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Recommendations

Summary

This section of the Minnesota Statewide Conservation and Preservation Plan (SCPP) makes recommendations on transportation and related policies that examine the impacts of surface transportation development on the critical resources of the state.

Roads and their use have negative impacts on natural resources. They fragment habitat, disturb hydrological regimes, and damage vegetative land cover and soils. Roads can also make barriers to nonmotorized recreation. Cars and trucks cause air, water, and noise pollution. Nevertheless, the roadway system of Minnesota also provides necessary access and mobility to the state's 5 million residents. The economic health of the state (agriculture and industry drivers) and nearly the entire array of development drivers of changes identified in the SCPP preliminary plan are indirectly or directly associated with the surface transportation system that provides these services.

The conservation planning and policy rationale for these three transportation-related recommendations is to provide an integrated approach to address some of the fundamental fragmentation of planning, design, and decision-making processes across transportation, land use, and conservation objectives. The recommendations target development drivers identified in the preliminary plan with potential approaches to integration of research-based resource conservation planning, assessment, and protection with efficient transportation system planning and land use decisionmaking processes. These recommendations suggest ways in which natural resource impacts resulting from the development of surface transportation can be minimized, mitigated or adapted through combinations of planning, design, regulation, and incentives across geographic scales, modes of surface transportation, and related government jurisdictions and community stakeholders.

The three recommendations presented below outline an immediate to near-term strategy with long-term effects to integrate transportation system development more effectively with other statewide and local planning and decision-making and to bolster its effectiveness with increased use of data analysis and research-based performance standards and practices. This integration is initially achieved through recommendations to align statewide planning and enhance cross-consultative environmental review of projects in early stages of planning and design. By adopting performance standards, best practices, and other protective conservation strategies across jurisdictions, transportation projects can also coordinate with county and metropolitan land use and environmental comprehensive planning and land use decision-making to reduce growth in per capita vehicle miles traveled (VMT). This performance standards–based approach also generates incentives for research, analysis, monitoring, and education to protect habitat and water resources.

The three recommendations presented in this section are:

- Transportation Recommendation 1—Align transportation planning across state agencies and integrate transportation project development and review across state, regional, metropolitan, and county/local transportation, land use, and conservation programs.
- Transportation Recommendation 2—Reduce per capita VMT through compact mixed-use development and multi- and intermodal transportation systems.
- Transportation Recommendation 3—Develop and implement sustainable transportation re-

search, design, planning, and construction practices, regulations, and competitive incentive funding that minimize impacts on natural resources, especially habitat fragmentation and nonpoint source water pollution.

Introduction

Sustainable Surface Transportation and the Minnesota Balance Statement

The provision of transportation is critical to the economic health of the state. Surface transportation is largely a public value, constituting the largest connective public space in the state. On the other hand, the conservation of natural resources is also fundamental to the state's well-being, economic and otherwise. On a vast spectrum of monetary and nonmonetary values, the state's air, land, water, aquatic species, and recreational values underpin the very character of Minnesota. These values must be brought into balance. The connective, mixed, and hierarchical character of surface transportation provides mobility over long distances and access to various destinations. As a necessarily pervasive system it interrupts, transforms, or replaces natural systems connectivity and functions and challenges or erodes biodiversity and ecosystems services provision.

The overlay of surface transportation on the land occurs at multiple scales. Responsibility for the provision of surface transportation in this state lies with the Federal Highway Administration (FHWA), the Federal Transit Administration (FTA), and the Minnesota Department of Transportation (MnDOT) in collaboration with counties and metropolitan planning organizations. Larger projects and systems especially have a footprint that is state-, region-, and ecosystem-wide, and all projects have immediate, or site-scaled, impacts (Figure T1). Impacts can be minimized, mitigated, or adapted from a conventional transportation policy, planning, and design perspective basically in three ways: loca-

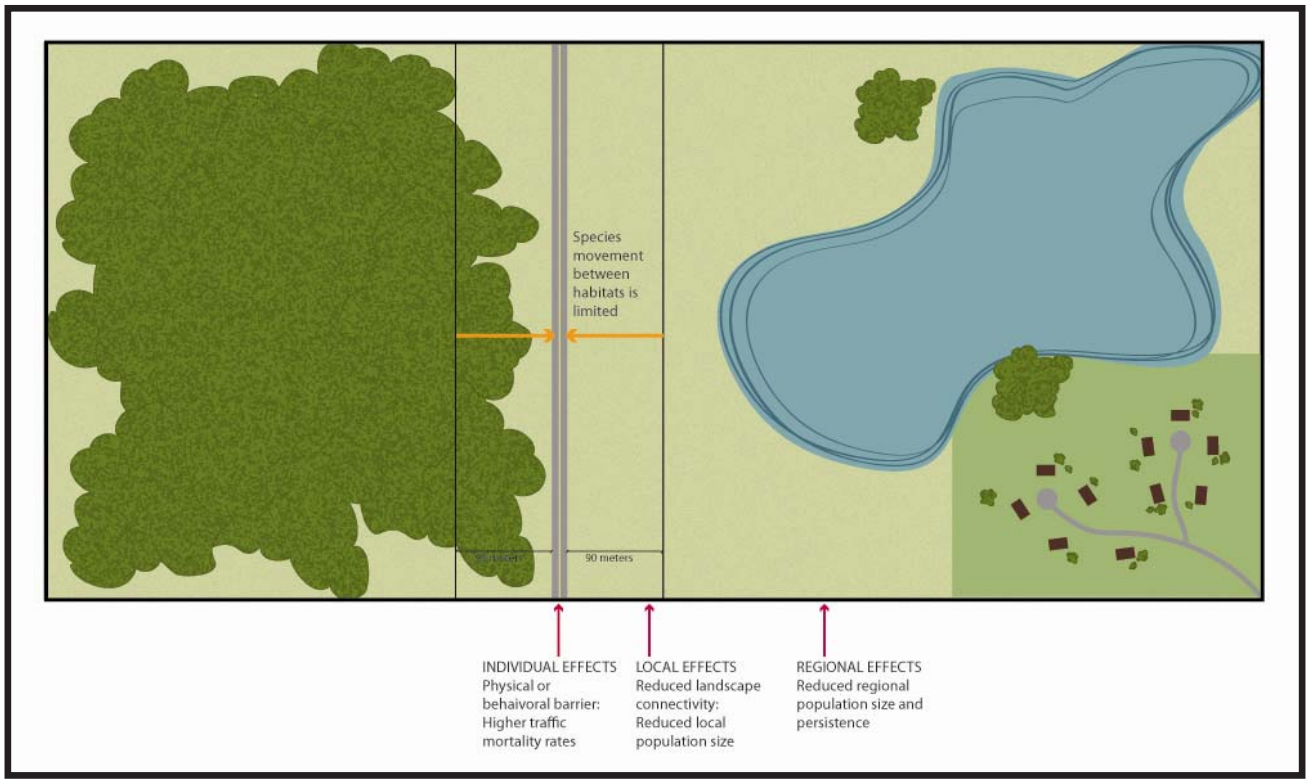

Figure T1. Fragmentation effects of transportation infrastructure. Credit: KatherineThering, UM Metropolitan Design Center.

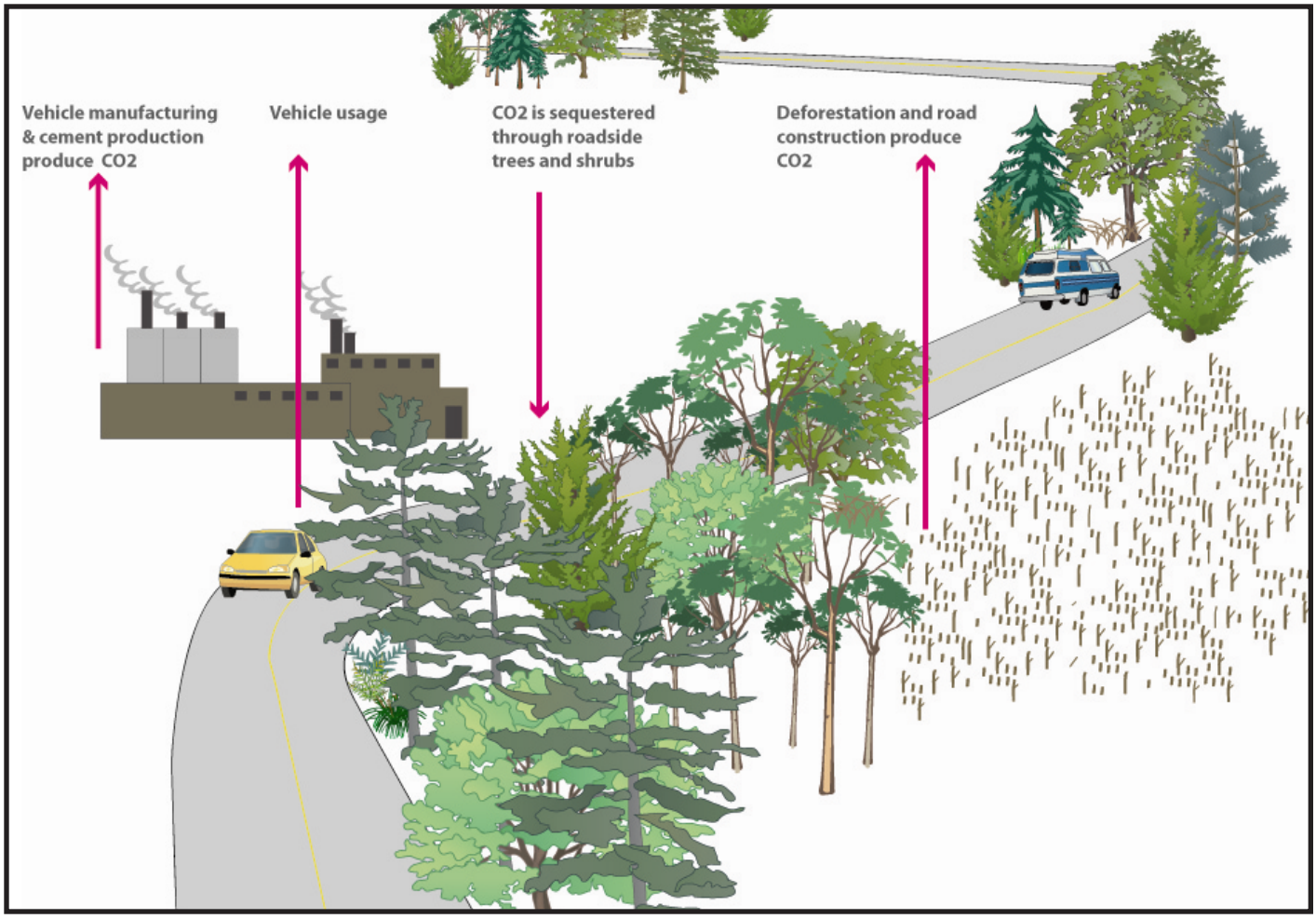

Figure T2. An overview of some of the elements of the "carbon footprint" of vehicular transportation. Credit: KatherineThering, UM Metropolitan Design Center.

tion of roadways away and buffered from resources; provision of multiple and connected nonmotorized modes and transit service in support of compact development; and careful policy making and integrative planning and design in relation to resources, all supported by balanced planning, regulatory, and incentive frameworks and enhanced cross-consultation in governance, planning, and project development.

Climate Change, VMT, Fuels, and the Road

The challenges of climate change converge to sharpen the particular challenges to the goal of sustainable surface transportation in Minnesota. Most notable is the composite environmental impact on air, land, and water of rapidly expanding automobile use related to dispersed settlement patterns, as measured in VMT (See Figures T3 and T4).

VMT can be correlated to the production greenhouse gases, especially carbon dioxide (CO_2) and carbon monoxide (CO). Between 1990 and 2003, greenhouse gas (GHG) emission from transportation increased by 43% and VMT increased by 42% in Minnesota (compared with 15% population growth, Figure T2).

VMT per capita increased by 23%, with much of the increase occurring in the Twin Cities metropolitan and collar county area. VMT growth statewide is projected to plateau at 0.9% (e.g., http://www.cts.umn.edu/Research/Featured/GreenhouseGas/index.html).

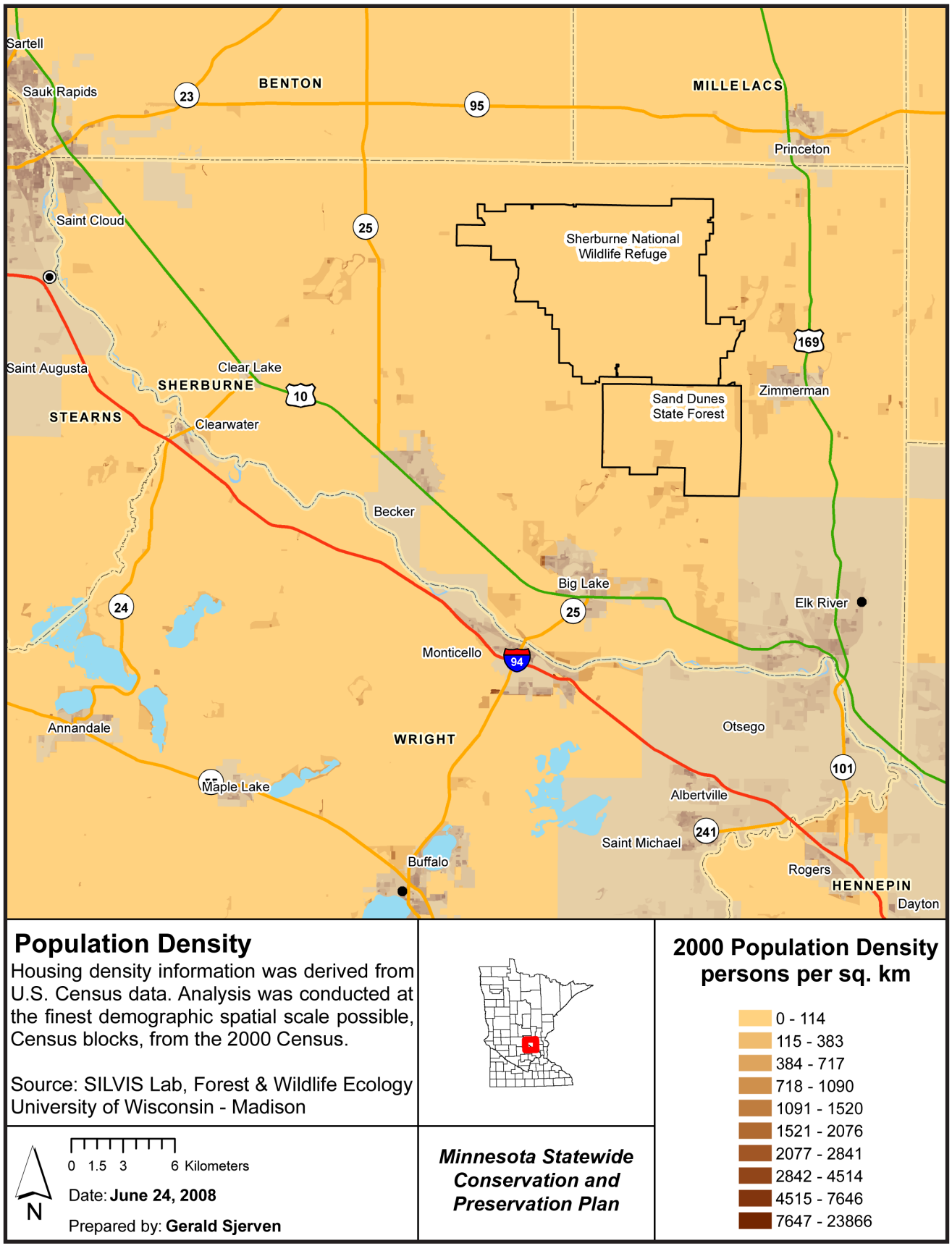

Figure T3. Population density. Credit: Gerald Sjerven, NRRI.

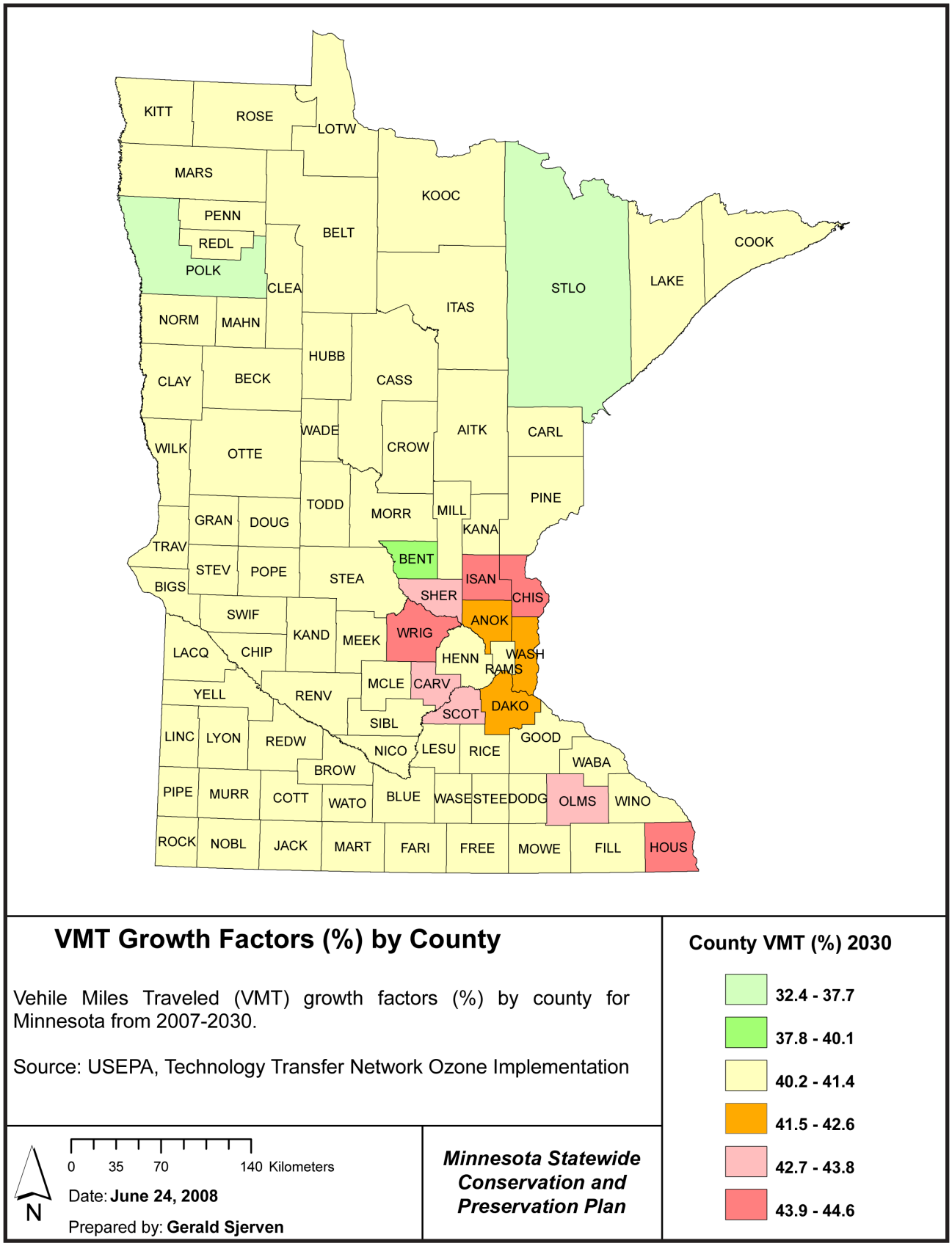

Figure T4. VMT growth factors by county. Credit: Gerald Sjerven, NRRI.

Nevertheless, the projected population growth, specifically in metropolitan areas, especially the Twin Cities, suggests clearly the need for an immediate strategic shift that would more closely integrate transportation with land use changes and environmental review.

Minnesota Transportation, Land Use, and Environmental Linkages and Disconnections

While land use, land-cover, design, and resource implications are cast by the imprints of the transportation network, these issues often run in parallel to (i.e., are not integrated into) transportation planning and design processes. Yet transportation planning and design might perform the important role of interconnecting land use and conservation planning processes.

Transportation directly affects the location and configurations of land use patterns. Conversely, land use patterns affect travel demand, the types and design of transportation facilities, and their performance, including their impacts on environmental resources.

In large part the disconnections stem from the different levels of jurisdiction, and therefore scales of impact, and the order in which decisions on transportation, resource conservation, and land use are made.

In light of these and other challenges, the future of the state depends upon a balanced and integrative approach to transportation, land use, and related infrastructure and environmental resource conservation planning and decision-making. A balanced approach requires thinking more strategically about the land use, transportation, and natural resources relationships that can reduce VMT, improve air quality, promote economic and community vitality, and reduce energy consumption while conserving natural resources.

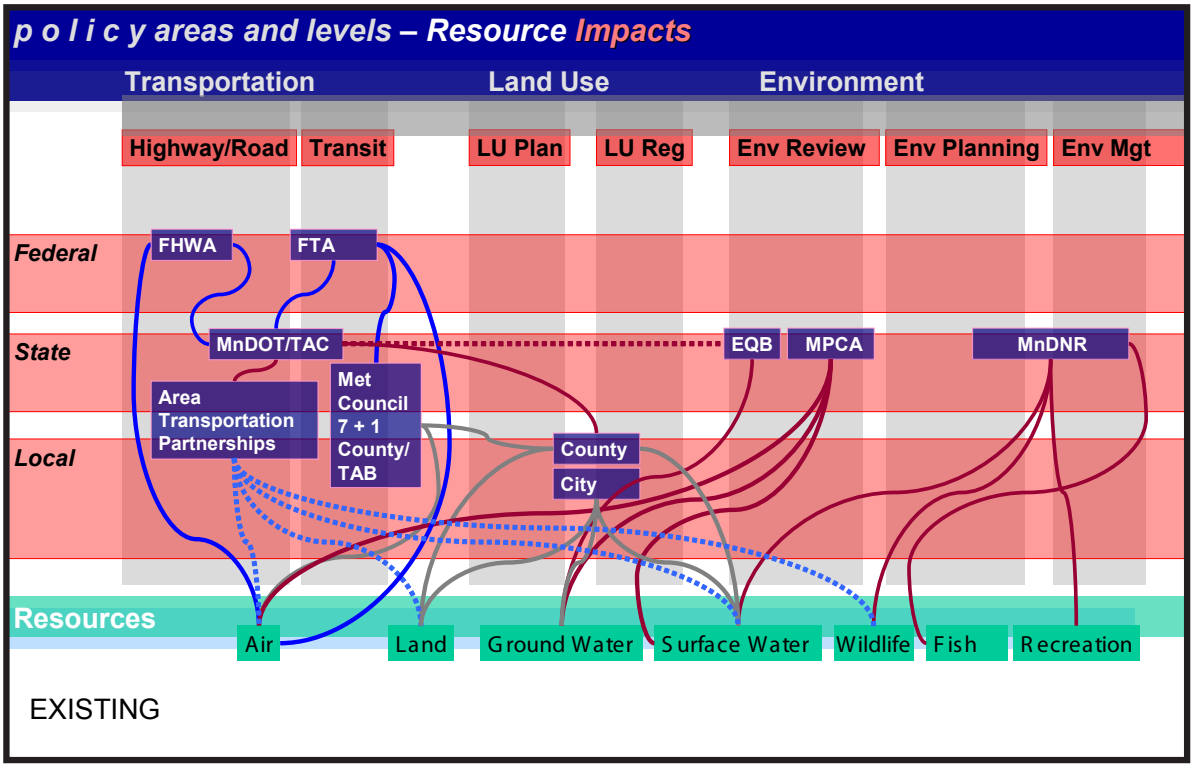

Figure T5. Policy areas and levels—resource impacts. Credit: Lance Neckar, UM.

Differences in Land Use, Transportation, and Environmental Planning Approaches

The existing process can be seen as a range of activities in transportation land use and environment across levels and jurisdictions of government having variously connected and disconnected (dotted lines) roles in resource conservation (Figure T5).

The intent of these recommendations is to strengthen existing elements of the process. Specifically the recommendations would enhance planning and review coordination across state agencies to create early opportunities for mitigation, adaptive planning, and land acquisition; and would make more effective the MnDOT Area Transportation Partnership (ATP) with the added potential of the Environmental Technical Advisory Team (ETAT) to make a comprehensive conservation approach to all resources affected by a transportation project (solid lines to resources, Figure T5).

Drivers and Trends

The preliminary plan of the SCPP identified major and proximal drivers of change and their impacts on four resources land, water, wildlife, and fish.

Habitat Loss

Development of roadways is a significant contributor to habitat fragmentation and degradation. In fact, road development is the leading cause of forest fragmentation in the state. Paved roads affect aquatic habitat integrity by physical alterations of drainage patterns that increase peak volumes of runoff, usually at higher temperatures and contaminant loads. Current trends in plant and wildlife populations show the direct effects of habitat fragmentation such as roadway construction (including widening and infrastructure upgrades). For example, 16% of the state's native plant species are listed as special concern, threatened, or endangered, and 32% of mammal, bird, and reptile species are recognized as species of greatest conservation need (SGCN) by the Minnesota Department of Natural Resources (DNR) .

These negative land-cover and wildlife trends will be minimized through integrated roadway planning and design. By leaving high-priority natural areas intact with connecting terrestrial natural resource corridors between them and reducing the number of unnecessary roads, habitat fragmentation and degradation will be minimized. Thus, integrated roadway and land use planning and design will help neutralize one of the major drivers of change for land cover and wildlife resources.

Hydrologic Modification

Hydrologic modification such as roadways is a major driver of change in water quality. Impervious surfaces such as roads affect surface waters through increased runoff of water (in extreme cases causing increased flooding and "flash flood effect"), sediment, phosphorus, and contaminants; decreased seasonal wetland persistence; and exacerbated drought impacts. Impervious surfaces affect ground water by preventing infiltration of precipitation and diverting the water to storm-water systems, which can reduce groundwater recharge. From 1990 to 2000, impervious surface area increased in all areas of the state, with a 20% increase in some areas.

Through careful and integrated planning of transportation systems, and resource-focused project planning and design processes for highways and bridges and local streets, the number, location, scale, and detailed design of projects can minimize inefficient roadway networks. These processes can (by planning) minimize the growth and scale of impervious networks and (by planning and design) minimize, mitigate, or adapt to negative impacts to surface waters and ground water of increased impervious surface.

Toxic contaminants and pollution

Fuel-burning by vehicles results in emissions of CO_2, the primary GHG responsible for global climate change; and air pollutants such as CO, particulate matter (PM), nitrous oxide (NOx), sulfur oxides (SOx) from diesel, and hydrocarbons (HCs) or volatile organic compounds (VOCs). All of these emissions negatively impact air quality.

Air quality trends reflect the negative impacts of fuel-burning by roadway vehicles. The last 20-some years have seen significant increases in VMT (73% between 1985 and 2005), average commute times, traffic congestion, and vehicle idling times, which all contribute to increased emissions. The impacts can be seen in a 53% increase in CO_2 emissions from 1985 to 2005, with transportation contributing 34% of total CO_2 emissions. With its high vehicle traffic, the Twin Cities had the worst air quality in the state in 2005, with more "moderate" air quality days than "good," five "unhealthy for sensitive group" days, and three days that were considered "unhealthy for all" .

Still, the most serious contamination from surface transportation may be the least understood: the addition of toxins and other contaminants either in solution or as sediments that run off of paved surfaces, sometimes directly into surface waters. This uncertainty will require well-focused research and monitoring efforts.

Recommendations

Transportation Recommendation 1: Align transportation planning across state agencies and integrate development and review across state, regional, metropolitan and county/local transportation, land use and conservation programs IP

1A. Institute interagency alignment of planning to coordinate transportation with other state planning cycles

The state should coordinate cyclical statewide plans across state agencies (e.g., MnDOT, Minnesota Pollution Control Agency [MPCA], DNR) and provide environmental data coordination and analysis, including determination of vulnerable ecological areas by resource, cumulative impact analysis and projection, performance standards and best practices research, and recommendations for land acquisition. MnDOT would continue to have the role of responsible governing unit (RGU) for surface transportation projects.

There are two overarching rationales of this recommendation.

The first is to bring MnDOT statewide surface transportation planning cycles into a more integrative alignment with natural resource planning cycles and related capital budget directions across state agencies by providing an integrated organizational structure, staff capacity and shared tools. Transportation and metropolitan planning organizational planning cycles include the MnDOT 10-Year Capital and Service Improvement Programming Process, the State Transportation Improvement Program (STIP), and the Metropolitan Council's Transportation Improvement Program (TIP).

The second rationale is to fuse enhancements in the integrative planning and environmental assessment processes with the design and implementa-

tion of projects. This recommendation provides a cross-consultative forum and analytical capacity to minimize impacts via integration of cyclical planning with project development. It sets a cross-agency and cross-jurisdictional context for project planning where the environmental assessment forum could be focused on the MnDOT Interregional Corridor District, Area Transportation Partnership (ATP) stakeholders, tribal governments, and the freight planners, with guidance of the statewide Technical Advisory Committee (TAC), the Metropolitan Council Technical Advisory Board (TAB), and other local and regional stakeholders. This cross-consultation may allow for more robust integration of housing and employment development planning into these considerations of resource conservation (http://www.dot.state.mn.us/metro/tsp/pdfs/chapter1.pdf).

This process would foreground project design with database development, analysis, resource assessment, and monitoring across scales and land cover morphologies. An integrative alignment could occur on the research/planning/assessment front. Strategic targeted joint MnDOT/DNR research projects on key resources at risk would build a common geographic information systems (GIS) and other monitoring-based database. Integration would also give the fullest consideration of alternatives, costs of minimization, mitigation, and adaptation; and best practices for projects.

If implemented, integration would provide incentive for feedback systems through monitoring and strategic research programs, organize and align early review of projects, and promote nonstructural and structural practices and performance measures.

Below, for example, are nine steps in an integrated project approach that foregrounds resource conservation (adapted from the Florida and Maine DOT processes):

1. Improve statewide transportation cyclical planning processes alignment with other state agencies; incorporate environmental minimization/mitigation costs in MnDOT STIP.
2. Provide district coordination for project scoping via ATP process and (new) Environmental and Technical Advisory Team (ETAT) and EQB alignment of environmental review across appropriate jurisdictions.
3. Develop purpose and need statement and environmental minimization and mitigation strategies across jurisdictions.
4. Develop alternatives to mitigate resource impacts (MnDOT/EQB with state agency, county, and metro planning cross-consultation).
5. Prepare detailed alternatives analysis and draft National Environmental Policy Act/ Environmental Assessment Worksheet (NEPA/ EAW) document (MnDOT/EQB).
6. Identify preferred alternative and conceptual minimization and mitigation plan (MnDOT).
7. Prepare final NEPA document finding of no significant impact or record of decision of mitigation processes and proposed outcomes (MnDOT).
8. Complete final project design, minimization, and mitigation coordination and permit decision (MnDOT).
9. Implement project and environmental monitoring (MnDOT and EQB).

1B. Integrate streamlined statewide environmental transportation project review with other statewide and cross-jurisdictional planning, design, budgeting, and review programs

Adopt environmental interagency stakeholder involvement (streamlining) project planning protocols through coordination across state, metropolitan, and county/local transportation, land use, and conservation decision-making responsibilities.

Modify the highway project development process (HPDP) to create a cross-consultative regional and local forum and an environmental team to lead federal- and state-mandated impact assessment. MnDOT and the EQB would create the forum and teams with participation of other review agencies, including MPCA, DNR, the Minnesota State Historic Preservation Office (SHPO), and metropolitan and county units.

Description of recommended action. A coordinated statewide interagency planning process around transportation and other statewide initiatives will enhance efficiencies and coherence of funding and other efforts with resource conservation objectives.

At the project scale, environmental interagency (streamlined) project development protocols (through MnDOT and EQB collaboration) will integrate resource protection into a more balanced and cost-effective project planning and design process. The effectiveness of this process will necessitate coordination across state, metropolitan, and county/local transportation, land use and conservation decision-making responsibilities. The central change to the project institutional process would be to modify the HPDP process to incorporate early ETAT processes and impact minimization and mitigation with local coordination and roadway project initiation through the ATP program administered through the district offices of MnDOT. (http://www.dot.state.mn.us/tecsup/xyz/plu/hpdp/).

The overarching rationale of this recommendation is to bring environmental planning into a scheduled and aligned interagency focus on conservation and to connect this planning into integrative project design and assessment. Project streamlining is intended to increase knowledge about and transparency on project planning and design and to provide a cross-consultative forum and analytical capacity to reduce impacts and to give fullest hearing of best practices and costs of minimization, mitigation, and adaptation.

In interagency planning, EQB could serve as a cross-consultative forum and environmental data gathering and analysis lead jointly with MnDOT. In projects, for example, MnDOT would lead as RGU, but should coordinate with EQB for data analysis and cross-agency review. The integrated efforts may, for example, occur as an expansion of MnDOT processes to meet FHWA/FTA environmental mandates or as extensions of context-sensitive design/solutions process approaches. As RGU for transportation projects MnDOT would mobilize environmental responsibilities to streamline review with other agencies for federal- and state-mandated impact assessment (e.g., MPCA, DNR, and SHPO). EQB and MnDOT will also work with metropolitan and county units on technical team-based adoption of project environmental performance standards-driven and other environmental practices in project planning, budgeting, and design.

Once a project is approved in the annual review process associated with the STIP, the purpose and need statements that formed their environmental assessment parameters will have been set. Since these projects have already been prioritized at the MnDOT district level through the regional ATP using the STIP projection of costs of minimization/mitigation, they would be potential candidates for streamlined environmental review. When streamlined environmental assessment occurs, EQB and MnDOT (and in the cases of transit corridors, the Metropolitan Council and/or the counties that are the joint RGUs for the project) are responsible to align all interagency environmental processes and to set and coordinate project performance standards and best practices and develop monitoring. This process will have local coordination based on analysis and cross-consultation via a new ETAT process.

The ETAT is a proposed facet of this approach. Each project would have an ETAT. The ETAT idea adapts the Florida DOT's district-level interagency planning coordination process. The ETAT would have primary responsibility to document, plan, and

design for transportation impacts by correlation of impacts to/on resources at scale through scenario modeling and overlay analysis. For example, at the ecosystem scale, corridor route alternatives would consider broader impacts over time and space, communities and species, and physical resource (air, land, water). Each ETAT would be composed of 12 to 20 members that represent federal, state, and local transportation, environmental, regulatory, and resource agencies. ETAT representatives would provide agency responses to the respective transportation planning entities—MnDOT and the affected metropolitan planning organization (MPO), MPOs, or counties through the ATP. During the early phases of programming screen, ETAT input would provide "agency scoping" to help satisfy the requirements of NEPA and other pertinent laws addressed during the NEPA process. At this stage, ETAT members would be offered the opportunity to accept or comment on the purpose and need statement, update the environmental reviews, identify required technical studies, and opt out of further involvement. (Additional information on this aspect of the recommendation may be obtained at http://www.dot.state.fl.us/emo/.)

A key tool needed here is an Internet-accessible GIS application that links ETAT members and the Minnesota Land Cover Classification Systems (MLCCS). Standardized GIS analyses (as prescribed by each environmental, regulatory, or resource agency) would be performed to identify potential impacts to environmental resources. ETAT members would need only an Internet connection to view and comment on results. These reports also would be available to the public through a read-only Web site.

Another decision-support tool needed for community response is visualization software such as Community VIZ that could be linked to the same database. The database system would house responses from ETAT members as well as MnDOT summaries of public comments.

State projects, including bridges, bottleneck and other corridor improvement projects, have the potential to direct the position, guide the processes and set the scales and types of land use development of a corridor. In the ATP/ETAT process these project-specific issues could be integrated across jurisdictions with appropriate guidance from MnDOT and EQB. Some example project types and models include:

- Corridor planning: coalitions plus Regional Rail Authority, community/private partnership joint land use planning, and urban design (Arlington, Va., model);
- Bridges: Woodrow Wilson Bridge (Virginia, Maryland) project model of engagement and flexibility of scope
- Bottlenecks and bypasses: multimodal and access-oriented planning and design and congestion pricing

At the local level, design decisions relative to passenger multi- and intermodal access and compact development are made. Decision support (e.g., community visualization exercises) helps to place issues in systemic resource context. Resources are often mapped, and could be understood in terms that would indicate transportation minimization/mitigation. For example, regulations on protection of streams that follow the statewide shoreland protection requirements for subdivision ordinances could result in best practices and performance standards for road construction across the functional classification.

Some typical kinds of transportation and land use decisions that require integration with statewide and regional planning and design on projects:

- Roadway design standards and geometrics: flexible (ecoregion standards) for arterial, local street right-of-way design
- Transit-oriented design: density bonuses for development in serviceshed
- Stream corridor/watershed subdivision ordinances: storm water–sensitive designs for street network/linked open space lot-size bonuses
- Zoning ordinances: mixed use, density bonuses for conservation

Description of impact on natural resources. Potential statewide advantages of integrated statewide cyclical plans would be integration of conservation with transportation and land use–related planning and data analyses (e.g., GIS, monitoring data). Issues to be considered include:

- VMT reduction toward legislated emissions and energy 2020 targets
- Transit use, nonmotorized travel, and other alternatives to VMT generation
- Greater and better targeted funding for mitigation (e.g., in the STIP process) including reversal of terrestrial and aquatic habitat loss and fragmentation; reversal of surface- and ground-water quality degradation; improved statewide storm-water performance standards for sediments and contaminants—total maximum daily load (TMDL); research on fate to ground and surface waters by land cover, land use, and soil type; and improved statewide multimodal recreational connectivity/access and integrated multifunctional land use and landscape management.

The principal objectives of the integration of performance- and practice-based project streamlining would be to reverse, stabilize, mitigate, or adapt to:

- Air: pollution by VMT reduction (emissions) through multi/intermodal planning and design
- Land: vegetative land-cover loss, drainage modification, erosion, habitat fragmentation
- Water: surface- and ground-water quality degradation through transportation projects
- Habitat: land and aquatic habitat fragmentation
- Fish: heating effects; contaminant, nutrient and sediment loading associated with storm-water runoff; invasive species and zoonotic disease transport
- Recreation: multiple modes of access

There is embedded potential for MnDOT development, for example, of new design and project performance standards for roadways that incorporates expanded transportation demand modeling, functional classification flexibility and ecoregion informants of environmental problems or constraints. These standards could have the following project impacts:

- Design standards on bioregional and hydrological criteria (e.g., roadside vegetation, culverts, pavement porosity) and related land use adjacencies
- Management practices, including right-of-way vegetation and bridge maintenance and painting
- Noise, vibration standards by key species of greatest conservation need (SGCN)
- Improved standards and practices for invasive species mitigation
- Chemical storage performance standards

Relationship to existing programs, laws, regulations. The complex array of programs, laws, and regulations illustrates the relative disconnect of transportation system development from land use development and environmental conservation. Today the long-range transportation planning process is embodied in the document, *Minnesota Statewide Transportation Plan: Moving Minnesota from 2000 to 2020* and there is a 2008–30 transportation system plan (TSP) for the eight-county Twin Cities metropolitan area. There is, however, currently no integrated statewide environmental or land use planning. More effective and efficient statewide environmental planning and assessment processes could be more closely aligned to transportation planning and funding processes. This alignment potential represents an important opportunity to provide a fuller environmental cost accounting as part of an aligned planning and budgeting process. MnDOT, for example, is audited by the Office of the Legislative Auditor (http://www.auditor.leg.state.mn.us/PED/2008/trunkhwysum.htm).

One connection between general long-term transportation planning and the development of projects is the three-year STIP cycle. The STIP is coordinated through the MnDOT Office of Investment Management (OIM). MnDOT statewide planning

for the STIP programming process sits within long-range planning processes currently in place. The STIP must adhere to certain requirements of project type and location. For example, there are these overall guidelines on statewide apportionment:

- 10 percent for enhancement activities (a potential source of environmental mitigation)
- 10 percent for safety activities
- 24 percent for transportation management areas (Twin Cities area)
- 26 percent for other areas of the state (includes 110 percent of 1991 secondary funding for rural areas under 5,000 population)
- 30 percent for any area of the state

Local coordination and project initiation is sought (and encouraged in the STIP guidance process) through the ATP program that is administered through the district offices of MnDOT (http://www.oim.dot.state.mn.us/pdpa/STIPGMar01.pdf). The ATP process is given guidance on target formulas for funding of certain types and settings of projects. For example, statewide 30% to 40% of funding should be used for preservation of existing infrastructure. This is a competitive process and is subject to yearly updates. The process by which localities bring forward priority projects (usually through the district offices of MnDOT and the ATP) is also the start of a capital project process.

Funding is distributed on a prorated target basis by ATP (http://www.oim.dot.state.mn.us/targetformula/Talking%20Points%20for%20Web%202-22-06.doc). Then, within each ATP, certain thresholds and caps are required by project type according to fiscal constraints allocation proportions (http://www.oim.dot.state.mn.us/districtplans/d-4/Chapter%206%20%20Fiscally%20Constrained%20Investment%20Plan.pdf).

By the time a project has been listed in the STIP, all environmental assessment has been completed, although this process should be more clearly elucidated in the STIP guidance document (http://www.oim.dot.state.mn.us/pdpa/STIPGMar01.pdf). The processes that accomplish the Federal mandates on environmental assessment and mitigation of individual projects are delegated through the NEPA. Again, these processes reflect the relatively disjointed—yet paradoxically connected—processes by which the agencies accomplish both the assessment and construction of surface transportation projects. Currently MnDOT operates by the letter of the environmental review laws embodied in the NEPA and the Safe Accountable Flexible Efficient Transportation Equity Act (SAFETEA-LU).

The environmental worksheet process begins in the EQB. There are two routes to a full environmental impact statement (EIS): either it is mandated or it is determined to be necessary because of size, location, and magnitude of potential environmental impact. Determination of the level of project assessment occurs as a process between MnDOT, MPCA, DNR, and SHPO. Normally highway and infrastructure distribution projects require an EIS. These types of projects and those deemed subject to an alternate urban area review (AUAR) have the scope that could be appropriately fitted to this recommendation (http://www.eqb.state.mn.us/documents/EnvironmentalReviewProcess.1.06.pdf).

Among the several existing elements or project reviews are:

- NEPA, EQB processes

  An environmental assessment (EA) is prepared for federal projects to determine if a full EIS is needed. An EIS is prepared for mandated projects. State EAW or AUAR processes are used for state or nonmandated transportation corridor, bridge and bridge replacement, and bypass and bottleneck projects (http://www.dot.state.mn.us/tecsup/xyz/plu/hpdp/book1/2cpr/class3/ea/ea.html).

  The EIS process currently contains the following steps:

  1. The RGU (MnDOT) determines if an EIS is needed.

2. An EA or EAW form is completed by the RGU and the project proposer as an aid in scoping the EIS. The EAW is distributed to reviewing agencies and noticed in the *EQB Monitor*. A press release is provided to a local newspaper.

3. A 30-day scoping period follows the notice, allowing for public review of the EAW and input into a decision on the issues to be analyzed. A public meeting is held during this period to receive verbal comments. The purpose of the scoping is to focus the EIS analysis on the pertinent issues and to determine what reasonable alternatives will be compared to the project.

4. The RGU makes an official scoping decision which outlines the contents of the EIS.

5. A summary of the scoping decision (EIS preparation notice) is published in the *EQB Monitor* and a press release is supplied to a local newspaper.

6. The scoped issues are analyzed with economic and sociological impacts being considered in addition to environmental impacts. The results of the analysis are compiled into a draft EIS document. Frequently, a consulting firm is hired to assist the RGU with the analysis and the document.

7. Any person can review and comment on the draft EIS for a period of at least 25 working days after a notice of the draft EIS is published in the *EQB Monitor*. A press release is sent to a local newspaper. A public meeting must be held to receive verbal comments.

8. The EIS is revised into final form based on the comments received.

9. The RGU makes an official decision on the adequacy of the EIS. A notice of the impending decision is published in the *Monitor* at least 10 working days in advance. The adequacy decision is based on three criteria: (1) Were all issues for which information was reasonably available addressed? (2) Were all legitimate comments on the draft responded to? and (3) Were proper procedures followed? In exceptional circumstances, this decision may be made by the EQB instead of the RGU (http://www.eqb.state.mn.us/documents/EnvironmentalReviewProcess.1.06.pdf).

- MnDOT ATP processes

  MnDOT regional districts prepare transportation plans in consultation with the counties and in the case of the Twin Cities, the Metropolitan Council. Some road, bridge, and transit projects in these plans go to the STIP. Mapping and planning protocols observed by county and local planning and engineering officials follow the target formulas for existing maintenance and other project types and the functional classification set out in this formula. Some projects remain local. Regardless of funding sources, the plans set forth mobility and access improvements to the network, and the roadway improvements that are codified by their functional classification. The functional classification system sets roadway design standards that are closely followed by district and county engineers as these standards are tied to safety and related capacity design standards as well as to state and county aid compliance. The connected pattern of standards means that generally all roadway widths and edge treatments are physically similar, described by their functional classification, regardless of where they are in the state. Very often these determinations are related to land use planning and to population projections. When land use changes by local subdivision, the roadway classifications set by county-level planning decisions (e.g., arterial improvements) generally also guide the design of collector and local streets. This design could in turn, along with other related roadway improvements have regional impacts on natural resources. Such develop-

ment-scaled decisions are also framed by city- and county-level land use planning and zoning decisions which tend to mirror the transportation hierarchy although strictly speaking occur separately from larger-order transportation decisions.

- MnDOT context-sensitive design and context-sensitive solutions (CSD/CSS)

  Primarily oriented to visual, aesthetic and recreational environmental enhancements, this program could have a broader and deeper scientific role.

- National Pollutant Discharge Elimination System (NPDES)

  The federal Environmental Protection Agency (EPA) and by delegation, the MPCA, are responsible for setting standards for impairment and for enforcing the Clean Water Act and the associated NPDES permits to industries, cities (and other larger public corporate entities classified as MS4 entities), and other point sources of contamination. The transportation network is not subject to permitting since it is not defined as a point source.

The potential for increased transparency, cross-consultation, and overall efficiency and effectiveness of streamlined processes has shaped updated federal guidance documents issued by FHWA and FTA on mandated roles in environmental assessment and planning integration:

"The development of the revised integrated environmental review process gives participants an opportunity to share past experiences and to strengthen the interagency relationships that were established during the development of the Highway Methodology NEPA/404 process. These stronger interagency relationships will help to improve understanding and ultimately reduce project delays in the future. Trust relationships, coupled with the changes noted below, are the keys to fulfilling the goals of TEA-21 (now SAFETEA-LU and the Cooperative Agreement). This process is recommended as beneficial and applicable to transportation development projects, regardless of the source of funding" (http://www.environment.fhwa.dot.gov/strmlng/linkingtrans.aspIn).

Time frame. An expanded time frame (years) will be needed to implement the alignment and project review processes recommended and assemble and create tools, and decades will be needed to evaluate transportation impacts.

Geographical coverage. Aligned planning will have a statewide effect. What Richard Forman (2003)calls the "virtual" catalytic effects of transportation system changes and the potential uncertainty built into complexity and/or lag are especially complex in the three-biome, multi-ecoregion, multiwatershed configuration of the state. Shifting land uses at edges of metropolitan areas and in biofuels production and distribution areas make transportation planning, design, monitoring, and management even more difficult. Changing patterns of land use and transportation, even economic development attendant upon increased energy costs add further uncertainty.

One focus in this document is on suburban expansion since population forecasts seem to place the greatest emphasis on this growth, particularly in the outer metropolitan areas surrounding the Twin Cities. From a transportation and land use perspective, that focus is a linchpin of environmental conservation for all of the state's resources. This fact is due in part to the patterns of urban settlement and their close relationship to these resources, especially water and land-based resources and agriculture.

While projections made prior to the current fuel and food cost rises and mortgage crises have not been precisely accounted for in this writing, population growth and related VMT projections have historically been closely tied:

"The target formula includes the state demographer's forecast of population for the year 2025 to represent future system usage.… Analysis of the state demog-

rapher's 1995 projected population and 1995 VMT as reported by MnDOT showed a 99 percent correlation between population and VMT" (http://www.oim.dot.state.mn.us/pdpa/STIPGMar01.pdf).

Surface transportation projects such as bottlenecks and bypasses, corridor improvement, and bridges have both site-specific and corridor- and ecoregion-wide impacts because of the scale-setting effect they have on land uses, systems of transportation, and ecosystems services production.

Challenges. Two administrative challenges are to align interagency and cross-jurisdictional environmental assessment with statewide transportation planning, and to insert environmental minimization, mitigation, and adaptation into the transportation investment planning process that frames project location, purpose and need statements, planning, design, and implementation. Another challenge is to link project planning and design more integrally with land use planning to achieve a more comprehensive statewide strategy to balance growth with resource conservation.

Other challenges, among many, include:

- Political: Metro and outstate funding formulas and the related project-type formulas may not fit with plans to conserve resources. Agency silos and legal silos may be obstacles.
- Research and Data: Environmental conservation will eventually be evaluated according to performance outcomes both statewide and on projects. A principal challenge is the research gap, especially relative to rapidly changing interrelated environmental conditions and impacts (e.g. research on fate of contaminants to ground and surface waters). This gap frustrates the cause of making a case for integration of modeling, environmental assessment, monitoring, and evaluation with planning and design.
- Modeling and Scenario Building: More precise measures might be modeled (e.g., projected VMT based on actual transportation data and multimodal data from other projects, not just projected population) in order to model more comprehensive and multimodal scenarios such as are created in the metropolitan planning areas and some counties. However, at this writing, a forecast of VMT is not necessarily available by county.
- Creation of new statewide roadway design, management practices, and standards (e.g., noise, vibration standards by key SGCN, improved standards for invasive species mitigation, roadside vegetation, culverts, pavement porosity, chemical storage performance standards, statewide storm-water performance standards for sediments and contaminants, bridge maintenance and painting standards) will affect bioregional and hydrological criteria.

At the project scale, there is the scientific gap in understanding of cumulative and virtual impacts of transportation projects. The complexity and specificity of resources, indeterminate temporal and spatial impacts drivers, and cumulative impact assessment are among the several scientific and technical challenges that underlie the considerable administrative challenges.

Other project administrative challenges include the cost justification for cross-governmental coordination: What are the costs, mitigation responsibilities and benefits of environmental streamlining/sustainability? Can they be monetized? What are the institutional culture challenges, especially relative to shared project control? In technical terms, there is the coordination challenge across mapping and other data-resolution issues (e.g., SGCN at township scale vs. point scale data in the county biological surveys and scales of attribute mapping in Data Deli sources and transportation project planning and design).

See 2005 Florida DOT data on efficient transportation decision making (ETDM) evaluation and the ETAT integration (http://www.dot.state.fl.us/emo/pubs/Final%20PMP%20Report_April%202005.pdf).

Costs. Cyclical planning alignment could be achieved cost-effectively by reassigning tasks or moving or creating two to five environmental assessment process team staff positions, probably in EQB. Data sharing (especially GIS) and these added staff would minimize costs across agencies and may support streamlining. Other project recommendations, especially the formation of ETAT-supported processes and changes in ATP workloads, might incur initial staffing costs within MnDOT (http://www.environment.fhwa.dot.gov/strmlng/newsletters/nov03nl.asp).

Transportation Recommendation 2: Reduce per capita vehicle miles of travel (VMT), through compact mixed-use development and multi- and intermodal transportation systems

Description of recommended action. The principal means by which VMT can currently be reduced are through reducing growth in lane miles and increasing intermodal and multimodal (including nonmotorized) transportation access and use. In the context of an automobile and truck fleet that cannot turn over (i.e. be replaced by more efficient vehicles and new fuels) in less than a decade regardless of other conditions, current efforts should concentrate on supporting planning and design of compact, mixed-use urban and suburban development and corresponding intermodal and multimodal transportation networks. Existing and proposed MnDOT plans and processes (e.g., interregional corridor plan, ATP, ETAT) should be used as foundations for support of compact urban and suburban development.

2A. Use alternative transportation planning and design processes and tools to support compact mixed-use development

Incorporate expanded transportation demand modeling (TDM) and Access Management modeling and other related strategies in statewide and local planning and project design to enhance local multimodal and passenger intermodal access that supports compact mixed-use development and resource conservation. For example, expanded Transportation Demand Management (TDM) analysis of MnDOT interregional corridor commutesheds, (i.e., areas of service at peak across modes) could suggest alternatives to usual applications of the functional classification standards. It is also important to have uniformity among expanded TDM requirements across neighboring communities so cities that implement expanded transit and nonmotorized TDM are not penalized budgetarily for their efforts by placing themselves at a disadvantage compared to civil divisions that do not implement TDM.

2B. Provide incentives for compact mixed-use development

Encourage and prioritize qualified transit and nonmotorized system fiscal investments in the STIP for regions that integrate local resource planning and performance-standard based design for compact development (Figure T6). Incorporate economic and employment development into resource protection. For example, focus these approaches on the Twin Cities metropolitan area and other employment and service centers.

2C. Augment and communicate information on practices and performance of compact mixed-use development and transportation

Conduct interdisciplinary research (e.g., case studies) to correlate VMT changes with types, locations and scales of development in relation to transportation demand and planning for systems and modes. Establish databases on VMT-related statistics for resource-sensitive roadway network design and for patterns, intensities and combinations of land uses in multimodal and passenger intermodal development. EQB could provide research coordination of state agencies (e.g., MnDOT, MPCA); counties and localities (including minor civil divisions), educational institutions, and nonprofit stakeholders and

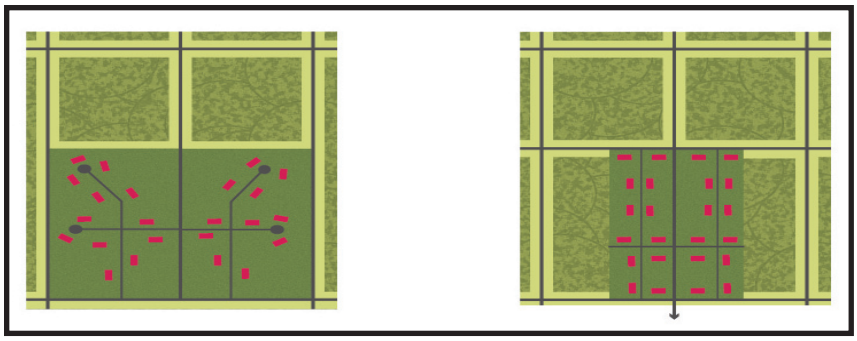

Figure T6. Left: conventional cul-de-sac low, density development in context of road networks and land cover. Right: Right: same number of dwellings in compact, connective street system. Credit: KatherineThering, UM Metropolitan Design Center.

foundations. Use this information to develop planning and design toolkits for the state, counties, metropolitan and local communities, developers, and citizens that include performance standards scorecards of structural and nonstructural approaches to VMT minimization/mitigation (e.g., based on models of per capita/per household VMT by land use configuration).

Description of impact on natural resources. The primary direct impact on natural resources of reducing VMT would be reduced emission of GHGs and other pollutants into the air. All internal combustion engines emit GHGs (including CO_2, CO, and NOx), HC (also known as VOCs), PM, and SOx (http://www.ec.gc.ca/cleanair-airpur/CAOL/transport/publications/trucks/truck3.htm).

By supporting compact, mixed-use development, reduced VMT would also directly or indirectly reduce other resource impacts. For example, reduced growth in lane miles would result in reduced:

- vegetative land-cover loss, hydrologic modification, soil erosion (land)
- surface- and ground-water quality degradation from transportation projects (water)
- terrestrial and aquatic habitat fragmentation (wildlife and fish)
- heating effects and contaminant, nutrient, and solids loading associated with storm-water runoff (fish)

Relationship to existing programs, laws, regulations. This recommendation is targeted to provide one approach to meeting the state legislative mandate to reduce carbon emissions by 20% by 2020.

The EQB has a number of "smart growth" resources on its Web site, including the memo *Growing Smart in Minnesota* (1999) and Smart Growth Bonding Criteria. The state Department of Administration also published in 2002 *Under Construction: Tools and Techniques for Local Planning.* In 2000 Minnesota Planning published a handbook on model ordinances (http://www.mnplan.state.mn.us/pdf/2000/eqb/ModelOrdWhole.pdf).

While Minnesota communities have a variety of density bonus and conservation ordinances, there is little consensus on the nature of the resource protection they offer. This and other potential positive effects of altering local practices are otherwise largely not regulated through subdivision or zoning.

Time frame. Years to implement processes, decades to develop data, modeling, scenario building and to monitor conservation effects

Geographical coverage. Statewide but with special attention to the metropolitan edge, where the conversion of agricultural lands present this and other challenges to the natural resources of the state

Challenges. The relationship of land use, transportation planning and design and conservation is poorly understood from scientific, governance, political, and cultural perspectives. There is not enough research to demonstrate interdependencies of decisions and to forefront natural resource protection. Data resolution issues make it difficult to quantify conservation performance standards that might be written into transportation planning and design standards at the statewide level or into local subdivision or zon-

ing ordinances. Government support of transportation occurs generally at statewide and regional levels largely disconnected from local, incremental governmental decision making that makes subdivisions of and assigns use to land via zoning. The mismatch of the landscape scale of resource protection and local land use processes and personal practices is a fundamental challenge. Ultimately land is largely configured according to private decisions, based in property rights—potentially a fundamental political and cultural challenge to conservation-based land use practices and processes.

Costs. Programmatic costs, development of research and coordinative support through EQB and MnDOT, local costs of ordinance revision.

Transportation Recommendation 3: Develop and implement sustainable transportation research, design, planning, construction practices, regulations, and competitive incentive funding that minimize impacts on natural resources, especially habitat fragmentation and nonpoint source water pollution

IP

LP

Description of recommended action. This recommendation seeks to minimize, adapt, and mitigate habitat fragmentation and nonpoint source pollution from surface transportation (and related land uses) through research and design linkages via EQB, MPCA, and other stakeholders with MnDOT, and through expanded regulation and funding incentives for innovative project approaches and increased environmental innovation on roadway design standards.

3A. Develop research programs on habitat fragmentation and planning, design, and construction techniques for adaptation, minimization, mitigation, and restoration

Roads fragment habitat. Some species are more or less impacted by road network configuration, width, pavement and shoulder treatments, bridging, and sizes and types of culverts. Species are generally also benefited by vegetated edge design and management and grade-separated crossings such as bridges or culverts. While there is a body of existing research around the academic efforts of Richard Forman, Daniel Sperling, and others, the main foci of environmental mitigation of habitat loss are still largely practice-based. See, for example, the FHWA CSS Web site (http://www.fhwa.dot.gov/context/index.cfm). For cases, see http://www.contextsensitivesolutions.org/.

Research is needed to explain land-cover and species relationships to local and regional impacts of road functional classification changes (widening and/or curbing), new routes, bridges, culverts, and other projects. Further research is needed to document effectiveness of innovative techniques including hybridizations of the functional classification, CSD/CSS, and innovative crossings of water.

Research specific to best conservation practices for Minnesota's prime terrestrial and aquatic habitats and SGCN would be embedded into EQB/MnDOT statewide and district office planning in the form of ecoregional GIS coverages at increased resolution. These would be used to make determinations of pending impacts and as planning, design and construction practice and incentive grant guidelines.

3B. Develop research and design linkages of nonpoint source pollution to surface and ground waters from right-of-way and adjacent land uses that would improve performance of roadway-based infrastructure in relation to hydrological resource resilience and overall stability

In this state, water is always close, whether on the surface or in the ground. The cumulative and spatial impacts of transportation and associated land use development on water quality and aquatic habitat are only beginning to be understood (Figure T7). Research is needed to develop a finer understanding of the spatial and biophysical dynamics and metrics

of transportation-induced contamination of water, especially surface water, but in areas of high permeability, also ground water. Research on fate to ground and surface waters by land cover, land use, and soil types is needed to improve statewide storm-water performance standards for sediments and contaminants TMDLs. These standards could inform review of all transportation projects for NPDES permits as recommended here. The research would identify issues and model and test hypothetical conservation planning, design, implementation, and management practices across scales. For example, research could:

- Develop data analysis and research in support of new MnDOT design performance standards and local standards and practices.
- Establish state watershed databases on nonpoint source pollutant fate by land use/land-cover types and establish design, planning, and management practices by contaminant, land cover, slope, soils, stream segment, overland distances (buffers) to surface waters, and relationship to ground water and to biotic resources (especially aquatic habitat).
- Relate project planning and design goals, incentives, and best practices to long-term (cumulative impact) models of performance on watershed bases.

3C. Implement a standard baseline of habitat fragmentation and nonpoint discharge review for all projects that increase impervious highway roadway or drainage infrastructure surface in Minnesota

Require all new roadway projects or functional classification upgrade projects on existing roads to secure NPDES permits.

This recommendation could link project development more closely to comprehensive habitat data and impact analysis via the connection between the MnDOT statement of project purpose and need and environmental review. The statement of purpose and need provides the basis for developing a range of reasonable alternatives and, ultimately, identification of the preferred alternative. It also sets budgetary frameworks. If properly described, it also limits the range of alternatives that may be considered

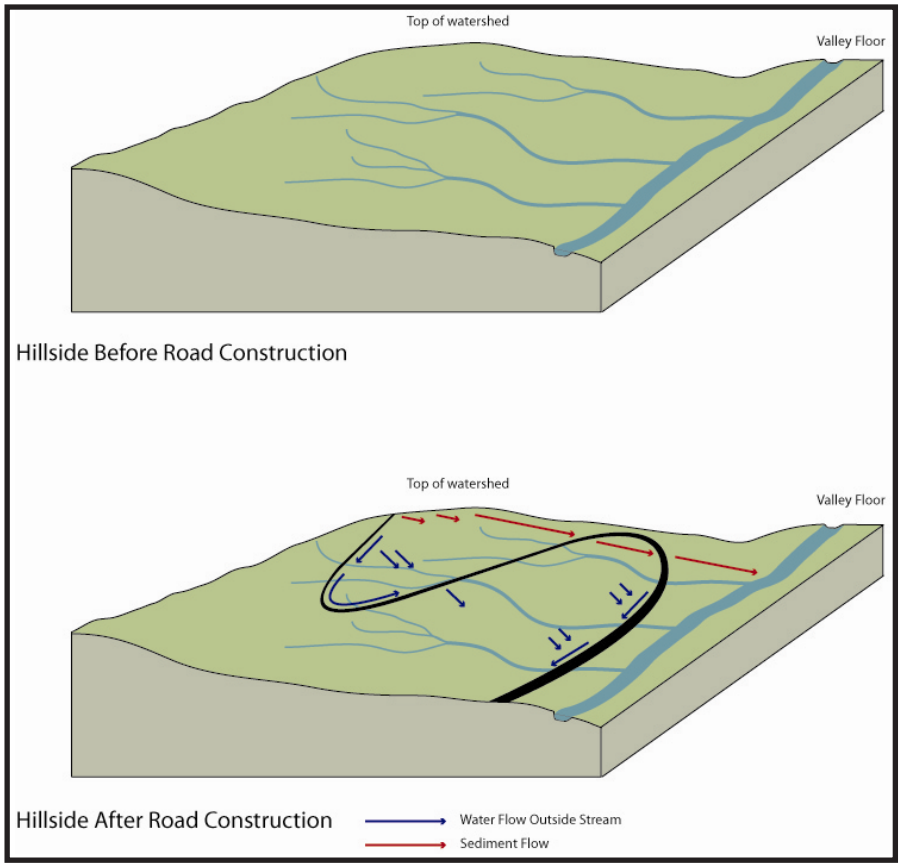

Figure T7. Road construction alters runoff speed, patterns, and volumes, and directs sediments and associated contaminants rapidly to the valley floor of a stream system. Credit: Katherine Thering, UM Metropolitan Design Center.

reasonable, prudent, and practicable in compliance with Council on Environmental Quality (CEQ) regulations, Section 4(f) of the Executive Order on Wetlands and Floodplains, and the Section 404(b)(1) guidelines. Further, it demonstrates the problems that will result if the no-build alternative is selected (http://www.dot.state.mn.us/tecsup/xyz/plu/hpdp/book1/2b/class1/purpose-need.html).

3D. Pilot incentive program grants for habitat and water-quality conservation design and construction innovations in transportation projects

The state should consider creating a grant program which would offer grants to MnDOT, counties, and local governments for transportation projects that demonstrate new or catalytic conservation approaches to road and related drainage design, development or (re)construction (Figure T8).

Description of impact on natural resources. The principal objectives of research programs would be to strengthen planning, design and implementation practices to reverse, stabilize, minimize, mitigate or adapt to:

- Vegetative landcover loss via increase in impervious cover and other drainage modifications related to transportation development associated with new routes, functional classification changes, and/or land subdivision
- Habitat disconnection
- Surface- and ground-water quality degradation through erosion and sedimentation during and after transportation project construction
- Construction impacts of bridges and culverts, including noise, vibration, and sedimentation
- Flow constriction and aquatic habitat fragmentation of roadway and bridge design
- Heating effects, contaminant, nutrient and sediment loading associated with stormwater runoff from pavement

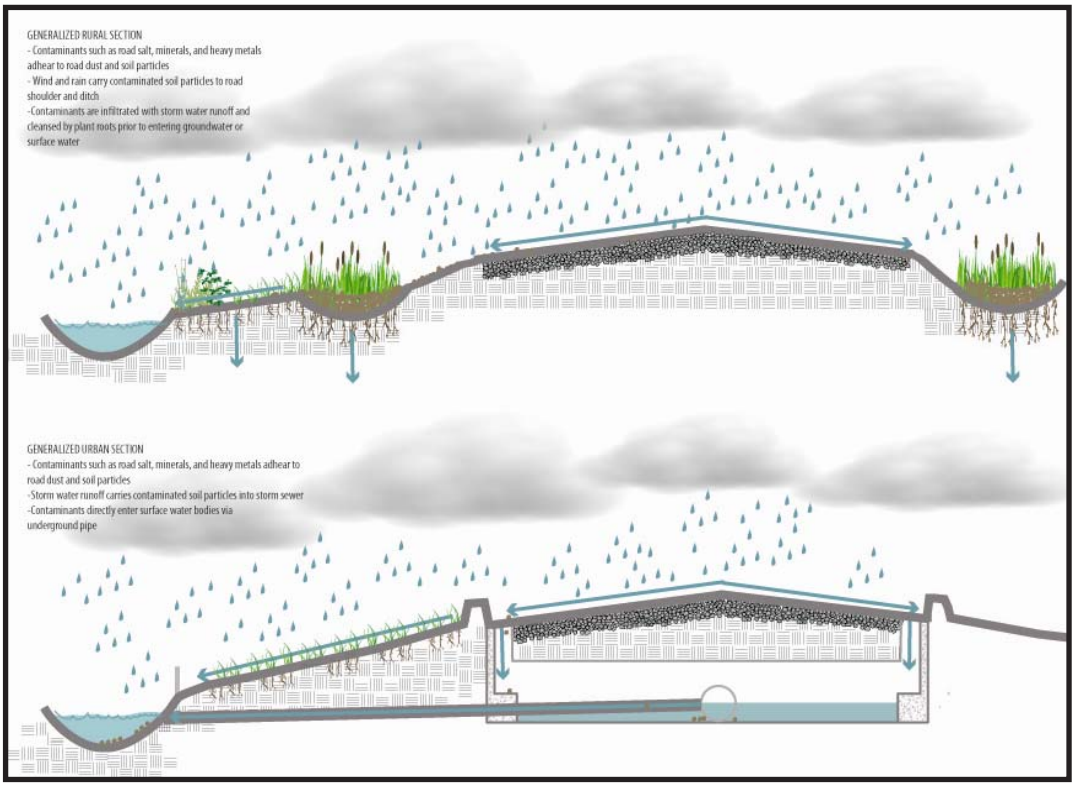

Figure T8. One current practice in road design is to provide vegetative infiltration areas in roadside swales to filter and slow runoff from paved surfaces. Curb and gutter additions to roads that accompany the changes in functional classification (e.g., to urban arterial) are especially detrimental near water bodies. Credit: KatherineThering, UM Metropolitan Design Center.

Relationship to existing programs, laws, regulations. NPDES review is used for some transportation projects (see http://www.dot.state.mn.us/tecsup/xyz/plu/hpdp/forms/forms_erosion.html). In the Twin Cities metropolitan area the Metropolitan Council has created the Livable Cities Demonstration Account program to provide competitive grants to communities to encourage environmental innovation in site planning and design. This program could be a model.

Time frame. Years

Geographical coverage. Statewide, with particular research focus on metropolitan edges, forest interiors, key watersheds, lake-to-lake movement, and water crossings in stream and river corridors.

Challenges. Data and mapping at appropriate resolution to assess impacts of transportation changes; jurisdictional implementation.

Costs. Programmatic costs include funding for development of research, innovative grants and coordinative support through EQB, MnDOT, MPCA, and DNR.

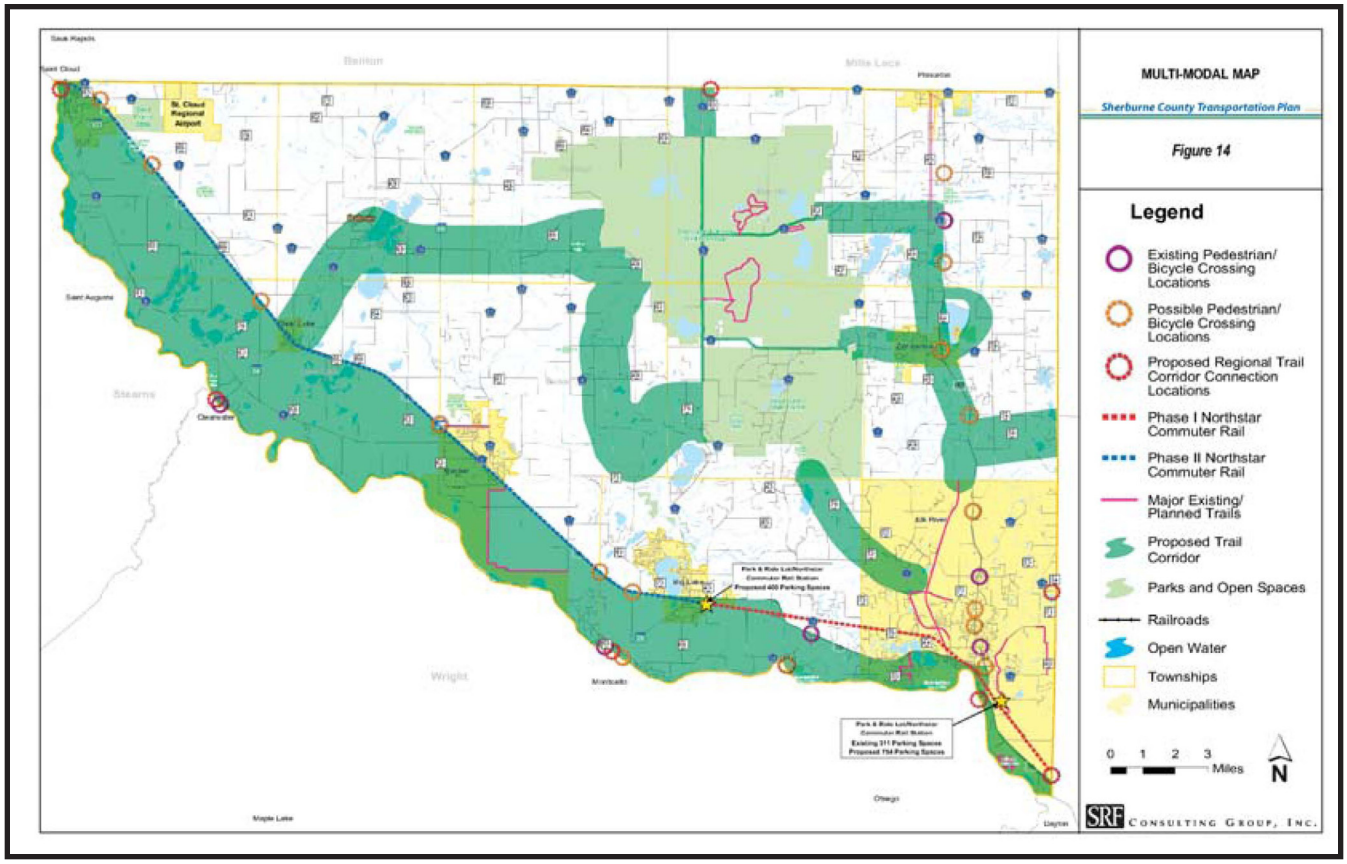

Figure T9. The several conservation green corridors in the Sherburne County Multimodal Plan (2007) represent a good beginning point to suggest the tradeoffs in resource conservation and the locations and types of roadway functional classification change and related bridging proposals that require more thorough analysis and design. In the eastern part of the county (shown in the box) functional classification upgrades are proposed for County Hwy 4 in the Sherburne National Wildlife Refuge and for County Hwy 5 between the Refuge Area and the Sand Dunes State Forest. Credit: KatherineThering, UM Metropolitan Design Center.

Road Impacts on Critical Habitat: A Case Study Analysis Based on the Sherburne County Transportation Plan

Sherburne County is predominately rural, but is undergoing rapid development. The county contains several important natural habitat areas, including Sherburne National Wildlife Refuge, Sand Dunes State Forest, and a border with the Mississippi River.

The Sherburne County Long-Range Transportation Plan (2007), in which the "green corridor" multimodal map (Figure T9) was used, begins to suggest how to assess the amount and quality of critical habitat changes with respect to planned changes in road functional classes. The intent of the transportation plan is to accommodate anticipated growth over the next 20 years (to 2030), including moving goods related to farming, mining and agricultural activity, as well as increased commuter use.

This analysis was based on the terrestrial critical habitat map created in the SCPP (Figures H2 through H7). The habitat map was formed by integrating a number of natural resource data layers, including sites of biodiversity significance, SGCN, game species, terrestrial vertebrates, and a number of other factors. The habitat analysis also incorporated key stressors and drivers of change, including road density, housing density, and connectivity at the wildland/urban interface. The present analysis expands on the SCPP habitat analysis in that it assesses changes in habitat as they relate to specific transitions in road function classes projected in the Sherburne County transportation plan (Figures T11 through T17).

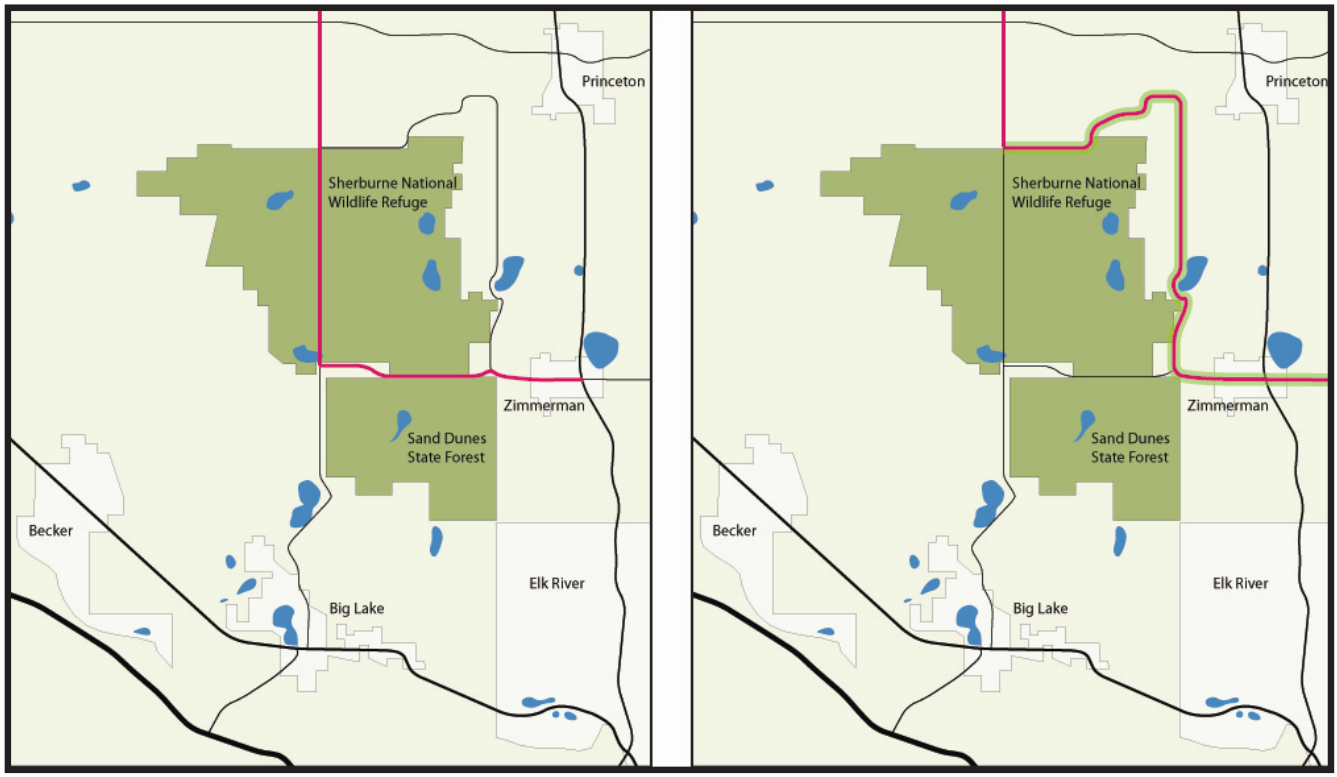

Figure T10. One alternative, right, to minimize the impacts of proposed upgrades in and at the southern edge of the Sherburne National Wildlife Refuge (County 5 and County 4) near Zimmerman would be to shift these "green corridor" projects around the habitat in the refuge and to design a location-specific roadway type to buffer impacts at the edges of the refuge and Sand Dunes State Forest.
Credit: KatherineThering, UM Metropolitan Design Center.

The proportion and quality of critical habitat was assessed along all roadways in the county, both existing (2007) and projected (2030) (Figures T12 through T15). Roads were analyzed by functional class: major, minor, and urban collectors and major and minor arterials. The buffer distance for the analysis varied with road functional class, as shown in Table T1. A change analysis was used to determine the degree of habitat change association with transitions in road classes.

The plan adds 7.5 miles of road to the existing transportation network (Table T2). There are strong differences in functional class, however, with 58 miles of road becoming minor arterials, predominately from the minor and major collector class of roads.

The direct and indirect influence of roads varies with road size (Forman, 2003), so the transition to minor arterials from small classes of roads has a significant potential on habitat quality. This is particularly true in areas where major collectors traverse significant natural areas. The north-south corridor along the western edge of Sand Dunes State Forest and the east-west arterial that bisects the large area between the state forest and Sherburne National Wildlife Refuge have both direct effects on local habitat and broader effects related to landscape connectivity within the region (Figure T16).

Functional Class	**Buffer Distance (m)**
Urban Collector	90
Minor Collector	90
Major Collector	180
Minor Arterial	270
Major Arterial	360

Table T1. Buffer distances for road functional classes.

Functional Class	2007	2030	Change
PRINCIPAL ARTERIAL	61.8	52.1	-9.6
MINOR ARTERIAL	35.6	93.7	58.1
MAJOR COLLECTOR	169.4	135.1	-34.2
URBAN COLLECTOR	14.8	20.3	5.5
MINOR COLLECTOR	76	63.8	-12.2
Total	357.6	365.1	7.5

Table T2. Road lengths (mi) in current and future functional classes.

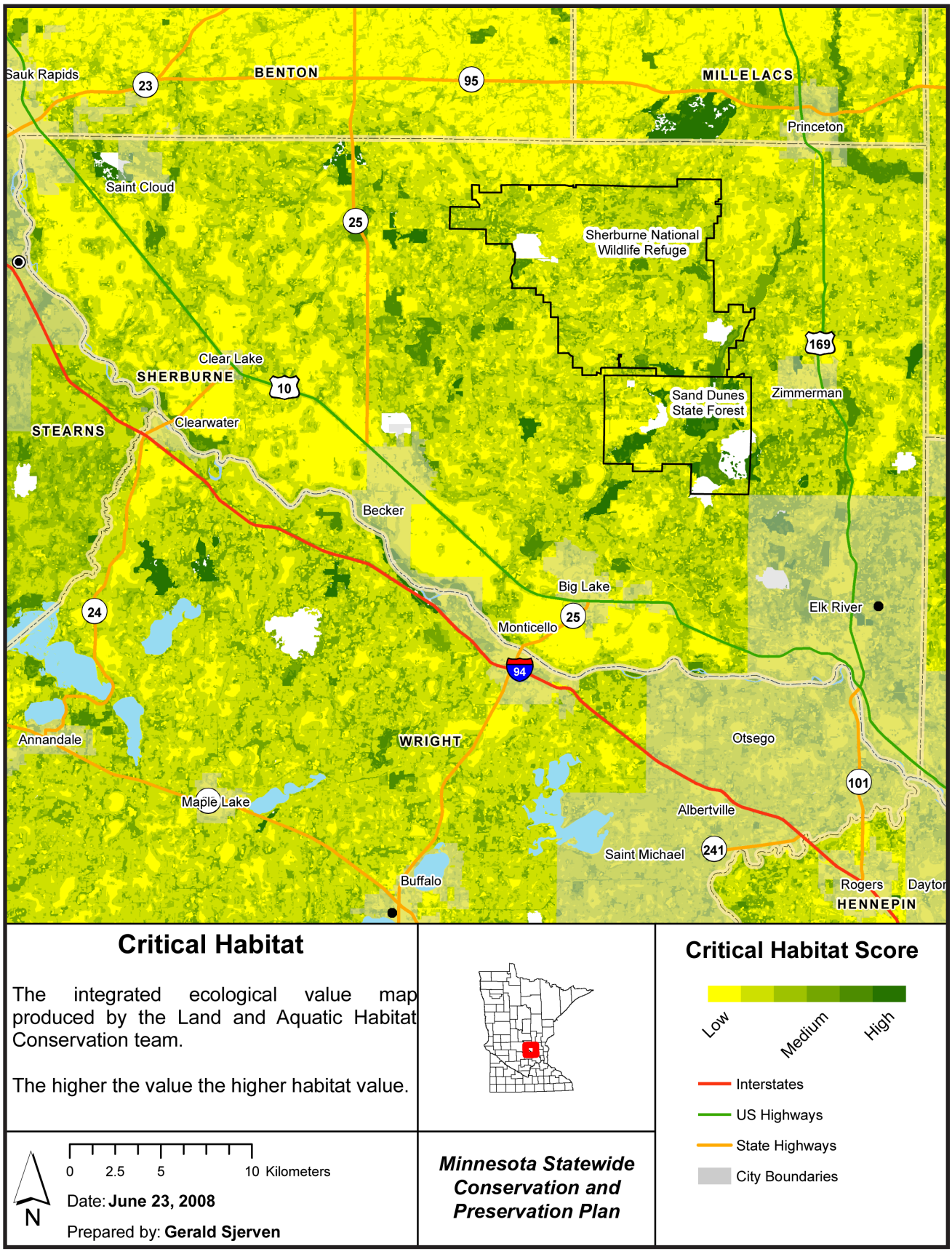

Figure T11. Critical habitat. Credit: Gerald Sjerven, NRRI.

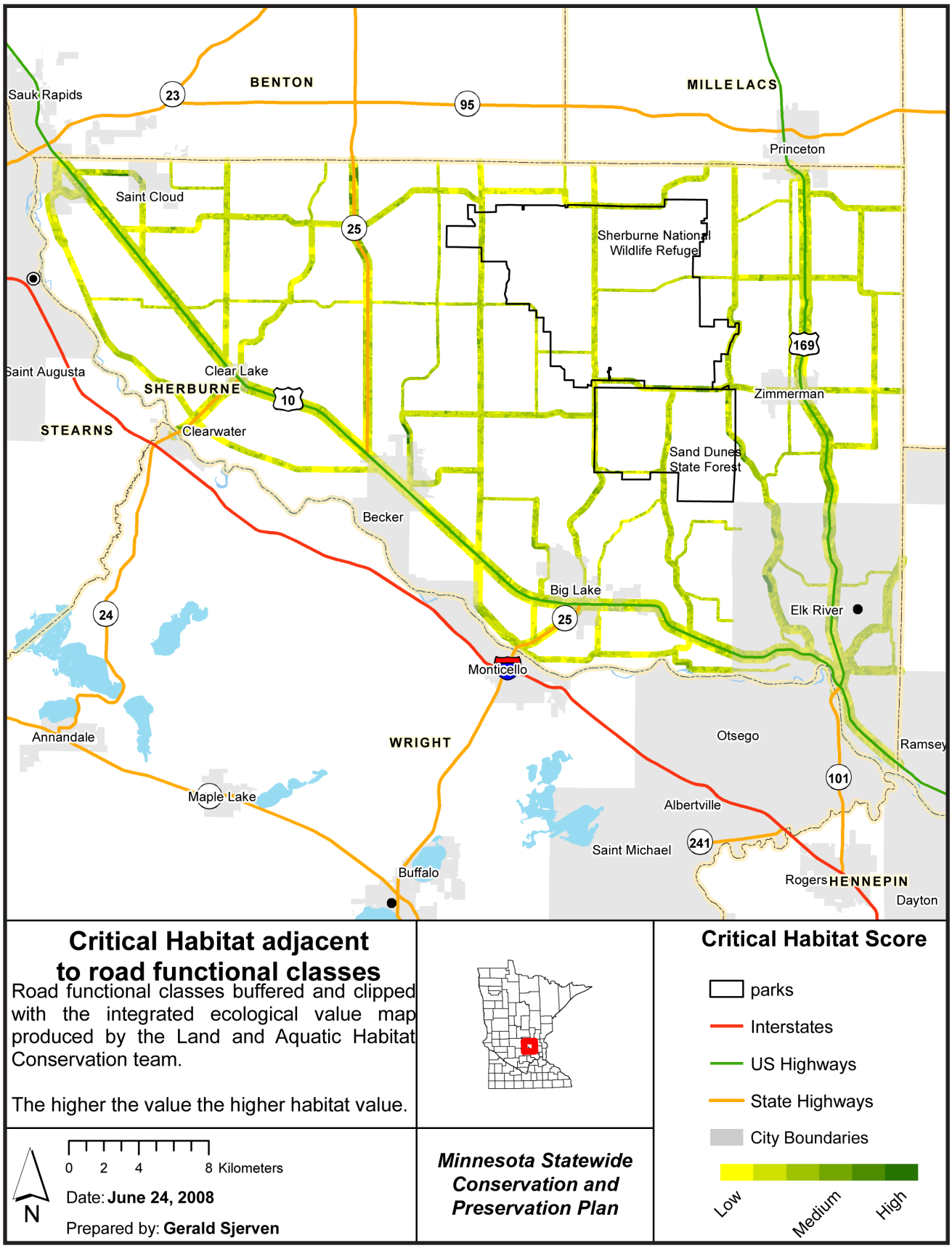

Figure T12. Critical habitat adjacent to road functional classes. Credit: Gerald Sjerven, NRRI.

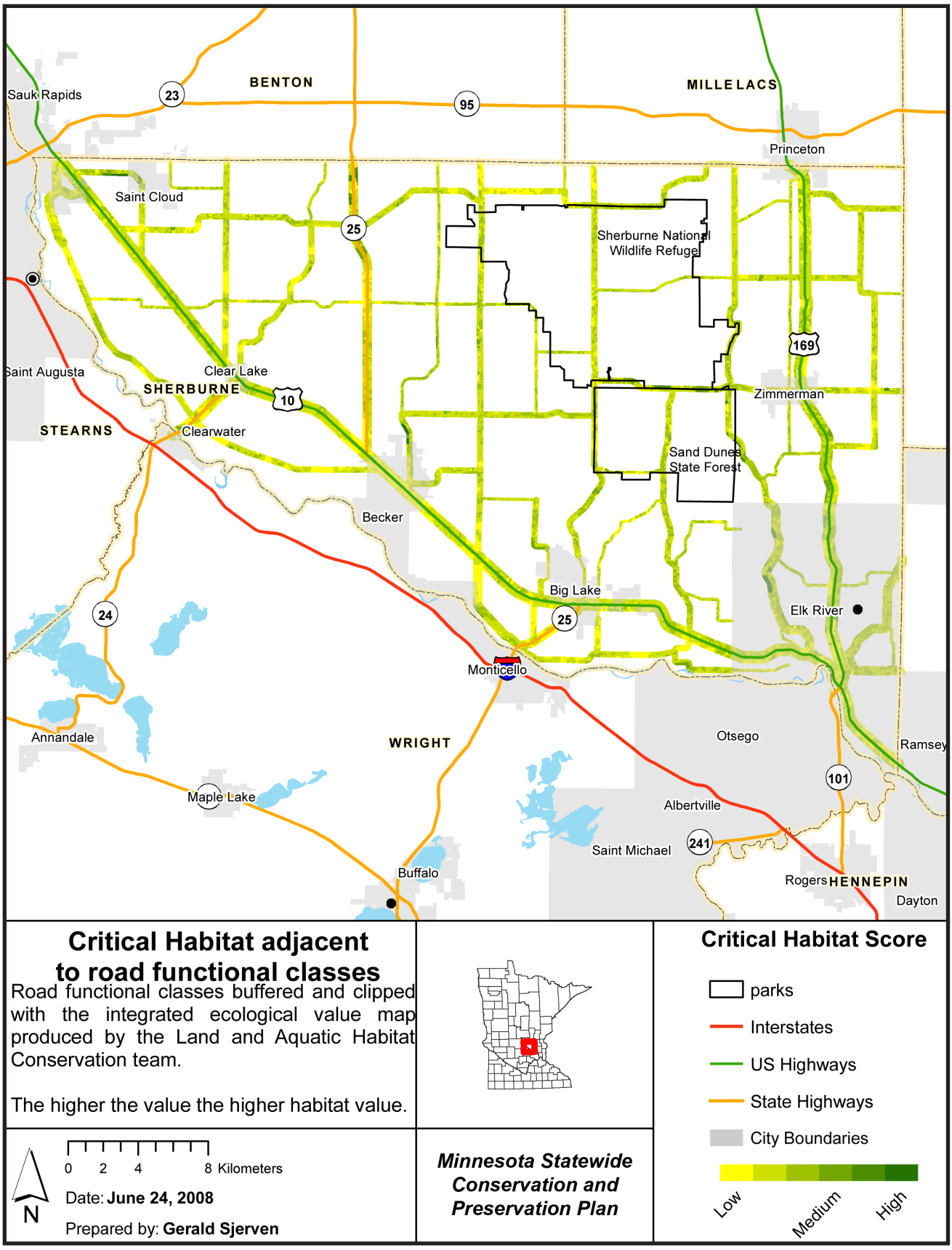

Figure T13. Critical habitat adjacent to future road functional classes. Credit: Gerald Sjerven, NRRI.

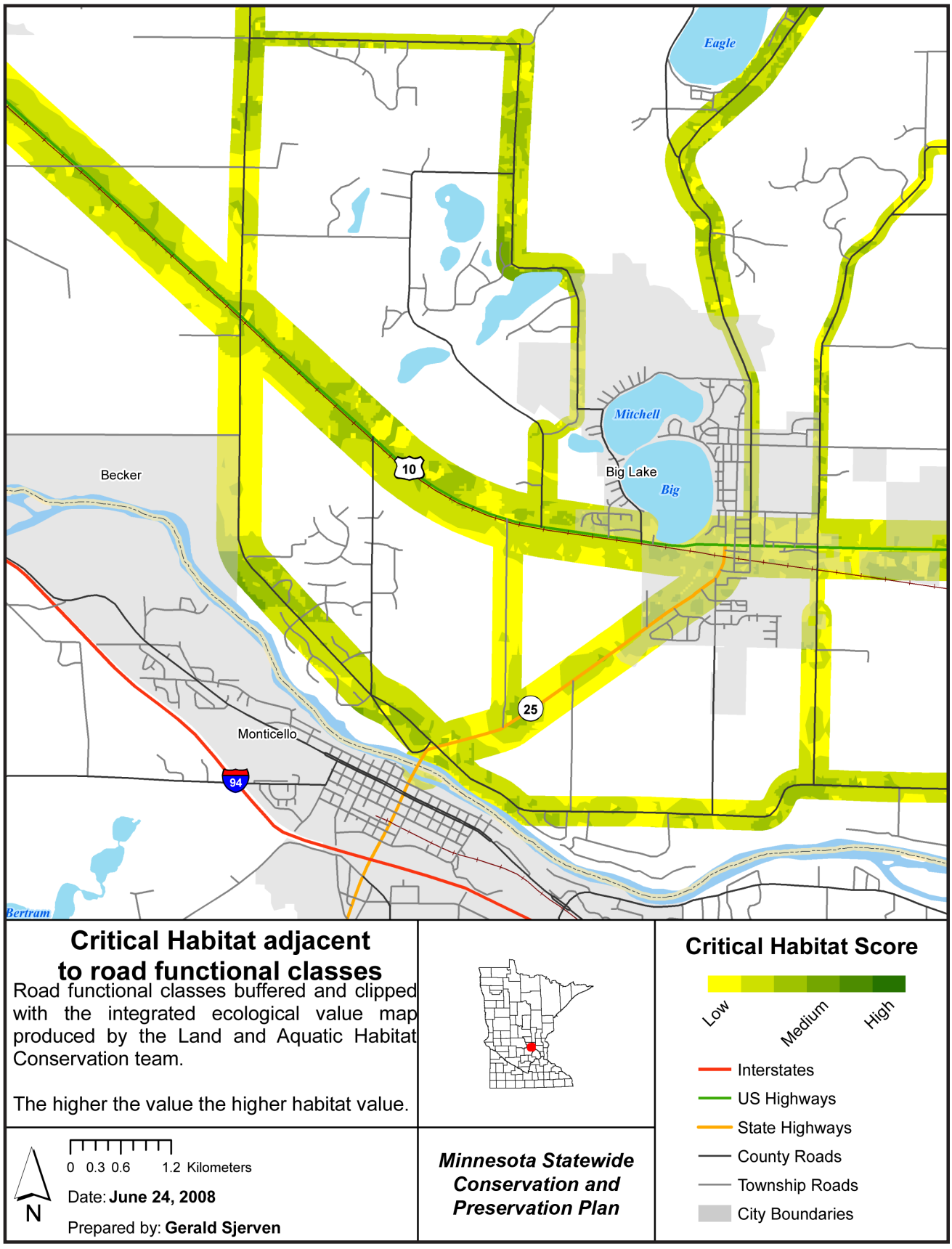

Figure T14. Critical habitat adjacent to road functional classes. Credit: Gerald Sjerven, NRRI.

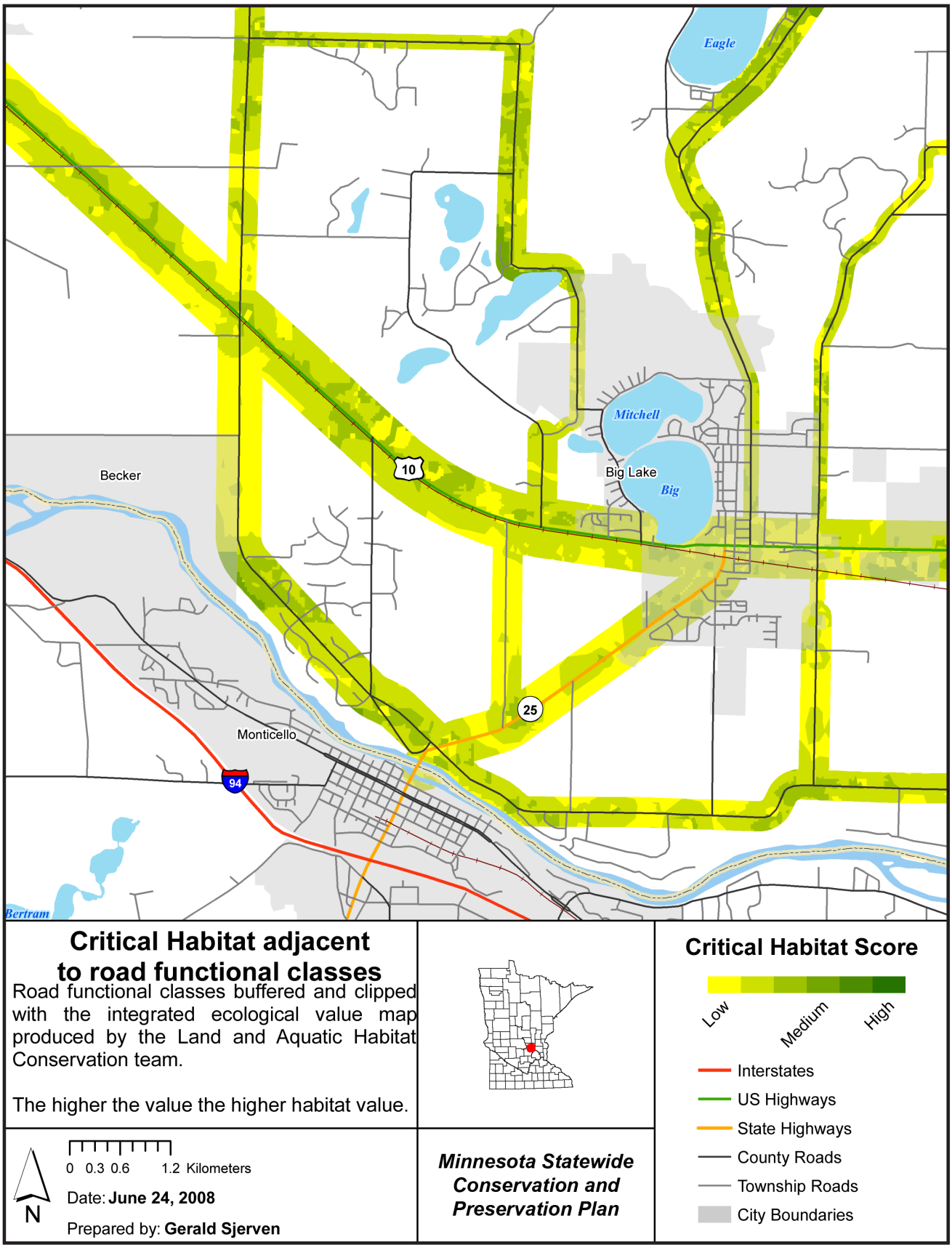

Figure T15. Critical habitat adjacent to future road functional classes. Credit: Gerald Sjerven, NRRI.

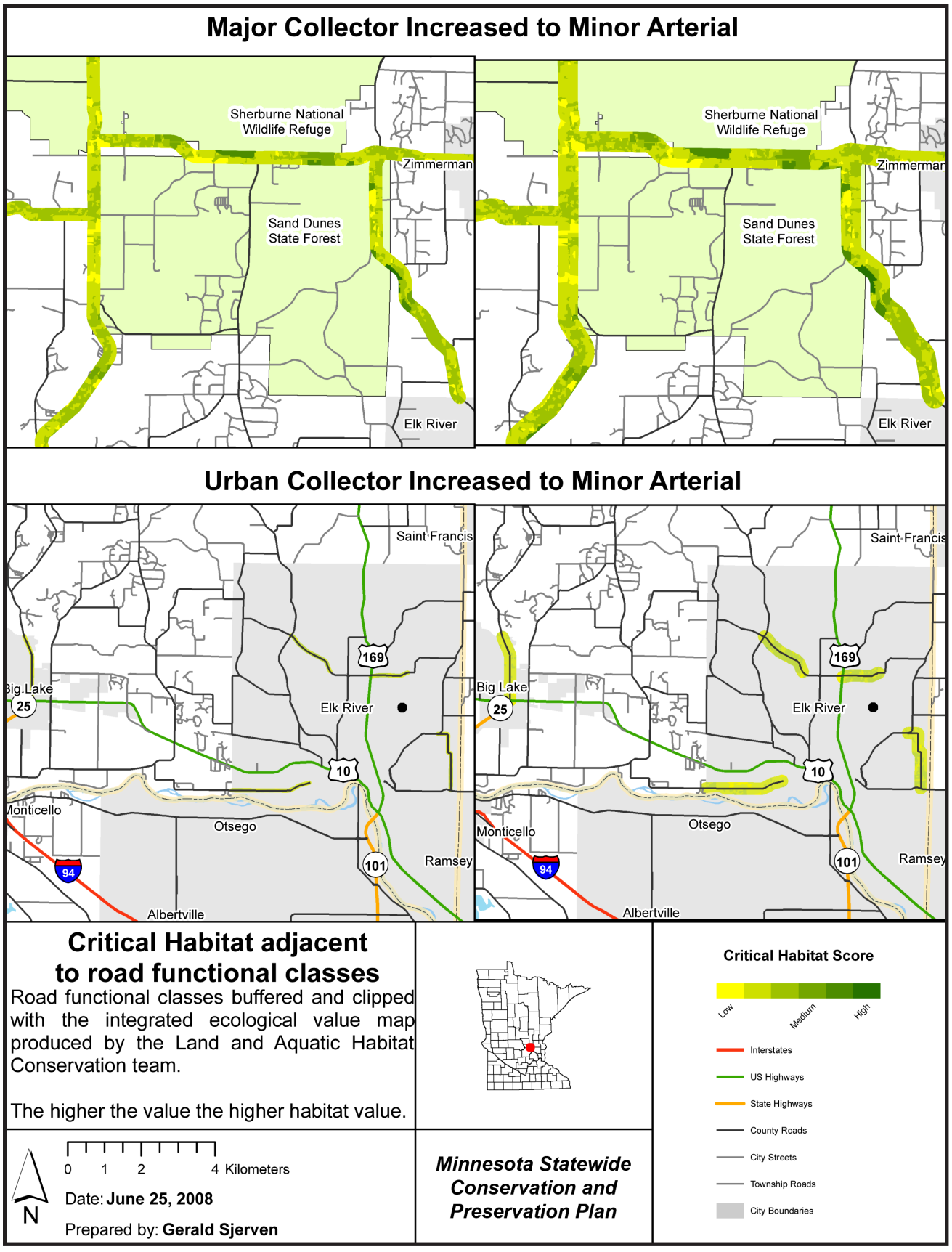

Figure T16. Critical habitat adjacent to road functional classes. Credit: Gerald Sjerven, NRRI.

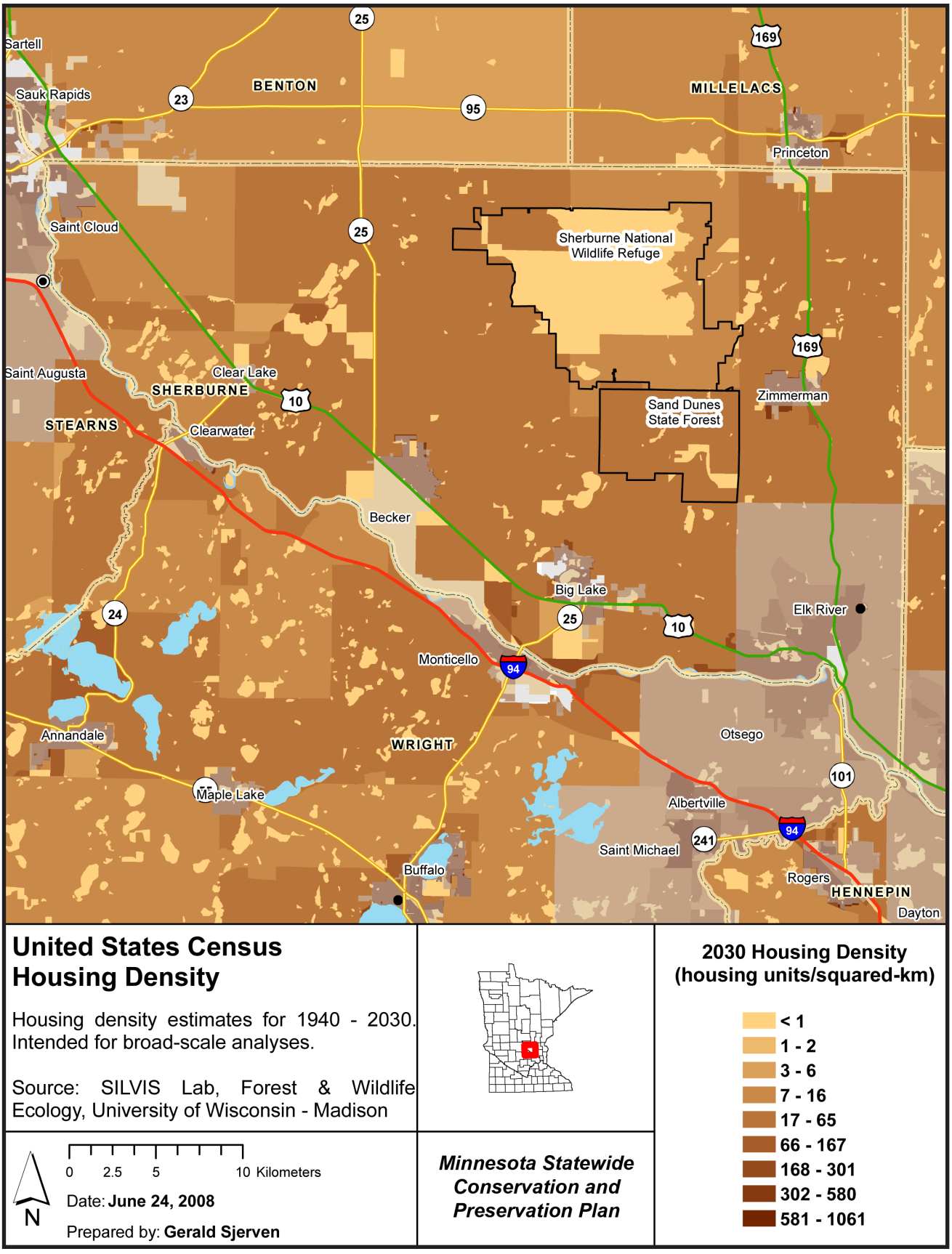

Figure T17. U.S. Census housing density. Credit: Gerald Sjerven, NRRI.