

MID-AMERICA REGIONAL COUNCIL

REGIONAL LANDFILL CAPACITY STUDY



MID-AMERICA REGIONAL COUNCIL
SOLID WASTE MANAGEMENT DISTRICT

PROJECT NO. 163530

REVISION 0
JANUARY 10, 2024

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Abstract

The purpose of this Regional Landfill Capacity Study (Study) is to forecast regional landfill capacity and to inform solid waste planning, programming, and permitting activities at the state, regional, and local levels as well as serve as a prelude to a future comprehensive integrated solid waste plan. This Study is not an evaluation of any specific landfill expansion or proposed landfill. The Study looked at seven active municipal solid waste (MSW) landfills serving the Kansas City region and one MSW landfill in the process of being permitted, Presidio Landfill, to develop a forecast of regional landfill capacity. Publicly available data was utilized including permitted airspace, remaining capacity, annual tonnage, and population. The Study includes key assumptions regarding projected annual waste, compaction rates, future added landfill capacity, and waste diversion. One baseline scenario and ten additional scenarios are included in the Study which calculated total landfill capacity based on changes to factors such as population growth, expansion capacity, the addition of Presidio landfill, waste diversion, and waste generation growth per capita. Results from the scenarios indicated the region has anywhere from 19 to 37 complete years of landfill capacity remaining. A presentation of the preliminary Study findings was presented in-person at two focus group workshops. The workshops included stakeholders from the private and public sectors and there was consensus among both focus groups that the methodology and assumptions for the scenarios considered were reasonable and appropriate. In conclusion of this Study, additional planning efforts are recommended to develop a more comprehensive evaluation of the current regional solid waste management system and programs. As the region is faced with solid waste facility permit applications and considers new policies, a comprehensive regional solid waste management plan is a recommended next step to provide the framework and guide future activities such as infrastructure, programs, and policies necessary to manage the region's solid waste system.

Introduction

The Mid-America Regional Council (MARC) is a nonprofit association of city and county governments and the metropolitan planning organization for the bistate Kansas City region. MARC provides a forum for the region to work together on a wide range of issues including solid waste management planning. MARC provides administrative services and staffing to Solid Waste Management District E (SWMD) which serves as a regional solid waste planning agency for local governments in Cass, Clay, Jackson, Platte, and Ray counties in Missouri — and works cooperatively with Johnson, Leavenworth, Miami, and Wyandotte counties in Kansas. It is one of 20 solid waste districts in Missouri formed in 1991 by Senate Bill 530.

Purpose

MARC and the SWMD retained Burns & McDonnell Engineering Company, Inc. (Burns & McDonnell) to develop this Regional Landfill Capacity Study (Study) to forecast regional landfill capacity. Findings from the Study were presented to public and private sector stakeholders in the solid waste industry to obtain feedback on the preliminary forecasts, scenarios, and estimates. This Study is intended to inform solid waste planning, programming, and permitting activities, at the state, regional, and local levels and to serve as a prelude to a potential future formal solid waste plan. This Study is not an evaluation of any specific landfill expansion or proposed landfill. This Study is an evaluation of existing and projected future regional landfill capacity based on several potential scenarios.

MARC and the SWMD are non-regulatory entities and have no formal role in the development, siting or expansion of landfills or waste transfer stations. In the region, landfills and transfer stations are governed by state and local permitting and zoning processes overseen by the Missouri Department of Natural Resources and individual city and county governments. This Study supports the SWMD's waste reduction, reuse, and recycling plans and programs by providing a range of estimates for the remaining capacity of current landfills within the region.

MARC Solid Waste Management District Background

The SWMD represents the overall interest of its members through a 15-member Executive Board and a Management Council made up of local officials. The Management Council provides overall policy direction to the Executive Board. The purpose of the SWMD encourages development of local and regional waste reduction, reuse, and recycling programs by providing the following services and programs:

- The Regional Household Hazardous Waste Collection Program.
- Grants to the public, private and nonprofit sectors.
- Regional solid waste planning.
- Technical assistance to local private and public entities.
- Recycling information through RecycleSpot.org and the Recycling Hotline at (816) 474-TEAM.
- Food waste reduction strategies.
- Illegal dumping action planning.

Regional Landfill Capacity Study

There are seven active municipal solid waste (MSW) landfills serving the Kansas City region and one MSW landfill in the process of being permitted, Presidio Landfill, which has received approval from the Missouri Geological Survey Program. There are several area transfer stations that facilitate the transfer of solid waste to the landfills included in the Study. Each of the landfills included in the Study are serving or will be serving the Study area with waste disposal. A map depicting the Study area, MSW landfills, and transfer stations in the region is presented in Figure 1. The following section describes the methodology, assumptions, and findings of the Study.

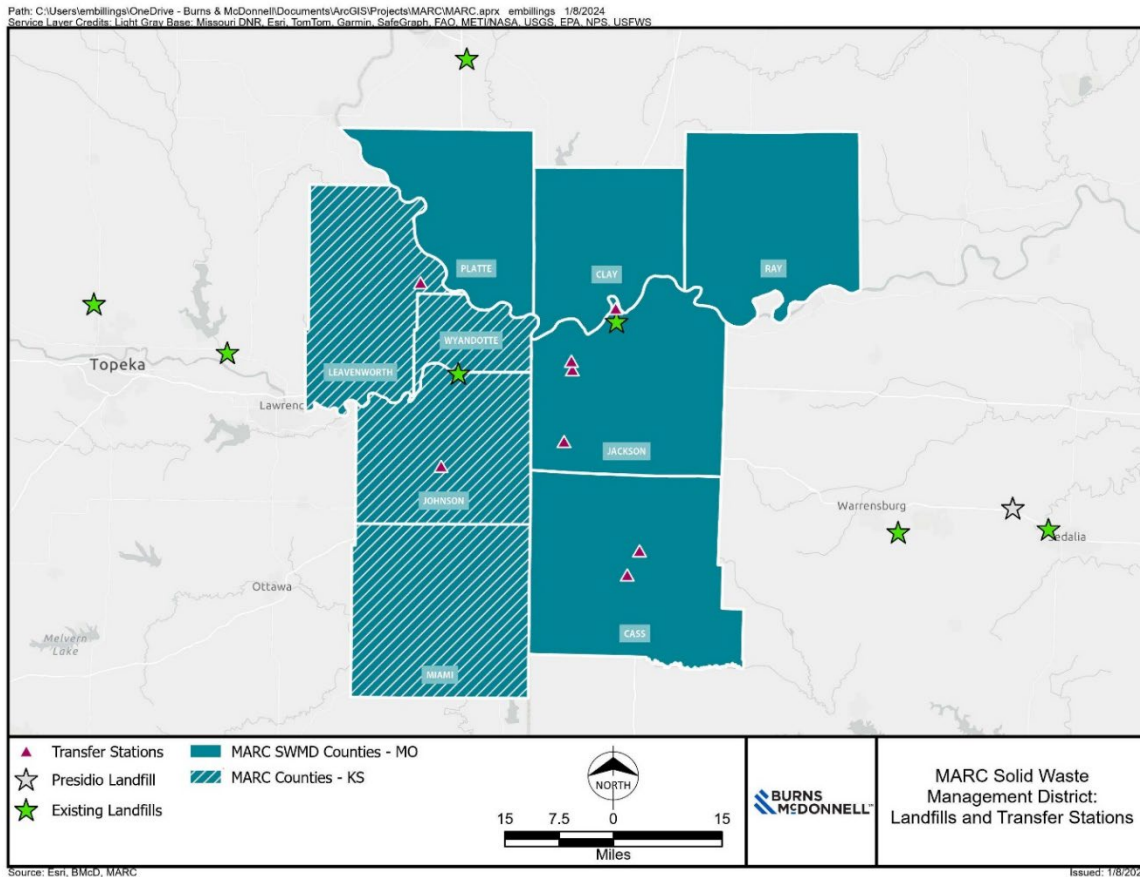


Figure 1: Study Area, MSW Landfills, and Transfer Stations

Landfill Data

The Study used publicly available data including permitted airspace, remaining capacity, annual tonnage, and population. Landfills are required to report annual tonnage and

projected capacity data to state regulatory agencies.¹²³⁴ Annual tonnages vary, so the Study used the three-year average from 2020 to 2022 as the baseline tonnage for each landfill. Tonnage data was converted to cubic yards based on the compaction rate for each landfill to present the annual fill rate. Table 1 presents average annual fill rate and remaining capacity data in cubic yards (CY). This data is used as the assumed baseline for all scenarios.

Table 1: Landfills Serving the MARC District

State	Landfill Name	Owner	3-Year Average Annual Fill Rate (CY)	Remaining Capacity (CY) as of Dec. 31 st , 2021
KS	HAMM	N.R. HAMM	756,855	54,460,947
KS	Johnson County	Waste Management	1,517,548	28,388,718
KS	Rolling Meadows	Waste Management	285,909	12,927,101
MO	Central Missouri	GFL	836,006	8,121,597
MO	Courtney Ridge	Republic	822,480	16,030,814
MO	Show Me Regional	Republic	181,228	3,817,270
MO	St. Joseph	City of St. Joseph	297,634	9,056,437
MO	Presidio	Pettis County Development Co.	N/A	18,600,000 ¹

1. Proposed landfill capacity.

Kansas and Missouri Landfill Comparison

There are three active MSW landfills in Kansas with approximately 95,800,000 cubic yards of remaining capacity and four active MSW landfills in Missouri with approximately 37,000,000 cubic yards of remaining capacity. The total annual fill rates of Kansas and Missouri landfills is similar at 2.6 million CY and 2.1 million CY respectively. Table 2 provides the total remaining capacity and annual fill rates for both states in the Study area. Landfills in Kansas represent approximately 72 percent of the total remaining capacity serving the region.

Table 2: State Comparisons of Fill Rate and Capacity

State	Annual Fill Rate (CY)	Remaining Capacity (CY)	Percent of Total Remaining Capacity
Kansas	2,600,000	95,800,000	72%
Missouri	2,100,000	37,000,000	28%

¹ Kansas Department of Health and Environment, Bureau of Waste. *2021 - 2025 State Solid Waste Management Plan*. <https://www.kdhe.ks.gov/DocumentCenter/View/22543/2021-2025-State-Solid-Waste-Management-Plan>

² Kansas Department of Health and Environment. Solid Waste Database Viewer. <https://maps.kdhe.state.ks.us/kssolidwaste/>

³ Missouri Department of Natural Resources, Waste Management Program. 2018 - 2022 Tonnage Reported and Fees Paid by Facility. <https://dnr.mo.gov/document-search/sanitary-landfills-tonnage-reported-tonnage-fees-paid>

⁴ Fitch, Charlene S. Missouri Department of Natural Resources, Waste Management Program. "Remaining Airspace in Missouri Sanitary Landfills" Presentation 2023.

Methodology and Assumptions

The Study includes key assumptions regarding projected annual waste, compaction rates, future added landfill capacity, and waste diversion. There are a substantial number of unknown factors that could impact landfill capacity that may occur but may not be captured in the assumptions included in this Study (e.g. natural disaster). The following assumptions were applied to the Study:

- **Baseline annual waste acceptance.** The assumed baseline annual waste acceptance rate for each landfill is based upon the most recent 3-year average including 2020, 2021, and 2022. Some scenarios apply projected growth rates to these baseline waste acceptance rates.
- **Population growth.** MARC has developed a regional population projections tool for the years 2020 to 2050⁵. The non-baseline scenarios apply MARC's projected population growth rates to the baseline waste generation rate over 10-year intervals. Beyond 2050, the analysis assumes that the annual growth rate continues to decline by 0.1% over each successive 10-year interval.
- **Landfill closures and redirection.** The Study assumes that all waste is redirected to other available landfills in the Study area once a landfill closes. Assumptions about the landfills that would receive redirected waste were based on ownership, proximity, and generation locations. While these assumptions do not impact overall landfill capacity for the region, fill rates for individual landfills are affected by assumptions on redirection of waste.
- **Compaction rates.** Landfill data is reported by weight in tons and capacity is calculated by volume in cubic yards. A compaction rate for each landfill was calculated based on historical tons per cubic yard. Compaction rates vary between landfills based on equipment selection, operating procedures, and material composition. The Study assumes that compaction rates remain constant at each landfill over its remaining capacity.
- **Subsidence.** Some settling and compression of waste, or subsidence, occurs naturally over time. This natural subsidence can be influenced by weight of overlying waste material, compaction rates achieved at the time of initial waste placement, settling, or natural decomposition related to the physical breakdown of material. Subsidence rates vary significantly from site to site and are not included in the assumptions of the Study.
- **Waste diversion.** Waste that is redirected to recycling or compost facilities as opposed to traditional landfilling is considered waste diversion. There are many forms of waste diversion efforts already occurring within the region. Scenarios in the Study

⁵ Mid-America Regional Council, Regional Data Tool. Population and Employment Forecast. <https://gis2.marc2.org/forecast/>

that consider waste diversion only include new programs that are additional to existing waste diversion efforts.

- **Maximum annual permitted acceptance.** State regulatory agencies often include maximum annual acceptance as part of a landfill permit. The Study did not apply any maximum annual acceptance and assumes that landfill will be permitted to accept as much volume as is generated for disposal.
- **Landfill acceptance area.** Private landfills can and do accept waste from outside the region. Landfills can bring in waste more than their current acceptance rate. The Study assumes that acceptance rates will remain constant or grow at constant rates that are stated as assumptions for each scenario.
- **Construction and demolition landfills.** In addition to MSW landfills serving the region, there are several construction and demolition (C&D) landfills. C&D landfills are limited to accepting C&D materials. While many MSW landfills are allowed to accept C&D waste, the Study did not consider the impact of C&D landfill closures on MSW landfills.
- **Expanded capacity scenarios.** The Study includes several scenarios that include expansion capacity at existing landfills. These scenarios are hypothetical and not based on any known or pending permits. The assumption of 10 and 20 million cubic yards may apply to a single landfill or at a combination of multiple landfills and could be due to vertical or horizontal expansion, or subsidence.
- **Presidio Landfill.** The Pettis County Development Company owns approximately 520 acres for the development of the Presidio Landfill. The permit application has proposed to develop 80 acres for landfill development⁶. The scenarios that include additional capacity at the proposed Presidio Landfill are based on the approved capacity projections by the Missouri Geological Survey Program, around 18 million cubic yards. The Presidio Landfill has an estimated 140 million cubic yards of additional capacity that may be developed in the future but is not included in the Study.
- **Waste generation rates.** Over the period from 2012 through 2022, waste generation per capita in the Study Area increased at an average rate of 1.81% per year. There are many factors that can impact per capita waste generation rates such as increases or decreases in commercial activity, development of new products, or other changes in consumer buying habits. Scenario 11 assumes that per capita waste generation will continue to increase at a constant rate of 1.81% per year for the remaining capacity of the Study area landfills.

Landfill Capacity Scenarios

This Study includes a baseline scenario and ten additional scenarios. The baseline scenario assumes the current waste generation rates for each facility remain constant over time with no development of new capacity. For each additional scenario, the impacts were calculated on total landfill capacity based on changes to one or more of the following factors.

- Population growth

⁶ Pettis County Development Company website accessed 11/21/23. <https://pettiscountygoinggreen.com/>

- Expansion capacity at existing facilities
- Presidio Landfill opening in 2028
- Implementation of additional waste diversion efforts to the current waste diversion
- Waste generation growth per capita

Scenario 1 is the baseline scenario that assumes the current generation projected into the future years with current remaining capacity at each landfill. Scenario 2 and all subsequent scenarios apply population growth. Scenarios 3 and 4 introduce the assumption of adding additional landfill capacity of 10,000,000 cubic yards and 20,000,000 cubic yards, respectively, through hypothetical expansions to existing landfill facilities. Scenario 5 introduces Presidio Landfill providing additional capacity starting in 2028. Scenarios 6 and 7 combine the addition of Presidio Landfill with expansions of existing landfills. Scenarios 8 through 10 explore the implementation of additional waste diversion efforts of 10 to 20 percent. Scenario 11 assumes that per capita waste generation will continue to increase at the historical rate of 1.81% per year in combination with population growth and no additional landfill capacity. A summary of each of the scenarios and their impact on landfill capacity are presented in Table 3.

Table 3: Scenarios Overview

Scenario	Population Growth	Expansion	Presidio Landfill	Additional Waste Diversion	Waste Generation Growth	Years of Capacity ¹	Final Year ²
1						25.9	2048
2	•					23.6	2046
3	•	10 MCY				25.5	2048
4	•	20 MCY				27.4	2050
5	•		•			26.9	2049
6	•	10 MCY	•			28.8	2051
7	•	20 MCY	•			30.6	2053
8	•	20 MCY	•	10%		33.7	2056
9	•	20 MCY	•	20%		37.5	2060
10	•		•	10%		29.7	2052
11	•				•	19.7	2042

1. As of December 31, 2022.

2. Represents last year of waste acceptance, regardless of month.

Scenario Results

Eleven scenarios were evaluated for this Study that included a combination of potential assumptions. The scenarios anticipate a range from 19 to 37 complete years of landfill capacity remaining. Scenario 11 is the “worst case scenario” with 19 years remaining capacity and final closure year of 2042. Scenario 9 is the “best case scenario” with 37 complete years of landfill capacity remaining and final closure year of 2060. All other scenarios fall within these two scenarios for the years of remaining landfill capacity. A comparison of each of the scenarios is depicted in Figure 2. The scenarios have been presented in order of capacity

longevity, rather than numerical order. A detailed graph for each scenario is presented in Appendix A.

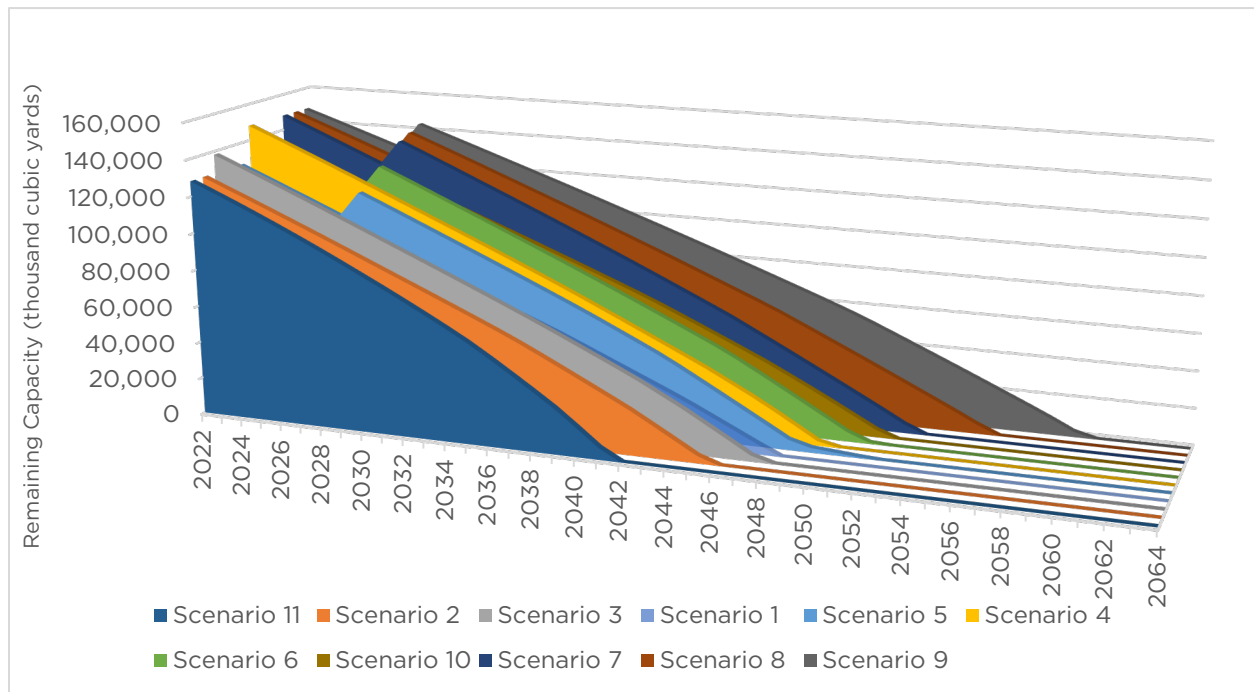


Figure 2: Comparison of Scenarios

Scenario 1 represents a baseline for general closure years based on the current volumes accepted by landfills in the Study. This scenario does not include population growth or any other assumptions but anticipates remaining capacity for each landfill and when they will reach maximum capacity. If there were no changes to the current acceptance rates or total regional capacity, it is anticipated that maximum capacity will be reached in approximately 25.9 years, concluding by the year 2048. Figure 3 depicts remaining capacity at each landfill on an annual basis for Scenario 1.

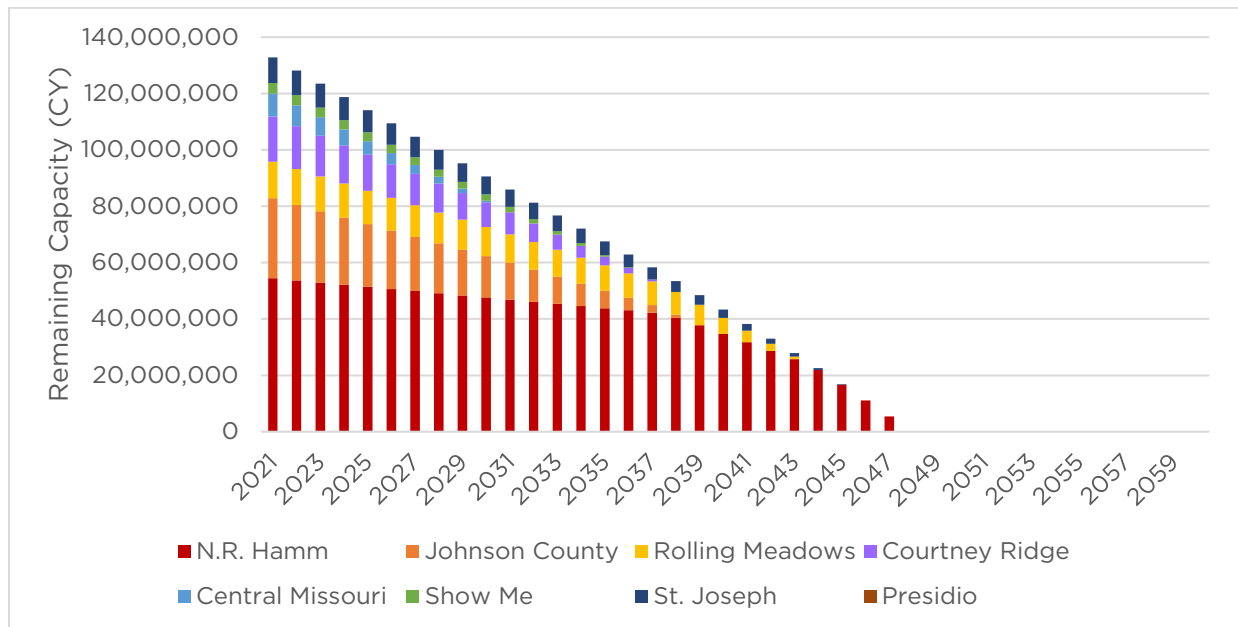


Figure 3: Remaining Capacity – Scenario 1

Scenario 2 builds upon the baseline by incorporating a factor for population growth. This assumes that waste generation increases due to population growth in the region. By applying population growth to the baseline assumption, years of capacity is 23.6 years, reaching maximum capacity by 2046. With the population growth factor applied, Missouri landfills begin to close in the year 2030 with Central Missouri, then Show Me Regional in 2035, and Courtney Ridge in 2036 followed by Kansas landfills, Johnson County in 2037, Rolling Meadows in 2041, and lastly St. Joseph in 2043, and HAMM in 2045. The landfill closure year for each of the landfills is presented in Table 4.

Table 4: Landfill Final Closure Year – Scenario 2

State	Landfill	Final Year
KS	HAMM	2045
KS	Johnson County	2037
KS	Rolling Meadows	2041
MO	Central Missouri	2030
MO	Courtney Ridge	2036
MO	Show Me Regional	2035
MO	St. Joseph	2043
MO	Presidio	N/A

Scenario 3 through Scenario 10 assume population-based growth, plus addition of new landfill capacity and implementation of diversion programs as further described in Table 3. The additional capacity and diversion programs increase total remaining capacity to up to 37.5 years for Scenario 9, which extends the final year of landfill capacity to 2060.

Figure 4 depicts remaining capacity at each landfill on an annual basis for Scenario 9. For illustrative purposes, an additional 20 MCY capacity has been added to Courtney Ridge but could be added to any combination of landfills. The impact from the additional capacity on the closure year of an individual landfill depends on which landfill adds capacity.

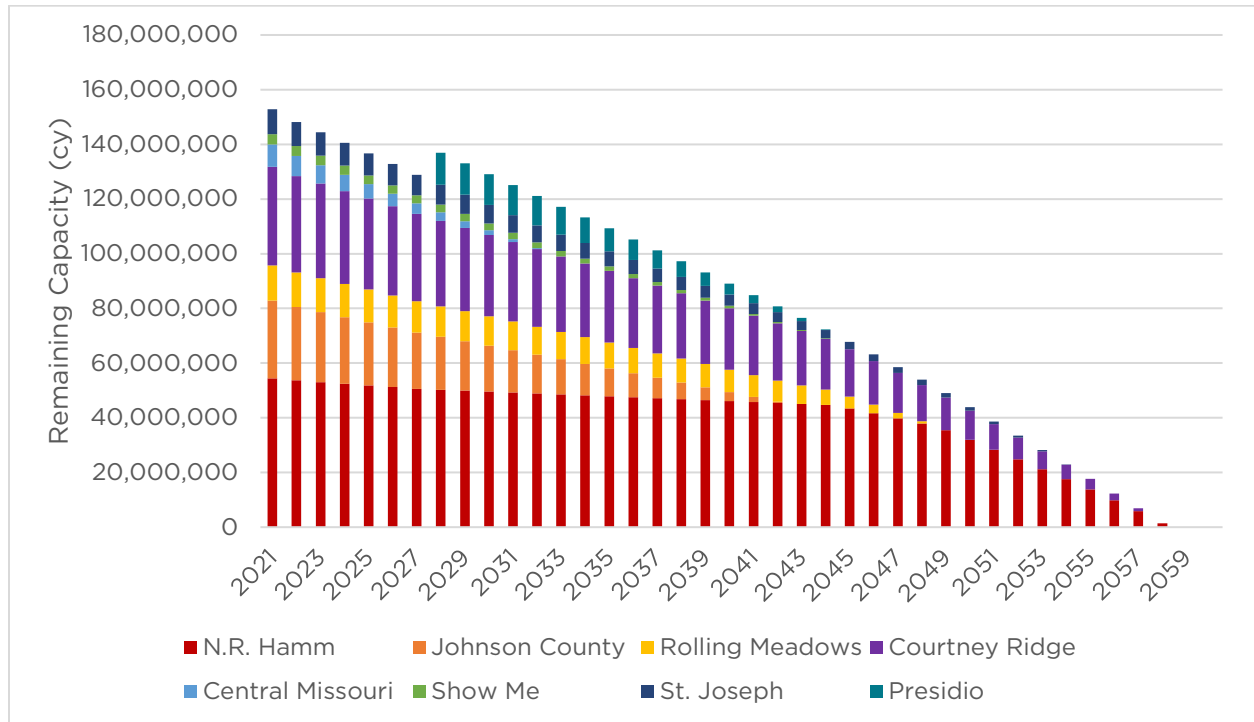


Figure 4: Remaining Capacity – Scenario 9

Scenario 11 applies a per capita waste generation growth rate in addition to the population growth factor with no additional landfill capacity added. This scenario anticipates reaching maximum landfill capacity in 19.7 years by 2042. Figure 5 depicts remaining capacity at each landfill on an annual basis for Scenario 11.

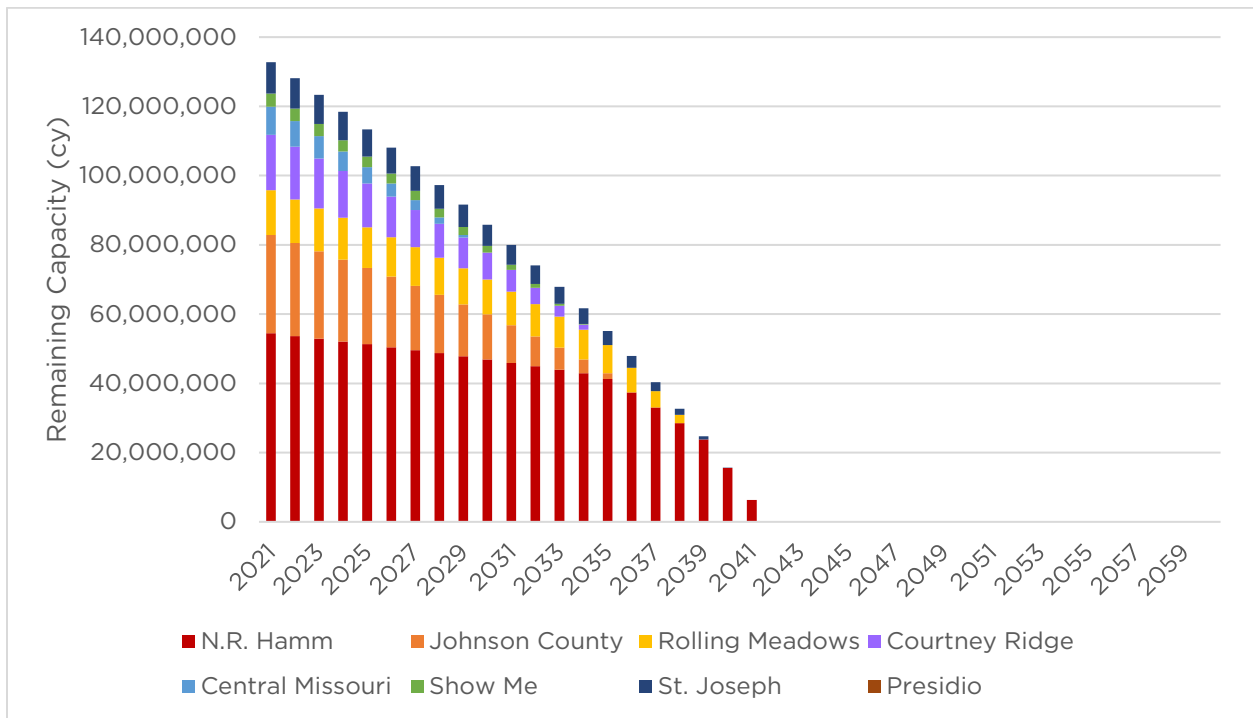


Figure 5: Remaining Capacity – Scenario 11

Stakeholder Engagement

A presentation of the preliminary Study findings was presented in-person at two focus group workshops on November 29, 2023. The workshops included stakeholders from the private and public sectors to present the preliminary results of the Study and obtain feedback on the assumptions utilized in the scenarios. The following sections highlight the workshop discussion and a summary of key points from each workshop.

Focus Group 1: Private Sector Solid Waste Stakeholders

The private sector solid waste stakeholders focus group attendees consisted of private sector representatives from landfills and transfer stations within the area of Study. A summary of the discussion is provided as follows.

- C&D waste can be disposed of in either C&D landfills or MSW landfills. While the cost to dispose of waste in C&D landfills may be less than MSW landfills, proximity to the disposal site also is a contributing factor. While there is validity to exclude the C&D landfills from the Study, C&D material and landfills are likely to impact landfill capacity in the region.
- Transfer stations play a critical role in the efficient transportation of waste from collection routes to disposal facilities. The community is already transferring waste from populated areas to landfills located further away. Transfer station infrastructure will continue to be important as landfills close.
- The decline of a competitive landfill environment may create less competitive disposal rates and cause disposal costs to rise.
- The region's landfill disposal costs impact the financial incentives for diversion. As the cost of disposal increases and remaining landfill capacity decreases, there will be more of an incentive to divert waste. Restricted landfill capacity is likely to increase recycling and further drive diversion.
- Landfill operators spend considerable time and effort achieving the highest feasible compaction rates. The Study's incorporation of site-specific compaction rates was well-received.
- Subsidence of material will have a considerable contribution to landfill capacity and will vary between landfills. The impact from subsidence is difficult to predict or apply to the assumptions but is likely to be captured in the scenarios with additional landfill capacity.
- The assumption of 20 million cubic yard expansion seems appropriate and conceivable given the potential availability for expansion at existing landfills.
- The permitting process for expansions at existing facilities and new transfer stations and landfills can be challenging due to high potential for public opposition. Permitting is a long and complicated process and adequate time should be allotted.

- Where feasible, expansion of existing landfills normally requires less effort and may encounter less opposition than development of new landfills.
- The assumptions and scenarios presented in the Study were validated. Attendees confirmed that the scenarios were valuable and pertinent to landfills in the Study area.
- Stakeholders recommended development of a scenario that accounts for increasing per capita waste generation rates. This suggestion has been incorporated into the Study as Scenario 11.
- Although an unlimited number of scenarios could potentially be considered, attendees agreed that Scenario 2 is a confident baseline and all scenarios considered were reasonable and appropriate.

Focus Group 2: Public Sector Community Leadership

The public sector solid waste stakeholders focus group attendees consisted of local community leaders engaged in the management of solid waste in the Study area. Attendees included representatives from the City of Shawnee, the City of Olathe, the City of Lee's Summit, the City of Kansas City, Missouri, the City of Raymore, Leavenworth County, and Johnson County. A summary of the discussion is provided as follows.

- There is significant value and necessity in the development of a community solid waste management plan, particularly with the potential permit application for a landfill in south Kansas City.
- The community has a heavy reliance on private sector landfills which makes it challenging for municipalities to take charge of their own waste management system and costs.
- One of the challenges with local governments entering the management of solid waste facilities is the turnover of leadership at the elected level and the extensive permitting process.
- The community could explore and consider a regional solid waste management authority. The community around St. Louis, Missouri is an example.
- Stakeholders recommended that a scenario be developed to account for increasing per capita waste generation rates and changes in consumer habits impacting waste management. This recommendation has been incorporated into the Study as Scenario 11.
- The public is supportive of and actively participating in diversion and waste reduction but there are continued challenges with incentivizing diversion, reducing contamination, and building trust that the system is recycling materials appropriately.
- Diversion is plateauing and new end markets are needed to support new diversion efforts.
- Disposal and processing costs are increasing and maintaining a healthy landfill market would best serve the community from a financial perspective.

- The local community surrounding the proposed south Kansas City landfill wants more local control over solid waste facility permitting.
- Overall, participants agreed with the assumptions in the scenarios presented. Scenarios 3 and 4 seem most appropriate due to opportunities for expansion at existing facilities. Scenarios 6 and 7 also seem applicable if Presidio Landfill is confidently moving ahead with development; although some stakeholders voiced disagreement that Presidio should be considered for the purposes of the planning process.

Focus Group Summary

There was consensus among both focus groups that the methodology and assumptions for the scenarios considered were reasonable and appropriate. Both focus groups advocated for an additional scenario that considered waste generation which has been incorporated as Scenario 11.

Study Key Findings

Landfills play a central role in the management of solid waste and developing this forecast of regional landfill capacity is an important step to inform solid waste planning, programming, and permitting activities. Additional planning efforts are recommended to develop a more comprehensive evaluation of the current regional solid waste management system and programs including evaluation of additional infrastructure (i.e. transfer stations, C&D landfills, processing facilities), financial impacts, regulatory implications, community engagement, and setting goals and objectives. Developing an integrated solid waste management system is a complex and challenging endeavor requiring a collaborative multi-jurisdictional approach considering technological, institutional, legal, social, economic, and environmental factors. This Study serves as a prelude to the recommended update to the SWMD comprehensive integrated solid waste plan.

The following are the key findings based on the Study scenario results and stakeholder engagement activities.

- The scenarios indicate the region has anywhere from 19 to 37 complete years of landfill capacity remaining. At the low end there is adequate time to plan for a future solid waste management system in a strategic, thorough, and methodological process that considers more factors than landfill capacity alone. Over the next five years, the confidence in scenarios with additional capacity may improve such as the opening of Presidio Landfill or expansion permitting of existing landfills.
- Solid waste facilities including landfills and transfer stations involve a rigorous permitting process that requires a minimum of five years but more likely, takes ten years or more.⁷ The appropriate amount of time should be allotted to plan, permit, and develop solid waste infrastructure to serve the region.
- The region's solid waste management system is reliant on private sector landfills except for St. Joseph Landfill. The community's heavy reliance on private sector landfills makes it challenging for municipalities to take charge of their own waste management system and costs.
- As landfills close, the solid waste system will become more reliant on transfer stations and new transfer station infrastructure. The region is already accustomed to transferring waste through transfer stations to landfills outside of the densely populated urban areas.
- As landfills reach capacity and close over time, the region will become more reliant on Kansas landfills, particularly HAMM Landfill, as it has the most capacity currently available.

⁷ Missouri Department of Natural Resources. Solid Waste Landfill Permits webpage. Accessed December 27, 2023. <https://dnr.mo.gov/waste-recycling/business-industry/permits-licenses-registrations-fees/solid-waste/landfills>

- Landfill closures will impact communities within the region differently depending on proximity to solid waste infrastructure and reliance upon those facilities.
- Recycling and composting infrastructure and activities contribute to the diversion of waste from landfill disposal. Waste reduction and minimization can impact the waste generated for landfill disposal and provide beneficial reuse of materials, reduce the environmental impact, and lengthen the capacity of landfills.

Next Steps

As the region is faced with solid waste facility permit applications and considers new policies, an update to the SWMD comprehensive integrated solid waste plan is a recommended next step. This process should be regional in scope and include a comprehensive facility evaluation of transfer stations, MSW & C&D landfills, composting facilities, and recycling processing facilities, as well as financial analysis, community engagement, goal setting, analysis of strategies, impacts of diversion, and regulatory implications.

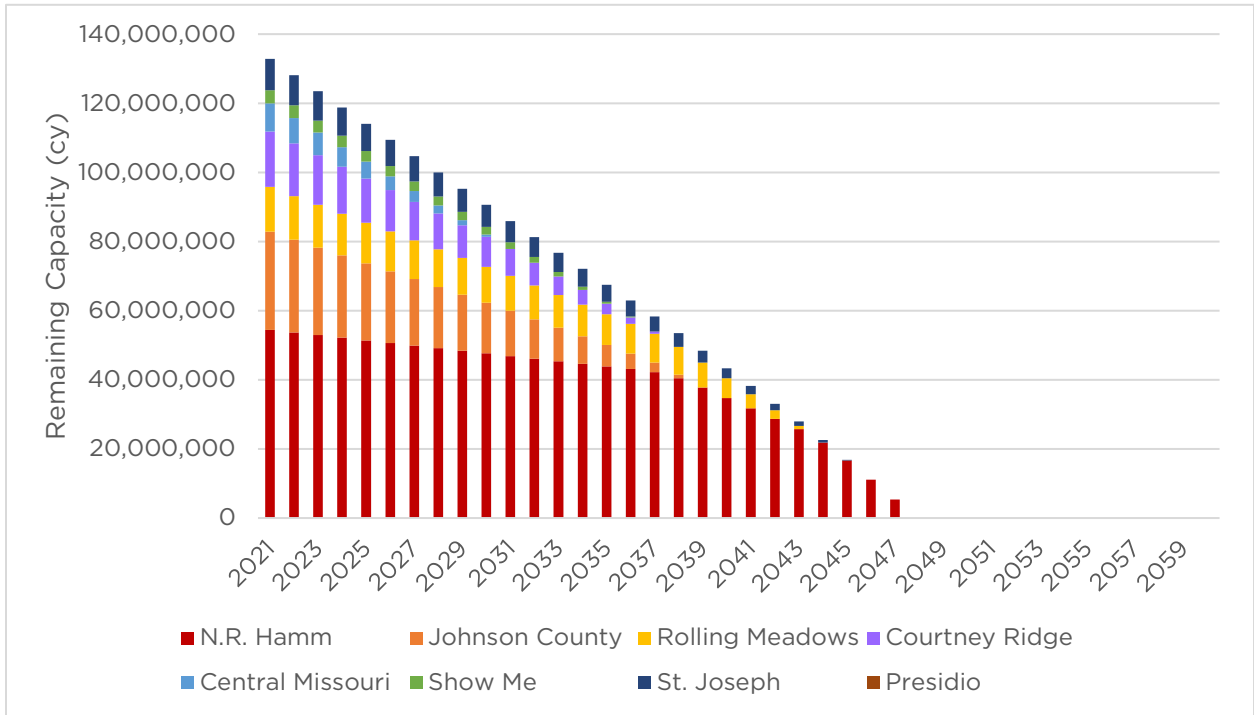
Developing an integrated solid waste plan provides the framework to guide future activities and to develop the infrastructure, programs, and policies necessary to manage the region's solid waste. An effective plan accomplishes the following:

- Reflects the community's values and guiding principles for waste management and diversion.
- Establishes local waste management planning goals.
- Includes operational and financial analysis and consideration of reasonable alternatives.
- Considers public and private strategies and investments.

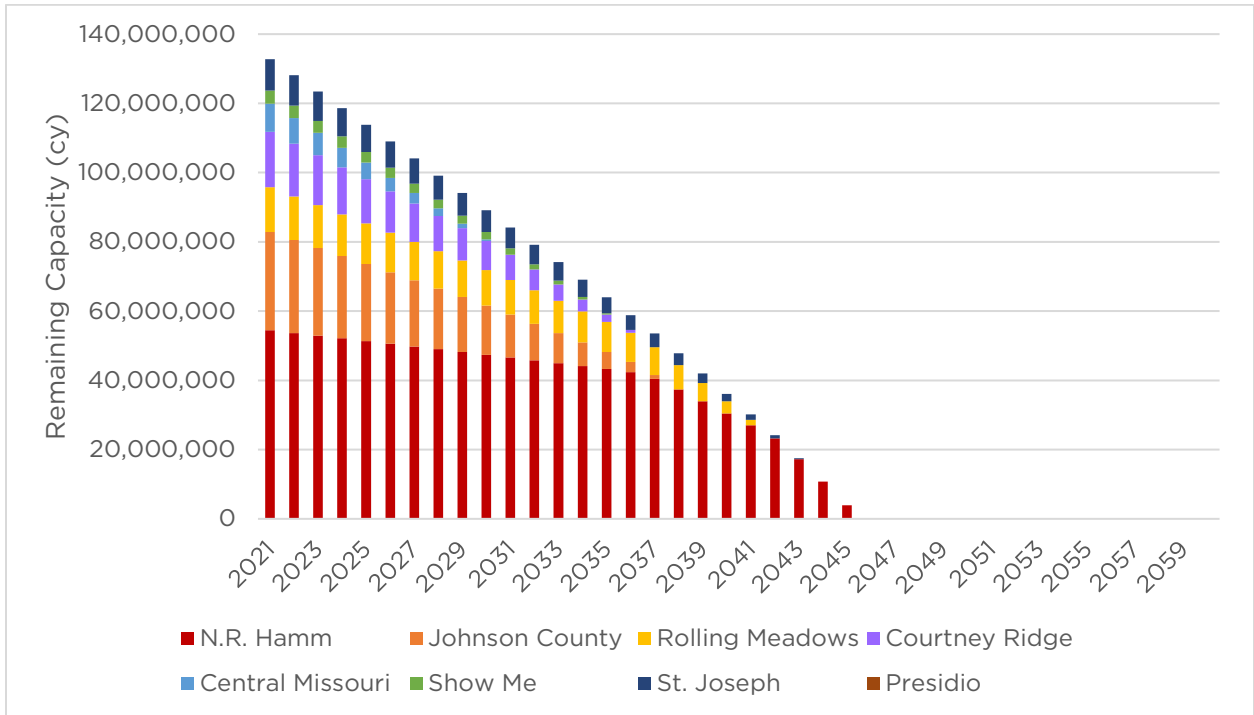
Gaining community support through active participation of the public from inception to completion of a solid waste plan yields a greater and more meaningful impact on the future of a region's solid waste management system. Stakeholder engagement from a broad and diverse base of stakeholders, including input from residents, businesses, and elected officials is a critical aspect of developing a solid waste plan.

A regional comprehensive integrated solid waste plan will address and identify critical short-term and long-term needs, and recommend alternatives and options for practical, cost-effective waste management solutions for the region's future solid waste system.

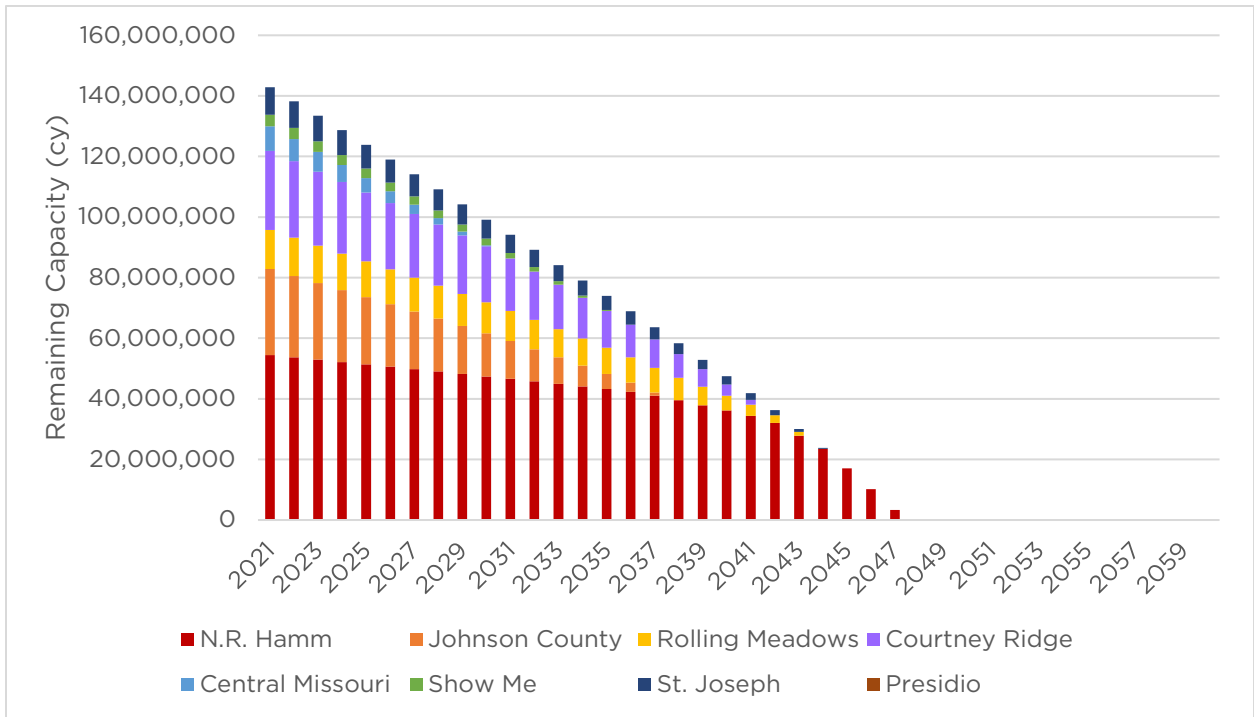
APPENDIX A - SCENARIO RESULT GRAPHS



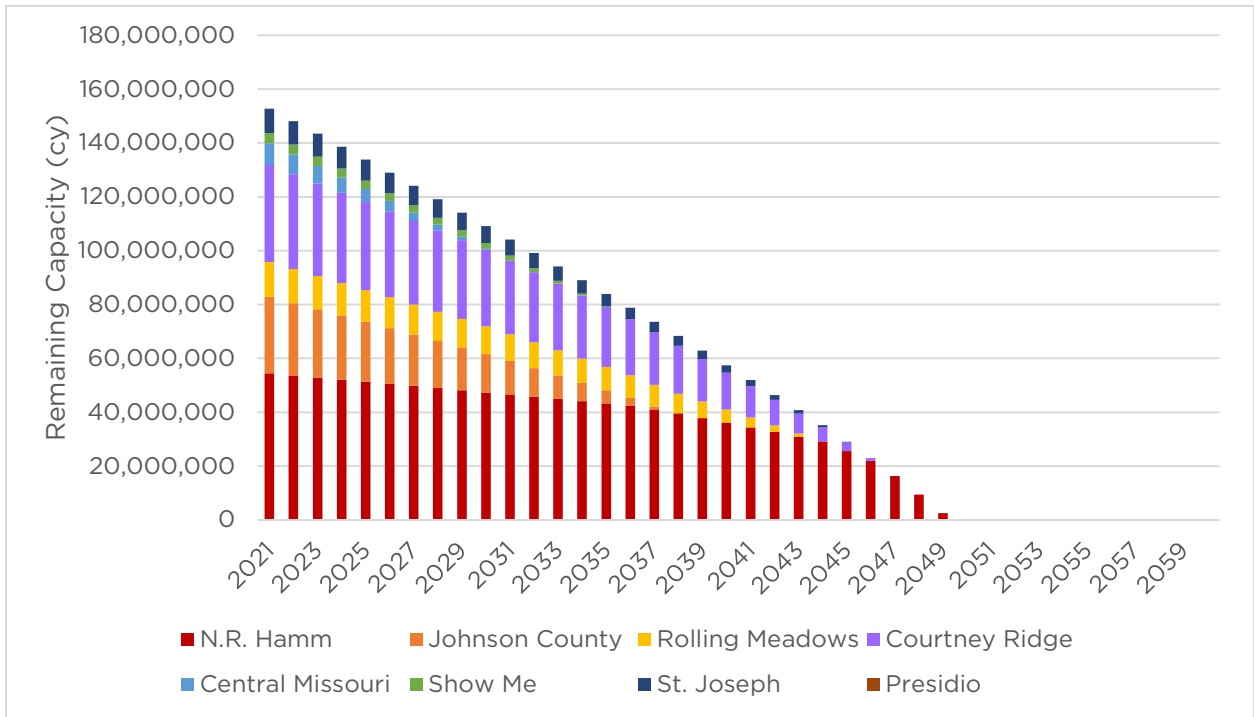
Remaining Capacity – Scenario 1



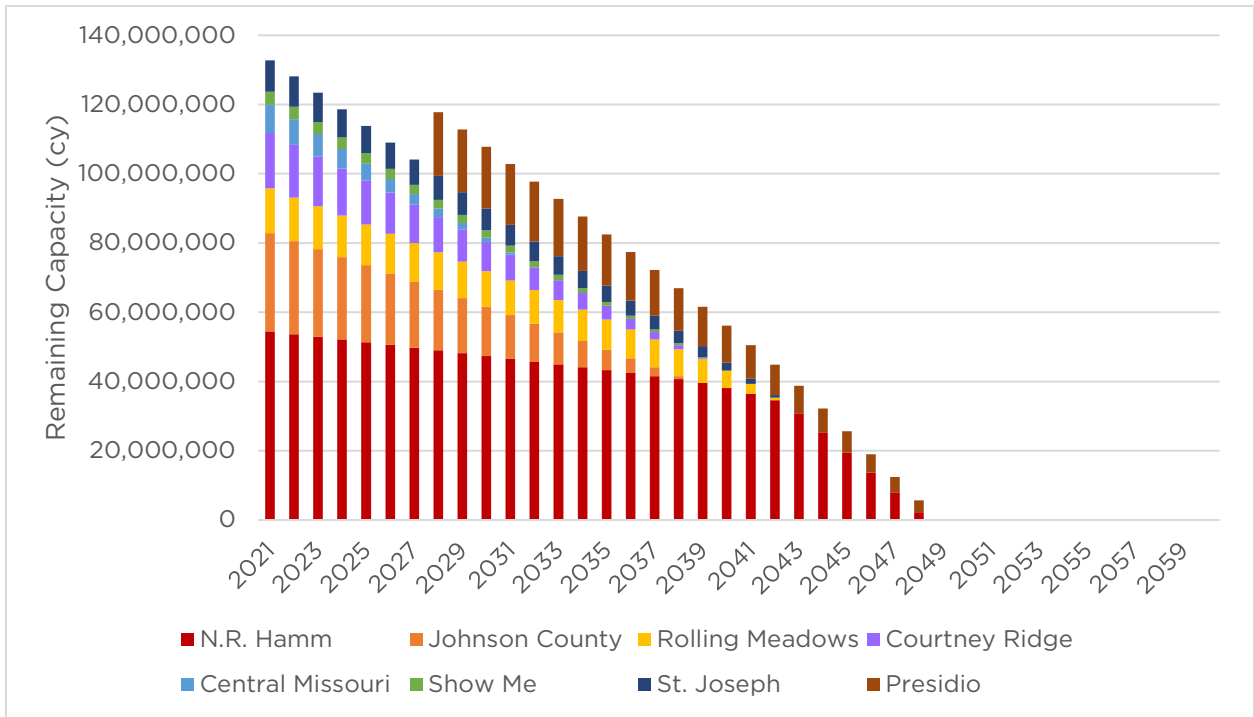
Remaining Capacity – Scenario 2



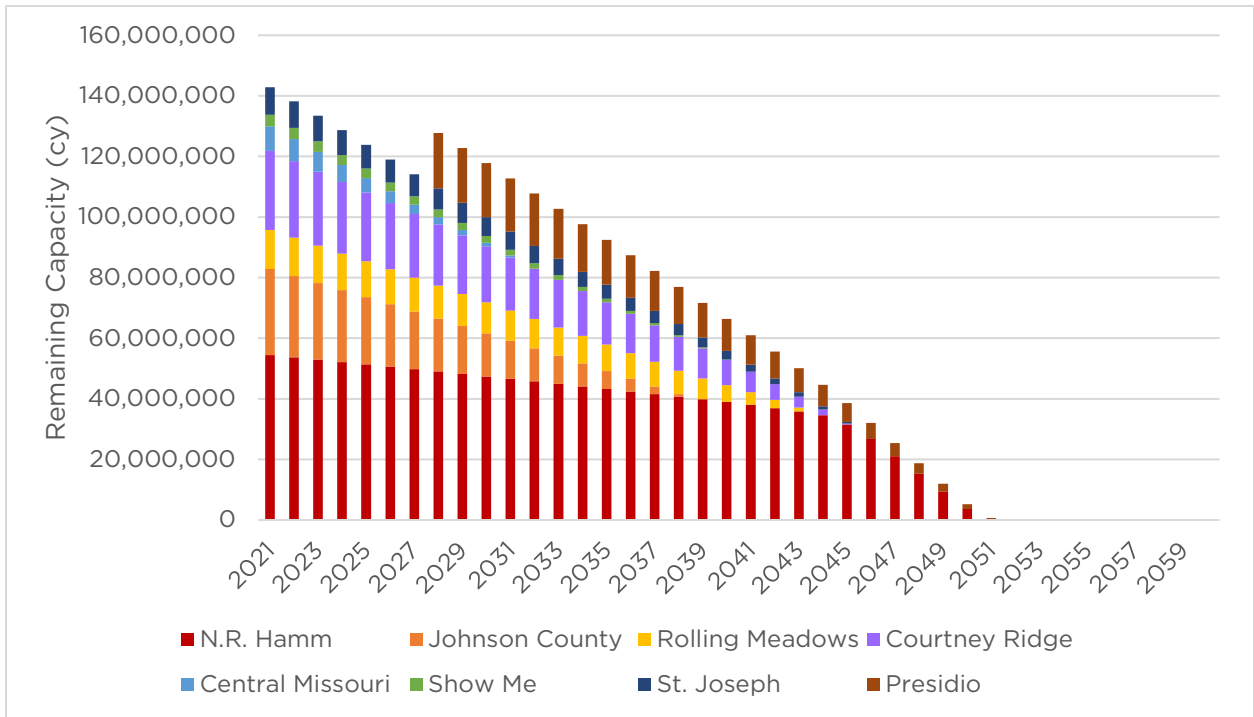
Remaining Capacity – Scenario 3



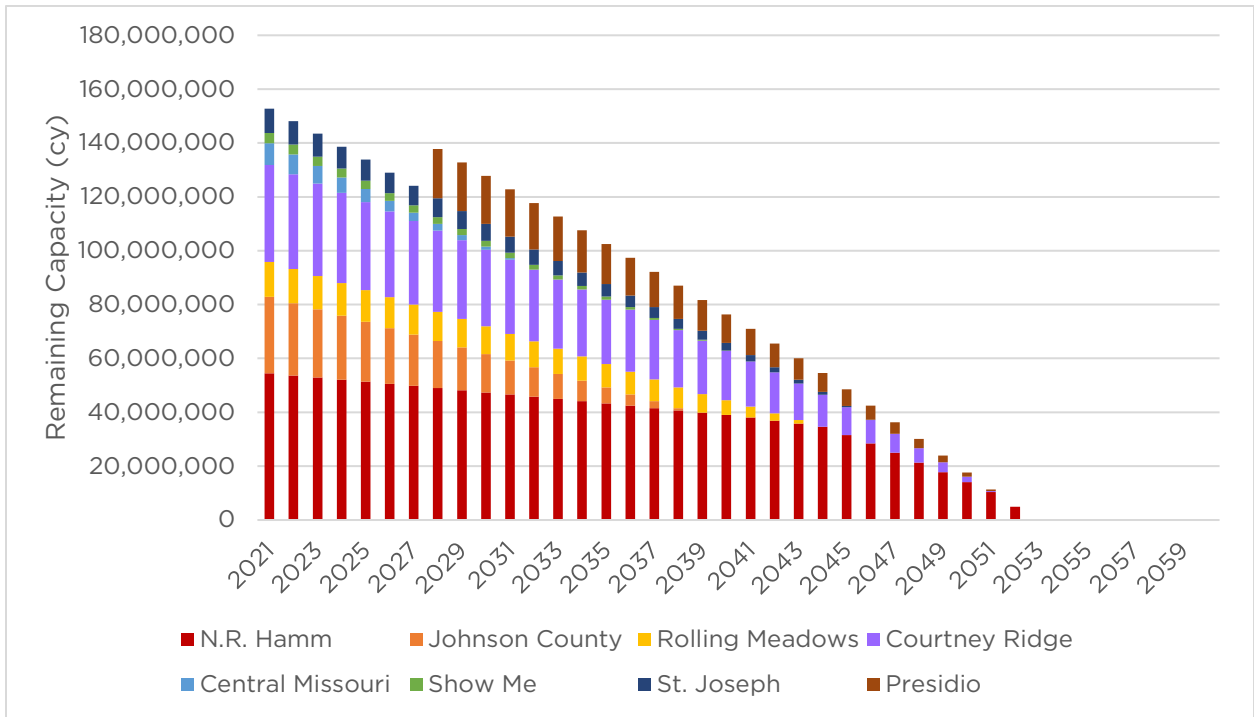
Remaining Capacity – Scenario 4



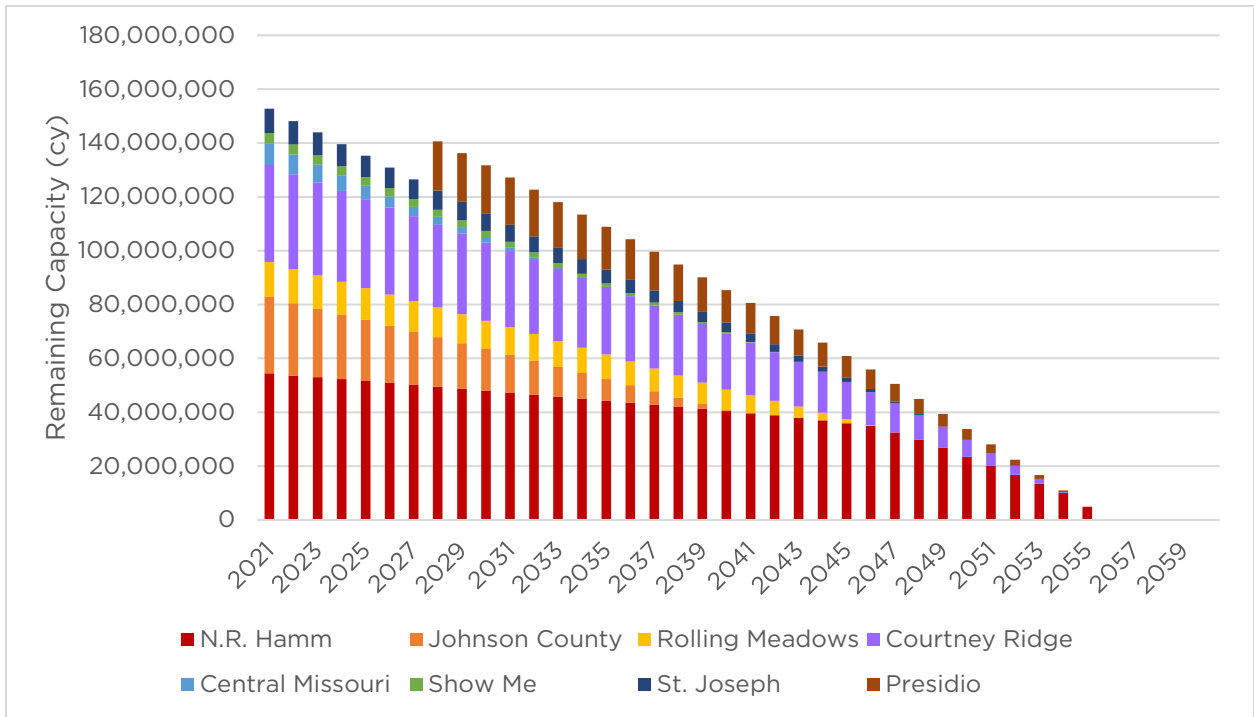
Remaining Capacity – Scenario 5



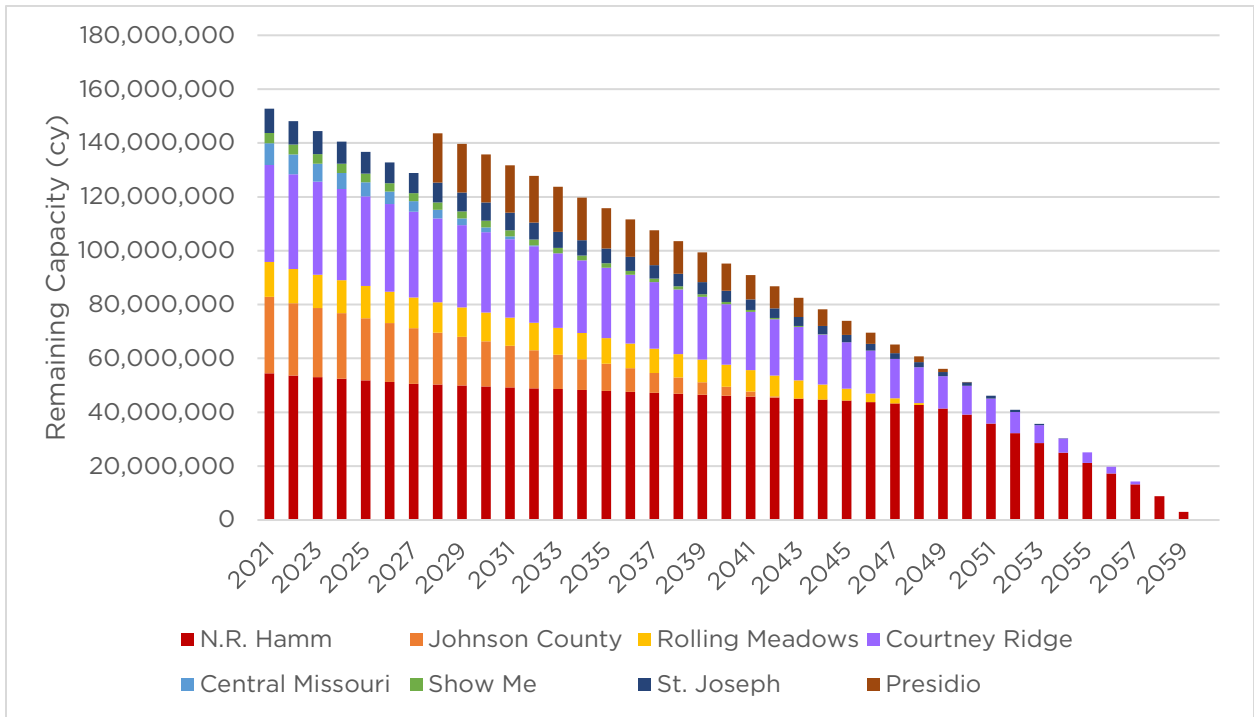
Remaining Capacity – Scenario 6



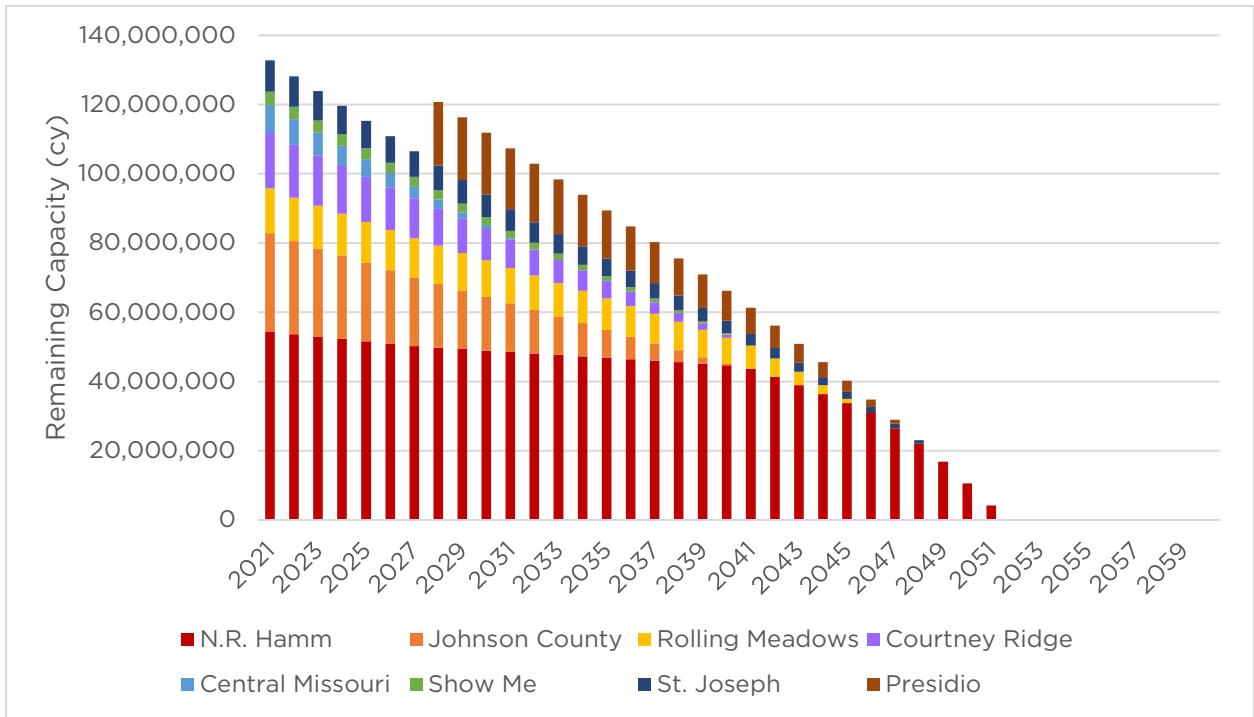
Remaining Capacity – Scenario 7



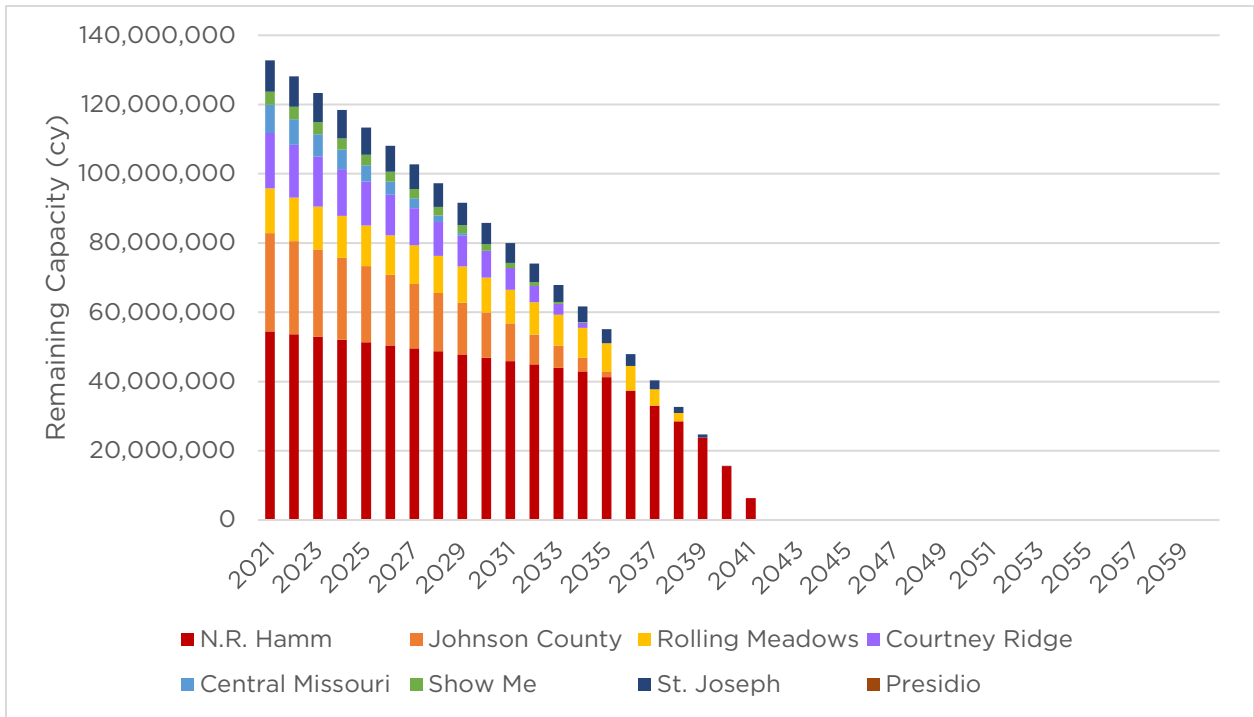
Remaining Capacity – Scenario 8



Remaining Capacity – Scenario 9



Remaining Capacity – Scenario 10



Remaining Capacity – Scenario 11

