appraisal. It was the appraisers' opinion that as of the effective date there are not enough conclusive market data to suggest that a farm's soil health impacts the value of that property.

Soil health was analyzed as a potential adjustment within the Sales Comparison Approach. However, a review of the individual soil health statistics among pilot participant farms and the traditional appraisal metrics captured on the most recent date of sale (Cropland A indication; $/NCCPI; & $/Tillable Acre) also did not warrant an adjustment due to lack of market evidence.

CONCLUSION

Delta Institute completed a Soil Health Appraisal Pilot Program to test a proof-of-concept appraisal approach, which incorporated measurements of soil health into the land valuation process. The goal of this Program was to test a replicable methodology towards soil health sampling and soil health index creation to be novel components of a modified Sales Comparison appraisal approach. The Pilot Program showed that while soil health was able to be analyzed as a potential adjustment within the Sales Comparison Approach, a review of the

individual soil health index scores among pilot participant farms did not warrant an adjustment simply due to lack of market evidence. In other words, at the moment, appraisers lack the baseline data required to identify and isolate any quantifiable market reactions to soil health.

From this, the Project Team concludes that limited information on the return on investment of building soil health for farmers operating budgets may prevent the institutional adoption of this novel appraisal methodology and have created a “missing market” for soil health in land valuation. Here, we see that the next steps should be to fill the gaps of this “missing market” by further building market evidence of the value of soil health.

An appraisal produces a meaningful, defensible value estimate by fulfilling three important criteria - appropriateness, accuracy, and quantity of evidence. The independent approaches to value are market derived and provide a range of value for the subject property. The final value estimate involves the exercise of judgment by appraisers, not simply applying qualitative or quantitative techniques. Integration of a novel soil health index into the advertisement of agricultural properties that are available for sale and further education of auctioneers, brokers, buyers, and other market participants of agricultural real estate will be necessary to monitor and capture soil health’s influence on market value.

The agricultural real estate market is becoming more quality oriented with growing interest in soil health but until buyers and sellers recognize the economic benefits of healthy soils, this approach is not likely to be able to be fully developed into a measurable matrix for valuation. Continued education, for lenders, buyers, sellers and other participants in the farmland market will need to be developed for this methodology to gain traction in the agricultural valuation practices of farmland appraisers. Delta also has identified loan officers as crucial partners needed to catalyze the creation of a soil health market and identify the emerging market pathways and platforms in which the appraised value of soil health may be traded. For example, if building soil health can be tied to greater land values and deliver more equity to farmers, then farmers may adopt soil conservation practices to secure lower interest rate operating loans. The Project Team will also continue to test the soil health metric creation protocol in new Major Land Resource Areas and other Midwestern markets, such as Iowa and Indiana.

In summary, soil health is measurable and may be improved given the right practices and context. Building soil health protects local water quality and may make farm operations more climate resilient and profitable. However, many Michigan farmers lack the incentives needed to adopt Soil Health Management Systems (SHMS) (e.g., cover crops and no-till) at scale. No farm real estate appraisal approaches currently exist to empirically assess the value ($/acre) of soil health. Soil health is more than yield; therefore, appraisers cannot explicitly establish a link between soil health and land value. For soil health to become a standardized metric and SHMS to become widely-adopted on farms across the Midwest, Delta must build upon the findings of this Pilot Program to compile and demonstrate in-depth market evidence to raise awareness of the value and return on investment of building soil health to farmers and appraisers, resolve bottlenecks in the soil testing industry, and actualize the proof of concept into a viable appraisal approach.

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