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This report is a combination of two reports (Task 1 and Task 2 and 3) on the Highway 61/Red Rock Commuter Rail Corridor. The Task 1 portion describes the baseline conditions related to subdivision-scaled growth in the corridor, with particular concentration on Cottage Grove, one of the station sites. Also considered are current plans for the downtown St. Paul Union Depot. The Task 2 and 3 portion focuses on issues relating to the relationship between transportation and the environment. An important issue in this study, therefore, is the design and institutional integration of objectives across investments in transit services at a regional scale, public space, and the long-term value of developed private space, especially in suburbia. The report offers designs for new, alternative patterns of regional growth, both urban and suburban, in broad corridors served by commuter rail service. The study also demonstrates the designs' effects on two principal problems of sprawl embodied in the street and highway network that is the bones and circulatory system of growth:

1. Unstratified, single-mode transportation infrastructure designed for peak demand, and
2. Degradation of environmental resources, especially water, the state's namesake resource and a central article of its competitive advantages.

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Transportation, Urban Design, and the Environment: Highway 61/Red Rock Corridor

Report #13 in the Series:
Transportation and Regional Growth Study

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Preface

The Transportation and Regional Growth Study is a research and educational effort designed to aid the Twin Cities region in understanding the relationship of transportation and land use. Many regions of the country are experiencing rapid commercial and residential development, often accompanied by population growth and growth in the total area of land developed. This has caused a range of concerns, including the direct costs of the infrastructure needed to support development and the social and environmental side effects of development patterns.

This study is an effort to better understand the linkages between land use, community development, and transportation in the Twin Cities metropolitan area. It is designed to investigate how transportation-related alternatives might be used in the Twin Cities region to accommodate growth and the demand for travel while holding down the costs of transportation and maximizing the benefits. The costs of transportation are construed broadly and include the costs of public sector infrastructure, environmental costs, and those costs paid directly by individuals and firms. Benefits are also broadly construed. They include the gains consumers accrue from travel, the contribution of transportation and development to the economic vitality of the state, and the amenities associated with stable neighborhoods and communities.

The University of Minnesota's Center for Transportation Studies is coordinating the Transportation and Regional Growth Study at the request of the Minnesota Department of Transportation and the Metropolitan Council. The project has two components. The first is a research component designed to identify transportation system management and investment alternatives consistent with the region's growth plans. It has six parts:

1. Twin Cities Regional Dynamics
2. Passenger and Freight Travel Demand Patterns
3. Full Transportation Costs and Cost Incidence
4. Transportation Financing Alternatives
5. Transportation and Urban Design
6. Institutional and Leadership Alternatives

The first three research areas are designed to gather facts about the transportation system and its relationship to land use in the Twin Cities metropolitan area. The other three research areas will use these facts to investigate alternatives in financing, design, and decision making that could have an impact on this relationship. Results of this research is and will be available in a series of reports published for the Transportation and Regional Growth Study.

The study's second component is a coordinated education and public involvement effort designed to promote opportunities to discuss the relationship between transportation and growth based on the research results. It is believed that this dialogue will help increase knowledge and raise the level of awareness about these issues among the study's many audiences including decision makers who make policy, agency professionals who implement policy, stakeholder groups who try to influence policy, and members of the general public who experience the consequences of those policies.

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EXECUTIVE SUMMARY

Commuter Rail and Sprawl: New Alternatives for Growth

Landscape architects in this study refer to the 'genetic code of sprawl' to describe all of the legal and formal frameworks and the systematized structures engendered by them that tend to create a sprawled suburban landscape. This 'code' is embedded into the designs, planning practices, and policies that encourage conventional suburban-style development and is embedded deeply in the culture of the Twin Cities region. This study develops designs for new, alternative patterns of regional growth, both urban and suburban, in broad corridors served by commuter rail service. The study also demonstrates the designs' effects on two principal problems of sprawl embodied in the street and highway network that is the bones and circulatory system of growth:

1. Unstratified, single-mode transportation infrastructure designed for peak demand, and
2. Degradation of environmental resources, especially water, the state's namesake resource and a central article of its competitive advantages.

Organization

This report on Task One, Two, and Three is a combination of two reports on the Highway 61/Red Rock Commuter Rail Corridor. The Red Rock commuter service has been proposed to serve communities from Hastings, Minnesota to Minneapolis, with a principal station in St. Paul. The Task One report, the first of this series, describes the baseline conditions related to subdivision-scaled growth in the corridor, with particular concentration on Cottage Grove, one of the station sites. Also considered are current plans for the downtown St. Paul Union Depot.

One finding of the Task One report shows there is a lack of design, planning, and policy integration across transportation, land use, and urban and suburban design in the corridor and the communities served by it. Rooted in the current policies and processes is a pattern of fragmentation stemming from a legal framework of local control and an administrative framework based in professional specialization. This lack of integration seems to produce, paradoxically, a somewhat homogeneous pattern of dispersed growth or sprawl.

Integrative Approaches

The Task Two and Three study focuses on issues relating to the relationship between transportation and the environment. An important issue in this study, therefore, is the design and institutional integration of objectives across investments in transit services at a regional scale (such as commuter rail), public space (such as streets and parks), and the long-term value of developed private space, especially in suburbia. Several innovative institutional propositions are raised in the final chapter of this report, all suggestive of greater cooperation across units of government in decisions about infrastructure provision in concert with land use, zoning, and urban design decisions.

Study Variables

One focus of this study has been to illuminate critical design and institutional variables that might alter the 'genetic code of sprawl' by which vehicle miles traveled (VMT) have grown so exponentially and surface and groundwater quality and groundwater quantity have been threatened. Despite the apparent sameness of post-WWII suburbia, communities actually operate separately from one another. This discourages connectivity, which requires coordination and cooperation in absence of regional or statewide authority. The design variables, therefore, are:

- ***Vehicle Miles Traveled (VMT)***

  VMT is a measure of spatial sprawl, and as such is an interesting and significant transportation variable to describe the phenomenon. For example, if a person cannot get a carton of milk without getting into the car, this is the VMT increase related to sprawl and zoning and transportation funding for improved arterials that places stores in strip malls rather than on a corner near one's home.

  Task One findings: Street networks in their current, internalized form become the framework (i.e., the bones and circulatory system) of single mode, single use suburban growth patterns.

  Design alternatives: Use of connective street and public open space patterns, multi-modal streets (i.e., walking, bicycles, transit), multiple uses with service destinations, alternative densities.

- ***Water Quality/Quantity***

  Task One findings: Storm water is currently treated as waste and piped to distant receiving basins, often with little ecological or recreational connectivity in largely independent institutional frameworks (there are 110 local water utilities in the suburban metropolitan area). Storm water design is currently part of comprehensive plan review, but new systems are designed and executed on a one-size-fits-all system with few opportunities for infiltration or other innovative practices.

Task Two/Three Design alternatives: Use of storm water collection, infiltration, and exfiltration as part of new connective infrastructure and framework of public space.

Commuter Rail

Commuter rail is different from light rail in that commuter rail depends primarily on the commute from home to job. This means that central cities in commuter rail metropolitan areas are strong job locations. Stations are farther apart, in fact, miles apart. All ridership is not governed by 1/4- to 1/3-mile radius pedestrian ridership. Commuters sometimes walk to the train, but most often they drive, take feeder transit, or bike.

Commuter rail is also different from bus service, although in some communities less well served by rail networks, dedicated commuter bus ways have been built with success.

The types of suburban places served by commuter rail are diverse, though they share certain types of patterns including street networks. Commuter rail riders also tend to be higher income than bus or, on average, even light rail riders.

As the Task Two and Three report explains, there are multiple ways to take advantage of commuter rail service in a variety of new suburban design approaches that are related to the specific characteristics of commuter rail service. In this report, this general category of design approaches is called commuter rail-oriented design.

Alternative Commuter Rail-Oriented Design: Subdivisions and Infrastructure

The attempt of the study is to demonstrate that VMT and water quality could be positively affected by alternative designs for subdivisions, called here commuter rail-oriented design-lo (3 to 4 dwelling units/acre) and commuter rail-oriented-med/hi (7 dwelling units/acre). The subdivision of land embodies the scale and process by which the land is developed and provided with relatively permanent infrastructure, including the hierarchy, form, and scale of streets. The subdivision designs in the Task Two/Three study investigate forms of subdivisions different from the current baseline (Task One) with particular attention to integrating these issues:

- commuter rail
- street design and networks (special attention to subarterial and arterial networks)
- land use
- station area design
- hydrological infrastructure

General and Specific Types of Findings

Certain types of design approaches explored in the Task Two/Three report could be effective generally and are broadly applicable to commuter rail corridors. Other approaches are more specific. For example, the patterns of street networks and mixed land uses might be generalizable. More specific types of findings in this study include those, for example, related to the street and rail geometry, soils, topography, vegetation, and other site-specific issues.

Findings

- ***Vehicle Miles Traveled (VMT)***

  Trips/Streets

  Trip behavior modeling is currently not well attuned to commuter rail-oriented design in terms of scale and street network patterns adaptable to modeling. However, it is likely that street and path networks with high connectivity, multi-modal characteristics, and relative stratification of types in a mixed-use setting may reduce VMT.

  Destination nodes—mixed use

  If there are also well-scaled (1/4–1/2 mile walking radius) destination nodes of mixed uses with everyday commercial and institutional services in these neighborhood settings, VMT is likely to be reduced by linked destination, multi-purpose trips. These neighborhood settings are located not only at the station area.

Density—bus feeders, jitney service

While transit-oriented densities (7–16 dwelling units/acre gross density) and bus feeders also reduce VMT, many commuter rail riders drive to the station. One alternative is a just-in-time jitney service such as that used on the Chicago METRA lines.

- ***Water Quality***

There are important opportunities in subdivision design related to water. Storm water from private property usually ends up in the street and then in a pipe. Perhaps we can better manage this global resource rather than simply taking it directly to the Mississippi River or other receiving waters. This is the essence of infiltration design for subdivisions. Unless runoff can be pretreated before it is piped back into distant surface water basins, many contaminants, including carcinogens, may reach receiving basins such as the Mississippi River from which both Minneapolis and St. Paul draw water. In a drinking water system that depends on such surface waters, all types of runoff must be controlled. The primary focus of the design work on the suburban sites has been to recapture storm runoff into the hydrological cycle via infiltration and exfiltration methods (e.g., filtering storm water through 50 feet of sand and returning it to the ground water) as opposed to directing it into distant receiving basins. This recapturing approach has been in large part possible because of the permeability of soils in this particular area and their great depth to the water table.

The main hypothesis of this design work is that the street is the intermediate conduit to the ultimate storm water receiving area. The design strategy is to incorporate infiltration/exfiltration[i] approaches into the street designs, which when combined with the open space design results in no net runoff for a ten-year storm (4.15 inches in a 24-hour period) from commuter rail-oriented design-lo (3-4.5 dwelling units/acre) or commuter rail-oriented design-hi (7 dwelling unites/acre) developments.

Infiltration Parkways

In two versions of street designs for parkways, storm water is conveyed and infiltrated via bio-infiltration swales in the street right of way.

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[i] *Exfiltration: The downward movement of runoff through the bottom of a treatment system into the soil layer. *Design of Storm water Filtering Systems,* Center for Watershed Protection. *1996.*

Local Residential Streets

Local residential streets store and exfiltrate storm water in large perforated pipes connected to standard catch basins in curb and gutter streets.

- ***Institutional Framework***

  The standards by which local comprehensive plans are approved must be coordinated with regional infrastructure investments, including transportation, environmental carrying capacity, including hydrological function, and integrative policy initiatives on land use and urban and regional design. New toolkits such as pattern books for street and performance standards for hydrological design and incentives that allow communities to innovate and protect resources must be provided regionally to shape flexible new development patterns.

CHAPTER 1

Introduction: Urban Design and the Genetic Code of Suburban Growth

What some call sprawl, others call home. Americans have longed for the delights of suburbia for almost two centuries. They have created a constellation of laws, financial incentives, design metaphors, and administrative processes by which they can realize the making and attainment of suburbia. The myth of suburbia combines the promises of safety, freedom of movement, green fields, good schools, access to jobs, and affordable housing. The generative factors of these attractive elements include government incentives of nearly every type, but especially transportation and housing. These types of market imperatives, when cast upon this incentive structure, have been particularly strong in the metropolitan area of the Twin Cities where, historically, many residents have been of European descent and have had agricultural or suburban roots.

In 1967, the Twin Cities region seemed embarked upon a bold experiment in regional planning and growth management. That same year, the Metropolitan Council, which was to guide the activities of an agency charged to create urban services for the seven-county region, was created. The Metropolitan Council was poised to take advantage of the congenial politics of a growing region led by its enlightened business elites. In a region rich in water resources, one critical focus of the Council was the provision of sewerage to protect water quality. Metropolitan parks were added as was solid waste disposal. Soon the staff planners were involved in the approval of local comprehensive plans. However, unlike Metro (formerly the Metropolitan Services District), the Council's parallel manifestation in Portland, Oregon, the Metropolitan Council did not possess the enabling legislation to impress a region-wide agenda on its work. The Council could approve local plans, but there were, in fact, no defensible standards by which it could reject plans. This has resulted in the approval of development plans that encourage sprawl.

Along the Highway 61 corridor, communities are regularly encouraged to develop at between 3 and 4 _ units per acre. Further, the legislature has provided no defensible means by which agriculture or environmental resources could be protected from leapfrog development. There is no urban growth boundary, and there are few incentives to preserve and or to develop at greater densities beyond the Metropolitan Urban Service Area (MUSA), in spite of statewide investments that enhance the values of a locale. However, the growth of suburban areas and regions is changing elsewhere in the nation, and in the Twin Cities, change may also be on the way. Rather than occurring in a comprehensive manner as it has in Portland, suburban growth has tended to take more incremental forms. For example, as suburban growth becomes more diverse demographically, certain fiscal disparities have been recognized. In 1971, the Minnesota Legislature narrowly passed the Fiscal Disparities Act. Since then, Representative Myron Orfield has demonstrated that these disparities occur across suburban areas and are present in the inner city as well. Environmental quality, taken for granted in suburbia, now finds itself threatened by the very nature of the growth. This value that once underpinned economic values was a critical determinant in investment decisions. The factors that previously stimulated the sometimes willy-nilly patterns of the past are changing.

Traffic and Transit Politics

On the transportation front, congestion has limited the freedom of movement for many in suburban settings. In the May 28, 2001 issue of *US News and World Report*, Philip Longman forefronted a host of concerns about the diminishing returns on presumed lower cost housing investment in suburban living. While automobile commuting times, for example, have not increased greatly in numerical terms in the last several decades, the actual effects on quality of life of these small increases has been marked. Psychologically we are reeling from the increasing and increasingly fragmented demands of our lives. More than half of one California family psychologist's caseload could trace their problems to decreased time and psychological well-being directly attributable to traffic. Many residents of suburban areas have decided to switch from cars to transit when available; in the last decade transit ridership has increased 21% nationally. In a recent survey, the role of the automobile in that growth also came into a new perspective. In the same issue of *US News and World Report*, Longman reported that Smart Growth America asked a cross-section of Americans: 'Which of the following proposals is the best long-term solution to reducing traffic in your state? Build new roads; improve public transportation, such as adding trains, buses, and light rail; or develop communities where people do not have to drive long distances to work or shop?' Seventy-five percent of the respondents called for either mass transit improvement or more connective, compact development; only twenty-one percent favored new roads.

Some conservatives have realized that transit investments are crucial to the economy. In the same article, Weyrich and Lind stated that rail transit investments serve "some important conservative goals, including economic development, which can be both spurred and shaped by rail transit systems; helping the poor move off welfare and into jobs (which they have to get to somehow); and strengthening the bonds of community…The dominance of automobiles and highways is a product of massive government intervention in the marketplace, intervention going back to World War I."

Quality of Life

In the meantime, in a recent Center for Transportation Studies Research conference, one commentator suggested that in Minnesota, three issues that define quality of life in the state needed to be resolved in an integrated fashion:

1. The polarity between highway investments and transit investments must be erased to maintain the accessibility Minnesotans expect.
2. Natural resources, especially water-based resources, must be protected for future generations.
3. The mortgage deduction component of tax policy must remain in place to keep the single-family housing market alive.

If direct costs are not compelling enough issues to examine alternatives to the baseline, consider the indirect costs that are embedded in these somewhat contradictory propositions. The Bureau of Transportation Statistics National Report, 1999, acknowledges, "[d]ata on transportation-related water pollution, solid and hazardous waste generation, noise, and the physical disruption of habitat are collected or estimated too infrequently to provide reliable national trend data for all modes and phases…Also, data are inadequate to generalize about the complex transportation network, diffused development patterns, and environmental quality; the secondary effects of transportation for land use are not addressed in this report."

The design and construction of transportation systems has engendered a host of secondary effects related to land use and resource depletion. These are the subjects of a growing literature on regional growth in planning, ecology, engineering, and design. Some of the most comprehensive thinking has come from planning. Some of this literature focuses on government. In "Growing and Governing Smart: A Case Study of the New York Region," Robert Yaro points to the products of growth being "racial, economic, and social divisions; increasing traffic congestion; inequities in infrastructure and school finance; adverse environmental effects" that give rise to questions about the structure and processes of metropolitan planning and governance. He suggests that there are models of incremental change that focus on issues of region-wide importance (such as transportation) that have engendered very successful taxing districts and authorities. These models seem to have promise for a commuter rail corridor such as the Red Rock corridor. A more flexible system of providing urban services to communities along the corridor would create a better correspondence between development patterns and commuter rail investments than communities could muster on their own.

The Genetic Code of Subdivision Today

The subdivision is the expression of the local template and stimuli of growth. It is the generative element, especially of housing development. Above and hidden below the ground, the subdivision joins structure to nature. The subdivision of land makes a formal template of growth, often only visible as improvements take shape on lots. Subdivsion is the "meat in the middle of the sandwich." It is the mediator between built and unbuilt, cultural and natural. It shapes public and private spaces as a bundled infrastructure of stuff—much of it in the street—that supports and is capped by structures that will be built on it. It arbitrates a relationship between these structures and that which lies below in the natural and physical systems of the site.

The general structure of housing, for example, is created by the four Bs: the builder, the banker, the budget, and the buyer. The four Bs are then also mediated by the subdivision itself, a product of many layers of plans (see Figure 1.1).

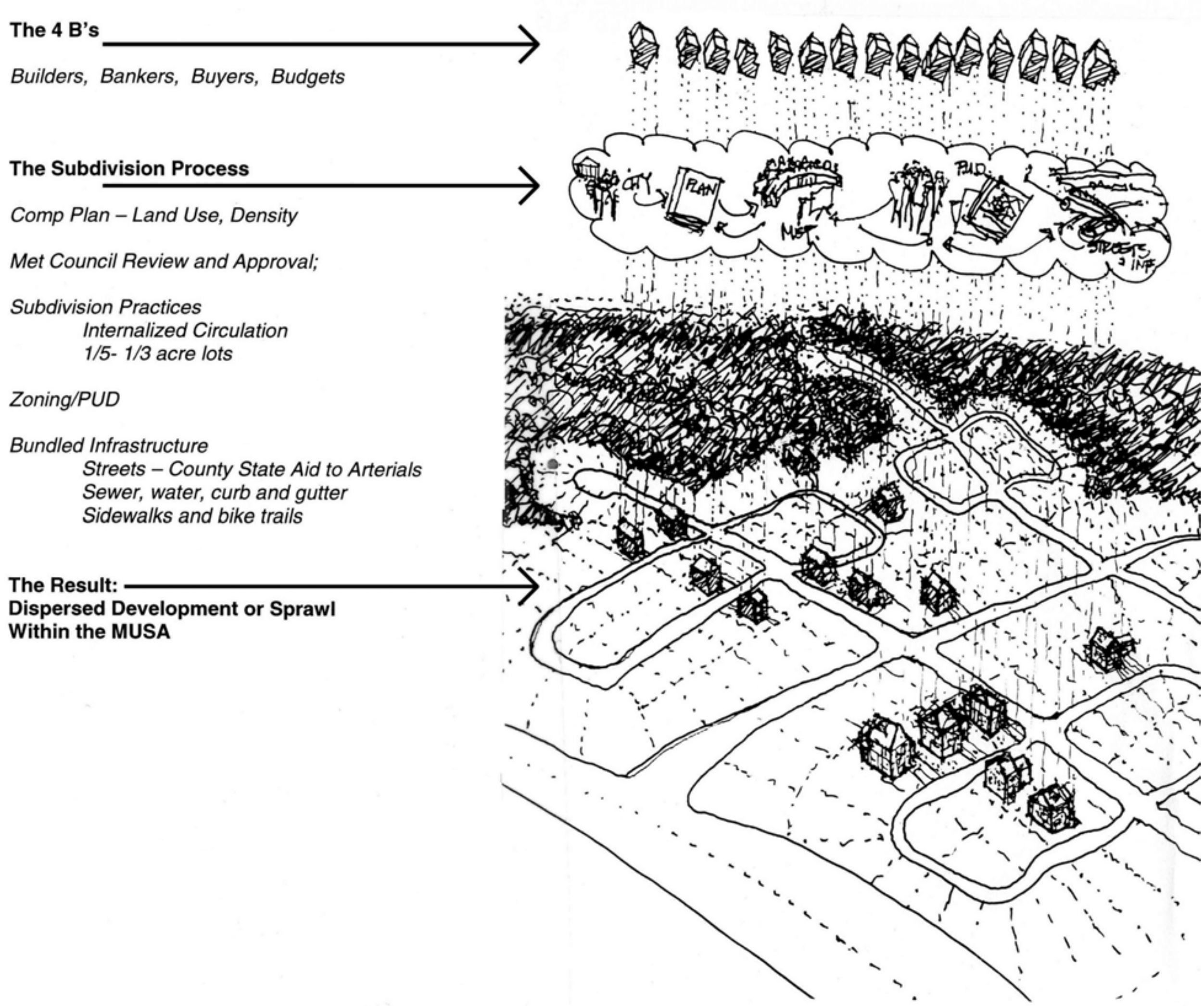


Figure 1.1 The Genetic Code of the Subdivision: Part of the Genetic Code of Sprawl/Congestion

In large part, the subdivision was chosen as the scale of design because it exemplifies the order of magnitude at which the land has been and is taken down (i.e., converted from green fields to improved property) in the period since the end of World War II. In this period, Americans have concretized a value shift that is seen in the subdivision. In the late nineteenth and early twentieth centuries, we began building American cities with an emphasis on the provision of public goods as a way of inducing choice in urban living—such as multi-modal transportation systems—and diversity of form and scale. We have since come to an individualistic value system that gives primacy to privacy—private property and private vehicles. We have provided matching economies of scale, all necessarily served by a highway and street system that encourage these values. When a subdivision is platted, a complex array of federal, state, and local government policies come into play to give it shape and serve it with infrastructure, including transportation and critical utilities. Streets are first platted and then constructed. Sometimes sidewalks are built, sometimes not.

While plats in nineteenth-century Midwestern cities traditionally followed the pre-established grid of the official map, or, more rarely, the design of a landscape architect, engineer, or developer, platting is a different process today. It is dominated by owners or developers and their engineering consultants. Engineers specify the ubiquitous curb-and-gutter street sections and their widths according to classification and expected service levels. The distribution of costs for streets is made according to this determination across levels of government and private developers. Since collector streets are essentially paid for by the developer, there is a natural reluctance to design them as through connective streets. Rather, these streets loop through neighborhoods looking much like the labyrinthine residential streets around them—and probably functioning more like them than conventional subarterial connectors. This formal and functional linkage accounts for the generally internalized pattern of streets in subdivisions and their singular use for residential development. Most residential developers do not have experience developing commercial properties, which exacerbates the separation of uses evident in the auto-intensive, strip-style commercial development of upgraded county roads serving as the arterial structure of suburbs.

Most, if not all, of the utilities related to water are bundled both into the contracts for construction and the physical space of the public right-of-way. Storm water is moved away from private property as a hazard and treated as waste in a largely hidden system of pipes, until it emerges, sometimes as untreated pollution, in surface receiving waters—lakes, streams, and rivers. Parks are created, usually according to recreational demands, often on some of the least saleable parcels. Sometimes parks are sited in drainage corridors, but sometimes these parks have no such obvious hydrological function.

The pattern and scale of public access, service provision, and the scale and type of private development are to a large extent determined by this layered process of intertwined and fragmented decisions. Lots are sized according to local zoning codes and designated for planned uses. Lots in single-family districts run between a 1/5-acre in sewered areas of cities to 10 acres or more in townships. Residential uses are separated from other uses. Since many local codes and practices are similar, though fine-grained differences exist, this process represents the translation of policy into the primary ordering of dispersed suburban growth.

Obviously, subdivision has already occurred in built-up areas, and to a great degree, the envelope and type of new activity that can occur on urban land is determined more by zoning and by the market than subdivision standards. But here too, the transformation of the city since World War II is predicated on suburban values. Streets designated as highways are widened and intersections broadened to afford higher levels of service in peak periods. These actions dovetail with market signals that, given current zoning conventions, offer precedence to large, auto- and truck-served facilities, so-called big-boxes, that replicate the scale and access patterns of suburbia. Off-street parking and loading requirements often determine that shape, size, and placement of buildings in the middle of large, usually pre-assembled, parcels of land. These patterns tend to preclude other types of options by fixing the primacy of individual vehicles to be the central ordering mechanism of city construction.

Urban Design and the Physical Order of the Genetic Code

New urban design starts with "what is" and asks "what if." Good urban design imagines the future whole. Ideally it precedes policy, rather than being used after-the-fact to decorate or mitigate the physical effects of policy. Design conceived in this way disaggregates and then integrates multiple areas of concern in a unified, if sometimes diverse, physical form. The urban design process renders composite images in context to give physical form to complex scenarios for the future. It investigates the public and private processes by which urbanization and suburbanization occur. In this study, design reveals both the look and the underpinnings of the status quo as it raises questions about change that could provide more cost-effective, manageable, and sustaining development objectives and processes. One measure of whether that outcome is, indeed, possible, is the appeal of these potential changes to our eyes, our pocketbooks, and our consciences, individual and collective.

This part of the study uses urban design to probe the physical aspects of two questions: what is the current genetic code of regional growth (Task One—the baseline) and how can its structure be changed (Tasks Two and Three)? Growth is the product of individual actions in a complex and interconnected system. Like the quest to isolate certain genes and to replicate certain combinations, the design inquiry into urban and suburban growth focuses on both the details and the composite spatial order of current and proposed patterns of urbanization and their relationship to transportation and the environment. One central approach of this part of the study is to use urban design inquiry to illuminate the structure and processes of dispersed growth, or sprawl. Once explicated, strategic interventions in their composite order may reveal new acceptable, even more desirable, alternatives to this pattern.

The Integration of other TRG Findings into the Framing of this Study

Why examine these questions at all? Why not leave well-enough alone? The Transportation and Regional Growth (TRG) Study has positioned these issues at the forefront of regional policy. Most of the other studies have already been completed. In summary, these are the findings of the investigators in these studies that frame the context of the questions addressed in this study:

- Adams, et. al sewerage. in Part I of the study, made certain findings that suggest that the central cities of Minneapolis and St. Paul have subsidized some of the growth in peripheral towns and other minor civil divisions. Further, there is no practical limit set to limit the spread of development.

- In Part II of the study, Barnes found that vehicle miles traveled (VMT) had risen 144% since 1970. This figure represents not only a dramatic increase in fossil fuel consumption (due in part to a roughly 22% population growth), but also an incalculable amount of pollution and adverse impacts of pollution added to the air and water. Barnes also found that the time spent in transit had remained roughly the same over the period, roughly an hour to 70 minutes a day. Another finding suggests that travel behavior is destination-oriented. The activity of the destination, the time it takes to get to and from it, and other externalities of the trip experience, influence choice of transportation mode, if choice is present.

There is no locational proximity relationship pattern between jobs and housing in this region, in part because of the presence of a full-built up transportation network (highways and streets); this pattern is overlaid by a retail strategy that looks at the provision of very generic packages of goods and services accessible to a broad geographic market.

- In Part III, Anderson and McCullough found that 84% of the full costs of transportation by car are internal and the costs of automobile ownership and expenditures of time are by far the biggest share of the full calculable cost of transportation. However, external costs, including those related to pollution remediation and health costs are expected to rise by 32% in 2020.

- In Part IV, Stinson and Ryan found that the rising public costs of transportation, including taxes of all types, were historically weak enough on a per capita basis to suggest that few people were making fundamental choices about housing, employment, and related transportation based primarily on price or operating costs. On the other hand, that picture might change if taxes were structured to encourage or discourage patterns of transportation use in relation to land use. For example, as total energy costs rise in the current (2001) pricing milieu and the potential increases for gas taxes to rise as well, more price-driven choices may emerge as significant preference indicators for more compact and diverse growth patterns. While estimates differ on the nature of change, fuel costs will rise barring a massive and reasonably timely shift in technology and policy. Problematically, the costs of road construction will also outpace demand if current trends continue.

These findings put new interpretations and emphases on the costs of sprawl indicated in environmental literature and suggest the role of design in presenting new alternatives for the shape of suburban growth.

For purposes of this part of the study, the most critical findings of other projects are those related to variables that are potentially dependent upon design or have shaped design in the baseline situations documented here; for example:

- the personal costs of time, and mode choice;
- the unknown public costs of transportation across modes, including indirect costs;
- the need to pay attention to destinations as the motivating force of travel behaviors, especially mode choice; and
- public investment cost /benefit equity across jurisdictions and sectors of the metro.

Smart Growth, Urban Design, Transportation, and Water: Central Issues of the Study

This study focuses on two principal issues of sprawl and their relationships to transportation and subdivision design:

1. The 144% rise in VMT in the metropolitan area between 1970 and 1990 occurred when the population rose 22%.
2. The loss and degradation of water resources that occurs in normal subdivision processes in an incremental pattern

The main transportation emphasis of this study of the Red Rock/Highway 61 corridor is to project new alternatives for an area to be served by commuter rail in the near future. According to the Metropolitan Council Transit 2020 Master Plan, this line is predicted to be operating in 2010. The focus of the work is to develop general and specific approaches to shaping commuter rail-oriented growth at the subdivision scale on multiple sites by type in the context of their hydrological patterns within their respective watersheds.

A fundamental assumption of the study is that transportation and water are regional resources, the value of which will be shared across local units of government. One premise of the design, therefore, is that new governance structures and/or funding formulae are needed to provide incentives to accomplish region-wide objectives, particularly if these sectors and districts are seen as broad corridors where the MUSA might be deemed to be more flexible because of increased transit service and hydrological protection.

Space (Not Time) and Money

While several previous parts of the TRG study paid attention to the temporal aspects of congestion and tried to make connections to expenditures, this study focuses on the spatial implications of baseline conditions and potential costs and their assessment. How can these variables, once introduced into the design of cities and suburban areas, quantify certain effects on the transportation system and the environment and provide new spatial definition such that a revised value structure would suggest policy options? In effect, Part II (Barnes) of the TRG study determined that to the extent choice exists, people choose their mode of travel based upon their perceptions of the best way to get to destinations. Another finding of that part of the study is that while time of travel per capita per day is relatively constant, the number of VMT has exploded since 1958**.** While it is impossible to quantify the relationship between VMT and pollution and resulting health and recreational costs to water quality degradation, there is a direct spatial relationship given current vehicular technology and roadway design standards. What has been lost in the creation and implementation of these current processes? New Urbanists and Smart Growth advocates have answered that urbanity—urban scale and a culture of neighborhoods—and ecological values have been the main casualties. The design case studies on this corridor evaluate various subdivision-scaled alternatives, often lumped together as “Smart Growth” or “New Urbanism,” to existing baseline development patterns.

Methodology

The method of this study, then, is to document and explain current patterns of subdivision (baseline in the Task One Report). The Task Two Report proposes outlines and principles of three alternative approaches to the structure of growth:

- Traditional Neighborhood Design
- Transit-Oriented Design
- Cluster Design

All of these approaches are considered in relationship to hydrologically-sound practices.

In the Task Three Report, fully-conceived and evaluated design alternatives for the same sites are used as comparisons. The main design variables in these alternative scenarios predicate the reintroduction of an integrated physical framework of urbanity or traditional suburbanity and ecological systems:

- connectivity in the street systems and of hydrological structure;
- mixed use zoning;
- mixed and higher residential densities;
- commuter rail transit and its systemic support.

Anticipating the other two reports, the principal transportation and hydrological design issues embedded in the Task One investigation of baseline conditions in the suburban areas are:

- the relationship of street and highway patterns to VMT and the nature of trips, of multi-modal traffic, and modal splits in relations to a commuter rail station;
- the role of hydrologically-sensitive corridors and areas in drainage planning;
- the potential of infiltration to replenish ground water and protect surface water.

CHAPTER 2

Land Use, Transportation, and Water: Nested Concerns

What can be done with the physical design to give shape to policy directions? Although design cannot solve everything, its integrated embrace of disparate factors could suggest alternatives as “whole solutions” to nested problems. The scale of the problem is multiple, and the critical systems cross these scales from the continental to the local. The scale, for example of the interstate system and the railroad system are, like the scale of the Mississippi River and its flyway, continental. Two systems move vehicles, the other moves non-human species and one of its principle supports, water. Within these vast systems are regional transportation systems and watersheds and all of their sub-units. Suggesting scenarios in physical forms that cross scales in their concerns (though they are primarily focused on the subdivsion) is the most cost-effective way of marginalizing risk as it simulates the possible and broaches the discussions of its merits. That is the crux of the approach presented in this study.

Commuter Rail: Regional Edges Frame in the Cities of Edges?

In 1998, the Minnesota Department of Transportation (Mn/DOT) commissioned Parsons Brinckerhoff Consultants to prepare a preliminary commuter rail network plan for the Twin Cities Metropolitan area (see Figure 2.1). This plan is a long term blueprint of prioritized corridors in a radial system. The Red Rock Corridor, the principal study area examined here, is in the second tier of priority, along with the Minneapolis/St. Paul link, just behind the Northstar Corridor from Minneapolis to Elk River and eventually to St. Cloud, the first corridor to be developed.

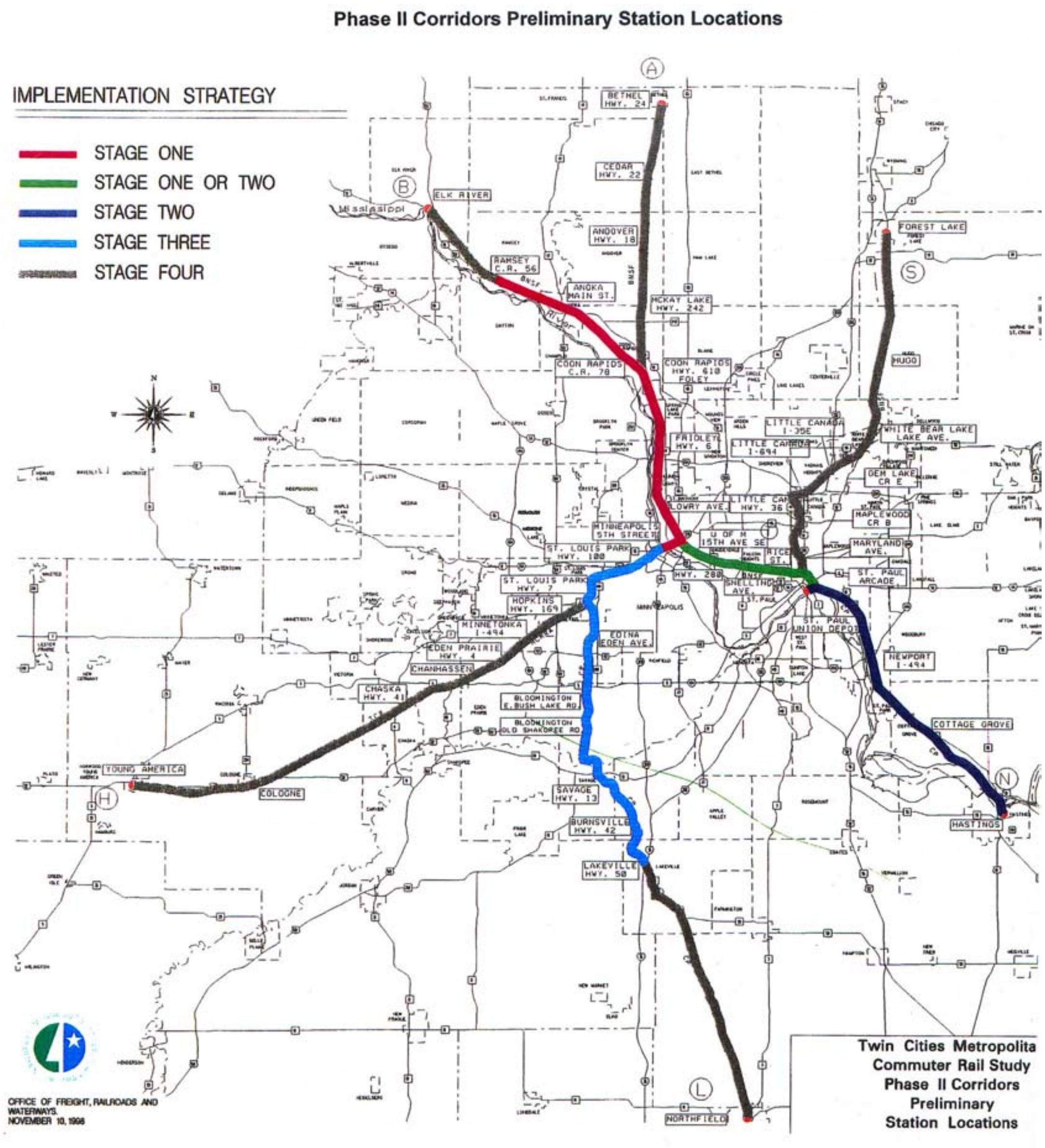


Figure 2.1 Commuter Rail Network Plan, Parsons-Brinkerhoff-Mn/DOT Study

Historically, the Twin Cities have been shaped by rail service. In the nineteenth and early twentieth centuries the Twin Cities became cities of edges. The development of James J. Hill's Great Northern Railroad was just the signature line among many in the cities: the Northern Pacific, the Milwaukee Road, and the Soo Line were among the most prominent. The multiple rail corridors have defined the boundaries of neighborhoods to a greater degree than even arterial streets, which in spite of large traffic volumes, are more often seams than edges. Only the freeway system has provided a sharper division pattern at a similarly expansive scale. This spatial order has given rise to a culture of separatism that is more euphemistically understood as a neighborhood-based political system. At the regional scale, the railroad and the freeway have also given separate identities to towns that are now suburban cities. As the rail corridors have been vacated or have become more permeable in other ways, the cities have reshaped themselves culturally too. This permeability is a challenge for commuter rail. There are some challenging issues present, for example, in this proposition on the Red Rock to share the active freight lines with commuter rail.

In *The Regional City,* Peter Calthorpe, the current consultant to Metropolitan Council for regional growth design, presents many valuable ideas that can help to begin to shape a more permeable and sustainable region. His discussion of commuter rail suggests, however, less enthusiasm for the way in which it can harden edges between neighborhoods and districts. The commuter rail system is less permeable than light rail because of the reduced number of crossings and larger distances between them. There are, however, generally more opportunities to create grade-separated crossings with commuter rail than with light rail. In addition, there is an opportunity to create new patterns of community space at these crossings, much in the way that suburban downtowns have traditionally offered this kind of setting in metropolitan regions already served by these systems.

Water: Surface and Ground

Minnesota is a state named for its principal resource, water. For the first 150 years of Minnesota's existence as a Euro-American settlement, water has been lifeblood for the state's economy, a central article of its quality of life, and the signature of its ecologies. Glaciation and the immediate post-glacial period have made water the principal ecological determinant in the state. The diverse forms have created an array of ecosystems in local niches and patches and corridors of continental significance. Water's big surface features are the Mississippi River, which flows through this corridor, and Lake Superior. Huge ground water reservoirs also exist in a patchwork that gives primary support to new cities, suburbs, and other forms of metropolitan and rural settlement. The health of these ecologies underpins the stability of quality of life in the metropolitan region, the state, the nation, and across the globe.

Over most of the state, subtle topography as well as agricultural and urban modifications of the prairie and forest landscapes mask the uniqueness of its hydrological features and systems (see Figure 2.2). The sprawling form of suburbs is especially homogenous, and its imprint is hydrologically similar across the water-rich eastern third of the country. The suburb creates its own surface hydrology of control and diversion that is largely separated from the many changing conditions attributed to natural cycles. In the suburbs, the approach is to contain water movement away from "improved property" (buildings). Water is moved toward the roadway, where in channels such as gutters, it is usually conducted to subsurface piped systems (storm sewers), and then collected and disposed of in receiving waters without any chance of significant infiltration to replenish ground water. We take the presence of water for granted; even the most water-impoverished west follows, to some degree, in this wasteful pattern.

This pattern of suburbanization has profound implications both for surface and ground water. Precipitation (or in fewer cases, rising water in floods) is directed from private property to public streets and other drainage ways. From here the water is piped, in some cases without any treatment that would reduce suspended solids or other contaminants, to receiving waters farther downstream. In the meantime, the ground water, which prior to this development pattern had been recharged by precipitation and runoff, receives only a small fraction of that water because of the increase in impervious surfaces (concrete, asphalt).

Two major problems with this system have emerged. The first is surface water quality. Unless runoff is pretreated before it reaches the piped system, many contaminants, including carcinogens and other health risks, present in ordinary runoff may reach receiving waters. The second is ground water quantity. As more and more land in the middle and upper thirds of watersheds is covered with impervious surfaces, fewer opportunities are given for precipitation to infiltrate, i.e., to be cleansed of its contaminants and become part of the drinking water resources and springs of the state's major recreational watersheds.

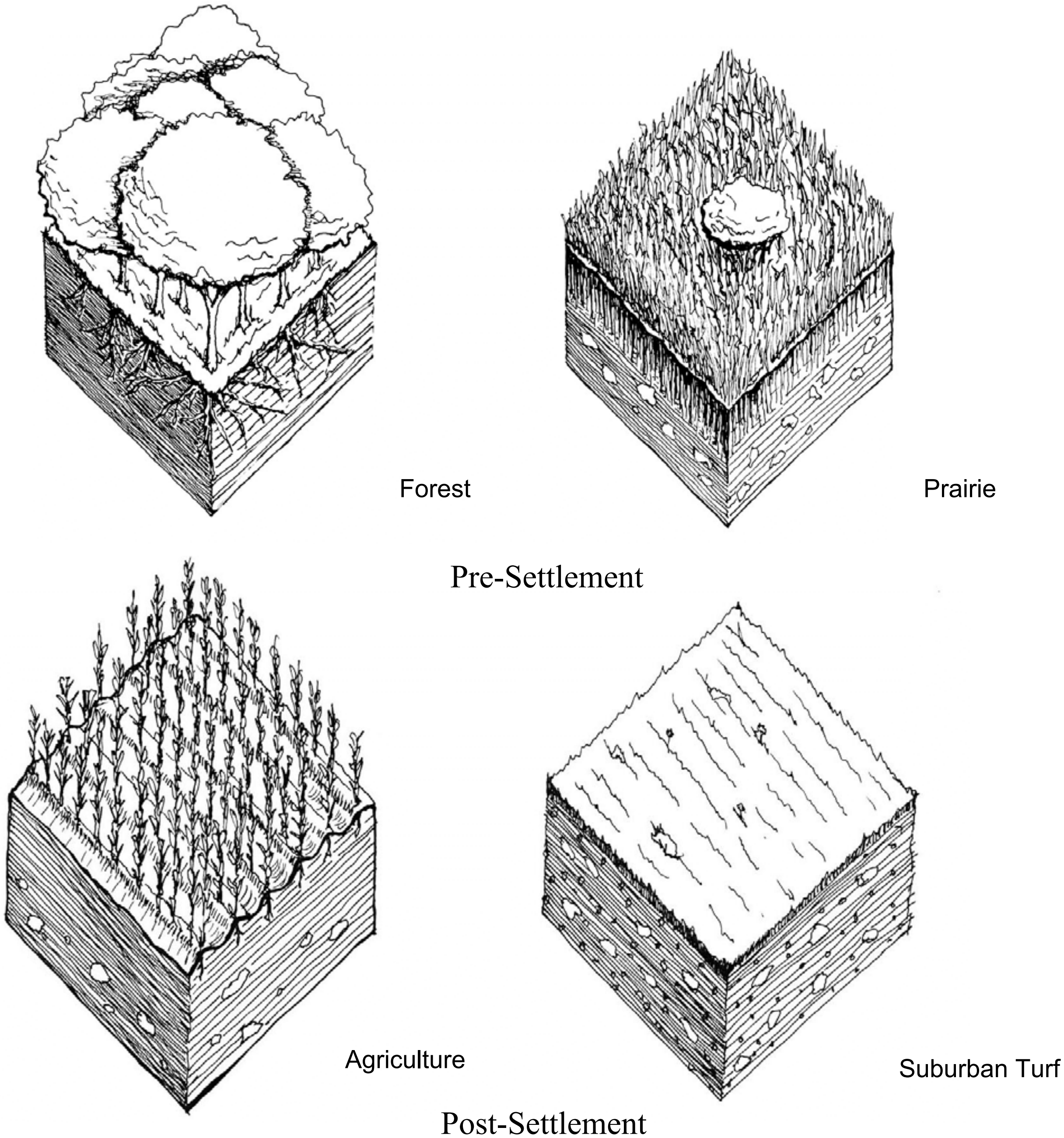


Figure 2.2 Infiltration & Vegetative Cover Images

Drinking Water and Recreational Surface Waters—Lakes, Rivers, and Streams: The Twin Cities Metropolitan Systems and their Hydrogeology

Each urbanized region has a unique relationship to the hydrological cycle. While the overall metropolitan water supply is a huge competitive advantage in the region's future development picture, there are warning signs indicating a need to pay attention to the protection of this resource. Some communities are experiencing peak-period shortages; others have contamination problems. Protection is not a one-size-fits-all proposition. The hydrological cycle affects water supplies differently depending on the geology of an area, patterns of water use and development, and the means of extracting and protecting water. There is no regional water authority; all water systems are local. Minneapolis and St. Paul draw water from the Mississippi River, the latter through a reservoir system of protected lakes (see Figure 2.3). In a drinking water system that depends on surface waters in such reservoirs, all types of runoff must be controlled. Typically, reservoir systems are buffered by substantial public land holdings; however, contaminated runoff that seeps into shallow groundwater layers (such as outwash) outside these buffers can move over distances and be discharged above into surface water.

The rest of the region's water for the suburbs comes from groundwater resources (see Figure 2.3). As suburban growth begins to move farther away from the rivers and toward the top of their watersheds, the use of groundwater will become more prevalent. This growth is a specific concern to this study area as both Woodbury and Cottage Grove have independent water systems that depend on ground water resources. This situation is somewhat heightened given their relative proximity to tributaries of the St. Croix and the Mississippi River below St. Paul. Woodbury draws its water from wells as does Cottage Grove, which has ten wells in the Prairie du Chien-Jordan aquifer, a body of water contained below the protective cap of bedrock. This aquifer is thought to be a very large body of water of uncertain dimensions.

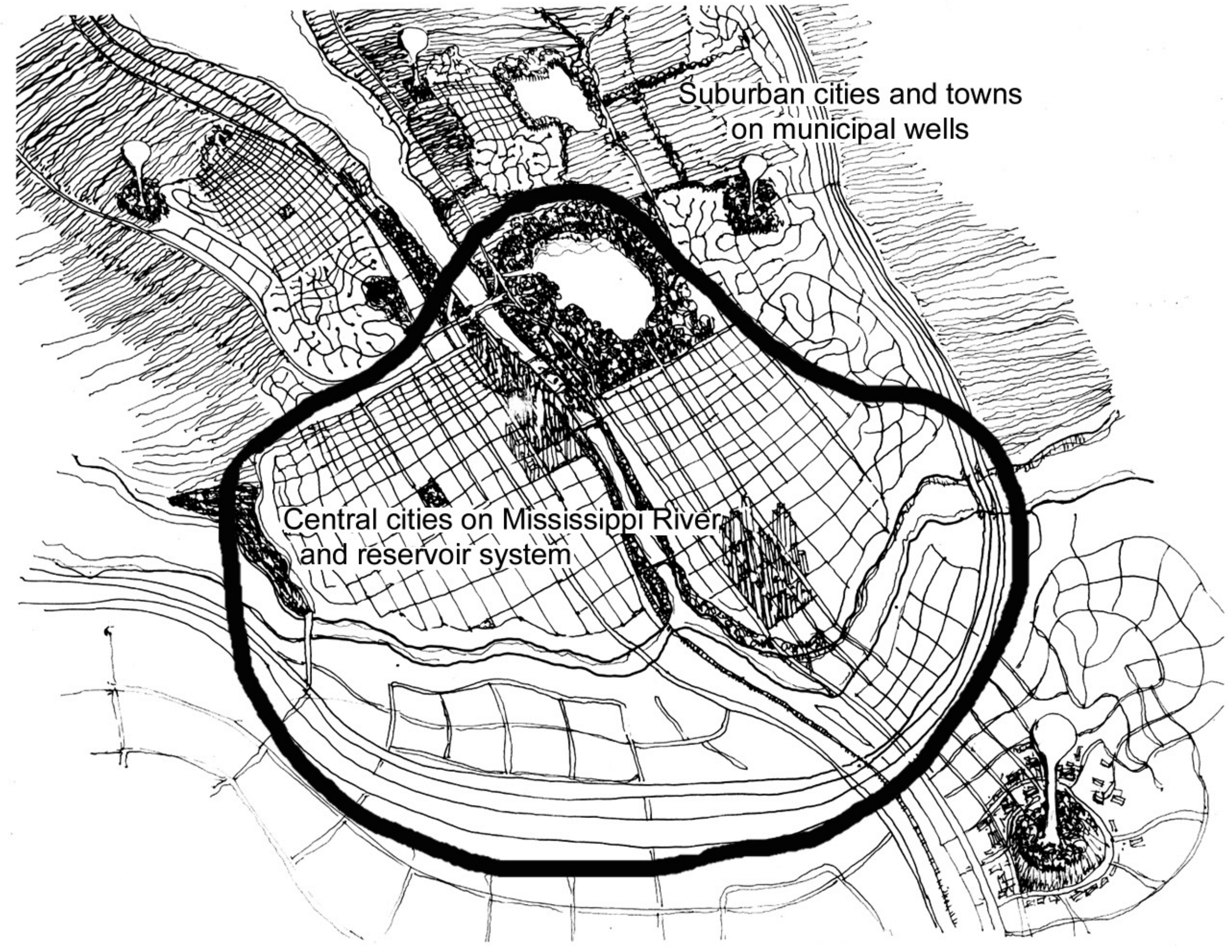


Figure 2.3 Regional Water—Cities, Suburbs, the River, and Ground Water

Nevertheless, in highly permeable soils with relatively shallow aquifers, the relationship between expanding urbanization of any type and the stability of the aquifer is challenged. Water is drawn out of the aquifer via wells for drinking and other purposes; this drawdown creates a sink into which wastewater can replace clean water. This is particularly the case in areas where lakes, rivers, and streams become potential points of entry for pollution into the shallow ground water layer. Suburbs north of the city take their water from the Shallow Glenwood aquifer, and this situation puts drinking water in peril.

In the Twin Cities Metropolitan Area, there is mandatory wellhead protection planning that requires approval of the Metropolitan Council, yet many other aspects of the Council's dealings with localities lack that level of authority. For example, the Metropolitan Council is charged only to "work with" localities to bring them into compliance on any number of specific issues such as non-point source pollution from runoff.

This situation suggests the need to address fundamental questions that may effect changes such that policy and law would better integrate our regional approaches with local initiatives and resources:

- How well are the approximately 110 local water systems in the region variously protected?
- Do we now have the best governance structure to protect this public good on a statewide, regional (seven-county? or 21-county?), subregional, district, and/or local basis? What role might a regional and subregional checks-and-balances system have in fostering the stewardship of this shared resource? Does such level-playing-field thinking match the politics and economics of water? How would a prudent approach fit state law, which tends to partition the hydrological cycle?
- What role might the privatization or local development and marketing of water resources by water-rich communities to non-local users have on the planning and management of this resource and the growth of the metropolitan area? Does the region have a position on the issues of privatization or local initiatives?
- Can the negative effect of local urbanization control (on a subdivision-by-subdivision basis) on the metropolitan area overall be enhanced by Metropolitan Council authorization and approval of water quantity projections, as part of comprehensive plan review and approval, and mandated adoption of best design, planning, and management practices at the subdivision scale? Can this checks-and balances system be sold to local units?
- What role should advanced modeling techniques and Geographic Information Systems (GIS) have in determining water capacity projections for regional growth or limiting local growth to certain areas at certain densities?

The situation suggests subregional or regional compacts on water resources. As the suburbs have begun to grow, several conditions of the current arrangement have begun to manifest themselves as potential problems:

1. The Cities' systems are surface water-/reservoir-based; piped infrastructure is largely in place and subdivision is largely complete, except on many brownfields. (Brownfields are contaminated and/or polluted former industrial lands usually cleared of buildings, although not always, for reuse and redevelopment.) The suburban systems are ground water-based. The Cities and suburban systems are independent of each other not only by type and source, but also by jurisdiction. Development practices in suburbs mirror those in the Cities, but serve much more dispersed settlement patterns, and these practices have had critical impacts on water quality (e.g., pollution from storm water runoff to surface

waters) and quantity (e.g., reduced ground water recharge due to increased impervious surface and piped infrastructure). The advantage of local control is possibility of locally-specific solutions; the disadvantage is that the regional, sub-regional, integrative, or coordinated perspective is lost.

2. All suburban systems are local, and ground water resources (quality and quantity), which are critically important factors underpinning regional health and competitive edge, is managed locally. Soon, barring the implementation of regional or subregional oversight, winners and losers will emerge depending on access to deep aquifers. Even the abundant supplies in the Red Rock sector seem likely to be tested if growth continues in the manner and at the scale that it has of late.

While in the Twin Cities, urbanization has not yet had a drastic effect on ground water in most areas, usually because of the depth to water and the protection of dolomitic limestone and sandstone layers and wellhead protection practices, this scenario is not impossible as development begins to move further up in the watershed and out onto agricultural and wooded lands. In the Zumbro River Valley in Rochester, this type of interaction is occurring. The Glenwood aquifer for Rochester's drinking water has been protected by a layer of shale over limestone. As this layer has been progressively perforated by suburban development that has moved up-slope, the aquifer has become more vulnerable to contamination.

Runoff, Surface Waters, and Ground Water Hydrology: Baseline Suburban Form and Water Quality and Quantity

In the book, *Groundwater Contamination from Stormwater Infiltration,* Robert Pitt and the other authors pay careful attention to the interaction of precipitation and ground water. Many of the implications of their book also shed light on ground/surface water interactions. The approach is relatively simple: The authors ask what are the characteristics of urban runoff, what are the concerns raised by these characteristics, and what is the nature of treatment that should be enacted to mitigate or dispel these concerns?

Urban runoff is by its very nature contaminated. Its most problematical sources in a neighborhood context are:

- paved parking and storage areas
- automobile service areas
- driveways
- streets, highways, and freeways
- landscaped areas
- paved freeway and highway shoulders
- roofs

Organic contaminants of chief concern in runoff have been in three classes: pathogens such enteroviruses; bacteria such as shigella and salmonella; and nutrients, especially nitrogen, which is a major constituent of street and highway runoff and a principal source of groundwater contamination in karst regions such as Florida, Ohio, and southern Minnesota. Eutrophication of surface water is a problem for all recreational uses, especially swimming and fishing. Not only is the water unsightly and organically overdeveloped, but the nutrient loads themselves present problems with bodily contact. Many of the most attractive edible and game fish do not tolerate eutrophic waters. Fish are also susceptible to intake of non-organic contaminants, or metals. Moreover there is also the possibility of leakage into groundwater from some surface waters. Pathogens can be brought into the groundwater when recharge areas are less than 35 feet above the groundwater in highly pervious soils such as on Long Island or in the low lying areas close to the Mississippi River west of Highway 61 in the Red Rock corridor.

Among the non-organic contaminants readily found in residential runoff are so-called heavy metals including:

- cadmium
- chromium
- copper
- lead
- nickel
- zinc

In addition there, are other chemical toxicants, especially associated with conventionally maintained landscaped areas, automobiles, and paved commercial operations principally such as:

- benzo (a) pyrene (gasoline-based)
- fluoranthene (oil-based)
- napthalene (pesticide)
- chlordane (pesticide)
- pyrene (oil-based, e.g., apshalt)
- and many others...

The problem of road salts, especially in cold weather states, also poses threats to surface and ground water.

Site-Specific or Generic?

Runoff is characterized also by the dynamics of flow phases, which have varying capacities to be cleaned of these elements. Problematically, as Pitt's work indicates, each of the contaminants in runoff has varied physical and chemical properties that clearly indicate site-specific solutions.

Lately the standard approach of conduct, collect, and dispose has been reevaluated. A new, watershed-based approach to runoff pretreatment has become more attractive to planners and some politicians, including the Metropolitan Council. This approach is usually embodied in a quick-and-dirty set of policies and best management practices. In *A Watershed Approach to Urban Runoff: Handbook for Decision Makers* the authors suggest, for example, more focused, locally appropriate approaches supported by some general best management practices. Critical first steps in the watershed-based approach include the types of pre-implementation approaches adopted in this project including 'Resource and Problem Assessment and Planning and Design.' In order to get a sense of how a specific watershed is working and to predict scenarios for development, the authors suggest using GIS. Similarly the "Best Management Practices" shown here can be adapted to a specific site and integrated into a total design. The principal aims of these practices are to address the two fundamental problems of quality and quantity with systems that use overland designs in combination with subsurface systems. Ponds and swales, which reconfigure soil, landform, and vegetation, become the bones of an approach to pre-treat runoff prior to its entry into piped systems or intermediate receiving basins.

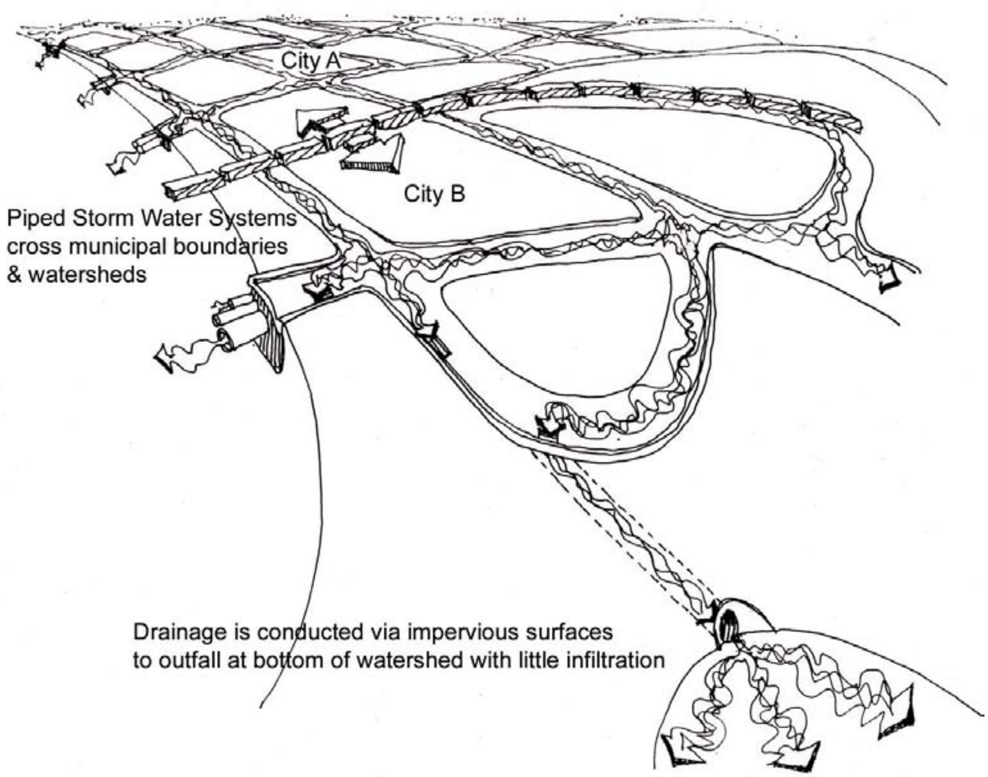


Figure 2.4 Storm Water Infrastructure Crosses Municipal & Sub-Watershed Boundaries

When suburban streets are laid out and percentages of impervious cover are anticipated for the various land uses around them, drainage plans are need to conduct water to detention, retention, and/or receiving basins. The streets become the temporary network of conveyance until water is dropped into inlets to the piped system bundled into the street. The main drainage objective of the system is to move large volumes of storm water away from private property. The interconnected subsurface system of pipes commonly located below the street system invisibly accomplishes this removal (see Figure 2.4). In the Red Rock this type of approach conveys municipal drainage from upper watershed communities such as Woodbury to lower watershed communities, such as Cottage Grove. In effect, if conventional (baseline) urbanization were completed south of Bailey Road in Woodbury (including our site), the small ponds that lie along the Military Road will be piped together, and drainage will outfall in the rock flume recently constructed in Cottage Grove near the Jamaica Avenue station site. This situation illustrates the loss of infiltration, and potential inequities in storm water management that can be encountered as suburbanization moves up into the middle- and upper-thirds of a watershed.

Abstracted Graphic Typology of Transportation Networks within Current Patterns

The form of suburban sprawl is not accidental. Nor is it precisely evident to most casual observers how it came to be. It is induced by such a complex array of factors that are a compound of the economic, social, physical, and mythic nature of American culture that we do not understand it, but rather accepted it as given. This array of factors is a type of generative organism that has created a redundantly-engineered, systemic, one-size-fits-all physical approach that can meet the everyday peak demands of late industrial and post industrial society. In this cultural milieu, quality and quantity of time become benchmarks of success. The suburb as a form has been positioned by planners, engineers, bankers, and developers to meet market demands efficiently, with little attention required to the nuances of their creation in specific places.

The concentric pattern of suburban sprawl is evident in the Twin Cities, modified of course, by the fact of two centers. Its basic pattern is ratified and mirrored by the extension of metropolitan urban services within the MUSA line and on the 494/694 Interstate Highway loop. In this pattern, critical corridors such as those established by transportation routes become the focused loci of specific kinds of growth. Corridors inflect the general patterns of concentric development and give them specific character. The Highway 61/Red Rock corridor, running parallel to the Mississippi River, is one example of the manner in which corridors establish access and development opportunity, but also edges (see Figure 2.5). As commuter rail service is established on the Red Rock corridor this inflection will create certain opportunities for growth between St. Paul and Hastings, even on conventional terms.

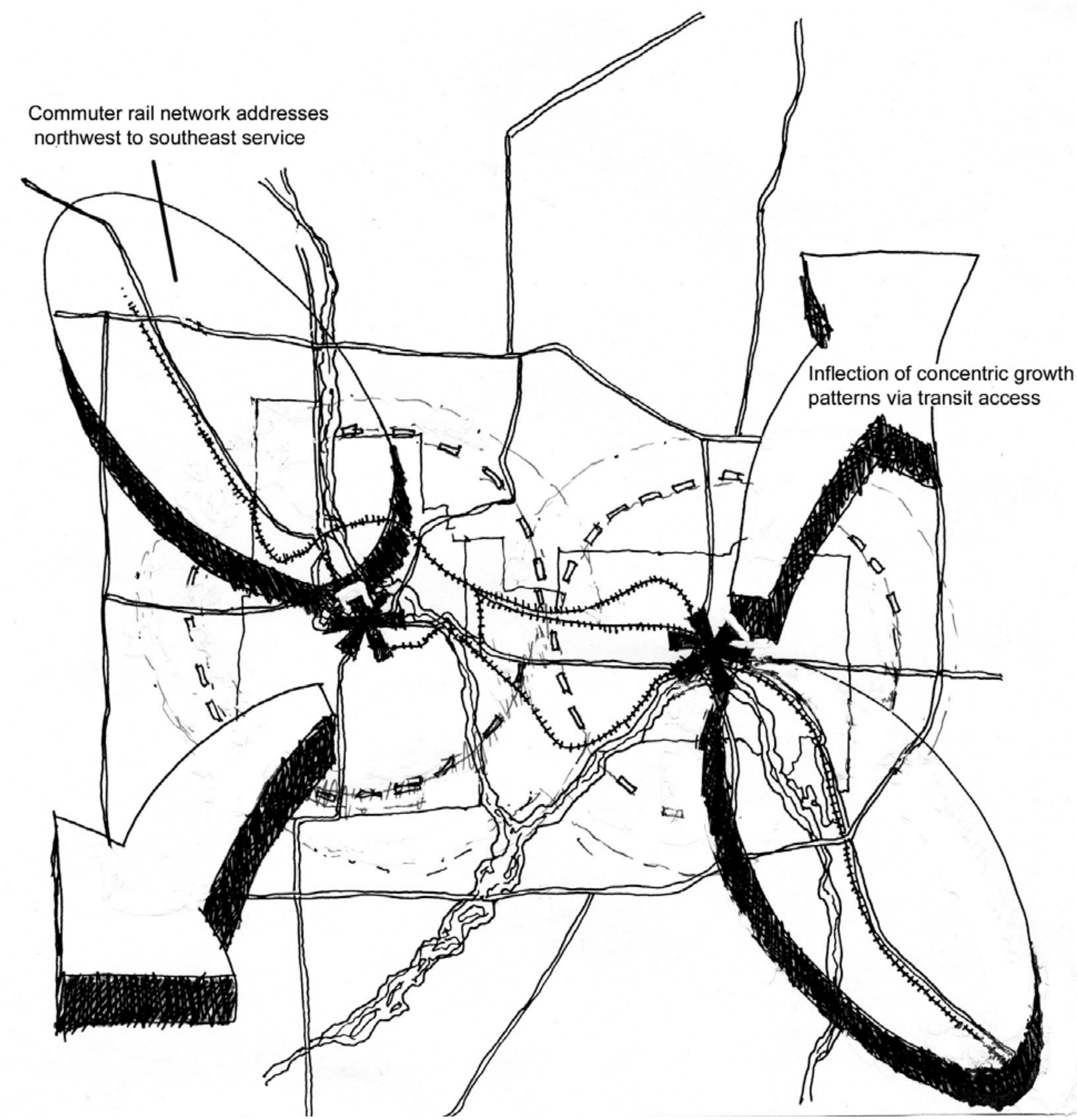


Figure 2.5 Concentric Growth: the MUSA and Commuter Rail on the Highway 6l/ Red Rock Corridor

This report in no way can suggest exactly how, for example, such factors as public educational policy ratify other market and cultural forces in a region. These types of topics have been well-published and debated, and whether one sees fiscal disparities of cities across the Twin Cities region as the fundamental cause for such radically different educational programs or the result of the cultural and market decisions that create the communities will not be debated here. Suffice it to say, as the current census data and school closings in Minneapolis reveal, there is a marked disincentive for young city residents to stay in their neighborhoods with school-age children. Ironically, however, the old pattern of neighborhood schools to which students walked has not been a pervasive model of suburban form. Busing seems ubiquitous. It might be argued, in fact, that the busing and very insular, non-pedestrian-friendly school locations and designs are just one byproduct of the larger complex of street network and house and lot design issues that creates this seemingly monolithic form.

The Genetic Code of Suburban Subdivision Form

But just how does the homogenous and highly introverted single-family residential landscape happen? In many presentations on the nature of sprawl, the complexity and opacity of development decisions by which sprawl is produced are cited. Without challenging that premise precisely, it seems helpful, nevertheless, to look in an abstracted, graphic manner at the processes of comprehensive planning, subdivision, street and underground hydrological infrastructure design and the relationship between water and how the local development controls development.

Subdivision Process: Scale and Circulation Network

The dominant loop and cul-de-sac internalized circulation pattern typologies currently in use are the product of well-established patterns of design and engineering from the post World War II period until now (see Figure 2.6). Prior to that, internalized and curvilinear circulation designs were created by landscape architects in the nineteenth century largely to preserve soils, topography, and existing trees. Often these suburbs were commuter rail communities. As these design conventions evolved, however, from free-standing communities to subdivision-scaled designs, the intermediate roadway network that provided connectivity between the residential street and the highway or the arterial was virtually eliminated. The newer typology, unquestioned until the current wave of interest in New Urbanism, is the product of a nested set of standardized approaches, many of which are present in the standards outlined previously for Cottage Grove and Woodbury. These standards, when wedded to the development process, yield the remarkable similarity of appearance in suburban places across the country.

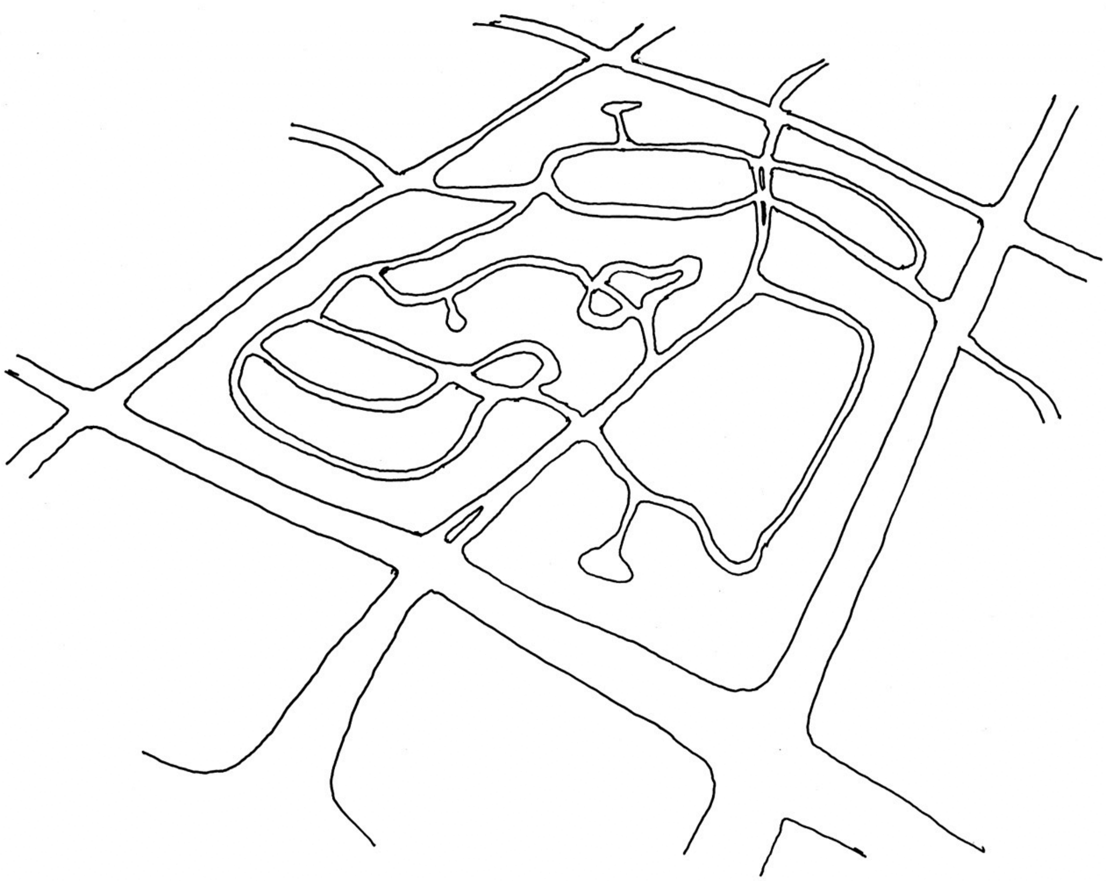


Figure 2.6 Subdivision Process: Scale and Circulation Network

Intermediate Transportation Network: Mixed Use

In this corridor, the highly developed county highway system has imprinted a mile-square form on the agricultural landscape of southern Minnesota (see Figure 2.7). These highways are the primary public framework of suburban development. Most comprehensive plans for suburban communities designate these roads as the future arterial network of the fully developed suburb. Once a subdivision is approved within this network, the costs of its widening and improvements (usually with curb and gutter and piped storm water systems) are shared by the state and the county. These roadways also become the locations for commercial development, partly because of their connectivity but also because of their accessibility, which is afforded by their generous proportions. In effect, this pattern compounds the internalized quality of the subdivisions. Many houses do not face these streets; the arterial streetscape is generally one of fenced, bermed, and/or planted buffers. Collector streets, which on older parts of the metro are dotted with corner stores and other commercial services and, sometimes, higher densities, are masked as single-family residential streets; often labyrinthine in their design, they are less functional as connectors and have little mixed use. In large measure, this residential homogeneity is because collector streets must be paid for by residential developers with no public policy incentives and often very little experience with non-residential development.

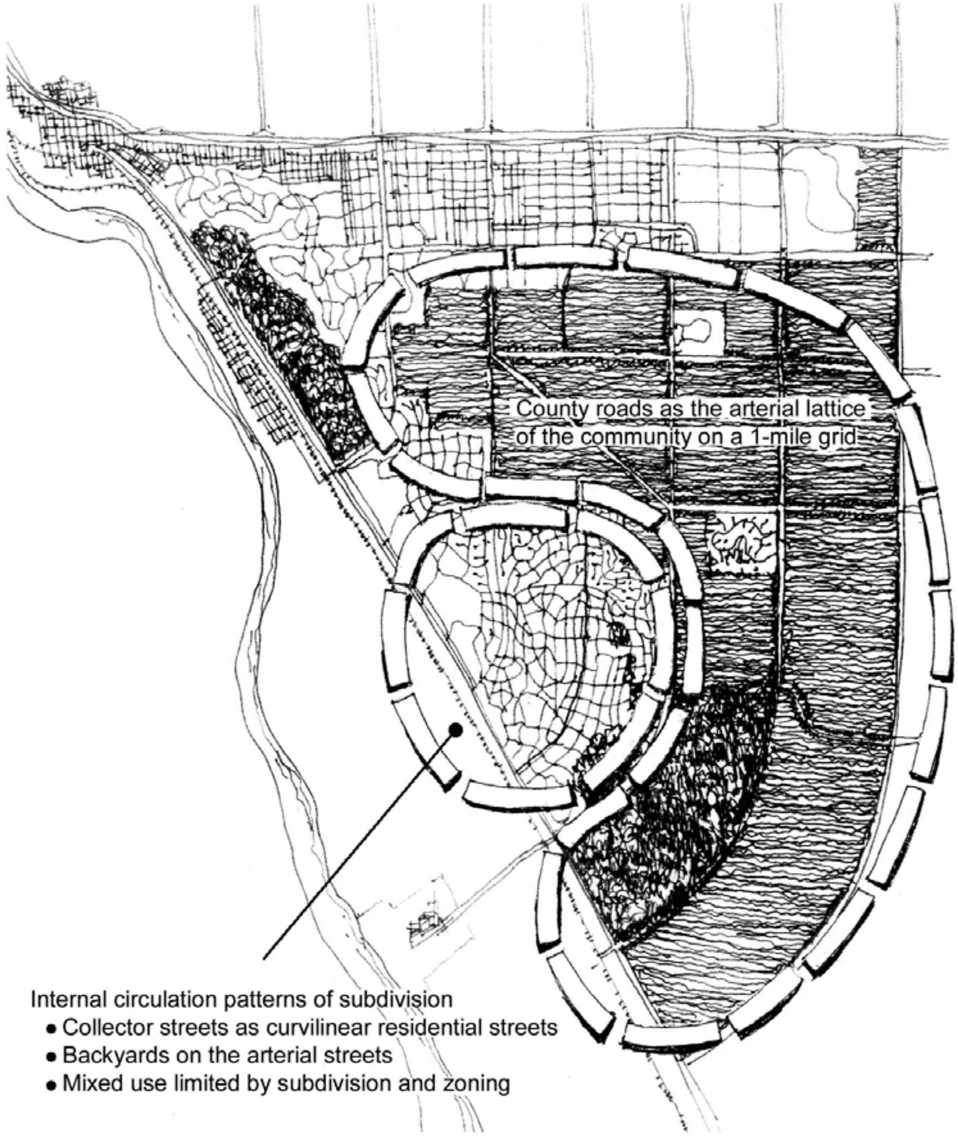


Figure 2.7 Connectivity of the Intermediate Transportation Network: Mixed Use

The Residential Street and the House Lot

Although the precise patterns vary in their specifics in this corridor, the desideratum of the post-1970s subdivision practice reflects the pervasive market success of suburban mythologies and economies associated with home ownership and enhanced value related to size. Houses from 2,500 square feet to the super-sized 5,000+ square-foot homes line curving residential streets of 1/4- and 1/3-acre lots (see Figure 2.8). The lots must be wide enough to accommodate at least a two-car garage; commonly garages constitute half of the façade of such dwellings, meaning that house and garage together demand that lots (including side yards) must be a minimum of 60 feet wide for the smallest of the houses. Most lots in exclusive subdivisions of chateau-like houses with three-car garages are wider, but their depth is often not more than 100 feet. In many cases the three-car garage is actually necessary to house the third recreational vehicle with a degree of suburban decorum; the other two vehicles are needed in many households since at least one adult must commute to work in a car from these locations. The block as such is no longer rectilinear, but instead creates awkward juxtapositions of the relatively small backyards, the more private realm of the yard; these exposed spaces often are fenced.

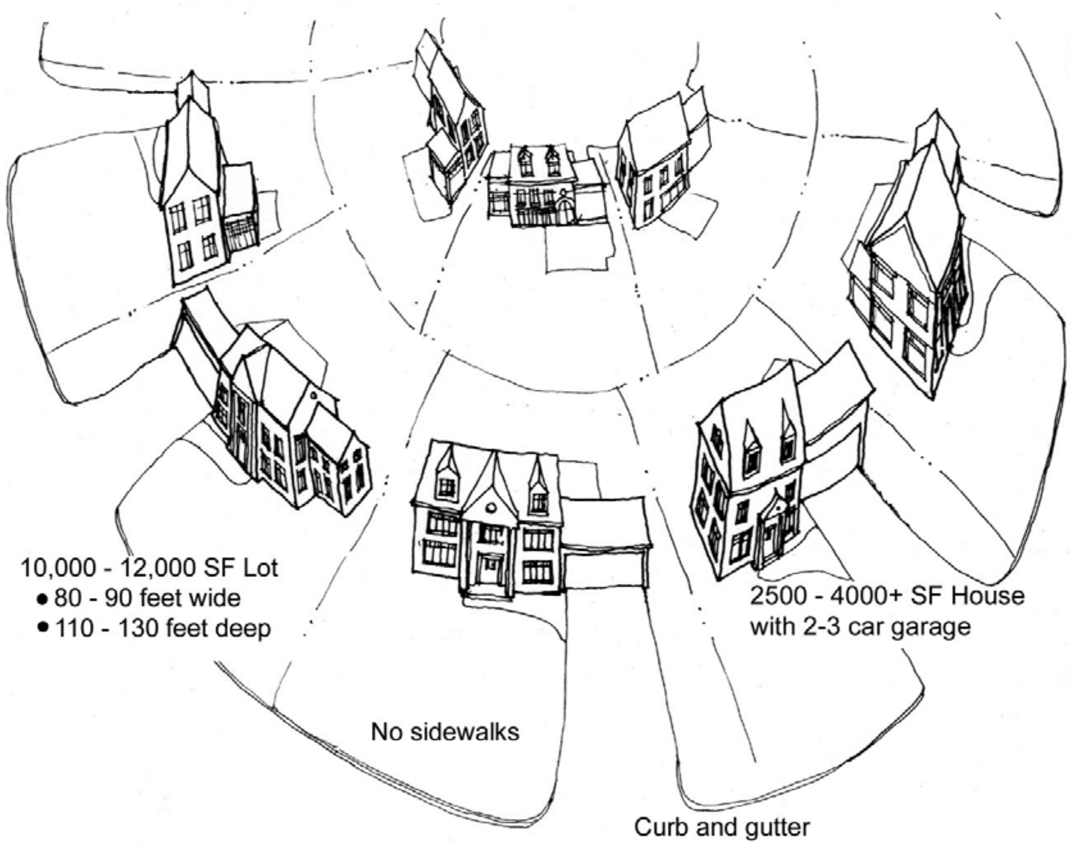


Figure 2.8 The Residential Street and the House Lot

The Block and the Park

Parks are located on the least developable parcels, usually on the lower intermediate receiving basins. Sometimes parks form corridors of connected lands, but usually as internalized trail networks behind houses, not as parkways. More commonly parks are simply surrounded by the houses, a playground, and perhaps a pond, in the middle of a very large (800-1,000 foot) superblock (see Figure 2.9). This pattern, made fashionable by English Garden City designers, has been particularly prevalent in Cottage Grove.

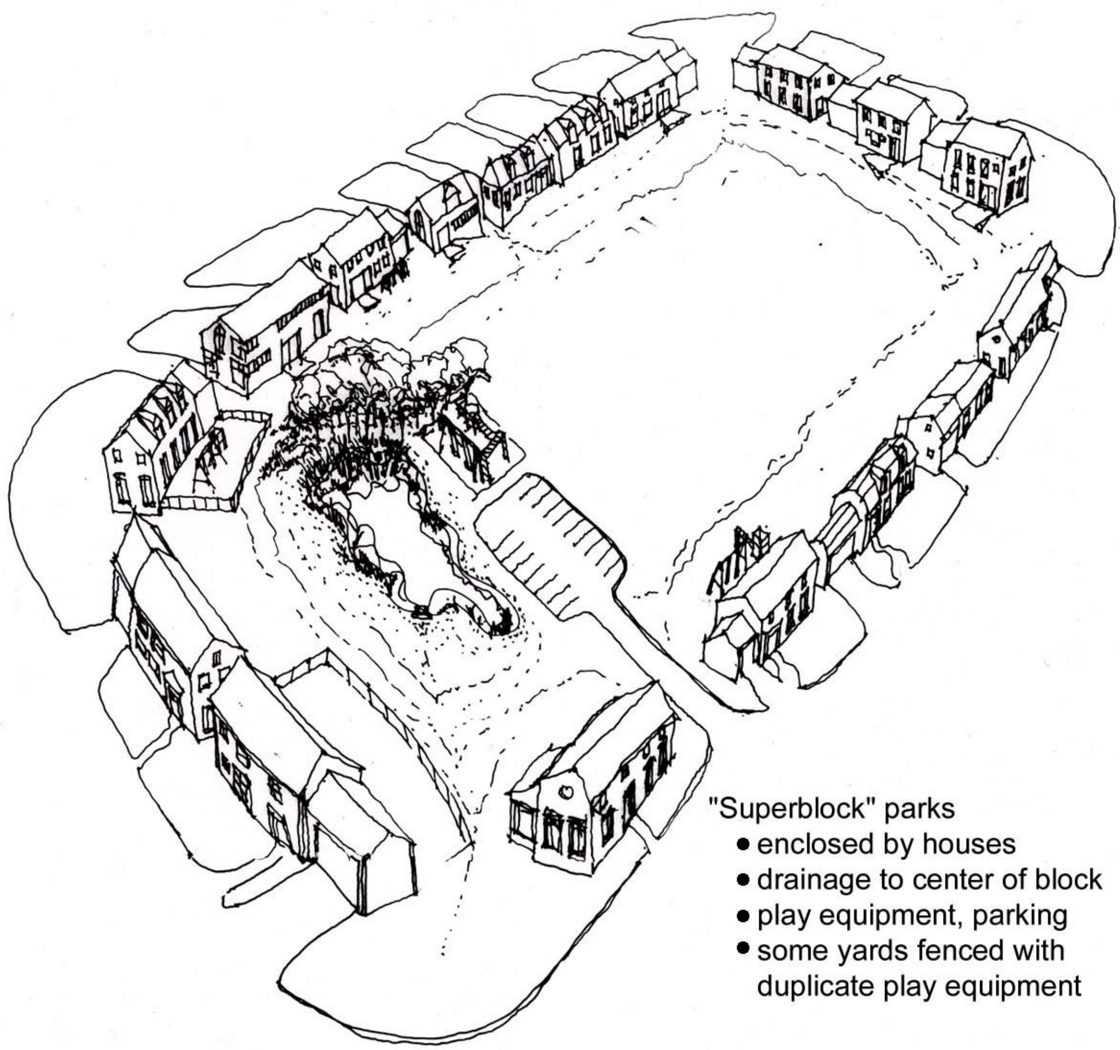


Figure 2.9 The Block and the Park

Subdivision, Transit, and Regional Growth

These decisions are made with some degree of regional review and approval. Prior to the development of any subdivision, the Metropolitan Council must approve the comprehensive plans of all cities in the seven-county metropolitan area, including Ramsey and Washington Counties where much of the Red Rock Corridor lies. However, if one looks carefully at these plans and the subdivision and zoning standards that guide local development in Cottage Grove and Woodbury, they authorize development at densities less than seven dwelling units per acre, which is the lowest threshold for bus service in the Metro area. This fact suggests clearly that there is an inconsistent position on sprawl between the transportation standards of Metropolitan Council and the development standards of local suburban communities. Timing is also an issue. Individual subdivision design and development comes well after the review and approval processes of Metropolitan Council and is largely unheeded by the region. Local control of actual development subverts regional planning and transportation investment and consumes more land than is necessary, with the net effect of shifting these costs to others in the region and reducing environmental carrying capacity. Paradoxically, pre-determined, and largely invisible, engineering standards must be met for services that may be needed in peak situations; over-scaled systems including water that must serve a dispersed, low-density pattern are only one result.

CHAPTER 3

Description of Existing Conditions in the Red Rock Corridor

The study examines a highway corridor paired with a proposed commuter rail corridor that is experiencing a modest to high level of growth. The Highway 61 Corridor south of St. Paul follows closely the Canadian Pacific Railroad/Burlington Northern Santa Fe Railroad tracks through Newport and Cottage Grove to Hastings (see Figure 3.1). This expanded corridor runs from downtown St. Paul's Union Depot through developed and undeveloped rings of suburban growth into the historic town of Hastings on the Mississippi River. The crescent of undeveloped land north and east of the paired corridors lying in Woodbury, Newport, and Cottage Grove represent a potential for enhanced commuter rail ridership. The projected development of the Red Rock Commuter Rail Corridor between the Twin Cities and Hastings will gradually intensify and re-shape development pressure. The development of the Red Rock corridor offers the opportunity to reconfigure public policy such that it would platform new patterns of development oriented to commuter rail to realize gains made on corridor investments.

A design study of transportation's role in shaping patterns of urbanization and reshaping hydrological systems in this corridor is therefore one that would illuminate for Mn/DOT and other stakeholders in the debate some critical issues about the integration of transportation and land use in guiding urban growth.

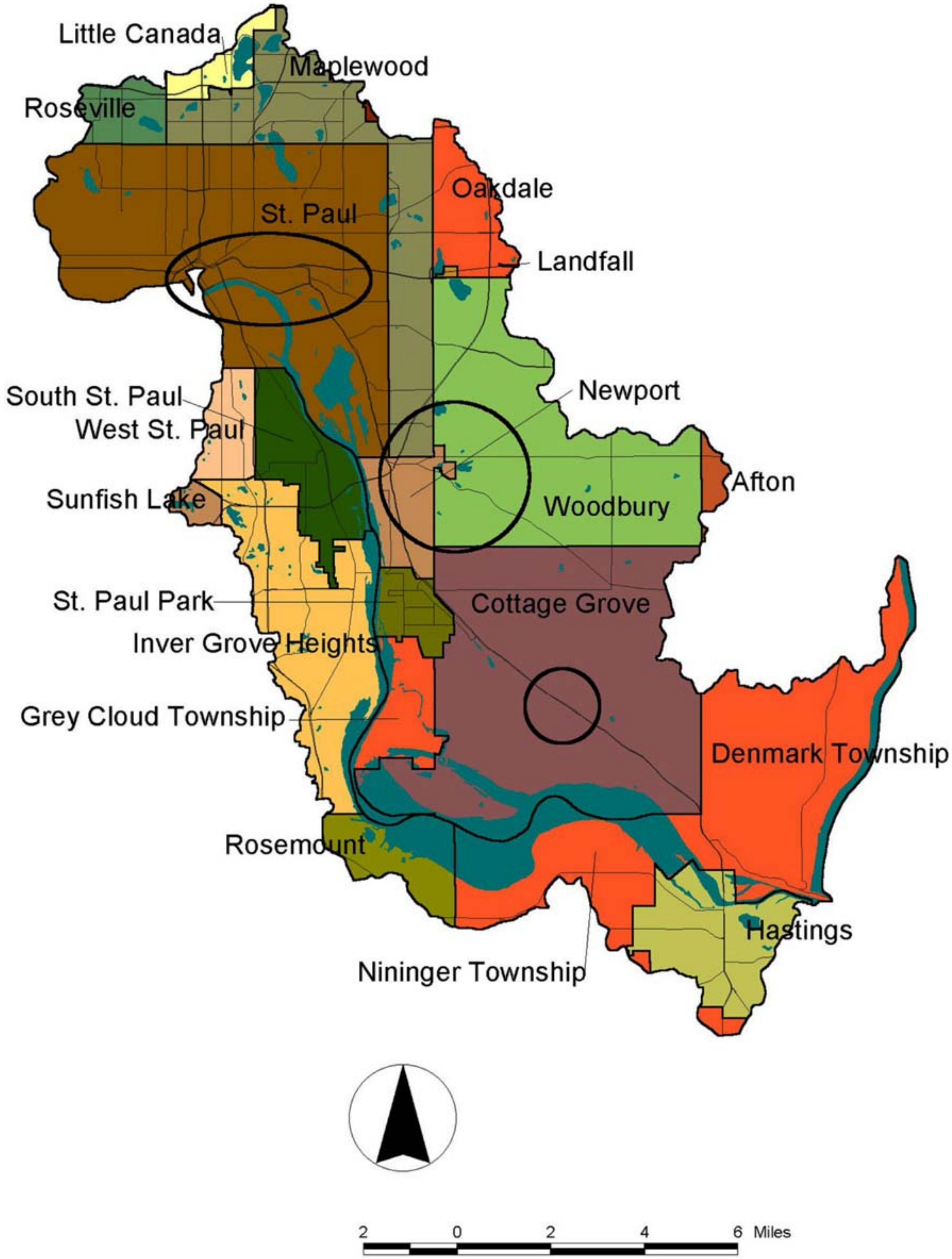


Figure 3.1 Municipalities in the Highway 61 Corridor as Defined by Watershed Boundaries

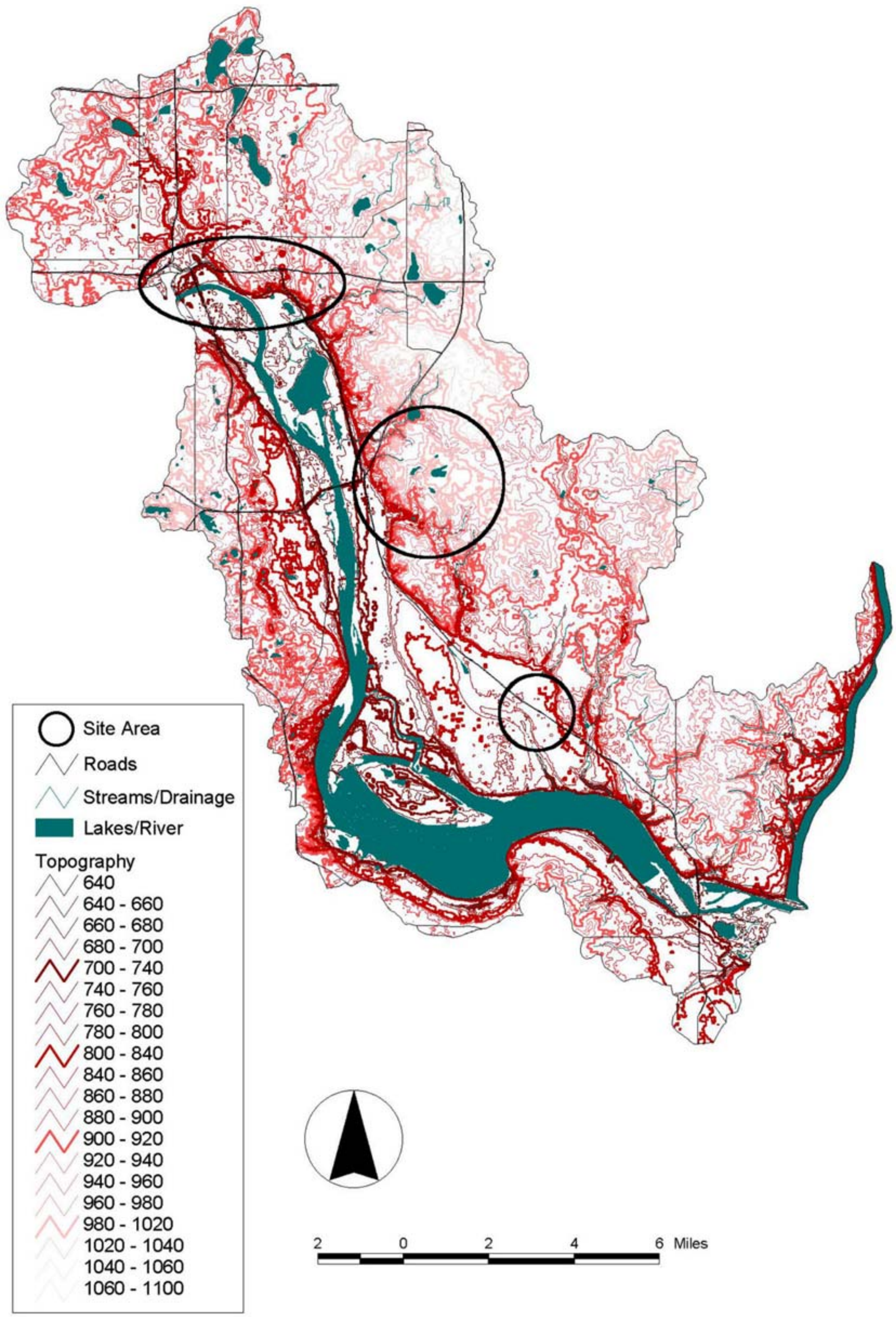


Figure 3.2 Topography and Hydrology in the Highway 61 Corridor as Defined by Watershed Boundaries

Strategic Assets and Drawbacks of the Corridor: Existing Density, Land Use Mix

Why study this corridor? In summary, it represents many of the typical challenges of urban growth currently facing the metropolitan area. In addition, within the corridor itself, there is still time to effect some change in it such that the public policy and investment in rail and in highways and streets could leverage a more compact and manageable development pattern. This pattern could ultimately prove more valuable than the baseline and possibly more affordable. While the corridor is in some ways representative of dispersed, disconnected, and Euclidean land development patterns, in other ways it is not. If growth in the corridor today is modest, the development of the Red Rock Commuter Rail service in the corridor could revolutionize its shape.

Existing 3–4.5 dwelling units per acre development patterns hardly approach transit-appropriate density, which is generally given at 7 dwelling units per acre for bus service and 16 dwelling units per acre for light rail service. The average fabric of Cottage Grove at about 4.5 dwelling units per acre is the planned location of the mid-corridor station with the largest projected ridership (1,472). One aspect of commuter rail that differs from light rail is that commuter rail riders are commonly not assumed to walk to the station. While it makes sense to develop transit-oriented densities and multi-modal fabric within a five- to ten-minute commute of the stations, this is not currently the plan for the undeveloped area. The intensity of job development in the area of the intersection of Highway 61 and Jamaica Avenue in the last 10 years has added more jobs to a base of an already approximately 1,500 (attributable to 3M and the commercial/industrial development east of Highway 61) making it a potential short or reverse commute destination, part of the 1,472 riders.

On the other hand, the existing character and shape of development is not entirely suggestive of a model commuter rail transit-oriented corridor, nor is it exactly typical of other highway corridors. Topography in the area just east of Highway 61 has been shaped by the pre-historic development of the Mississippi River channel (see Figure 3.2). Steep side slopes, some with exposed rock, have separated blufflands from the valley floor. Close to St. Paul, in the valley of Newport and Saint Paul Park, the developable area south and west of the highway and the rail line is circumscribed by floodplain development issues and pre-existing highway development patterns, especially related to the crossing of the 494/694 beltway in Newport. The historic gridiron town plans in the floodplains have been enlarged with draped grid additions. The development pattern east of the highway, especially in Newport and Woodbury, follows topographic opportunity and constraint and is shaped by conventions of post-World War II suburban internalized circulation. This means that subdivisions have been developed in all sorts of configurations and at various scales to avoid navigating steep slopes. In addition, the street systems are dominated by internalization including the predominance of loops and cul-de-sacs within a lattice of perimeter arterials that were formerly county roads. The effect has been the creation of suburban cities along the corridors as a series of subdivision-scaled islands, but with a particular pattern, which has favored development on the bluffs east of 61 because of its potential access to Interstate 94 and other favorable locational characteristics.

CHAPTER 4

Subdivision-Scaled Sites in a Commuter Rail Corridor

The Highway 61 portion of the Red Rock Commuter Rail Corridor presents, in some ways, typical challenges of suburban growth. How can market demands be met while also sustaining the environmental qualities and, in this instance, commuter rail investments that sustain real estate values?

The study examines three sites at the subdivision scale:

- A unique site in St. Paul at the heart of which is the Union Depot in Lowertown, a commuter rail and potential Amtrak station; the southern gateway to the city and the Mississippi River are also part of the context of this site.
- The site in Woodbury is technically off the Highway 61/Red Rock corridor to the east of Newport. It is currently planned to contribute to the sprawling pattern of Woodbury.
- The Cottage Grove site is a potential station site for commuter rail. It includes a large existing employment node dominated by the 3M chemical plant, several retail centers, and approximately 180 acres of developable land at the edge of County Road 19 and Cottage Grove Ravine Regional Park. It is also a site that may show promise for developing a strategy for a flexible MUSA.

The choices of these diverse types of sites raise little opportunity for internal comparison. Rather, these sites demonstrate important issues of urban and suburban growth related to developing a critical commuter rail spine that will eventually run from Hastings through both St. Paul and Minneapolis to St. Cloud.

Overview

The sites and their characteristics in broad outline are as follows:

- **Union Depot, Lowertown, and Gateway to St. Paul** has been the target of recent urban revitalization efforts from the 1970s until the current period. The focus of many of these efforts has been in Lowertown, where the Union Depot is located and along the Mississippi riverfront, which is also accessible from the station site. Warner Road, the floodplain right-of-way along the Mississippi River, has been improved and walkways, bikeways, and park improvements have created a parkway edge along the flats below the city. The relationship that this site might have to three important objectives of this revitalization—additional downtown housing and commercial services, linkage to the river pedestrian and bicycle routes, and the reinstatement of rail service to downtown St. Paul—are critical issues that must be integrated into this design inquiry. Further, the connective relationship this area could have to the Highway 61 corridor has historically been compromised because of intervening topographic change, the railroad, and the highway itself.

- **Woodbury** is a suburban city of rapid growth at the upper tiers of the income and housing cost hierarchy; it is the suburban city par-excellence. Its residential districts are inwardly-oriented with little connective circulation outside of the existing structure of county roads, which have become the arterials of the community. Its residential monoculture is matched by an equally homogenous pattern of commercial development centers, largely located on these arterials and mostly separated from residences. The Woodbury site is a prime piece of land adjacent to Bailey Elementary School. The role of alternative development scenarios in a rapidly developing suburban city on a site such as this that has little or no connectivity to either the rail corridor or to frequent service transit suggests the potential for traditional neighborhood or cluster approaches. Cluster would be only a slight modification of the Woodbury baseline since the 1999 comprehensive plan (see Figure 4.1) for the site is “Mixed Residential” use. In the traditional neighborhood development (TND) approach, intra-city trips—to the store, schools, entertainment—are the focus of reducing VMT since transit to a central city job, regional retail, and service destinations is largely precluded by existing policy and/or automobile-oriented transportation infrastructure.

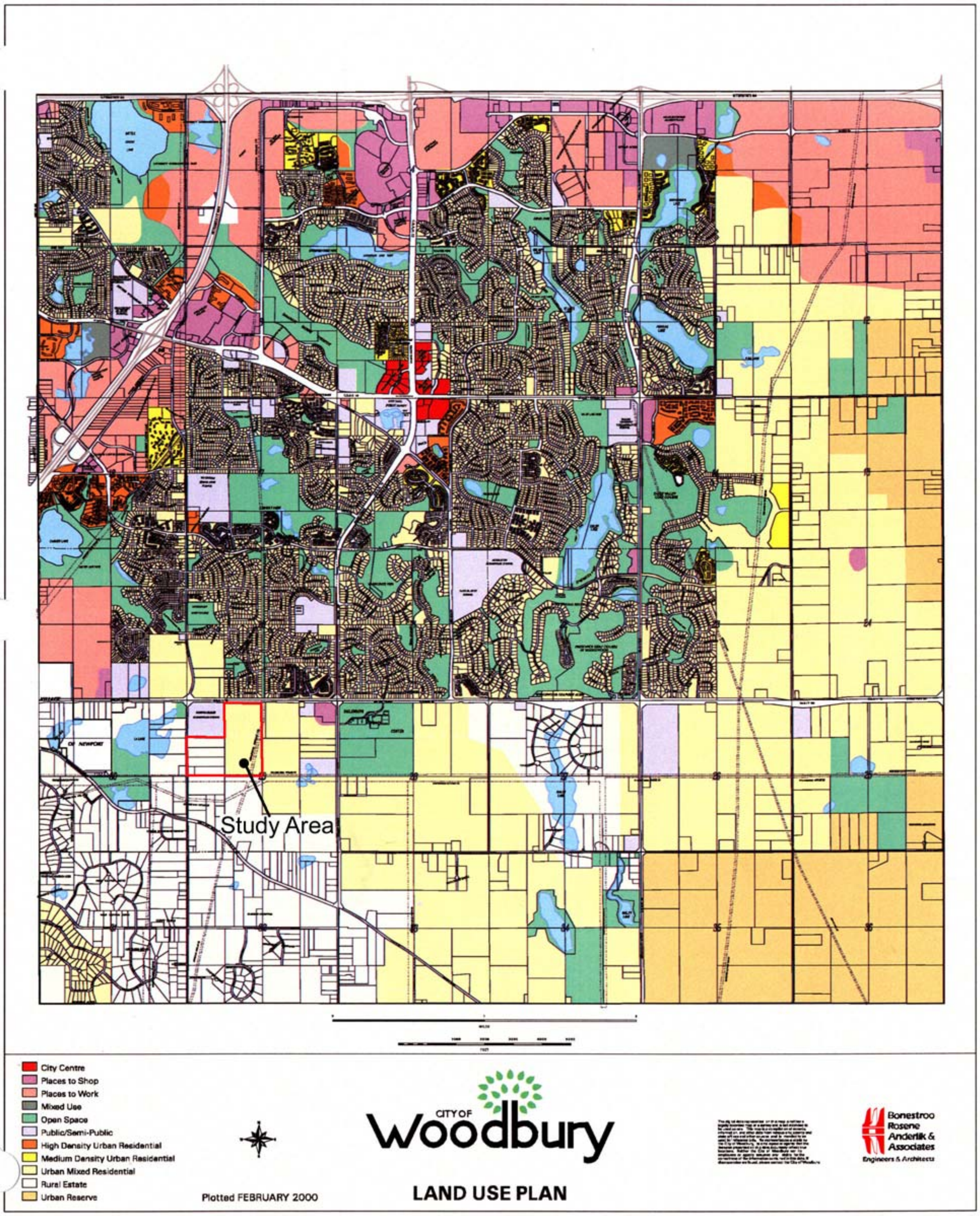


Figure 4.1 Woodbury Comprehensive Plan (1999 Draft)

- **Cottage Grove:** The Jamaica Avenue site is one of two alternative station site potentials, the other is at Eightieth Street (see Figure 4.2). The Jamaica Avenue site presents an opportunity to develop a station in an existing grade-separated location with a large existing job base dominated by 3M and the mixed commercial area near proposed job development areas in a new industrial park and in the soon-to-be sewered urban reserve along County Road 19.

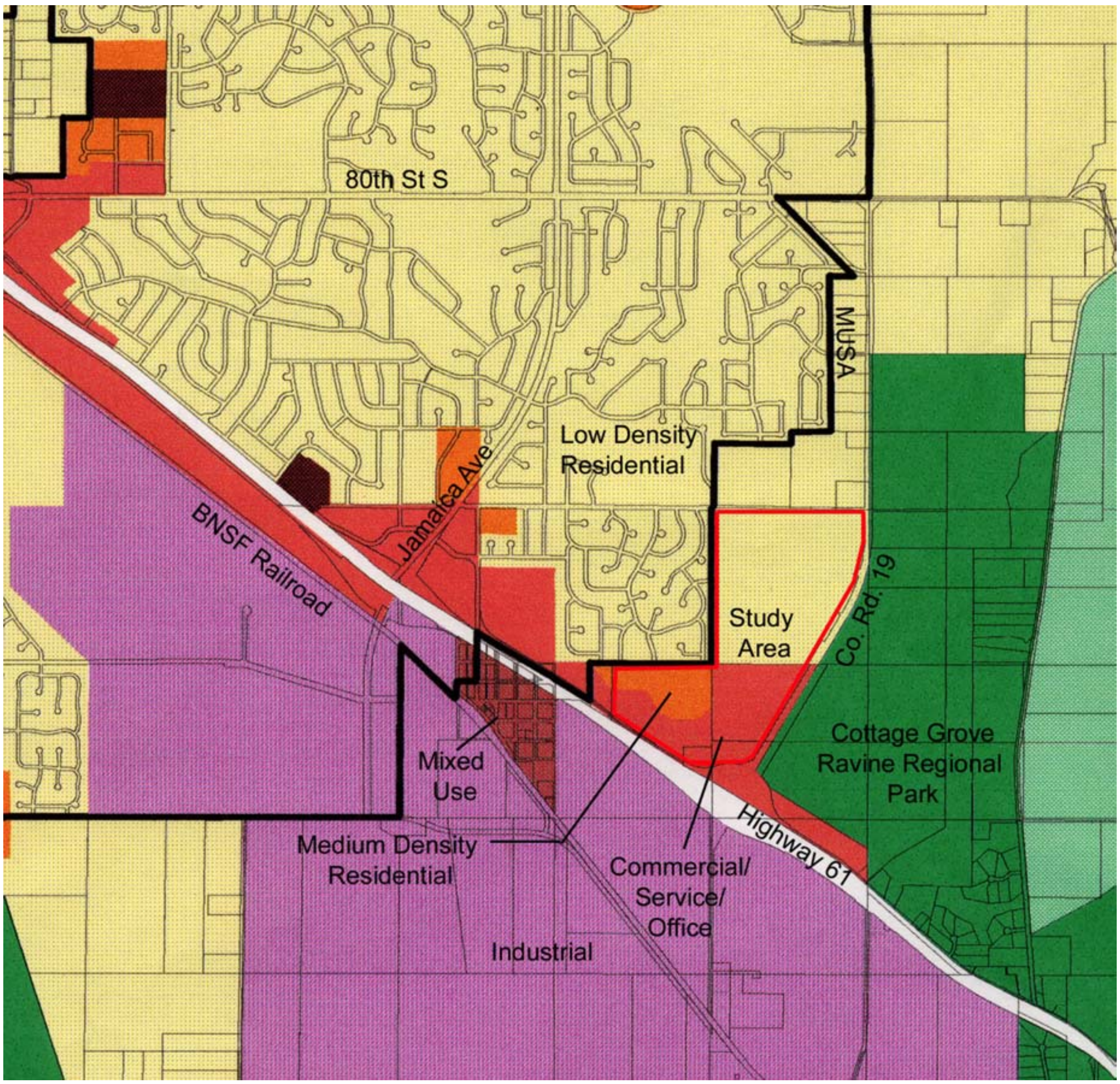


Figure 4.2 Cottage Grove 2020 Comprehensive Plan: Land Use

Baseline Development in St. Paul/Gateway

The cornerstone of the baseline development approach in St. Paul has been the potential of the historic St. Paul Union Depot as the downtown commuter rail station and the AMTRAK station (see Figure 4.3). There is a clear intention to serve the depot with existing tracks, now running beyond the concourse. The two most prominent alternatives are the Canadian/Union Pacific Route river view corridor and the central Burlington Northern Santa Fe Rail corridor. While the Canadian Pacific route would alleviate the 10- minute penalty associated with the train reversing direction at the Union Depot, the final route for commuter rail between downtown Minneapolis and downtown St. Paul has yet to be determined. Capital cost, operations and maintenance costs, service provider, and travel time, are all issues that will determine which route is eventually chosen. From an urban design point of view, pedestrian and bus/light rail connectivity between the station area and Lowertown and downtown and the Mississippi River is equally of concern. These issues have been forefronted in a variety of plans by the city, the St. Paul Riverfront Development Corporation, the Lowertown Redevelopment Corporation, and various consultants. On a sub-regional level, bicycle connectivity along the river is another important issue.

Hydrological analysis for the baseline development in St. Paul/Gateway study area was not performed because existing development complicates the use of large-scale hydrologic design. This study area currently exhibits a high percentage of impervious ground cover due to its urban nature and most drainage is piped. Because St. Paul is located in the lower third of the watershed, it has less impact than the upper two thirds of the watershed on the quality of the water being discharged from the watershed and the quantity of aquifer recharge. Additionally, the St. Paul study area is considerably smaller than the suburban study areas, making a positive hydrological impact of a similar level through design much more difficult.

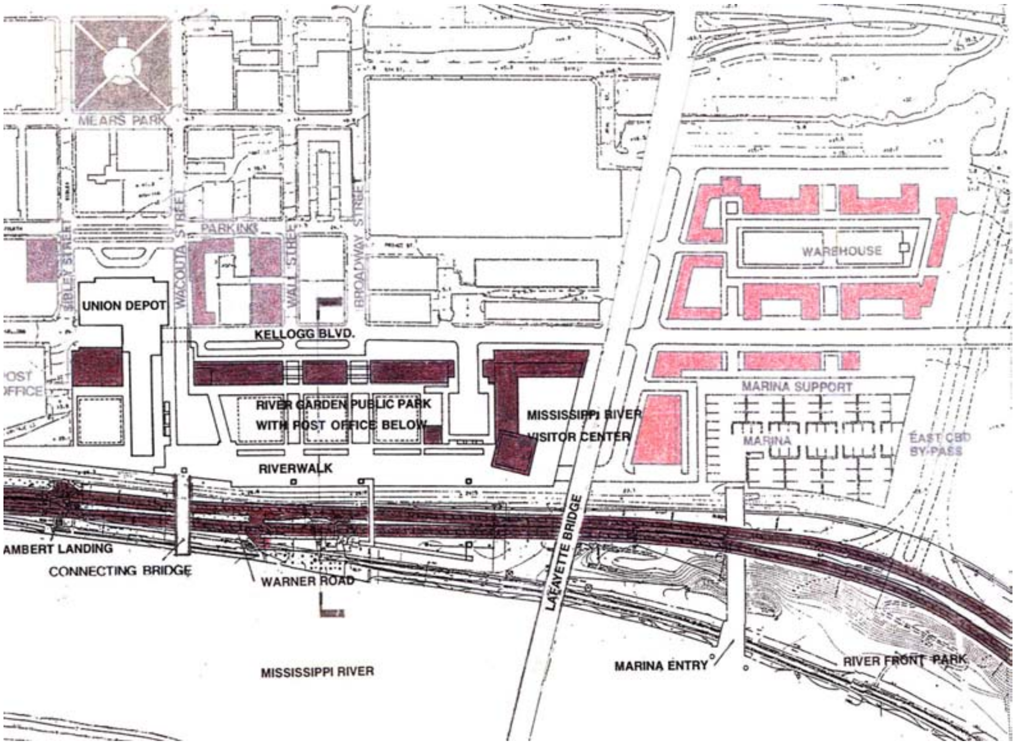


Figure 4.3 St. Paul Union Depot Plans: River Garden, Concept 1—Lowertown Redevelopment Corporation

Baseline Development in Woodbury and Cottage Grove

In spite of some differences, the subdivision layout and the basic patterns of development in both Woodbury and Cottage Grove are similar in their internalized patterns. Each subdivision tends to be organized as a neighborhood unto itself with the county roads serving as the major arterials and connective streets of these cities.

Woodbury Site: Existing Conditions

The Woodbury site is an L-shaped piece of property that wraps the Bailey Elementary School property on the corner of Bailey Road and Woodlane Road. The site consists of 120.11 acres of gently rolling hills with small ephemeral drainage ways and ponds. It lies within a corridor of farms south of Bailey Road dominated with agriculture with hedgerows of various species and patches of remnant oak groves surrounding residences. To the south of the site (fronting Bailey Road) lies a 10-acre development on very hilly terrain, pocked with small ponds. These ponds, as well as those on our site, are planned to be linked together in a drainage system that would conduct runoff from Woodbury to Cottage Grove, very near the proposed alternative commuter rail stations, either at Eightieth Street or Jamaica Avenue.

The Woodbury site is divided into six sub-watershed catchment areas (see Figure 4.4). Each catchment is analyzed in relation to its soil type, vegetative cover, topography, and built structures (see Table 4.1).

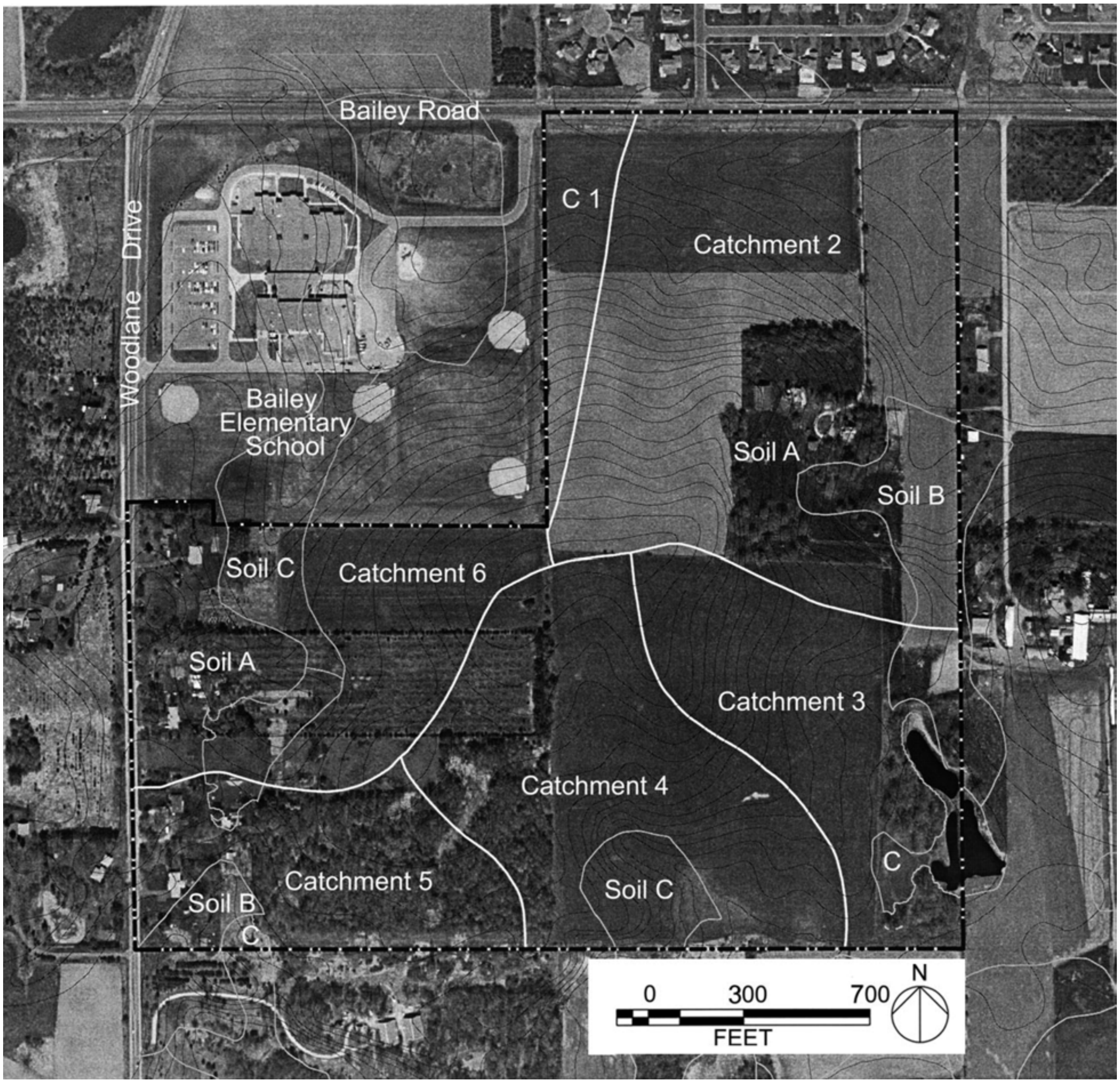


Figure 4.4 Woodbury Site: Existing Conditions

Table 4.1 Woodbury Site: Existing Conditions

Location	*Area in Square Feet*	*Area in Acres*
Catchment Area 1		
Agricultural Fields (Row Crops) in "B" Soils	189,309.93	4.35
Total Pervious Surfaces	***189,309.93***	***4.35***
Roadway with shoulder on"B"	5,466.81	0.13
Total Impervious Surfaces	***5,466.81***	***0.13***
Total Area:	**194,776.73**	**4.47**
Catchment Area 2		
Agricultural Fields (Row Crops) in "B" Soils	1,342,854.81	30.83
Humid grassland in "B" Soils	180,801.63	4.15
Forest in "B" Soils	171,641.95	3.94
Total Pervious Surfaces	***1,695,298.39***	***38.92***
Roadway with shoulder on"B"	18,655.35	0.43
Gravel Driveway on "B"	14,926.50	0.34
Buildings and Out-buildings on "B"	9,499.75	0.22
Total Impervious Surfaces	***43,081.59***	***0.99***
Total Area:	**1,738,379.98**	**39.91**
Catchment Area 3		
Agricultural Fields (Row Crops) in "B" Soils	548,832.56	12.60
Humid grassland in "B" Soils	48,856.49	1.12
Humid grassland in "C" Soils	52,251.76	1.20
Forest in "B" Soils	53,387.30	1.23
Forest in "C" Soils	43,636.05	1.00
Total Pervious Surfaces	***746,964.17***	**17.15**
Open Water	***25,310.73***	**0.58**
Total Impervious Surfaces	***0.00***	**0.00**
Total Area:	**772,274.90**	**17.73**
Catchment Area 4		
Agricultural Fields (Row Crops) in "B" Soils	771,017.46	17.70
Agricultural Fields (Row Crops) in "C" Soils	117,547.02	2.70
Forest in "B" Soils	172,124.30	3.95
Total Pervious Surfaces	***1,060,688.78***	***24.35***
Total Impervious Surfaces	***0.00***	***0.00***
Total Area:	**1,060,688.78**	**24.35**

Catchment Area 5

Humid grassland in "B" Soils	112,880.51	2.59
Humid grassland in "C" Soils	26,783.44	0.61
Forest in "B" Soils	362,378.97	8.32
Forest in "C" Soils	7,208.01	0.17
Lawn in "B" Soils	68,619.80	1.58
Total Pervious Surfaces	***577,870.73***	***13.27***
Roadway with shoulder on "B"	8,989.90	0.21
Private Driveways on "B"	5,022.96	0.12
Buildings (Homes)	5,674.31	0.13
Total Impervious Surfaces	***19,687.18***	***0.45***
Total Area:	**597,557.90**	**13.72**

Catchment Area 6

Humid grassland in "B" Soils	467,284.74	10.73
Humid grassland in "C" Soils	104,205.80	2.39
Grass Lawn in "B" Soils	116,951.27	2.68
Grass Lawn in "C" Soils	37,901.42	0.87
Forest in "B" Soils	85,038.10	1.95
Forest in "C" Soils	30,699.46	0.70
Total Pervious Surfaces	***842,080.79***	***19.33***
Roadway with shoulder on "B"	17,703.09	0.41
Drives on "B"	3,724.74	0.09
Buildings on "B"	4,844.72	0.11
Total Impervious Surfaces	***26,272.54***	***0.60***
Total Area:	**868,353.33**	**19.93**

Total Site Area:	***5,232,031.64***	***120.11***

Woodbury Site: Baseline

The 1999 Woodbury comprehensive plan (see Figure 4.1) maps this area as urban mixed residential. In the plan (available from the Metropolitan Council or your public library), on pages 5-9–5-11, the stated goal is to develop this area as a planned unit development (PUD) with a maximum density of 4.5 dwelling units per acre. The proposed model for this development is Randall Arndt's greenway-type development, which is based upon cul-de-sacs (see Figure 4.5). The performance criteria, noted on page 5-11 of the comprehensive plan, emphasize protection of natural areas, the minimization of traffic, no more than 50% of units to be two-family, town homes or detached town homes. Edges of the development must be consistent with density, scale of adjacent developments, and 15% must be affordable units. If there is no PUD/cluster proposed, it may be assumed to be single-family residential at approximately 3.0–3.5 dwelling units per acre—see page 5-10 of the 1999 Woodbury comprehensive plan—which addresses the Metropolitan Council goal of 3 dwelling units per acre.

Design Guidelines

Following existing development standards and patterns, the subdivision would comprise:

- 321 single-family dwelling units on 1/3-acre lots;
- A development pattern that is largely internal in its circulatory structure including a dominance of cul-de-sac patterns;
- Drainage to the south and north based on current, conventional plans;
- A small park, partially enclosed by homes;
- Curb-and-gutter road sections throughout;
- Upgrade county highways as arterials;
- Collectors/subarterials as residential streets.
- See also Table 4.2

Figure 4.5 Woodbury Site: Baseline Design

Table 4.2 Woodbury Site: Baseline Development

Location	*Area in Square Feet*	*Area in Acres*
Catchment Area 1		
Lawn in "B" Soils	132,057.87	3.03
Total Pervious Surfaces	***132,057.87***	***3.03***
Roadway with shoulder on "B"	5,321.21	0.12
Neighborhood Street on "B"	2,952.35	0.07
Houses in "B" Soils	16,633.06	0.38
Total Impervious Surfaces	***24,906.61***	***0.57***
Total Area:	**156,964.48**	**3.60**
Catchment Area 2		
Lawn in "B" Soils	1,173,544.01	26.94
Remnant Forest in "B" Soils	3,086.35	0.07
Total Pervious Surfaces	***1,176,630.36***	***27.01***
Roadway with shoulder on "B"	18,827.38	0.43
Neighborhood Street on "B"	124,445.08	2.86
Houses in "B" Soils	199,265.84	4.57
Driveways in "B" Soils	140,473.89	3.22
Total Impervious Surfaces	***483,012.19***	***11.09***
Total Area:	**1,659,642.55**	**38.10**
Catchment Area 3		
Lawn in "B" Soils	455,224.20	10.45
Remnant Humid grassland in "C" Soils	52,261.00	1.20
Remnant Forest in "B" Soils	53,396.74	1.23
Remnant Forest in "C" Soils	43,643.77	1.00
Total Pervious Surfaces	***604,525.71***	**13.88**
Open Water	***25,315.20***	**0.58**
Neighborhood Street on "B"	23,058.28	0.53
Houses in "B" Soils	40,301.18	0.93
Driveways in "B" Soils	20,092.15	0.46
Total Impervious Surfaces	***83,451.61***	**1.92**
Total Area:	**713,292.53**	**16.37**
Catchment Area 4		
Lawn in "B" Soils	865,583.84	19.87
Total Pervious Surfaces	***865,583.84***	***19.87***
Neighborhood Street on "B"	138,586.15	3.18
Houses in "B" Soils	115,035.02	2.64
Driveways in "B" Soils	101,054.04	2.32
Total Impervious Surfaces	***354,675.22***	***8.14***
Total Area:	**1,220,259.05**	**28.01**

Catchment Area 5

Lawn in "B" Soils	450,255.47	10.34
Lawn in "C" Soils	28,595.39	0.66
Total Pervious Surfaces	***478,850.86***	***10.99***
Roadway with shoulder on "B"	12,649.31	0.29
Neighborhood Street on "B"	37,145.23	0.85
Neighborhood Street on "C"	618.32	0.01
Houses in "B" Soils	42,896.10	0.98
Houses in "C" Soils	2,952.37	0.07
Driveways in "B" Soils	34,321.21	0.79
Driveways in "C" Soils	2,875.36	0.07
Total Impervious Surfaces	***133,457.89***	***3.06***
Total Area:	**612,308.75**	**14.06**

Catchment Area 6

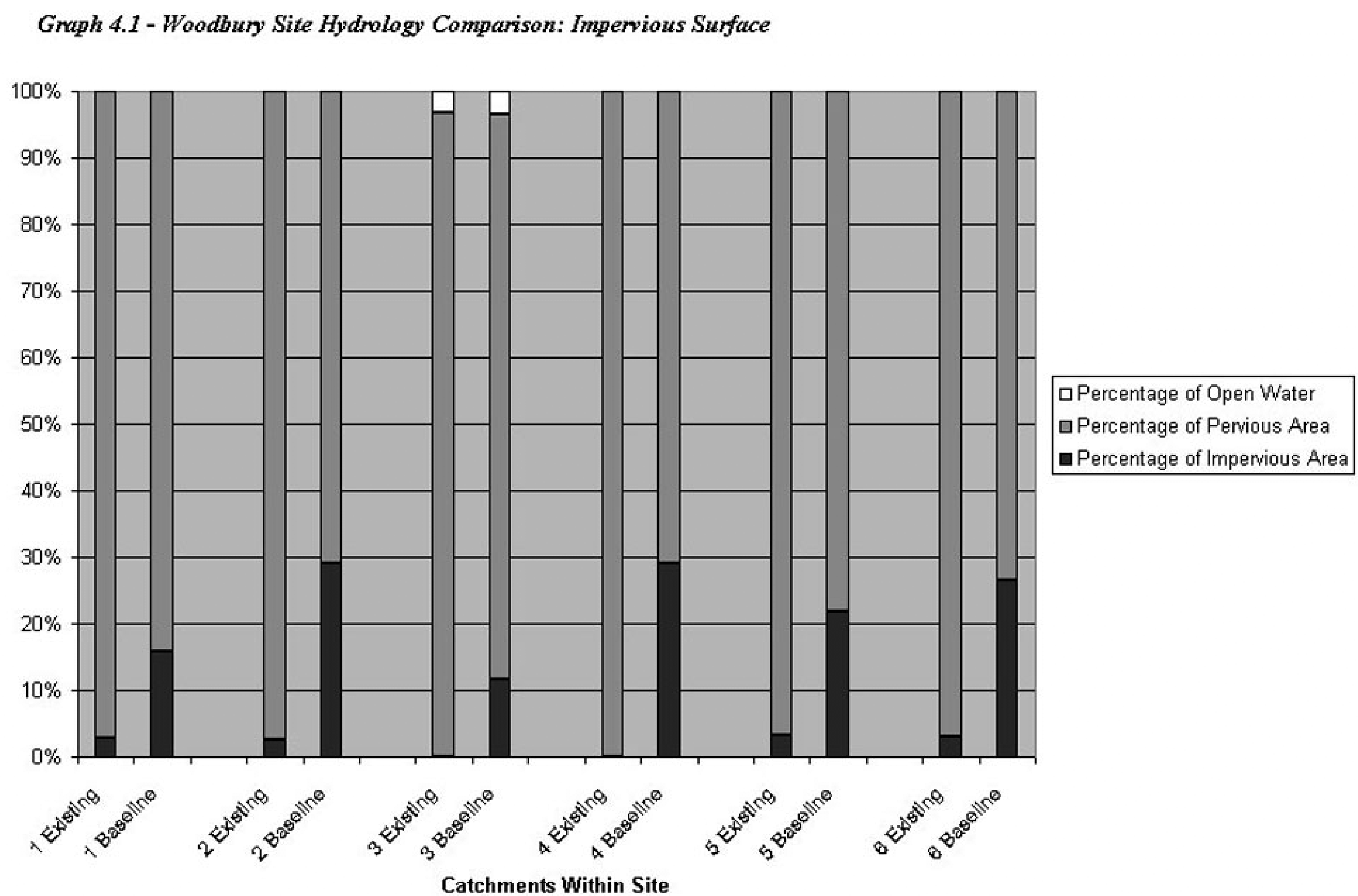
Lawn in "B" Soils	505,753.08	11.61
Lawn in "C" Soils	132,651.90	3.05
Total Pervious Surfaces	***638,404.98***	***14.66***
Roadway with shoulder on "B"	22,134.11	0.51
Neighborhood Street on "B"	47,939.72	1.10
Neighborhood Street on "C"	15,778.07	0.36
Houses in "B" Soils	67,737.87	1.56
Houses in "C" Soils	18,325.89	0.42
Driveways in "B" Soils	44,866.82	1.03
Driveways in "C" Soils	14,376.81	0.33
Total Impervious Surfaces	***231,159.29***	***5.31***
Total Area:	**869,564.27**	**19.96**

Total Site Area:	***5,232,031.64***	***120.11***

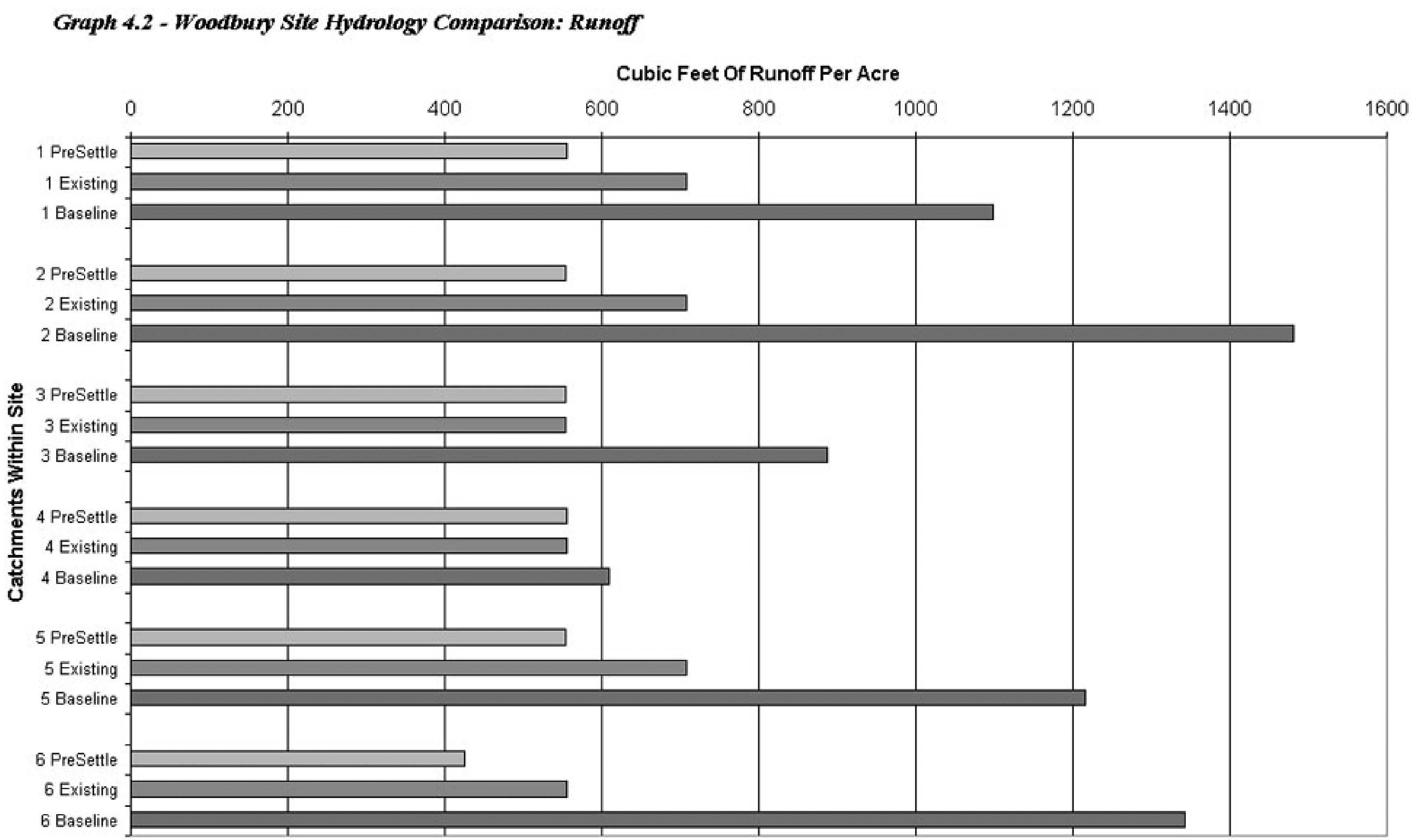
Woodbury Site Hydrology Comparison

The percentage of impervious surface increases from the existing conditions to the baseline conditions. With the increase in impervious surface and the piping of storm water comes decreased concentration times, a higher runoff volume, and higher and faster peak discharges. Comparisons are shown graphically in graphs 4.1–4.4.

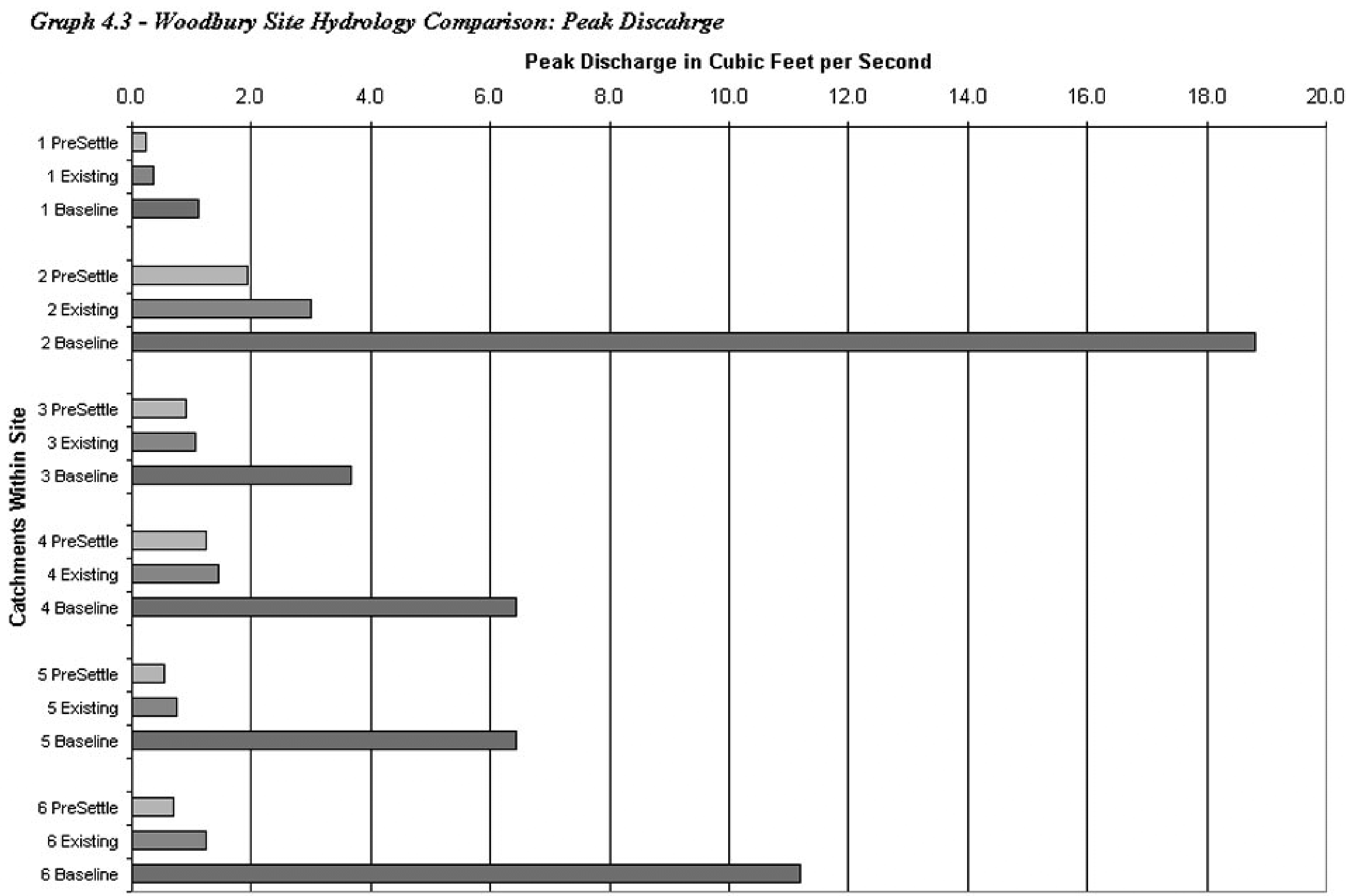
See Appendix B for hydrologic analysis methodology.



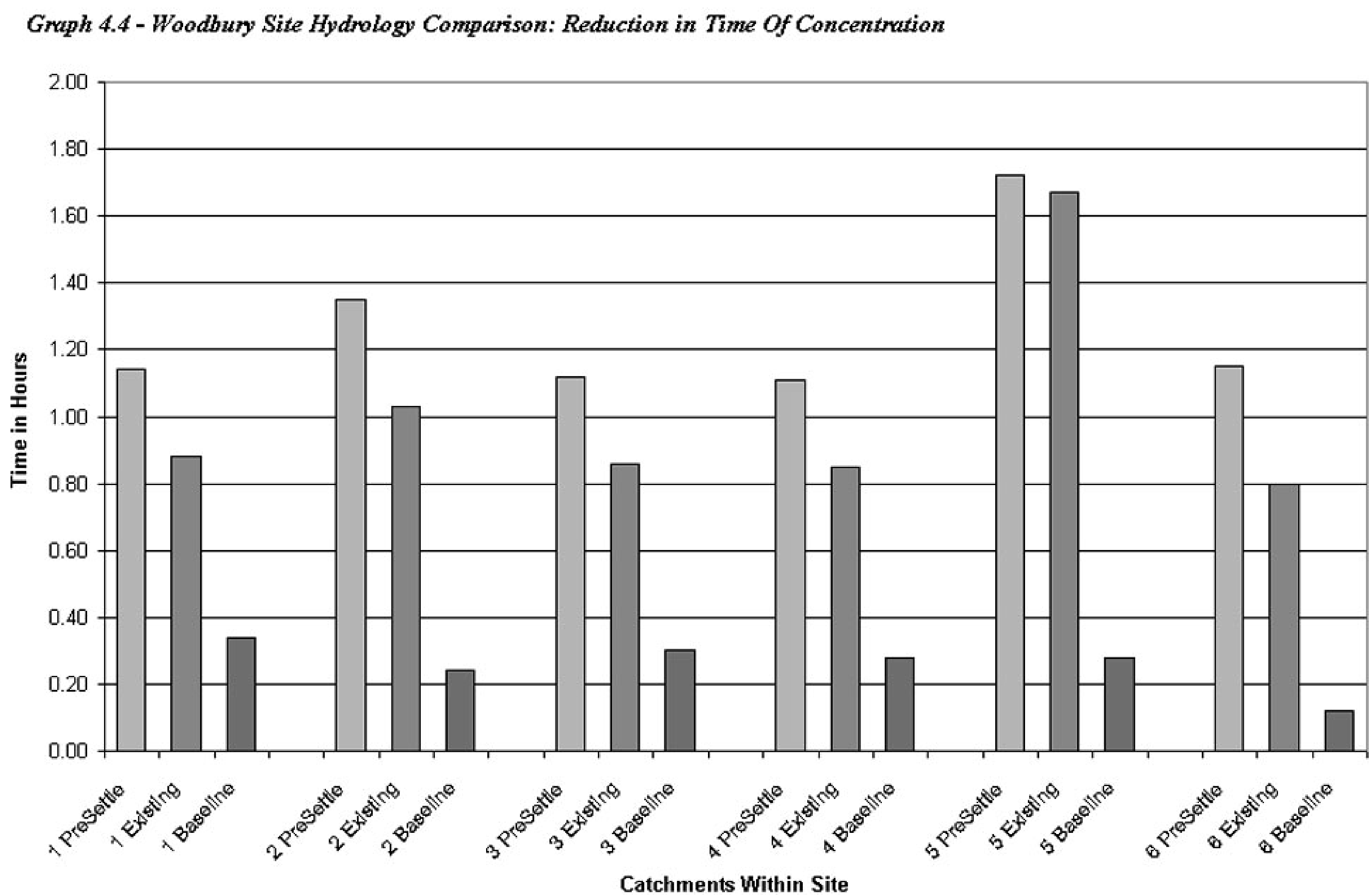
Graph 4.1 Woodbury Site Hydrology Comparison: Impervious Surface



Graph 4.2 Woodbury Site Hydrology Comparison: Runoff



Graph 4.3 Woodbury Site Hydrology Comparison: Peak Discharge



Graph 4.4 Woodbury Site Hydrology Comparison: Reduction in Time of Concentration

Cottage Grove Commuter Rail Station Area at Jamaica Avenue

The Cottage Grove site includes the area around the Langdon village plat and the 3M property between Highway 61 and the rail line, and the subdivision site on Highway 19 and Highway 61.

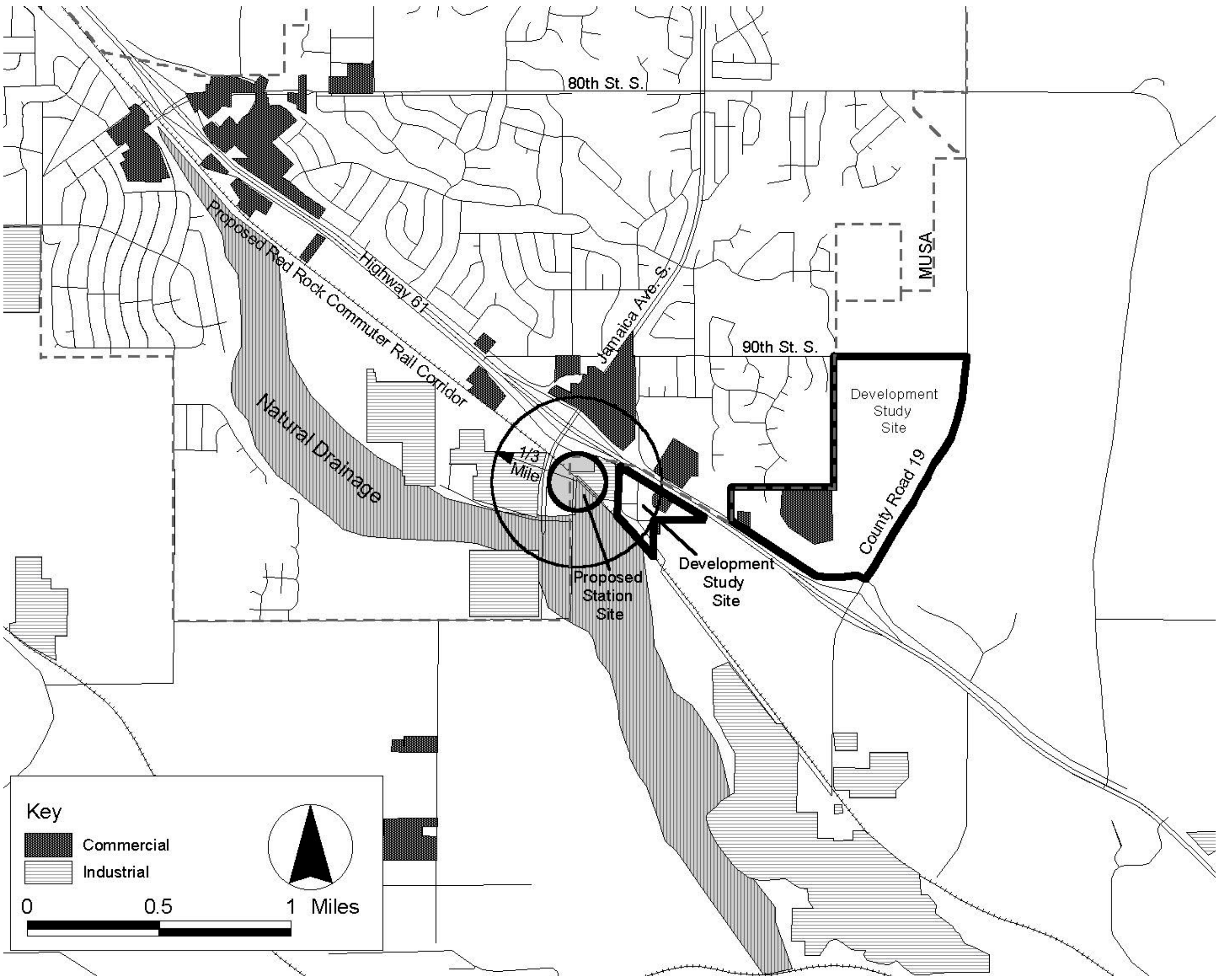


Figure 4.6 Existing Context Plan

Cottage Grove Site: Existing Conditions

The Cottage Grove site is bordered by Ninetieth Street South to the north, County Road 19 and the Cottage Grove Ravine Regional Park to the east, a frontage road for Highway 61 to the south and an internalized housing development to the west (see Figure 4.6). The site is a mix of flat land presently dominated by agricultural fields and deep ravines covered in forest. Due to the proximity of the site to a natural open area and the Mississippi River, the site has a large potential for impacting the water quality of nearby surface water and that of ground water and the volume of recharge. Commercial development in Cottage Grove borders the east side of Highway 61 and is progressing toward the site. The site is in close proximity to the proposed Commuter Rail Station Site at Jamaica Ave. South.

The Cottage Grove site is divided into seven sub-watershed catchment areas (see Figure 4.7). Each catchment is analyzed in relation to its soil type, vegetative cover, topography and built structures (see Table 4.3).

Figure 4.7 Cottage Grove Site: Existing Conditions

Table 4.3 Cottage Grove Site: Existing Conditions

Location	*Area in Square Feet*	*Area in Acres*
Catchment Area 1		
Agricultural Fields (Row Crops) in "A" Soils	169,338.86	3.89
Humid grassland in "A" Soils	31,313.99	0.72
Agricultural Fields (Row Crops) in "B" Soils	3,110,018.86	71.40
Humid grassland in "B" Soils	13,349.84	0.31
Forest in "A" Soils	192,571.86	4.42
Forest in "B" Soils	86,295.10	1.98
Total Pervious Surfaces	***3,602,888.51***	***82.71***
Farmstead in "B" Soils	80,809.40	1.86
Roadway with shoulder on"A"	7,560.65	0.17
Roadway with shoulder on"B"	15,916.22	0.37
Total Impervious Surfaces	***104,286.27***	***2.39***
Total Area:	**3,707,174.78**	**85.11**
Catchment Area 2		
Humid grassland in "A" Soils	116,350.54	2.67
Agricultural Fields (Row Crops) in "B" Soils	745,259.49	17.11
Humid grassland in "B" Soils	0.00	0.00
Forest in "A" Soils	119,012.60	2.73
Forest in "B" Soils	36,194.62	0.83
Total Pervious Surfaces	***1,016,817.25***	***23.34***
Roadway with shoulder on"A"	26,462.22	0.61
Roadway with shoulder on"B"	25,383.70	0.58
Total Impervious Surfaces	***51,845.92***	***1.19***
Total Area:	**1,068,663.17**	**24.53**

Catchment Area 3

Agricultural Fields (Row Crops) in "B" Soils	72,423.61	1.66
Humid grassland in "A" Soils	33,676.98	0.77
Humid grassland in "B" Soils	17,224.42	0.40
Forest in "A" Soils	9,486.46	0.22
Forest in "B" Soils	56,429.55	1.30
Total Pervious Surfaces	***189,241.01***	**4.34**
Roadway with shoulder on"A"	15,740.45	0.36
Total Impervious Surfaces	***15,740.45***	**0.36**
Total Area:	**204,981.46**	**4.71**

Catchment Area 4

Agricultural Fields (Row Crops) in "B" Soils	168,457.07	3.87
Humid grassland in "A" Soils	15,583.93	0.36
Humid grassland in "B" Soils	0.00	0.00
Forest in "A" Soils	29,489.69	0.68
Forest in "B" Soils	13,701.30	0.31
Total Pervious Surfaces	***227,232.00***	***5.22***
Roadway with shoulder on"A"	16,143.06	0.37
Total Impervious Surfaces	***16,143.06***	***0.37***
Total Area:	**243,375.05**	**5.59**

Catchment Area 5

Agricultural Fields (Row Crops) in "B" Soils	371,421.41	8.53
Agricultural Fields (Row Crops) in "B" Soils	936,373.88	21.50
Humid grassland in "A" Soils	542,521.86	12.45
Humid grassland in "B" Soils	43,450.67	1.00
Forest in "A" Soils	213,525.19	4.90
Forest in "B" Soils	25,383.08	0.58

Total Pervious Surfaces	***2,132,676.10***	***48.96***
Roadway with shoulder on"A"	32,403.59	0.74
Total Impervious Surfaces	***32,403.59***	***0.74***
Total Area:	**2,165,079.69**	**49.70**

Catchment Area 6

Humid grassland in "A" Soils	1,469,716.57	33.74
Humid grassland in "B" Soils	385,275.01	8.84
Forest in "A" Soils	465,590.61	10.69
Forest in "B" Soils	107,553.39	2.47
Total Pervious Surfaces	***2,428,135.58***	***55.74***
Roadway with shoulder on"A"	8,221.06	0.19
Parking on "C"	552,169.45	12.68
Drives on "C"	33,424.75	0.77
Total Impervious Surfaces	***593,815.26***	***13.63***
Total Area:	**3,021,950.85**	**69.37**

Catchment Area 7

Agricultural Fields (Row Crops) in "B" Soils	474,120.68	10.88
Total Pervious Surfaces	***474,120.68***	***10.88***
Farmstead on "B" Soils	54,092.62	1.24
Roadway with shoulder on"A"	11,652.71	0.27
Total Impervious Surfaces	***65,745.33***	***1.51***
Total Area:	**539,866.01**	**12.39**

Total Site Area:	***10,951,091.00***	***251.40***

Cottage Grove Site: Baseline Development

The baseline design for this subdivision uses the Land Use map from the Cottage Grove 2020 Comprehensive Plan as a guide for land use and development densities. The low density residential area to the north demonstrates the current pattern of recent internalized circulation development plans in Cottage Grove. Townhouses are located in areas intended for medium density residential. Commercial, service, and office development is focused closer to Highway 61 (see Figure 4.8 and Table 4.4).

Design Criteria: Baseline

- 310 single-family dwelling units on _-acre lots plus town homes and apartments;
- A development pattern that is largely internal in its circulatory structure including a dominance of cul-de-sac patterns;
- Drainage to the south and north on based on current, conventional plans;
- A small park, partially enclosed by homes;
- Extend MUSA/Urban Reserve to Highway 19 edge;
- Curb-and-gutter road sections throughout;
- Upgrade county highways as arterials;
- Collectors/Sub-arterials as residential streets.

Figure 4.8 Cottage Grove Site: Baseline Design

Table 4.4 Cottage Grove Site: Baseline Development

Location	*Area in Square Feet*	*Area in Acres*
Catchment Area 1		
Lawn in "A" Soils	272,829.25	6.26
Lawn in "B" Soils	2,280,651.91	52.36
Total Pervious Surfaces	***2,553,481.17***	***58.62***
Roadway with shoulder on "B"	24,344.33	0.56
Driveways in "B" Soils	271,074.38	6.22
Houses in "A" Soils	40,502.00	0.93
Houses in "B" Soils	380,808.74	8.74
Neighborhood Street on "B"	506,020.34	11.62
Total Impervious Surfaces	***1,222,749.79***	***28.07***
Total Area:	**3,776,230.96**	**86.69**
Catchment Area 2		
Lawn in "A" Soils	253,105.64	5.81
Lawn in "B" Soils	610,873.83	14.02
Forest in "A" Soils	8,923.35	0.20
Forest in "B" Soils	7,902.79	0.18
Total Pervious Surfaces	***880,805.61***	***20.22***
Roadway with shoulder	18,035.61	0.41
Neighborhood Streets	75,364.85	1.73
Residential Homes	50,472.56	1.16
Household Driveways	32,474.05	0.75
Total Impervious Surfaces	***176,347.07***	***4.05***
Total Area:	**1,057,152.69**	**24.27**
Catchment Area 3		
Forest in "B" Soils	4,050.86	0.09
Lawn in "A" Soils	49,554.44	1.14
Lawn in "B" Soils	118,912.63	2.73
Total Pervious Surfaces	***172,517.93***	**3.96**
Roadway with shoulder	6,701.97	0.15
Neighborhood Streets	20,283.89	0.47
Residential Homes	10,974.07	0.25
Household Driveways	12,233.94	0.28
Total Impervious Surfaces	***50,193.86***	**1.15**
Total Area:	**222,711.79**	**5.11**
Catchment Area 4		
Lawn in "A" Soils	22,195.68	0.51
Lawn in "B" Soils	139,514.56	3.20
Forest in "A" Soils	23,003.52	0.53
Forest in "B" Soils	9,783.73	0.22
Total Pervious Surfaces	***194,497.49***	***4.47***

Roadway with shoulder on "A"	15,661.21	0.36
Impervious Sports Surfaces	6,371.85	0.15
Parking Lots	9,574.78	0.22
Total Impervious Surfaces	***31,607.85***	***0.73***
Total Area:	**226,105.34**	**5.19**

Catchment Area 5

Lawn in "A" Soils	339,836.99	7.80
Lawn in "B" Soils	891,197.07	20.46
Forest in "A" Soils	97,975.62	2.25
Forest in "B" Soils	5,590.88	0.13
Total Pervious Surfaces	***1,334,600.56***	***30.64***
Roadway with shoulder on "A"	38,983.84	0.89
Neighborhood Streets	280,818.03	6.45
Household Driveways	60,159.79	1.38
Commercial Buildings	203,451.16	4.67
Parking Lots	248,668.03	5.71
Total Impervious Surfaces	***832,080.86***	***19.10***
Total Area:	**2,166,681.42**	**49.74**

Catchment Area 6

Lawn in "A" Soils	835,762.16	19.19
Lawn in "B" Soils	365,688.54	8.40
Lawn in "C" Soils	297,668.34	6.83
Forest in "A" Soils	221,022.53	5.07
Forest in "B" Soils	59,278.69	1.36
Total Pervious Surfaces	***1,779,420.25***	***40.85***
Roadway with shoulder	12,270.40	0.28
Neighborhood Streets	285,527.66	6.55
Commercial & Residential Driveways	117,446.33	2.70
Commercial & Residential Buildings	333,049.67	7.65
Parking Lots	503,775.86	11.57
Total Impervious Surfaces	***1,252,069.92***	***28.74***
Total Area:	**3,031,490.17**	**69.59**

Catchment Area 7

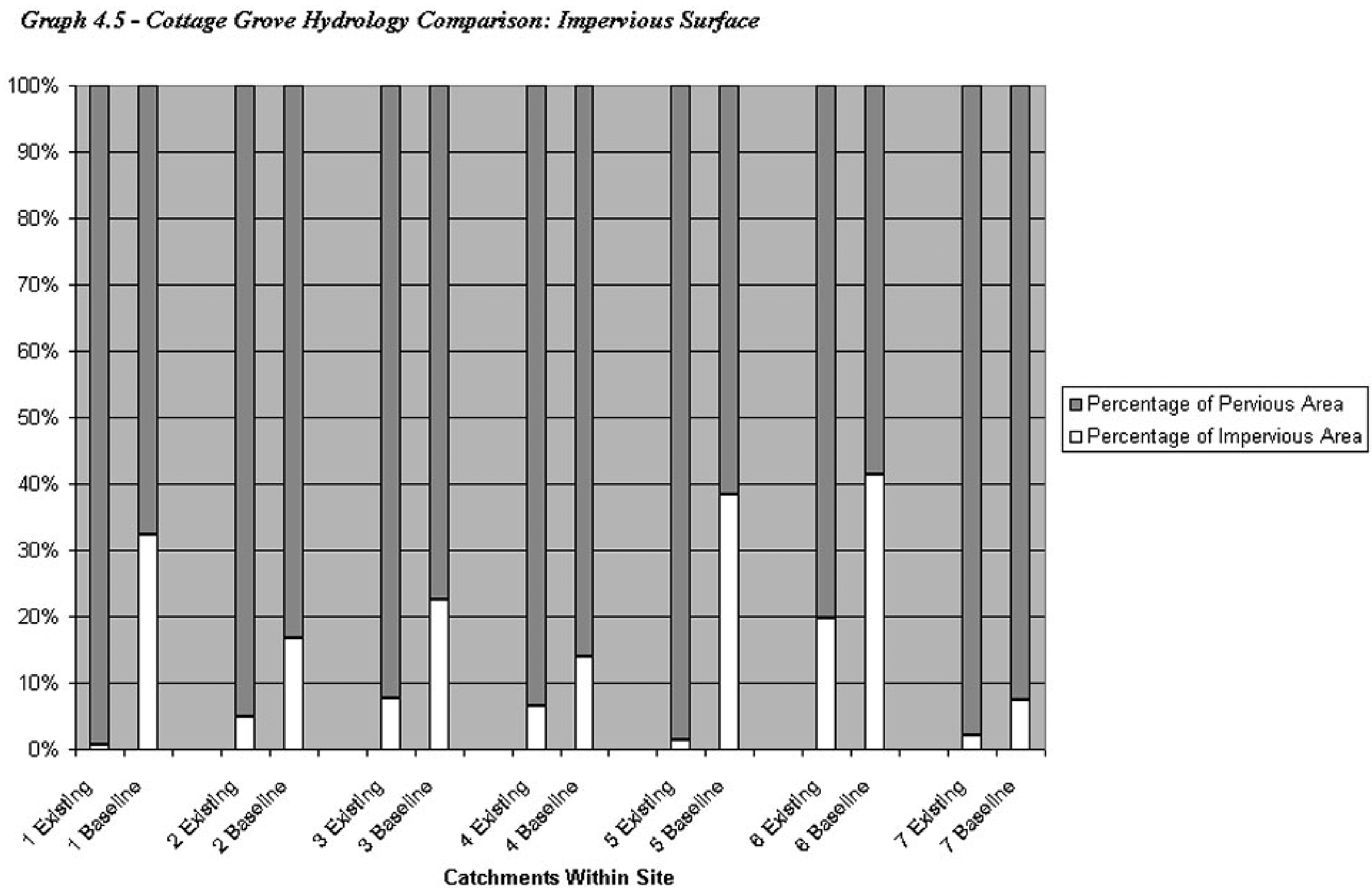
Lawn in "A" Soils	435,849.59	10.01
Total Pervious Surfaces	***435,849.59***	***10.01***
Residential Homes	20,928.75	0.48
Roadway with shoulder on "A"	13,940.30	0.32
Total Impervious Surfaces	***34,869.05***	***0.80***
Total Area:	**470,718.64**	**10.81**

Total Site Area:	***10,951,091.00***	***251.40***

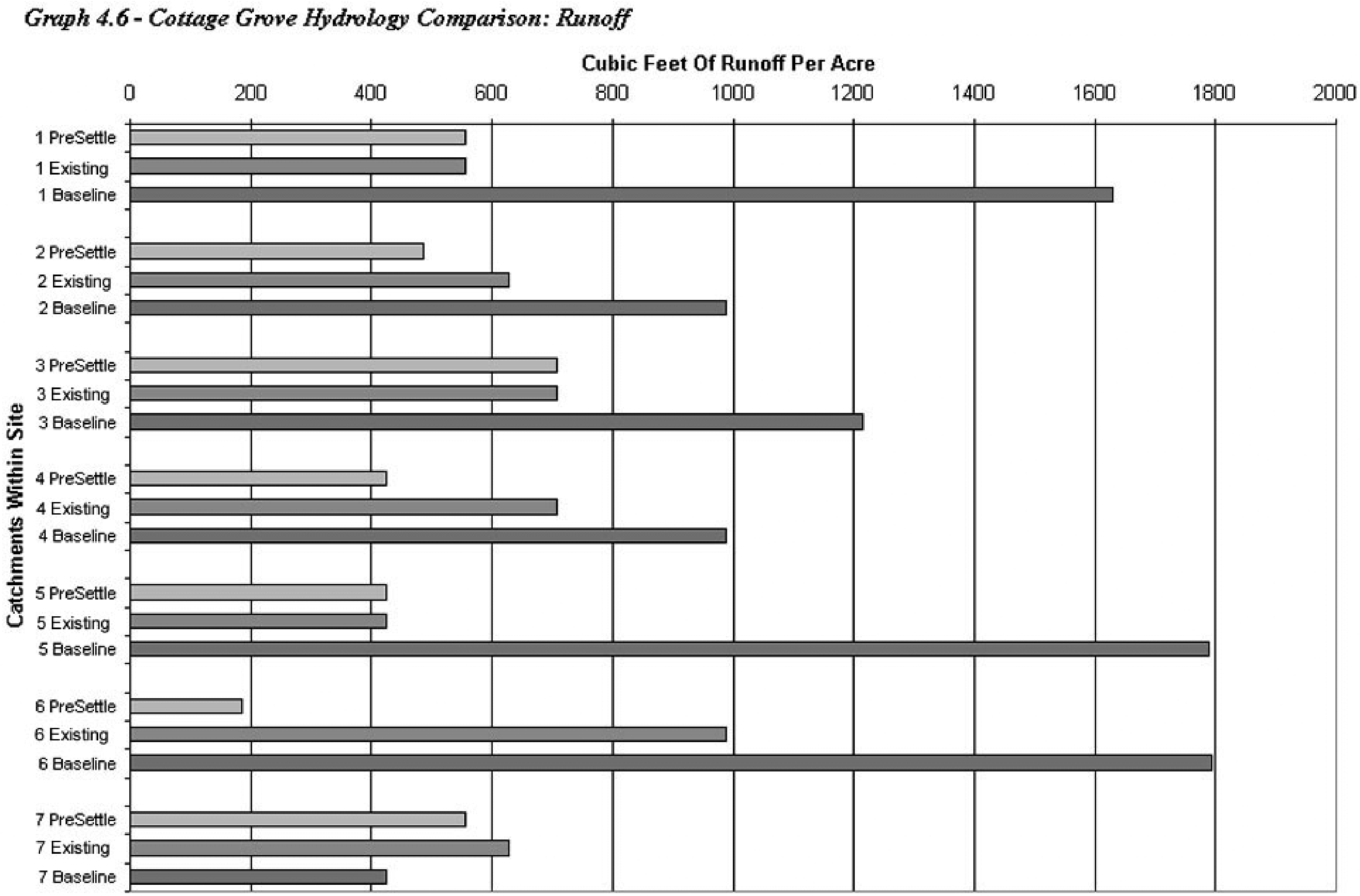
Cottage Grove Site Hydrology Comparison

The percentage of impervious surface increases from the existing conditions to the baseline conditions. With the increase in impervious surface and the piping of storm water comes decreased concentration times, a higher runoff volume, and higher and faster peak discharges. Comparisons are shown graphically on graphs 4.5–4.8.

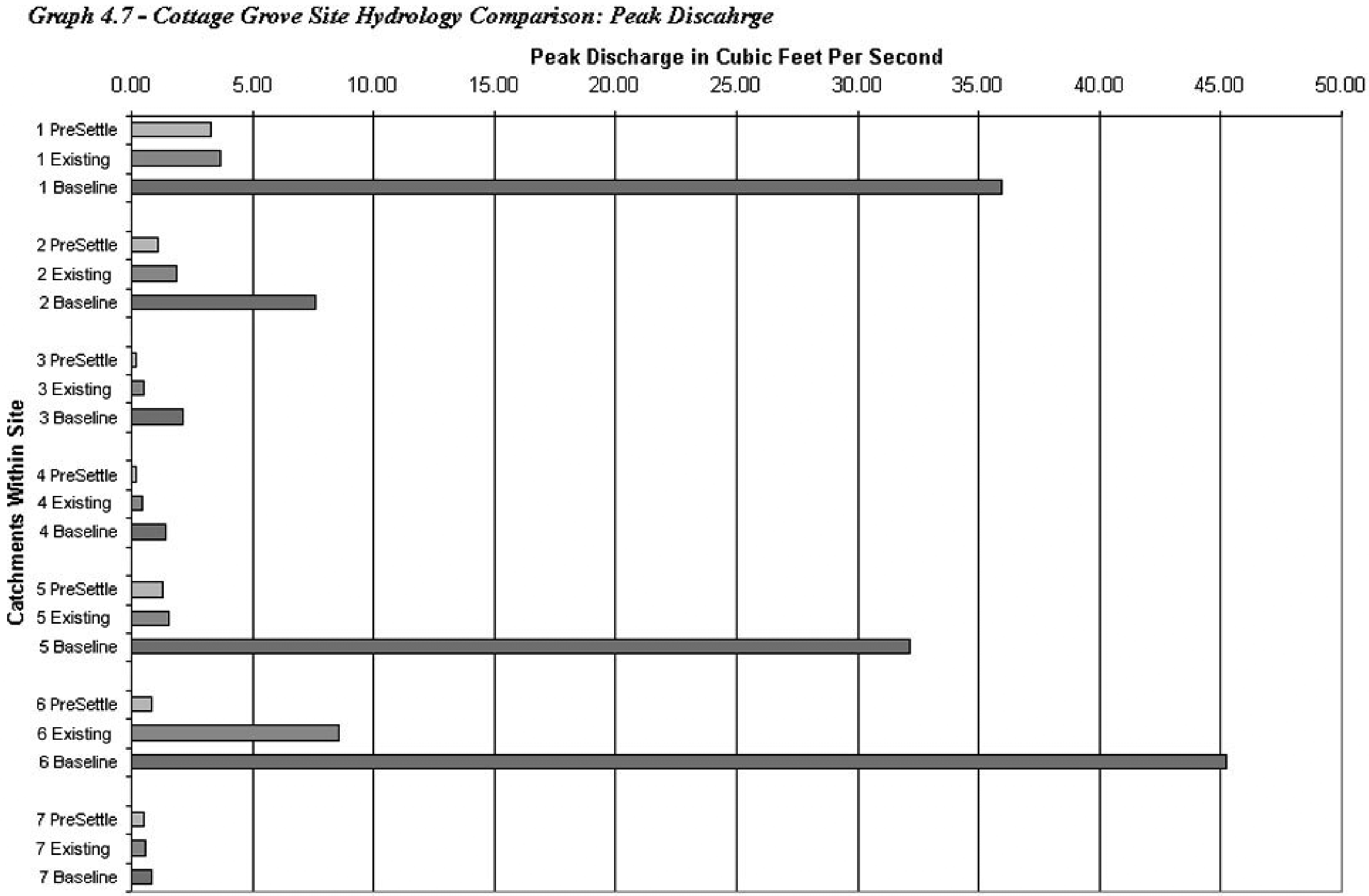
See Appendix B for hydrologic analysis methodology.



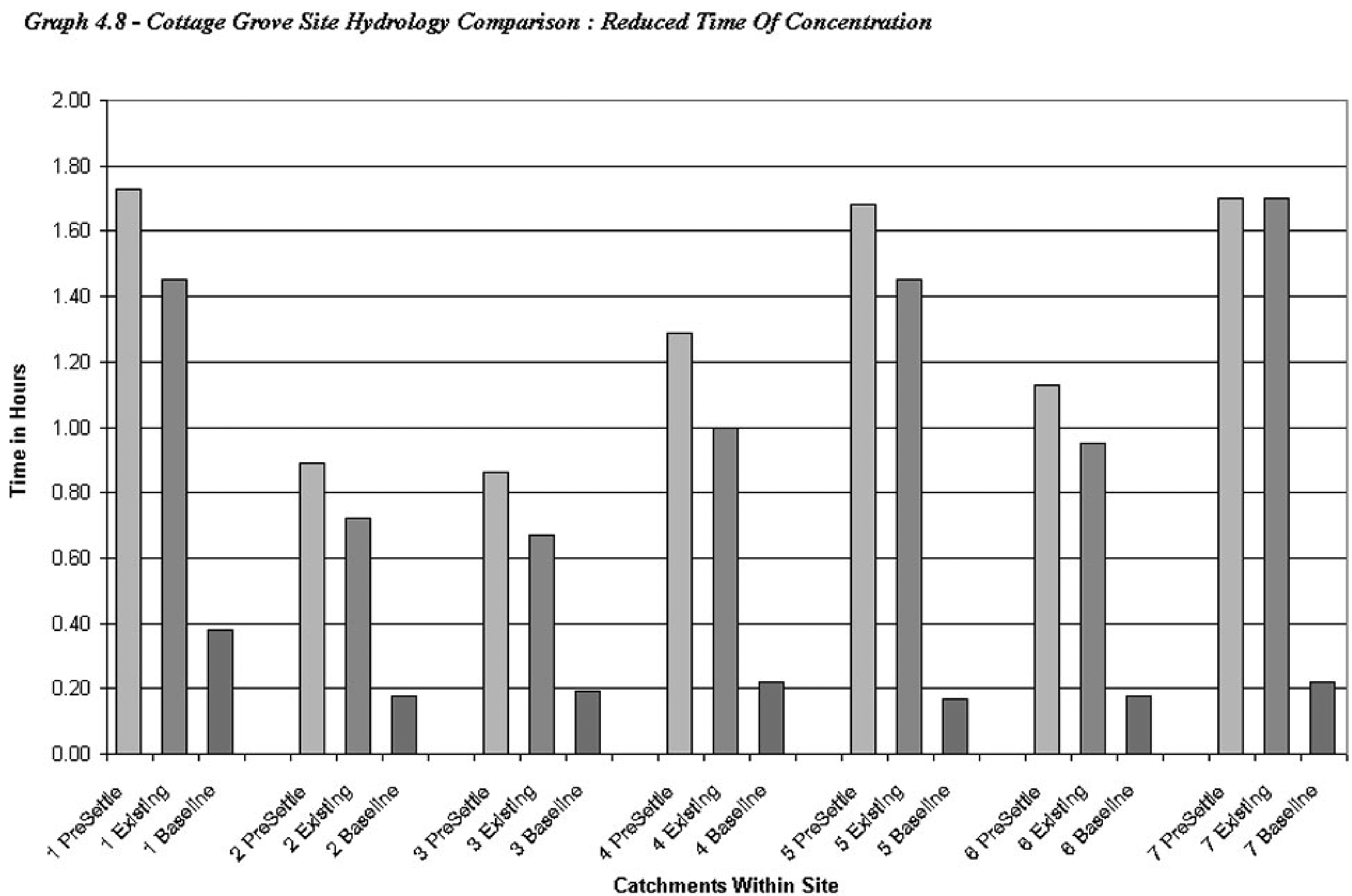
Graph 4.5 Cottage Grove Hydrology Comparison: Impervious Surface



Graph 4.6 Cottage Grove Hydrology Comparison: Runoff



Graph 4.7 Cottage Grove Hydrology Comparison: Peak Discharge



Graph 4.8 Cottage Grove Hydrology Comparison: Reduced Time of Concentration

CHAPTER 5

Infrastructure Design Standards in Subdivision

Urban Infrastructure Standards and the Suburb

Each of the cities has slightly different approaches and standards for constructing residential streets, sidewalks, and subgrade infrastructure. However, in the cases of the two suburban cities, there is a remarkable similarity in the results, even if the resulting private development differs rather substantially in price.

City of St. Paul

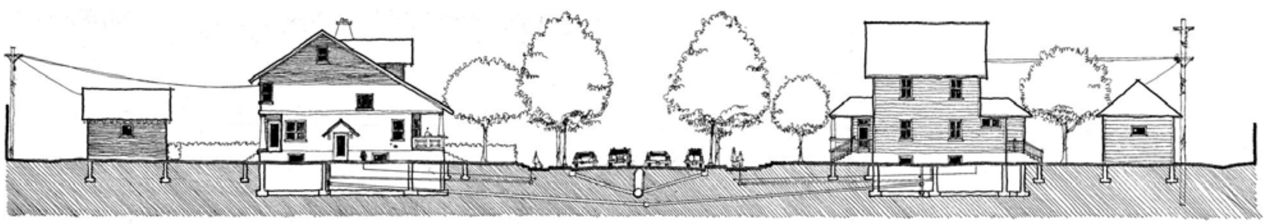


Figure 5.1 Typical section through a St. Paul neighborhood

Most of the residential areas of the City of St. Paul are already subdivided and served by streets and piped infrastructure (see Figures 5.1 and 5.2). Brownfield areas are an exception to this, including rail yards, but most of the city would be difficult to transform to alternative systems such as overland drainage and infiltration.

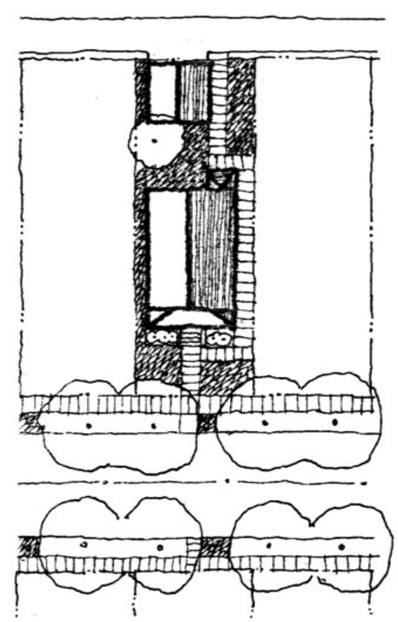


Figure 5.2 Typical St. Paul Lot

Subdivision: Storm Sewer, Sanitary Sewer—Bundled Infrastructure in the Streets

- Minor arterials—80 feet right of way, 44 feet paved;
- Collectors—66 feet right of way, 36 feet paved;
- Local streets determined by Public Works director;
- Cul-de-sacs—not to exceed 600 feet in length, minimum right of way 50 feet, roadway radius 40 feet.

Storm Water

- Each sub-division is required to provide storm water management for all storms up to and including 100-year storms.

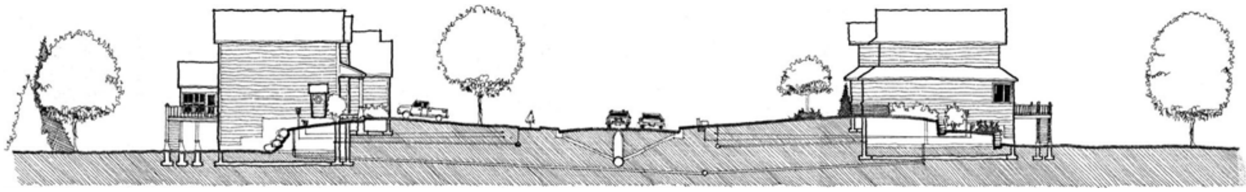


Figure 5.3 Typical section through a Woodbury neighborhood

Subdivision: Storm Sewer, Sanitary Sewer—Bundled Infrastructure in the Street
The subdivision ordinance is largely the source of guidance for the form and sizing of piped infrastructure and street section design.

Sanitary Sewer
• Minimum 8-inch sanitary sewer pipe composed of vitrified clay pipe.

Water main
• Minimum 6-inch cast iron pipe—for pipe more than 6 inches, the additional cost to be born by the parties requiring the larger size (sec.2-162).

Building services
• _-inch type copper water service, 4-inch extra heavy cast iron soil pipe sewer service (sec. 21-164).

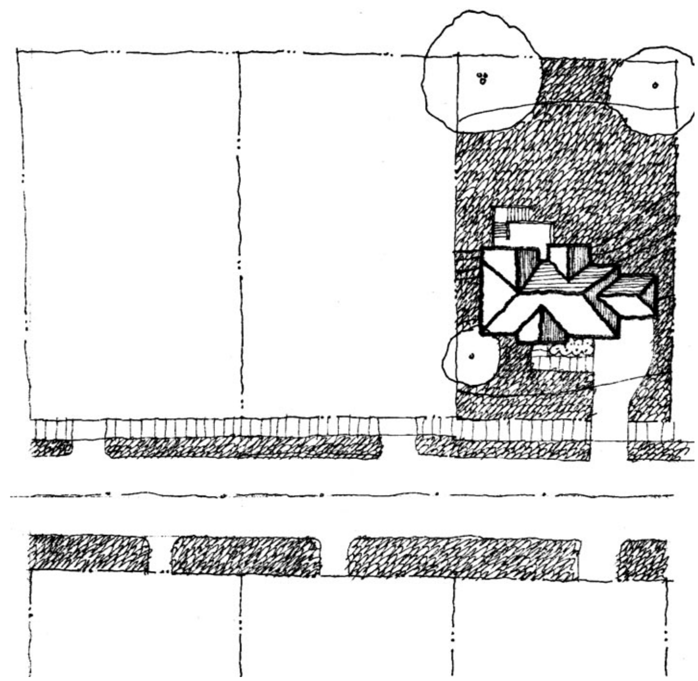


Figure 5.4 Typical Woodbury Lot

Street Standards
• Concrete curb and gutter shall be included as a part of the required street surface improvement
in subdivisions and shall be designed for installation along both sides of all roadways (sec. 21-86).
• Publicly dedicated streets shall have a 50' row and a 28' wide bituminous street with concrete
curb and gutter (sec. 21-160).
• Curb and gutter shall be provided along both sides of all streets (sec. 21-160).
• Approved gutter types:
  - Type B-618

    - Integral rolled or surmountable
    - Concrete
- Storm sewer system or a system of open ditches, culverts, pipes and catch basins, or both systems (21-90).

- Private streets—vehicular access to two or more parcels of land, which is not dedicated to the public but is owned by one or more private parties.
- Pavement-concrete or hot mix bituminous as approved by city engineer.
- Sidewalks—4 feet in single family area; 6 feet for multi-family and industrial areas, 10 feet in commercial areas.
- Street plan provisions—hierarchical; service roads to buffer neighborhoods from high traffic arteries.

Lot Size

- Single family minimum requirements: 10,000-square-foot lot size, setback 35 feet, frontage 80 feet.
- Requirements in unsewered subdivisions: 5-acre lot size, frontage 200 feet, setback 50 feet, 35% maximum site coverage.

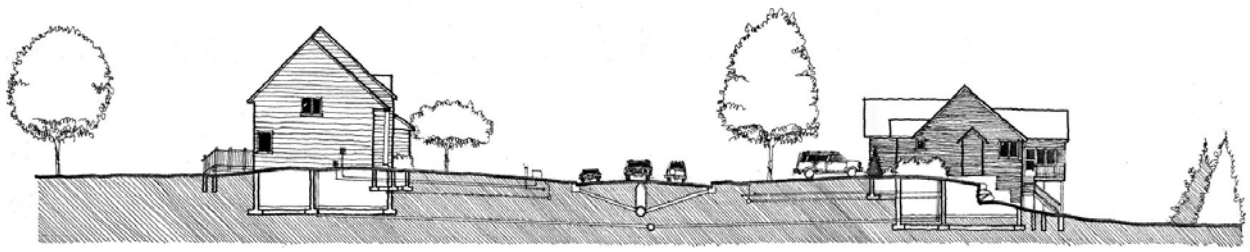


Figure 5.5 Typical section through a Cottage Grove Neighborhood

Subdivision: Storm Sewer, Sanitary Sewer—Bundled Infrastructure in the Street

Storm sewer design and construction is controlled as a part of the subdivision ordinance, Section 10-3-3 of the Subdivision Agreement. Subsection B1. and B2. Public Improvements, stipulates that the city engineer shall exact an agreement by the subdivider to furnish and construct all public improvements to the specifications of the city engineer. Sizes of pipes, other features will be specified. Costs are set for the public improvements by the city engineer; after the agreement is drafted and signed, the city engineer lets the construction contract.

Sanitary Sewer

- Minimum 8-inch sanitary sewer pipe—pipe over 8 inches may be required and the additional cost may be born by the city.

Water Mains

- Minimum 6-inch iron pipe or other approved pipe; 8-inch or larger may be required and additional cost may be born by the city.

Building Services

- 1-inch, type k copper water service and 4-inch standard weight cast iron soil pipe sewer service are minimum requirements.

Depth

- Laid at a depth not less than 7 _' below the established grade, or as low as the street mains (10-5-6).

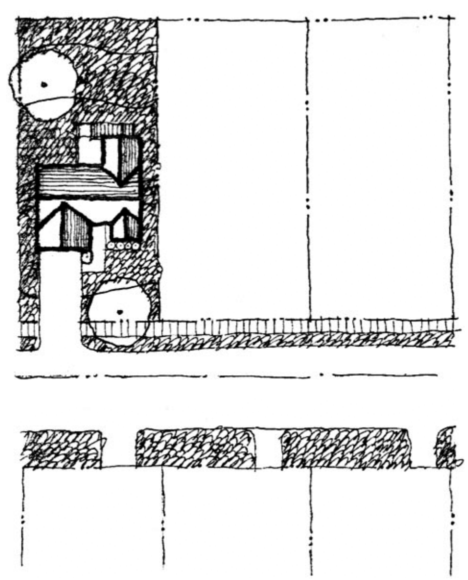


Figure 5.6 Typical Cottage Grove Lot

Residential Subdivision Regulations

- 100% of improvements including, but not limited to, street lighting, public sanitary sewer, water, storm sewer, curb and gutters (10-3-4).
- All streets and alleys shall be improved with concrete or bituminous surface and with concrete curb and gutter (except for rural areas) (10-5-3).
- Storm sewer system or a system of open ditches, culverts, pipes and catch basins or both systems (10-5-6).

Street Standards

- Private streets—vehicular access to two or more parcels of land, which is dedicated to the public but is owned by one or more private parties.
- Alley—24 feet row/20 feet paved industrial/commercial only.
- Access—60 feet row/32 feet paved.
- Collector—80 feet row/ 48 feet paved.
- Minor arterial—120 feet row–160 feet row.
- Bitum. or concrete gravel for streets with fewer than three lots.
- Curb and gutter—required Mn/DOT spec. #2531.
- Sidewalks—required in m/f districts, between blocks greater than 900 feet.
- Hierarchical, dead-end streets must permit future extension.

Lot Size

- Single-family minimum requirements: 10,000 square feet., set back 30 feet, frontage 75 feet.
- Requirements in unsewered subdivisions: three-acre lots, frontage 180 feet, setback 30 feet.

CHAPTER 6

Current Trip Generation—Patterns in the Regional and Local Transportation Network and the Cottage Grove Station

This analysis describes the baseline conditions for the above project. It addresses three areas:

1. Baseline Roadway Configuration
2. Baseline Travel Characteristics
3. Baseline Commuter Rail Characteristics

Each of these subject areas is deigned to address an issue of the study that will be further analyzed in the investigation of land use alternatives.

Baseline Roadway Configuration

Roadways are required for two purposes: to provide access to land and to provide a route to move from one location to another. The roadway system is categorized by four different levels based on functional classification—a hierarchy of roadways each serving a different degree of mobility and access. The Metropolitan Council's functional classification guidelines are summarized in Appendix C.

Mobility is generally defined in terms of speed. Access relates to the amount of connectivity to a roadway; the more access points to a roadway the more difficult it is to provide a high level of mobility. Figure 6.1 shows the concept of functional classification: principal arterials (generally freeways and expressways) are designed to provide a high level of mobility with a minimum of local access. Local roadways are designed to provide high levels of local access with a low level of concern for mobility.

Principal arterials are ideally spaced every three to six miles apart. Minor arterial spacing of one to two miles is considered appropriate in developing suburban areas such as the study area, compared to 1/2 to one mile in fully developed areas. Collector roadways are typically found every 1/2 to one mile in developing areas (i.e., located between adjacent minor arterials), and between 1/4 to 1/2 mile in fully developed areas.

Although a roadway hierarchy implies a "traffic-shed" of smaller roadways flowing into larger roadways, the functional classification system actually serves to create a series of overlapping grids. These grids provide for a dispersal of trips across a broader network and, assuming some degree of land use mix, provide opportunities for access and mobility in multiple directions.

The adopted comprehensive plans for Cottage Grove and Woodbury (see Figures 6.2 and 6.3) define actual or conceptual locations for both existing and future principal arterials, and minor arterials and collector roadways. Minor arterials in the study area are generally spaced one mile, although the location of the roadways is affected by access spacing on the principal arterials, pre-existing development conditions, and topographic constraints (e.g., bluffs, wetlands, streams, etc.). The arterial and collector roadways in the study area are depicted in Figure 6.2. The only arterial connection that has not yet been constructed is Mile Drive between Military Road and Dale Road.

Phase 2 must consider whether a higher density grid network is more appropriate for higher density levels envisioned in the study area.

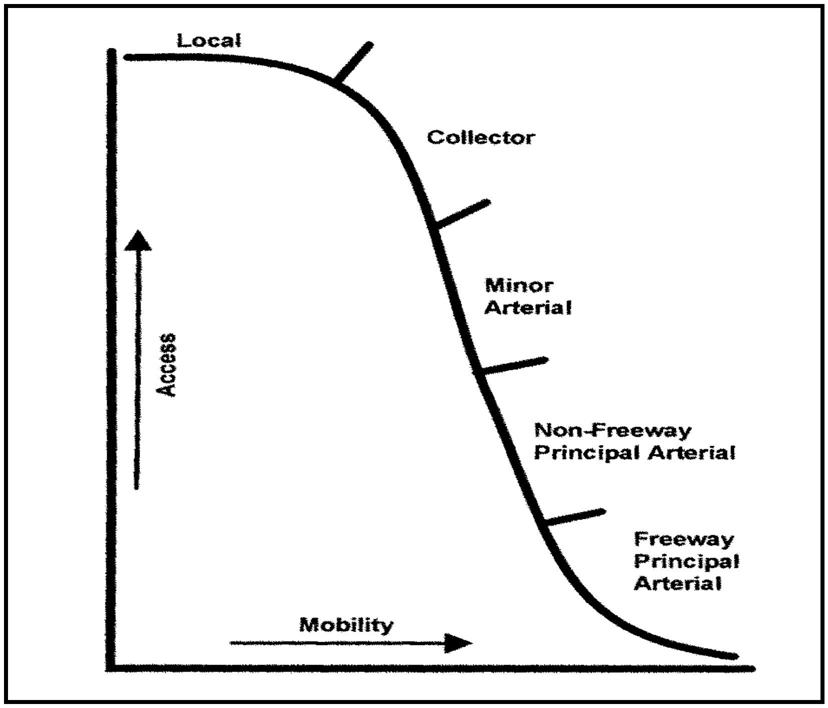


Figure 6.1 Mobility/Access Diagram

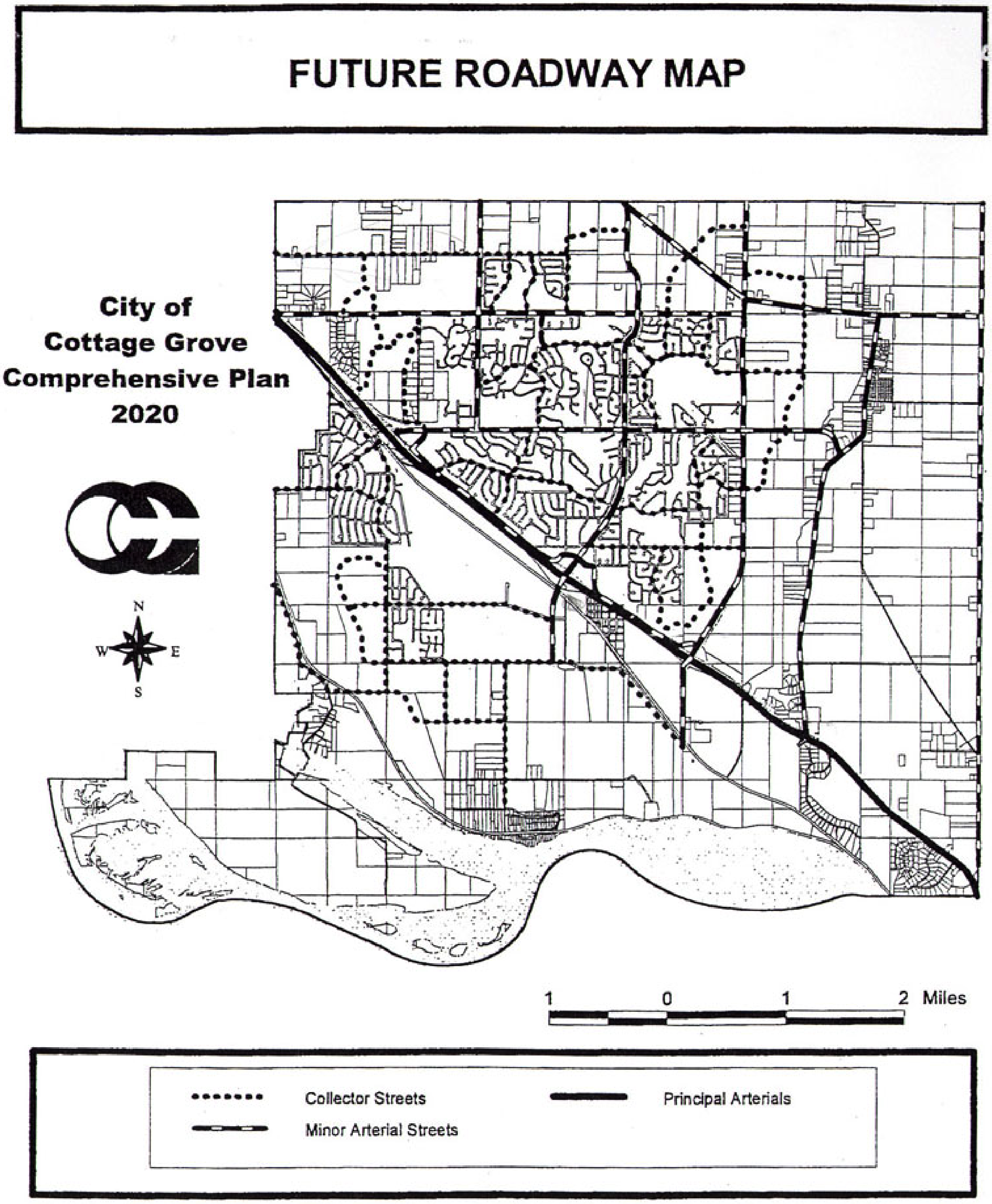


Figure 6.2 Future Roadway Map

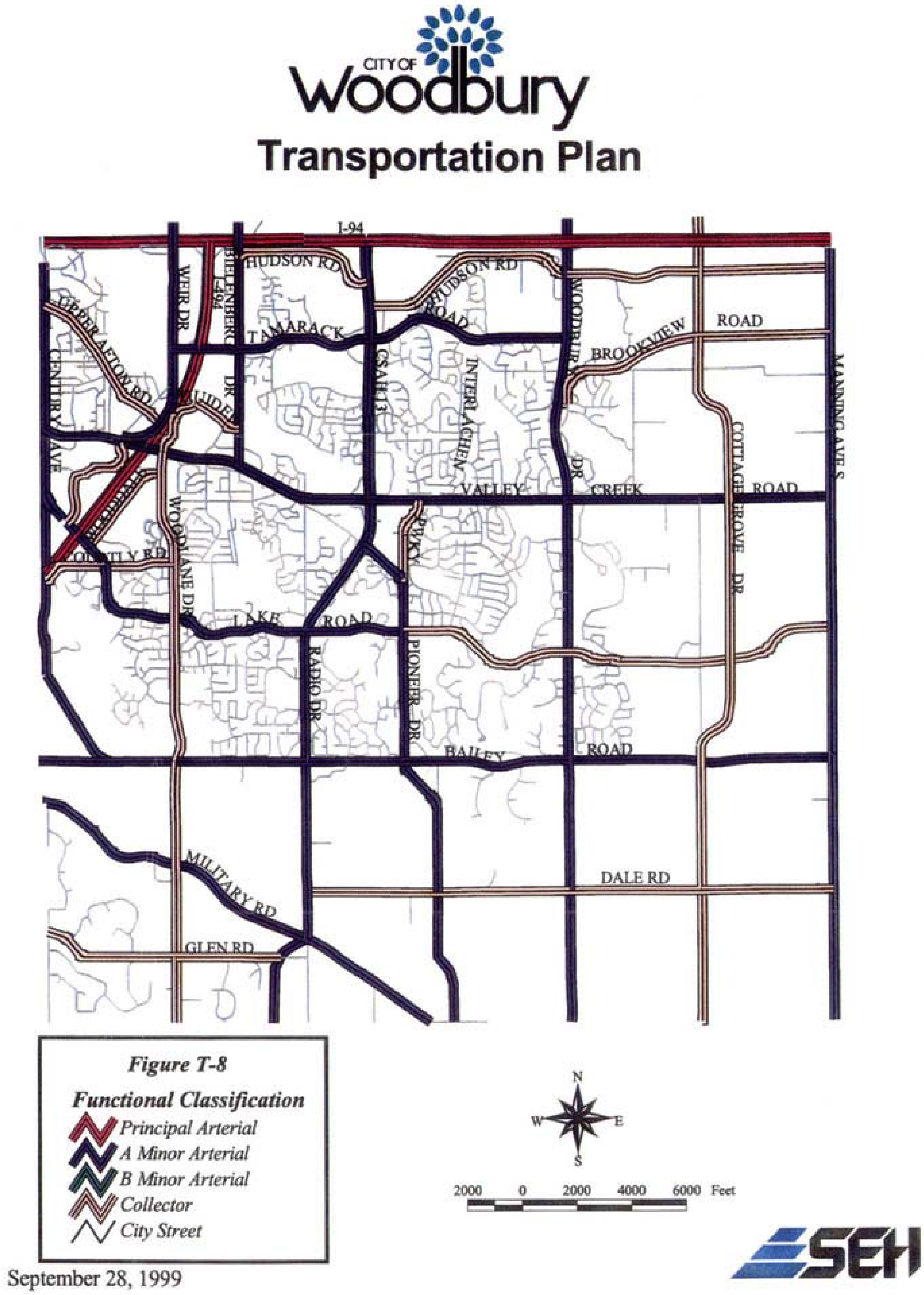


Figure 6.3 Cottage Grove Functional Classification

Baseline Travel Characteristics

Alternative land use and transportation configurations will affect the number of trips made, the travel and arrival modes used by the trips, and the routing of those trips. All of the above are calculated by the Twin Cities regional traffic forecast model, which was completed by the Metropolitan Council in 1994 based on data from the 1990 Twin Cities regional travel behavior inventory and contemporary state-of-the-practice computational software and methodology. It is primarily used for major project planning and is calibrated and validated at an accuracy level sufficient for most regional and corridor-level analysis. The model employs an enhanced, classic four-step travel demand forecasting process—trip generation, trip distribution, mode choice, and highway assignment.

For the purposes of this study, the Twin Cities are divided into five districts as shown in Figure 6.4. These districts are the study area, downtown St. Paul, downtown Minneapolis, other areas with a peak period transit access time from Cottage Grove of less than 45 minutes, and all other areas which may or may not have any available transit service. Aggregating the region in this way isolates the effect on regional travel patterns of specific transit destinations (downtown areas) and areas with reasonable transit access from travel that has no possible relation to the transit system. The aggregation is broad enough to level out land use variations that would be evident in between single zones.

The Twin Cities regional traffic forecast model divides trips into six purposes—home-based grade school (HBG), home-based university (HBU), home-based work (HBW), home-based other (HBO), non-home-based work, and non-home-based other—to reflect the types of trips people make, and nine travel modes: walk to transit, informal drive to transit, formal drive to transit, single occupancy vehicle (SOV), informal high occupancy vehicle (HOV), formal HOV, walk to commuter rail, informal drive to commuter rail, formal drive to commuter rail. For the purposes of this study, only home-based trips are pertinent, and these can be classified as simply work trips (HBW) or non-work trips (HBG, HBO, UNW). Non-home-based trip activity cannot be linked to the household location and is typically not transit-oriented.

The mode choice component of the regional model considers, among many factors, distance from transit access in assigning a travel mode to a trip. The portion of each zone within 1/3 mile of transit, between 1/3 mile and one mile of transit, and further than one mile from transit is used to assign three different mode splits to trips generated in that zone. The model calibration from the 1990 regional travel behavior inventory identifies 1/3 of a mile as a threshold for a "short walk" to transit. This allows the regional model to account for the linear nature of fixed-route transit within an irregularly shaped or large zone. Table 6.1 is a cross tabulation of that data with 2020 baseline socioeconomic data provided by the Metropolitan Council that demonstrates the relative transit accessibility of population and employment in the study area compared with the entire region.

Table 6.1 Transit Accessibility (2020 Data)

	Within 1/3 mile of Transit		Between 1/3 mile and 1 mile of Transit		Further than 1 mile from Transit	
Twin Cities						
Population	1,350,057	44%	633,961	20%	1,114,667	36%
Households	571,599	45%	268,134	21%	435,380	34%
Employment	1,055,769	58%	420,009	23%	349,544	19%
Study Area						
Population	19,578	37%	14,039	26%	19,982	37%
Households	6,658	35%	5,050	27%	7,304	38%
Employment	1,776	24%	1,249	17%	4,235	58%

The results of the baseline travel analysis of trips generated in the study area are shown in Table 6.2. The 3% work transit share is typical of an outlying suburban area. The majority of these transit trips (93%) are destined to one of the downtowns, which is typical considering the type of transit service available in the study area. While downtown Minneapolis has a very high transit share, it attracts a very small number of trips. Highway travel time and transit travel time to downtown Minneapolis from the study area are each greater than fortyfive minutes, which is longer than most Twin Cities residents commute daily. Downtown St. Paul is the dominant commuter rail market, accounting for more than 75% of all home-based work transit trips.

The regional model is well suited for providing regional travel statistics. The map in Figure 6.5 displays the average number of vehicle miles traveled (VMT) per household in each zone. This is a useful tool for understanding the auto travel patterns in different parts of the region. The pattern of VMT per household appears to be closely related to both land use and transportation infrastructure density, although other less obvious factors may be controlling the pattern as well. The study area has, on average, higher VMT per household than the regional average and appears to be similar in that respect to other outlying suburban areas such as Lakeville, Rogers, or Grant.

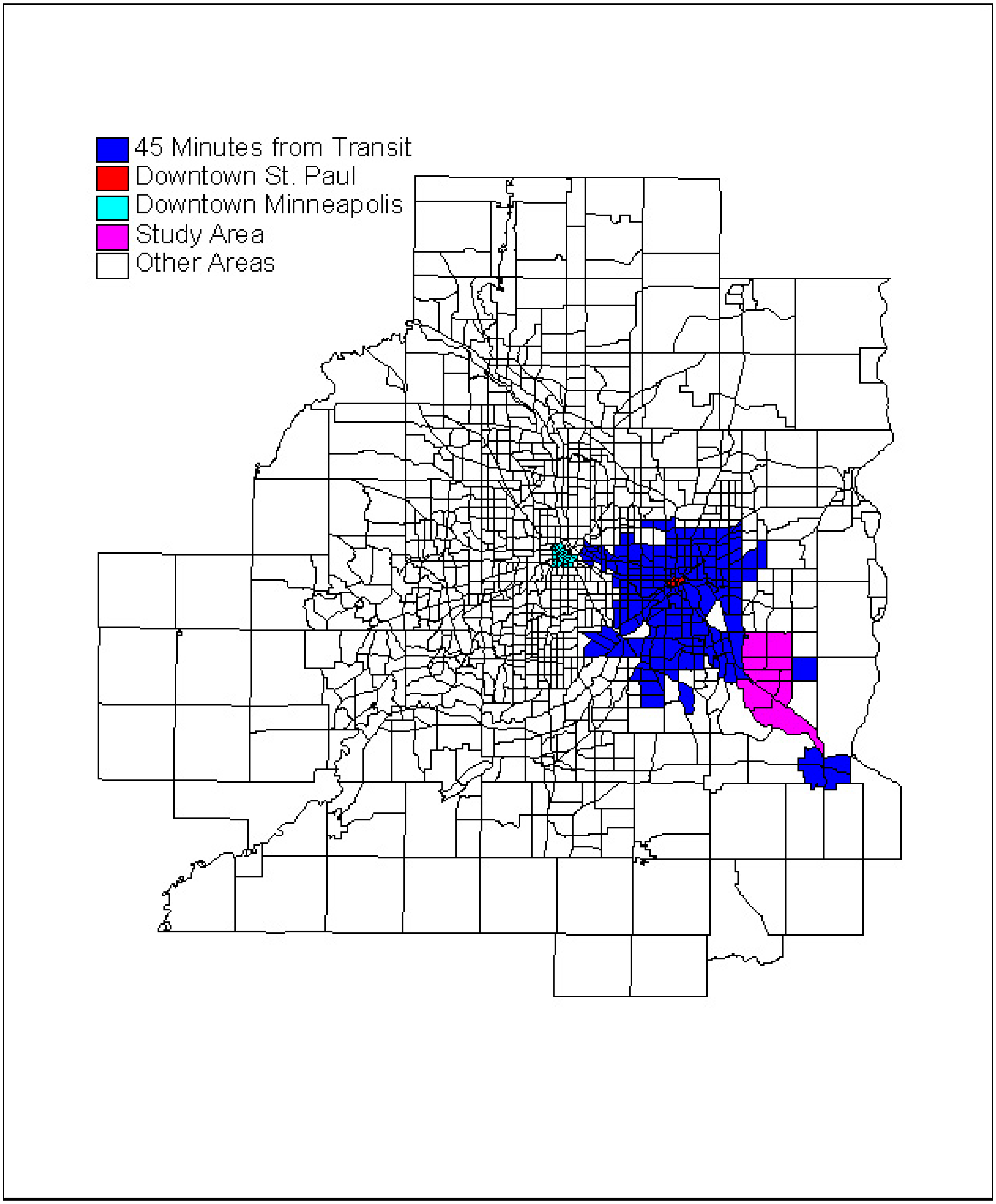


Figure 6.4 Analysis Districts

Table 6.2 Baseline Travel Mode Characteristics* Daily Home-based Trips—Year 2020 Forecast

	Work Trips				Nonwork Trips				Total Home-based Trips			
Destination	**All Trips (percent of total)**		**Transit Trips (percent by transit)**		**All Trips (percent of total)**		**Transit Trips (percent by transit)**		**All Trips (percent of total)**		**Transit Trips (percent by transit)**	
Downtown St. Paul	3,453	10%	879	25%	883	1%	1	0%	4,336	3%	878	20%
Downtown Minneapolis	470	1%	185	39%	627	1%	0	0%	1,097	1%	185	17%
Other Areas within 45 Minutes Transit Access	14,025	41%	42	0%	18,115	17%	16	0%	32,140	23%	58	0%
Stay Within Study Area	4,047	12%	23	1%	64,755	62%	167	0%	68,802	49%	190	0%
Other Areas	12,385	36%	8	0%	20,545	20%	22	0%	32,930	24%	30	0%
Total	**34,380**		**1,137**	**3%**	**104,925**		**206**	**0%**	**139,305**		**1,341**	**1%**

* Includes TAZs 1082,1083,1084,1085,1086,1087,1088,1090,1097, and 1098

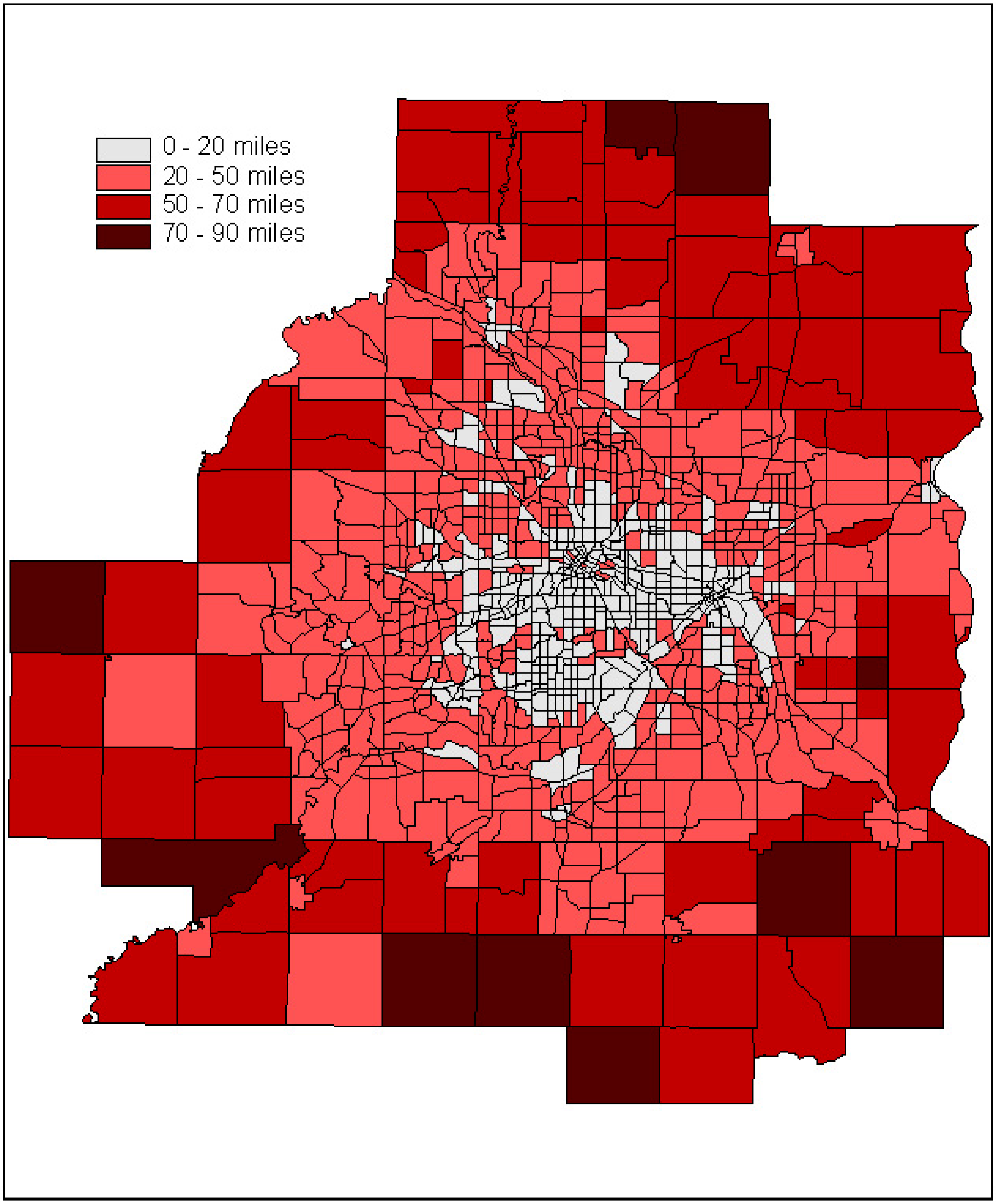


Figure 6.5 Vehicle Miles Travels by Household

Baseline Commuter Rail Characteristics

The baseline analysis assumes the construction of the Red Rock Commuter Rail line from Hastings to Minneapolis with a connection between downtown St. Paul and downtown Minneapolis provided along the Central Corridor. The Red Rock Study did not state where the stations were to be located within Newport and Cottage Grove, but for the purposes of forecasting (both for this report and for the Red Rock Study) some assumption must be made about station locations.

All forecasts and assumptions in the baseline analysis are based in the Red Rock Commuter Rail Feasibility Study: 2020 Draft Ridership Forecast (Red Rock Study) complete in April 2001 (available online at: http://www.redrockrail.org/project.htm).

The assumed operating characteristics of the Red Rock line are:

- Hastings to Minneapolis Central Business District (CBD): Four trains per day in peak direction.
- Minneapolis CBD to Hastings: One train per peak period (reverse commute).

The estimated travel time to downtown St. Paul from Cottage Grove is 17 minutes. The estimated travel time from Cottage Grove to downtown Minneapolis is 53 minutes, which includes an assumed 10-minute layover in downtown St. Paul required to permit the engine crew to change operating ends of the train. This is necessary because the track configuration at Union Depot does not permit a through movement to the BNSF tracks serving the Central Corridor.

The Red Rock Corridor Study defined a conceptual feeder bus service. In general, it would consist of smaller local loops operating every 30 minutes or 60 minutes, and would both feed into nearby commuter rail stations as well as provide some transit connectivity within the community.

The Red Rock Corridor study estimates that the line would carry 5,890 daily passengers in the year 2020. About 3,560 riders (60%) are attributable to the Red Rock portion of the corridor with the remainder using only stations in and between downtown Minneapolis and downtown St.

Paul. A total of 1,474 daily riders would board or alight at the Cottage Grove station. Of those riders, 1,288 riders (88%) would be oriented to downtown St. Paul and 168 riders (11%) would be oriented to downtown Minneapolis.

Park-Ride Connections

The baseline forecast assumes an auto connection to each station from each traffic assignment zone (TAZ) in its travel shed. Table 6.3 shows the estimated park-ride commuter rail ridership at the stations in the Red Rock Corridor as estimated by the Red Rock study. As a significant number of commuter rail trips in the study area drive to the station, the correct definition of these travel sheds is important. The model travel sheds were reevaluated by comparison to travel times calculated from a more detailed Washington County road network. Five-minute travel time isochrome diagrams for each station can be seen in Figures 6.6–6.8. This analysis generally validates the original model assumptions, which were used as the basis of forecasts for this study and for the Red Rock Corridor Commuter Rail Feasibility Study.

Table 6.3 Park-Ride Demand

Station	Estimated Commuter Park-Ride Demand
Hastings	162
Cottage Grove	589
Newport	390
Lower Afton Road	271

* Source: Red Rock Corridor Commuter Rail Feasibility Study 2020 Ridership Forecast

Among the issues to be addressed in Phase 2 of this study is the interaction of commuter rail and bus service in the study area. As Figures 6.9–6.12 show, there are significant areas where the travel times to either commuter rail station and to the Woodbury park-and-ride are approximately equal. Station selection in those areas would depend on in-vehicle transit travel time, traveler bias towards commuter rail or express bus modes, and the specific amenities that will be available at each station. The sensitivity of mode choice to trips generated in those areas is currently unknown.

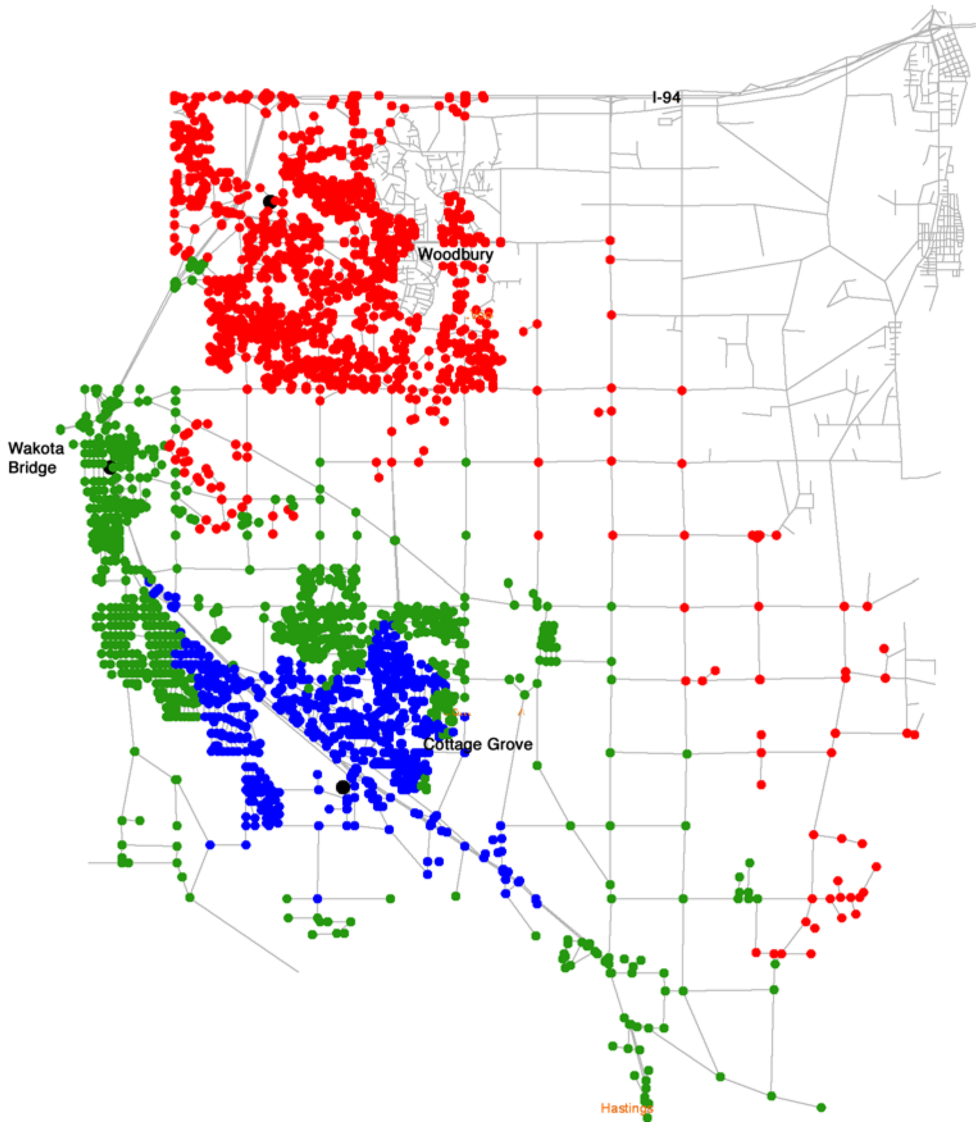


Figure 6.6 Five-minute Isochrome from Cottage Grove Commuter Rail Station

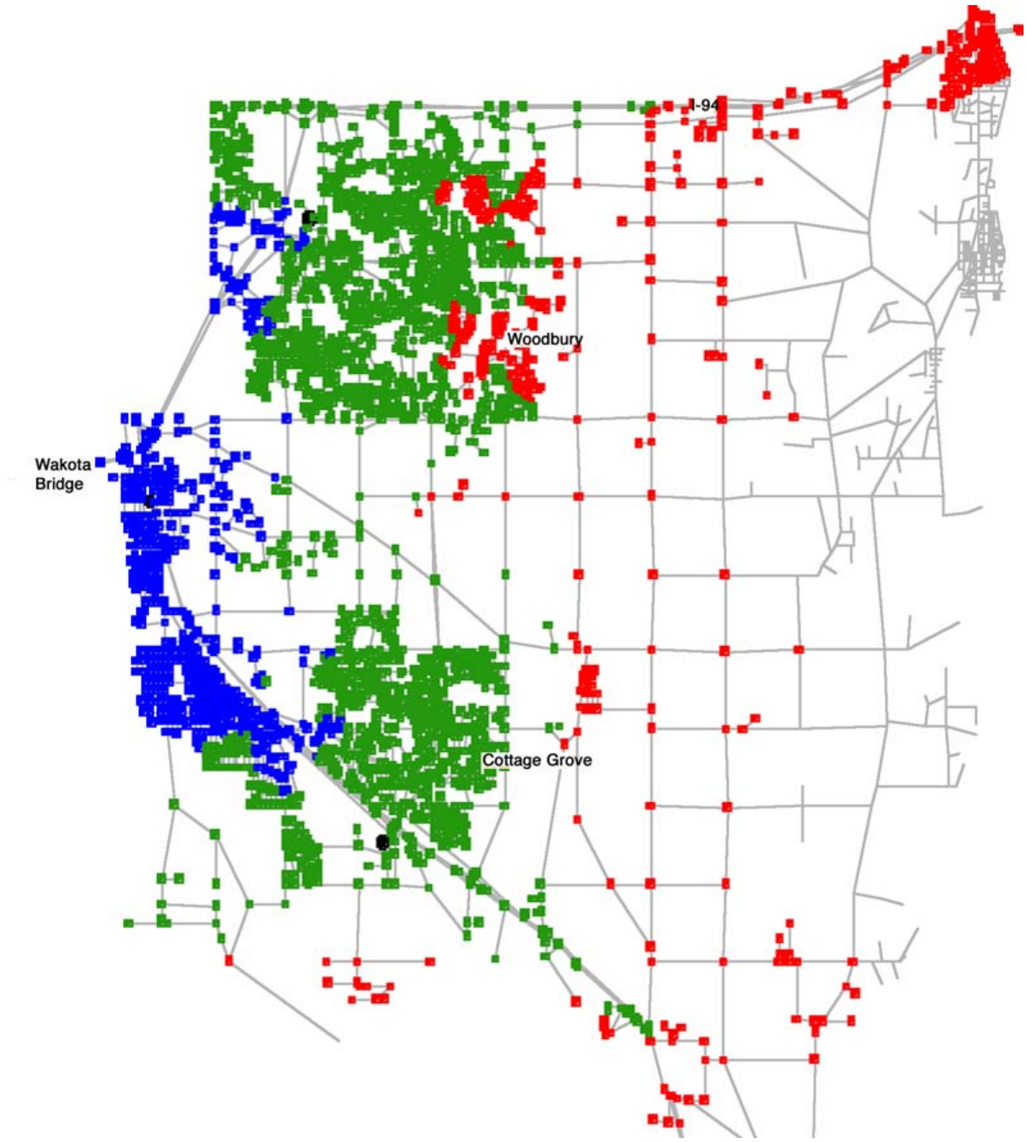


Figure 6.7 Five-minute Interval Isochrome from Glen Road Commuter Rail Station

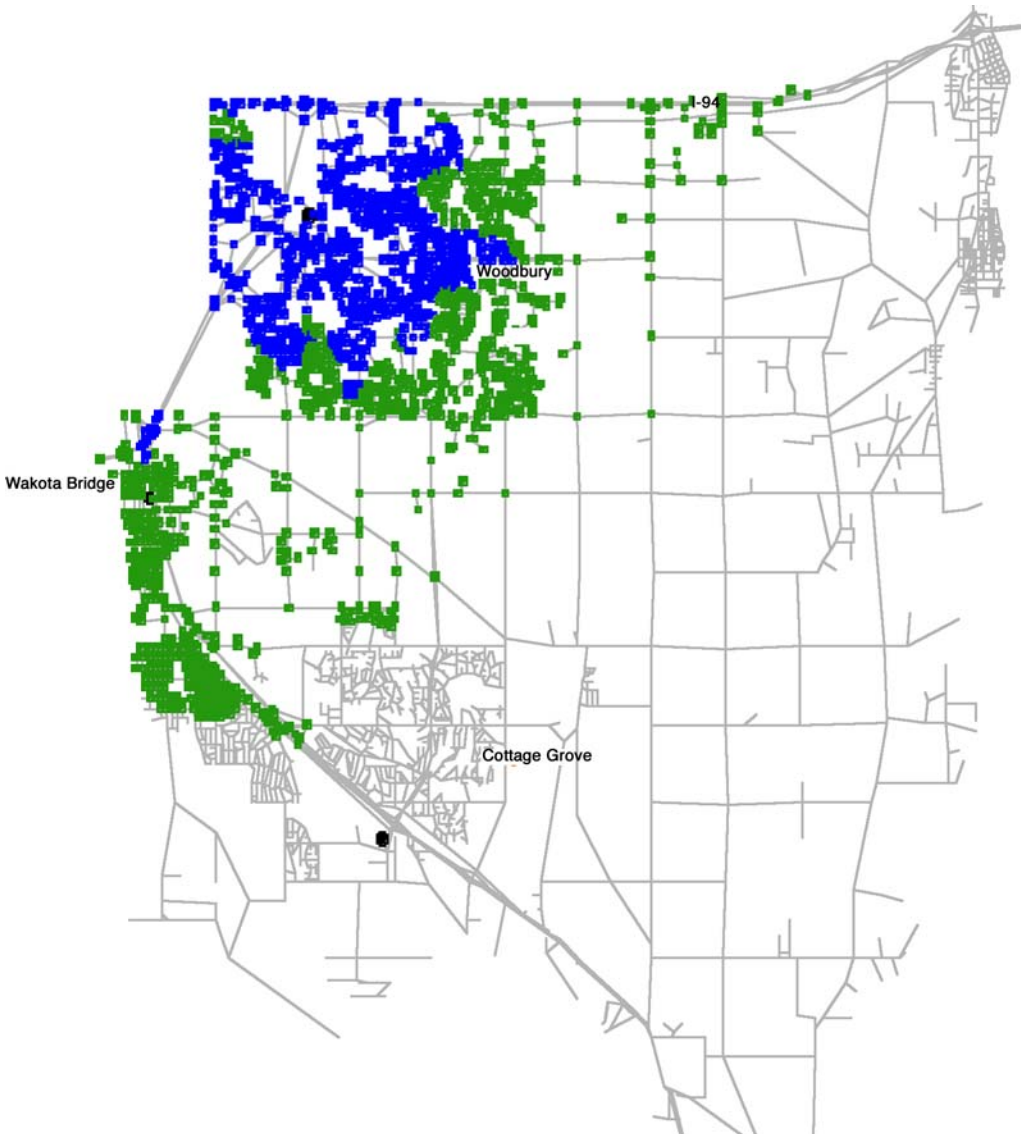


Figure 6.8 Five-minute Interval Isochrome from Woodbury Park-and-Ride

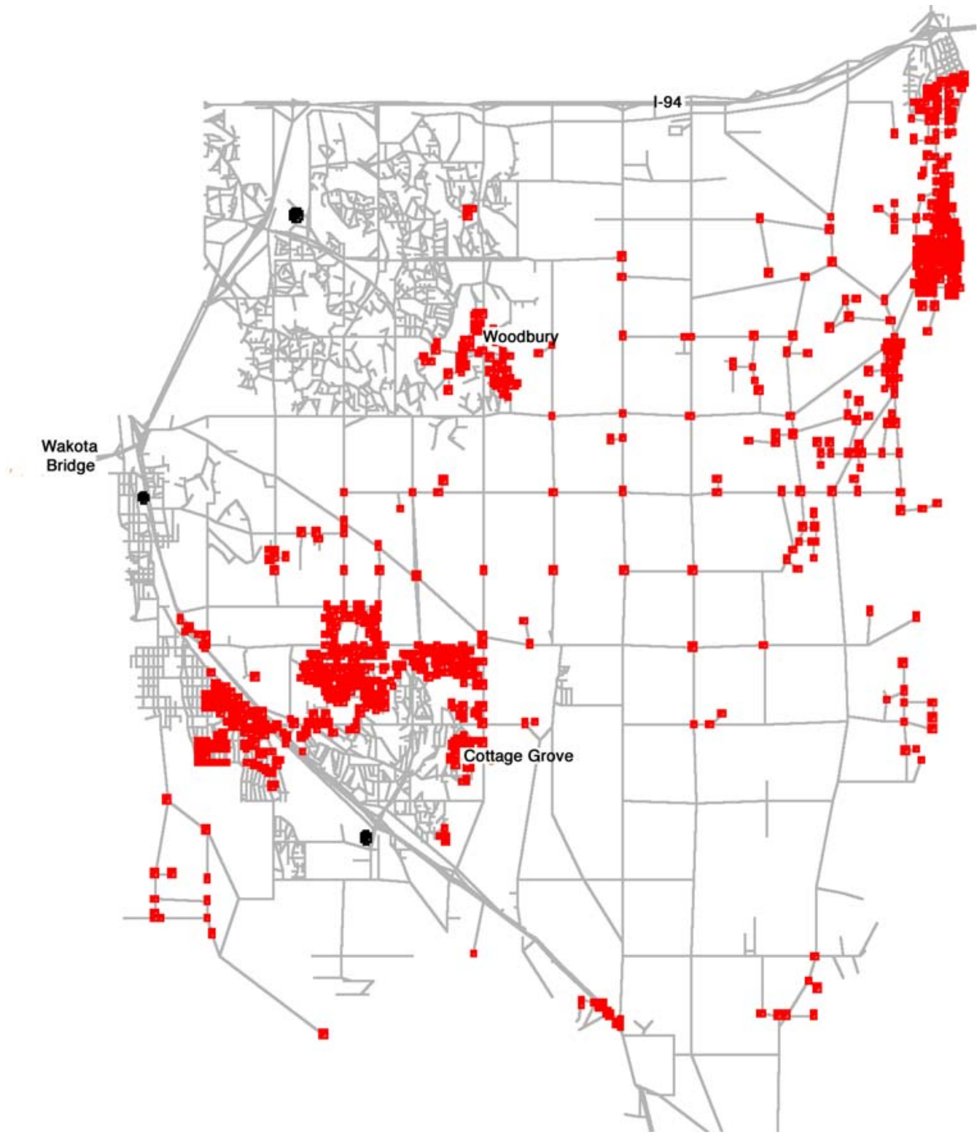


Figure 6.9 Equal Travel Times to Cottage Grove Station and Glen Road Station

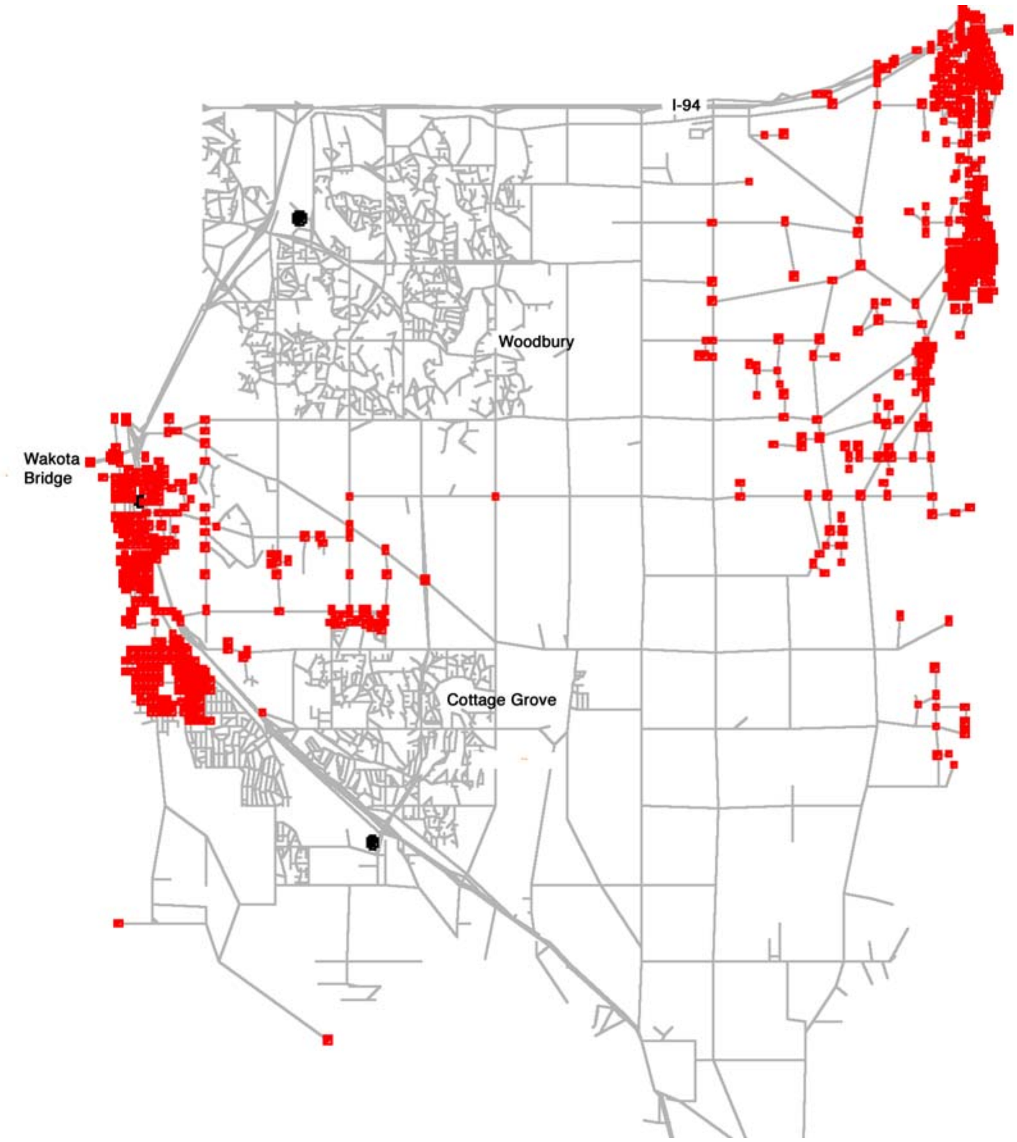


Figure 6.10 Equal Travel Times to Cottage Grove Station and Woodbury Park-and-Ride

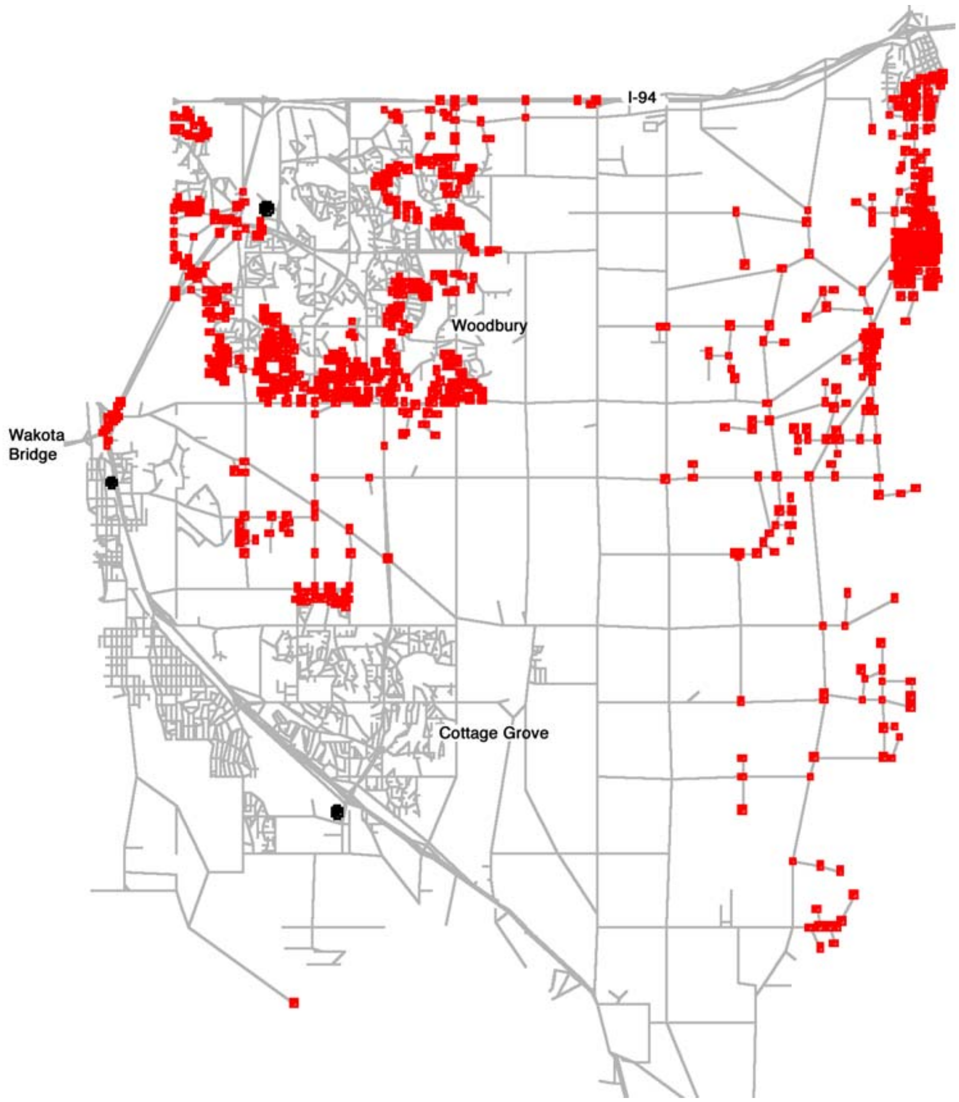


Figure 6.11 Equal Travel Times to Glen Road Station and Woodbury Park-and-Ride

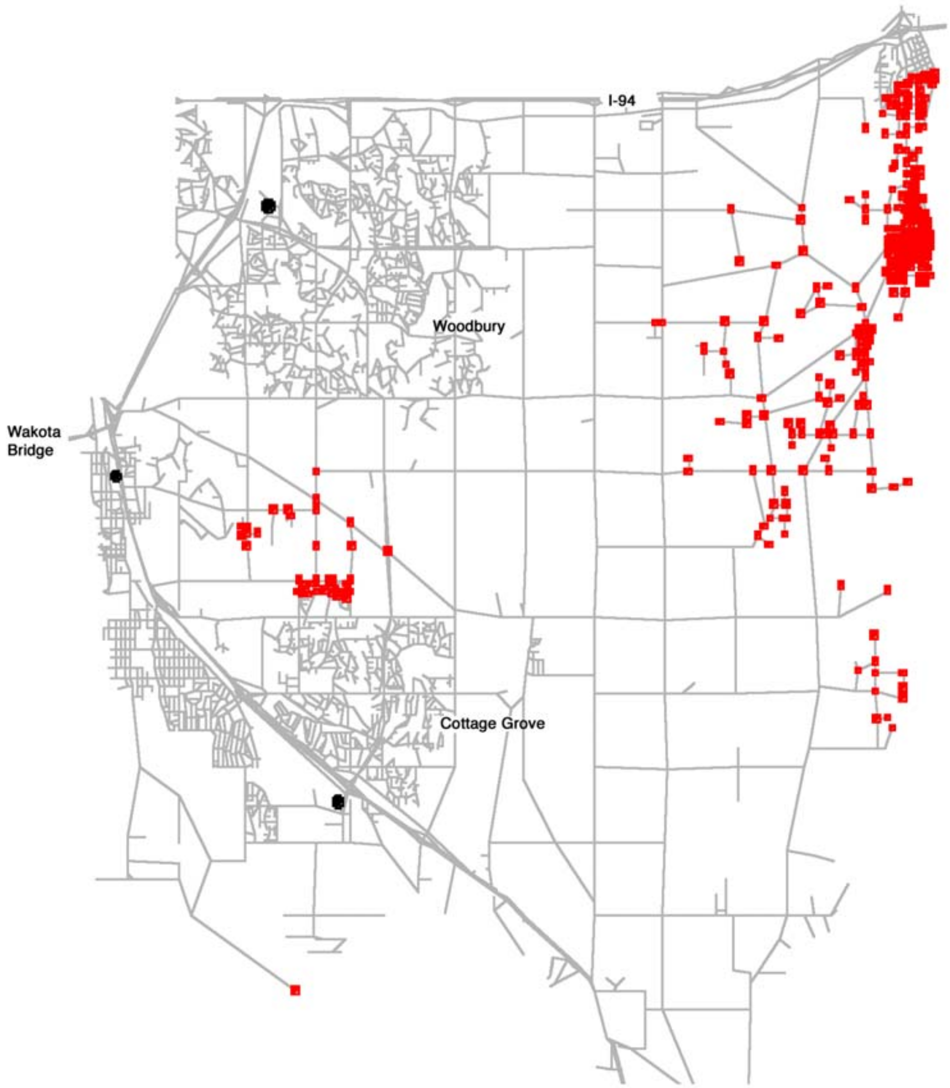


Figure 6-12 Equal Travel Times to Cottage Grove Station, Glen Road Station, and Woodbury Park-and Ride

CHAPTER 7

Overview & Introduction: Design for Commuter Rail-Oriented Development Highway 61/Red Rock Corridor

Overview

The question of "how shall we grow?" underlies the design and planning approaches used in this study. This is an American question. In the twenty-first century in the United States, we have inherited a culture and economy of growth, but the question of "how?" has new dimensions. Today, one of the principal issues facing the Twin Cities metropolitan area is a slowly increasing consciousness that how we grow will have new spatial dimensions than in previous eras. Our horizontal and dispersed settlement pattern, or sprawl, has indulged in the carrying capacity of our environment. Growth is footloose in geographical distribution, and, paradoxically, at the subdivision scale, it is, homogenous in pattern. In part, this sameness is due not just to mass production of houses and their parts; at the scale of the landscape, this sameness is also due to the relatively constant form that transportation and drainage infrastructure takes as a bundled system. Sprawl has raised questions of urban and suburban design for the metropolitan area. This study examines new design alternatives to sprawl at the subdivision scale using commuter rail as an agent of change in the expanded development corridor around Highway 61 between St. Paul and Hastings on three sites (St. Paul, Cottage Grove, and Woodbury) in that segment of the proposed Red Rock Commuter Rail Corridor.

In the Task One (Chapters 1–6) baseline report on existing conditions in the corridor, the research characterized the status quo of suburban growth:

Internalized Form and Unstratified Street Network

- The infrastructure of streets within the highway grid is increasingly built with less diversity of types and labyrinthine or internalized forms. It is an unstratified system in which few intermediate (subarterial) street types such as collectors are built to provide connective multi-modal or transit streets.

"One-size-fits-all" Drainage Infrastructure

- We have built a broadly cast, horizontal "one-size-fits-all" infrastructure, usually in transportation right-of-ways, to capture, manage, consume, and/or waste many resources—especially the water resources with which this report deals—that sustain growth.

Frame-built Single-family Housing

- We have built a ubiquitous, wood-based housing fabric based on the value of the single-family home. Collectively, this ideal actually creates an ironically homogenous incarnation of the culture and economy's individualistic orientation that gave rise to the value of the single-family home.

Institutional Framework: Auto Dependency and Genetic Code of Sprawl

- We have institutionalized this cultural ideal, evidenced in our settlement patterns, with the laws and practices that control the form and space of growth. These laws and practices and the economies that have given growth its engines have created a pattern that is not only sprawled, but also highly privatized and dependent upon automobiles. In other words, at the core of this institutional framework, we have engendered a relatively inflexible genetic code of sprawl.

The consequence of the ubiquitous and hardened nature of genetic code is that we have given ourselves few alternatives, in part because the alternatives (e.g., more compact and diverse) are largely illegal. These alternatives also do not match the homogenous vehicular and hydrological infrastructure built into the primary network of public space in which we invest. Under and within our streets, we conventionally pipe drinking water to houses and storm water and waste water away, out of sight and mind. All of the designs shown in this report attempt the reverse: preservation of diverse natural and cultural resources. These alternative proposals for a new development are seen not as a "one-size-fits-all," but as performance-standards/toolkit-based propositions attuned to local environmental, social and economic conditions, and other opportunities.

Smart Growth and Design

Smart growth depends on design and planning as a process of thinking and evaluation. Time is needed to evaluate fundamental change. Design and planning are the vehicles by which alternatives are weighed. Embedded in the alternative designs shown here are three principles:

1. *Design; Plan; Discuss; Decide; then Build.* Visualizing space on paper, in the computer before building it, or even passing laws about it, saves money. Design work here, for example, looks beyond the sewered lands of the MUSA, where it has to look if we hope to solve the problems within the MUSA. There is a special need here for assistance, guidance, and money to be directed in new design and planning toolkits on this urbanizing edge. Change is necessary if, however, leapfrog development can be recast in areas where we want transit riders to live**.** Although the work in this study focuses on the subdivision as an artifact and process by which the land is suburbanized, or taken down, we also examine the region, sub-region, and watershed as well as the street, the park, and the house lot—all over time.

2. *Multi-modal systems thinking is the beginning point for transportation design.* We need transportation mode choices and we need these modes to be connective to destinations. We need new subarterial street types to platform them. Redundant and connective transportation infrastructure systems are needed to create secure multi-modal regions. Multi-modal systems increase access, reduce per capita VMT, a central article of this work, and encourage a variety of clustered destinations. Land use diversity supports choice and economic diversity. Environmental issues can be addressed by design and plan, not mitigated later. Security—economic, ecological, and infrastructural—is founded on this diversity and the redundancy of systems.

3. *Commuter rail can spur evolutionary and more fundamental change via hybrid building forms.* In the context of apparent political polarization, evidenced in the legislature here, between advocates of compact, transit-oriented smart growth and advocates of conventional horizontal suburban growth, commuter rail as seen in this research, has some hybrid potentials. Commuter rail-oriented development could merge with existing patterns and economies, but be augmented with new ones, based in a new, valuable connectivity in the public realm. Gross densities are comparable in cluster subdivision designs shown in this

report to current densities in Cottage Grove and Woodbury—about 3.5 to 4.5 dwelling units per acre. The difference is in the design, of the street network, and the connectivity of open space as a value-added, hydrologically-attuned system. Even the densest solutions are typically similar to urban neighborhoods in the Twin Cities, with a high plurality of single family houses except on transit streets. Commuter rail and these alternative proposals are not designed to overthrow or undermine existing patterns and economies, but to buttress, even augment, them with new ones based in a new, valuable connectivity in the public realm.

If realized, the new commuter rail transit system could shape employment, housing, and regional form. As such, it could refine and clarify the economic and spatial strategy of the region. Strategically, the integration of job development and commuter rail would address congestion at peak. A principal political and economic obstacle for commuter rail here is the decline of the downtowns' job share, although Minneapolis and St. Paul are not the most job-sprawled of U.S. metropolitan areas.(*1*) Still, the Twin Cities central business district—downtown—employment share of the roughly one million total metropolitan jobs is only 12%, lower than equally suburban-scaled metropolitan regions such as Chicago or Seattle. Automobile- and truck-oriented land use patterns prevail, in large part to address conditions at peak. If realized, for example, this system would be a new armature for job development, especially in the two downtowns. Strategically this integration of job development would not only address congestion at peak, but also the armature could stimulate new opportunities for suburban development. Affordable housing development in various communities near the line could support reverse commutes, such as to the job center near the Jamaica Avenue station site in Cottage Grove.

Commuter Rail Futures, the Red Rock, and the Metropolitan Area

In the preparation for and work on this project, the team and the Technical Advisory Panel were continually struck by the difficulty of promoting the integration of design with planning and regulation to make an institutional framework supportive of a commuter rail-oriented pattern of suburban and urban development. In the course of reviewing the Task One report (Chapters 1–6) and moving into the Task Two and Three (Chapters 7–14) work, there were a series of intermediate meetings of the Technical Advisory Panel and several presentations of the work in various formats to various stakeholder groups: a public workshop at the Carlson School; an urban design studio review; and presentations to the Center for Transportation (CTS) Annual Research Conferences, the CTS Board, and the Citizens' League. These presentations, while informal, crossed a range of audiences whose opinions about commuter rail betrayed modest information that previewed the deadlock on commuter rail and the gas tax reached in the legislative session in May, 2002. In other words, the feedback characterized the difficulty of promoting a clearly defined discussion of issues whereby citizens and public officials could weigh the costs and benefits of commuter rail and its potential for more integrative patterns of associated development. The marginal role of transit, even suburban-serving transit systems such as commuter rail, in our Twin Cities suburban, automobile-structured culture, is an obvious measure of the situation. Of the top 30 standard metropolitan service areas (SMSAs), the Twin Cities is almost always near the bottom in terms of transit expenditures. In part, the limited amount of literature on this topic is also problematic; there are few new systems and little academic study of the systems in place.

The Red Rock Corridor is part of a larger planned commuter rail network for the Twin Cities Metropolitan Area that would eventually afford commutes between St. Cloud/Rice and Hastings through stations at Minneapolis and St. Paul.(*2*) The link between Minneapolis-St. Paul and the Red Rock Corridor are second stage corridors in priority at this writing behind the Northstar Corridor (Minneapolis to St. Cloud/Rice) which is stalled in the legislative funding process.

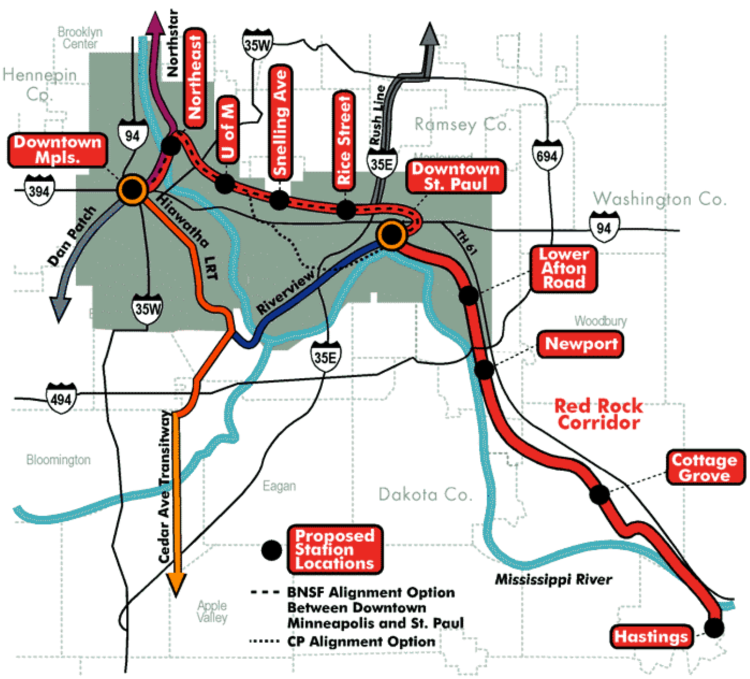


Figure 7.1 Red Rock Route Map (www.redrockrail.org/largemap.htm)

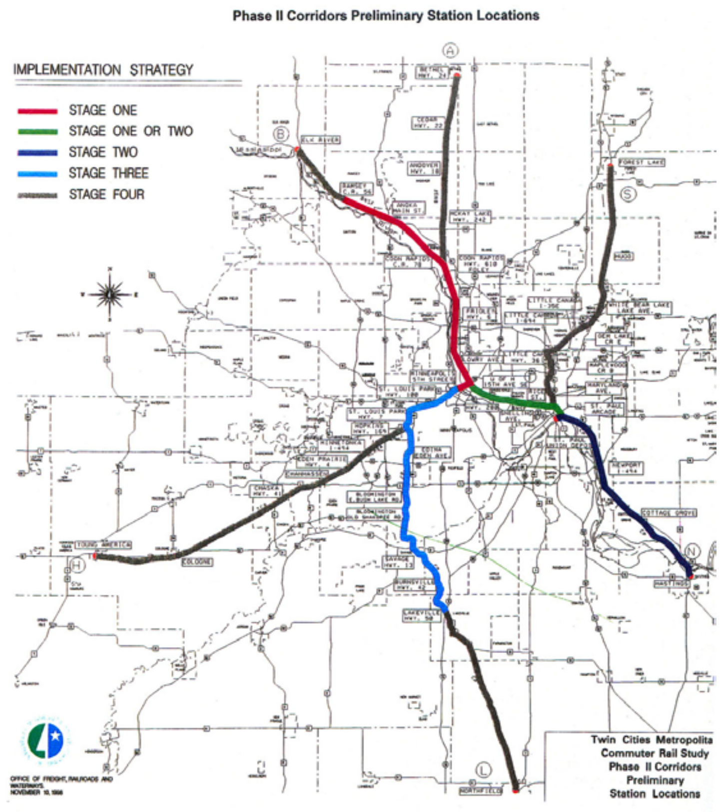


Figure 7.2 Twin Cities Metropolitan Commuter Rail Study (Mn/DOT-Parsons Brinckerhoff, 1997)

Highways and Rails: Institutional Frameworks

Commuter rail is not the only tool in the kit to fix sprawl. Discussion of commuter rail's attributes points to the institutional obstacles to its enactment as a potential armature or backbone system. Suburban growth has been founded nationally on federal policy in the twentieth century. Since 1916, the federal government has subsidized highway construction, getting a half-century head start on mass transit funding, according to Rothblatt and Garr in *Suburbia: An International Assessment*.(*3*) This construction was dramatically augmented by the Federal Highway Trust Fund in 1956 that funded the interstate system from excise taxes on vehicles. Rothblatt and Garr add, explaining some further aspects of the sameness of Levittown-like suburban development that, "[w]ith highway projects making accessible land on as unprecedented scale, and inexpensive financing insured by federal guarantees [such as VA and FHA], even the houses bore the stamp of the national government."(*4*) Finally, they also cite the federal role in water and sewerage projects, although they do not make the connection between such projects and the physical or institutional outcomes of this intertwined process. This pattern created the national strand of the genetic code of sprawl, the platform of the American Dream: a single-family home, private and yet conveniently located via one technology, cars.

For some Minnesotans, this triumph of the exigencies of privacy over time and space, coupled with a faith in science and technology over the necessity of beauty or sustainable futures, guides another type of decision-making. This attitude produces a "best surprise is no surprise" landscape, regardless of local conditions. However, as noted in the Task One report (Chapters 1–6), with congestion and other costs rising too quickly to be met by existing technologies (including largely non-quantified environmental costs), the moment seems ripe to think in terms of a hybrid solution. The heart of such a solution on a metropolitan scale could be regional commuter rail, overlaid on other modes and interconnected at destinations.

Why? Simply depicted, it is a problem of re-matching the physical fabric of suburban growth (called popularly land use) with the technologies of movement and connectivity (transportation) to provide a sustainable region in the global matrix. We have to manage elements of a region that originated from different values manifested over different times in different conceptions of space with different technologies. We continue, for example, to build a predominantly nineteenth-century physical fabric of suburban wood-framed housing. But it is nested in a twentieth-century transportation structure tilted toward big-box commerce and logistics, all trying to serve a seamless conception of twenty-first-century global economy and culture, overlaid now, after September 11, by increasing concerns for security. Jobs are everywhere and nowhere in particular, especially as downtowns have continued to lose their share. Patterns of commuting have transcended the nineteenth-century constructs by which the suburbs and the radial concentric transportation network came into being. This freeform, footloose pattern of employment, business, and living, founded on local control of land use, makes a puzzle of all design and planning and is a challenge to transit.

In such a mixed situation, it seems wise to create a hybrid transportation infrastructure, one that for reasons of security, political ideology, and long-term, economy, provides choices. The nineteenth-century innovators who set the whole notion of a suburban America in motion imagined a certain amount of redundancy in the infrastructure to assure that the possibility of democratic access would leaven the exclusivity of suburbia and give structure to patterns of growth. We have allowed that redundant system to deteriorate, but we have an opportunity in commuter rail to match disparate issues with a multi-modal backbone.

Task Two and Task Three: The Nuts and Bolts of the Study

In preparing this report on the work of Tasks Two and Three, in contrast to the existing suburban templates, the research team was contracted to demonstrate the potentials of various smart growth approaches to the design of subdivisions on the same lands as were used for demonstration in the Task One work. The main agenda was to suggest how the bundling of hydrology and transportation, for example, and other potential points of synthesis could be designed in such a manner as to provide a smart model for suburban development in relation to stations on the Red Rock/Highway 61 corridor. On the urban side, it was our opportunity to begin to expose other issues of station area development than those that might be conventionally framed in a contract for station design and engineering that entailed a more operations-specific scope of work.

It was also our charge to abstract more general issues of cost and benefit that could be used to evaluate other commuter rail corridors and their developments.

This study, while hardly comprehensive, examines three of the basic types of sites that would be targets for changed design approaches were the Red Rock to be built on the suburban edge in Woodbury, away from the line; in Cottage Grove around and near a station site; and in the city of St. Paul.

The Suburban Subdivision: Hardwiring a Multi-modal Future

The proposals offered for the suburbs of Woodbury and Cottage Grove are not precisely "new urbanist" proposals of the sort usually understood to be related to older architectural forms or light rail transit. The design principles do bear similarities, and purer new urbanist approaches must be a critical component of our growth strategy within the city and the inner suburbs. Here, the proposals adapt the values of suburban living, including the densities, to new metropolitan and local patterns of connectivity with (and via) rail and with open space and natural systems. This approach, combined with more compact infill in built-up areas and near stations and retrofitting of right-of-ways, is the essence of the new suburban fabric that is proposed in various manifestations as an evolutionary step toward framing sustainable growth on the Red Rock Corridor.

We assume that the subdivision is the most basic form by which the land is fitted out with the hardwiring of infrastructure that gives long-term form to urbanization. In this study, we have, therefore, concentrated on the subdivision as the scale and unit of study since it is here that the land is imprinted with our intentions of settlement over time—infrastructure, building, hydrological management, and land cover.

The subdivision designs presented here hypothesize, as alternatives to the current baseline presented in Chapters 1–6, that the state's provision of transit as a public good ought to be integrated with the street network, hydrology (ecology), form, culture, and economy of a region. In order to accomplish this, the institutional framework of the region would probably require critical and fundamental adjustments reflective of a revised set of values of sustainable practices and common goods. From a transportation perspective, the chief article of this institutional framework idea is multi-modality. Multi-modality induces choice in the physical pattern of transportation infrastructure. However, the argument for multi-modality flies in the face of many paradigms of American suburban life in the twenty-first century especially here in Minnesota, not the least of which is a disinclination to fund transit improvements that not enough others might ride.

In the Task One report (Chapters 1–6), we revealed some of the difficulties of integrating various approaches to and issues of design in the mode by which the land is taken down. This baseline report assumed that current zoning, hydrological practices, and other elements of the current regulatory and institutional framework were in place. All of this pointed to a baseline "genetic code" by which conventional sprawl occurs. It demonstrated that the combination of low density and internalized street patterns gives little advantage to transit connectivity or multi-modality. Further it was revealed that there is a crescent of relatively undeveloped land potentially within 10 minutes of the suburban Cottage Grove station sites at Jamaica Avenue or Eightieth Street, but just beyond the MUSA. By using hydrology as a rough proxy for environmental concerns, we demonstrated the effects of bundling transportation and hydrological design that occurs when highways, roads, and streets are built or rebuilt as a key part of this process. This work was also informed by design of a subdivision on a site in Woodbury near Bailey Elementary School, also potentially within 10 minutes by car from a station (either Lower Afton Road or, more likely, Newport).

Downtown St. Paul and Lowertown: Jobs and Water in a Multi-modal Urban Center

Connectivity is the design emphasis for the station area around the St. Paul Union Depot. Connections to and with the Mississippi River are given new spatial and symbolic importance in the pedestrian, bicycle, and storm water designs. Employment provides another critical connective element, and its physical presence is recognized by the development of the pedestrian network as well as the land use mix. The backbone of a commuter rail system is the pattern of trips between home and work. This pattern is the fundamental structure and economy of in-place systems built in the nineteenth century in Chicago and eastern seaboard cities and of new systems such as the Seattle Sounder. In this system model, the critical element of success is the development of an employment district in walking distance or short intermodal commuting time/distance from a station. While there is arguably a dual employment base to be served in the Twin Cities, the projected train segment of the commute time from Hastings or Cottage Grove to Minneapolis (approximately 55 minutes) is currently not assumed to be competitive with driving. St. Paul, while having fewer jobs than Minneapolis in its downtown area, could benefit from intermodal connections at the station and some redevelopment of employment near the Union Depot. Then there is the job sprawl trend noted earlier.

Deliverables

We began this portion of our study with well-defined deliverables as the substantive objectives for the completion of the second and third tasks mandated by our proposal and contract with Mn/DOT. These deliverables frame the chapters of this report:

- CHAPTER 8: Literature Review
- CHAPTER 9: Document physical form of precedents for sustainable urbanization
- CHAPTER 10: Develop physical design hypotheses for TOD, TND, Cluster, Storm water
- CHAPTER 11: Project traffic patterns, trips, modal shifts for new pattern
- CHAPTER 12: Document and project hydrology for new developments
- CHAPTER 13: Compare and contrast impact issues across baseline to alternative approaches
- CHAPTER 14: Develop a cost-benefit issues analysis

These deliverables also frame the design objectives of our commuter rail corridor study, a portion of the Red Rock/Highway 61 expanded corridor from St. Paul to Cottage Grove. Tasks Two and Three (Chapters 7–14), are deceptively clear. The subdivision designs treat multiple variables across scales to try to demonstrate how they effect changes in travel behavior and therefore VMT, while also tending to the environment. Some topics are not treated except in the briefest manner such as financing, direct project costs, and other economic issues. In part, this difficulty reflects the broad reaches of issues of the genetic code of suburban sprawl and the depth of complexities inherent in it.

Chapter 7 References

1. David Glaeser, Matthew Kahn, Chenghuan Chu. "Job Sprawl: Employment Location in U.S. Metropolitan Areas," Center on Urban and Metropolitan Policy, Brookings Institution, June 2001. The authors also noted that the chief problem of job sprawl is governmental fragmentation, measured here by numbers of units of local government. http://www.brook.edu/dybdocroot/es/urban/publications/glaeserjobsprawl.pdf

2. Red Rock Corridor DATA http://www.dot.state.mn.us/passengerrail/onepagers/redrock.html

DATA:	30 mile corridor from Hastings to Minneapolis, through St. Paul (Union Depot) along Trunk Highways 10 and 61. The proposed Red Rock Corridor Commuter Rail line would use existing rail tracks owned by Burlington Northern Santa Fe Railway and Canadian Pacific and include 9 to 10 possible stations.
HISTORY:	At the request of the 1997 Minnesota Legislature, Mn/DOT initiated the *Twin Cities Metropolitan Commuter Rail Feasibility Study*. In January 1998, Phase I of the study identified the Red Rock Corridor as one of the seven corridors with potential for success. In the *Commuter Rail System Plan*, completed in January 2000, the Red Rock Corridor was identified as the Stage 2 Corridor in Tier 1 staging.
ESTIMATED PROJECT CAPITAL COSTS:	$262M in 2001 dollars (cost estimate from 2001 Red Rock Corridor Feasibility Study).

3. Rothblatt and Garr, 31.

4. Rothblatt and Garr, 32.

CHAPTER 8

Literature Review

In the Twin Cities Metropolitan area, suburban growth has changed the demography and the political landscape of the region. The latest census reveals that wealth has increased, but so have commuter travel times. Recently, a suburban attorney wrote a letter to the *Star Tribune* newspaper in frustration that the recent legislative session had not funded a transportation bill to add more lanes to relieve the congestion on his commute. He did not mention transit as an option. In April, Lori Sturtevant of that paper profiled the views of the mayor of Eagan as a leader of suburban anti-transit (and anti-urban) attitudes.

Nevertheless, smart growth articles have peppered local and national media. In the Twin Cities, the forecasting work of the Metropolitan Council and its consultant, Calthorpe Associates, has revealed that constituents favor a denser, corridor-based strategy with more infill-intensive pattern than the current baseline regionally.(*1*) Neal R. Peirce, writing Sunday, February 3, 2002 in an article for the Washington Post Writers Group called "Solving Sprawl: How Do We Start?" has suggested that a number of model efforts have been mounted such that anti-sprawl rhetoric has new flesh in the shape of compact, mixed use, and connective development. The newest book, *Solving Sprawl*, published by the National Resources Defense Council, compiles these 35 projects and legal approaches:

> "On Whidbey Island, an hour's ferry ride from Seattle, officials discovered big lot (5-acre) zoning wasn't protecting the environment—rather it was leading to a generation of sprawling "ranchettes." So a new "cottage housing development zoning" code was passed, catering to the growing singles market and allowing up to 15 small detached homes an acre as long as a there was a common area and parking hidden from the street. An initial project, the Third Street Cottages, have been built, increasing density and underscoring the village character. Neighbors work together in the garden or pick fruit from the old trees saved during construction. A formula has been invented for attractive "starter homes" that both foster community—and can be sold at reasonable prices."

As these project citations demonstrate, smart growth has been generally identified with the new urbanism movement and, sometimes with certain environmental agendas. Both of these associations, however, stem from deeper roots. Recently, there also has been, in the work of Bruce Katz (editor of *Reflections on Regionalism*) and in some of the writing in the *Nation*, recognition of the relationship affordable housing issues might have to smart growth.

New urbanism both as a phrase and the germ of an idea appears, perhaps first, in 1953 in the book *The City of Man* written by the city planner, Christopher Tunnard. Tunnard's work dealt with issues of context from a topographic and cultural perspective. As his book points out, the issues of sprawl historically had been balanced by the suburban towns that had been planned, designed, and built in American suburbs on streetcar and commuter rail lines and in the English socialist models of the garden city. These garden city ideas have subtly underpinned both new urbanism from a formal perspective as well as the environmental agendas. The form of commuter rail suburbs was perhaps first explored by Tunnard. However, few significant American planning and design historians have paid much attention to the relationship between the form of these suburbs and commuter rail service. In some ways, the recent historiography of transit has been dominated by Sam Bass Warner's pioneering work on Boston suburbs in *Streetcar Suburbs*, and, one might argue, if history or historiography have any influence, that the direction of design thinking has been perhaps skewed by this fact toward light rail.

At its core, the agenda of new urbanism is anti sprawl. The new urbanism/smart growth media explosion has occurred in spite of the relatively small number of built projects or changes in local ordinances. New urbanism/smart growth advocates promote compact development and mixed use accomplished in a physical fabric of traditional architectural scale and appearance. Yet new urbanism is primarily a project-based movement; its architectural advocates have tried to broaden it via pattern book publications. In some more systemic versions, transit, especially light rail, which is seen by many as the signature infrastructure of new urbanism, is forefronted as the central article of public incentives and development leverage. Similarly, urban growth boundaries and systemic housing policies have given shape to smart growth in Portland, Oregon and the state of Maryland, respectively. Elements of this composite version are advocated by the Metropolitan Council's current regional growth consultant, Calthorpe Associates.

The current literature (if somewhat ephemeral in some instances) is huge, and the project team had various contacts with it. The literature broadly includes, for example, a newsletter called the *New Urban News* and many books. *New Urban News* tracks projects, including economic impacts and legal changes. Recent books spring, again, from ideological roots in environmentalism, architecture, city planning, and landscape architecture although there are also some books written from a scientific and positivist social scientific point of view. New books, *Community by Design: New Urbanism for Suburbs and Small Communities*, by Kenneth Hall and Gerald Porterfield, and *Travel by Design: the Influence of Urban Form on Travel*, by Marlon Boarnet and Randall Crane, are among the few to explore the dynamics of transportation and urban form. *The Charter of New Urbanism,* a counterpoint to the Congres Internationuax d'Architecture Moderne (CIAM or International Congress of Modern Architecture) charter, includes essays by Randall Arendt, the apostle of the cluster; Peter Calthorpe, and Robert Davis, the founder of Seaside, Florida. Calthorpe recently published (with William Fulton) *The Regional City: Planning for the End of Sprawl*, a follow on to his immensely popular book on transit-oriented design, *The Next American Metropolis: Ecology, Community, and the American Dream*. Fulton previously authored *The New Urbanism: Hope or Hype for American Communities*.

One of the critical analyses attempted here (see Chapter 11: Project Traffic Patterns, Trips, Modal Shifts for New Patterns) is the modeling of land use mix in relationship to transportation network in order to quantify the effect of transit-oriented design on VMT. On the transportation side of community design, there are several newer publications that examine transit from an anecdotal and largely non-quantified perspective including: *Sustainability and Cities: Overcoming Automobile Dependence* by Peter Newman and Jeff Kenworthy. Robert Cervero, an important figure in transportation planning and the author of a Federal Transit Administration-sponsored report on *Transit-Supportive Development in the United States* and numerous publications on suburban sprawl, is the co-author with Michael Bernick of *Transit Villages for the 21st Century*. Information of a more specific nature on community design and planning is contained in a specialized literature. One of the more helpful studies from this specialized literature has been a comparative study of densities, development types, and real estate values prepared for METRA (Chicago Commuter Rail Service), by S.B. Friedman & Company, Chicago, Illinois, 2000. “METRA Rail Service and Residential Development Study: Summary of Findings.” Appendices include “Rider Survey Findings.”

On the environmental side, the themes of regional water and transit in the context of regional planning are critical to the research approach and design issues in this project. Water as a planning and design issue has taken on new importance as suburban growth has begun to cause contamination and supply problems. Portland has the most developed integrated metropolitan and regional approach to water as a resource and potential gauge on growth. Certain individual developments and guideline-based approaches are also beginning to emerge and with them new technologies for dealing with storm water as a new green infrastructure. Our department has distinguished itself in this area largely due to the work of Professor Robert Sykes, who has served on this research team. He is a consultant to local governments and companies about land design for water management including current work with the Minneapolis Community Development Agency in the planning for the South East Minneapolis Industrial area, an underused industrial district on the edge of the University's East Bank Campus. He is the principal author of *Watershed Land Design*, a handbook on subdivision-scaled design for the Legislative Commission on Minnesota Resources. This study examined some of the formal devices of design needed to reduce storm water effects on suburban design in the Brown’s Creek watershed. Among his colleagues are Professor Bruce Ferguson, University of Georgia, who is the author of the *Bibliography on the Regulation of Development for Stormwater Management* and *Introduction to Stormwater: Concept, Purpose, Design.* Two books by another colleague, Tom Schueler, *Design of Stormwater Filtering Systems* and *Design of Stormwater Wetland Systems* have influenced this work. On the scientific side is the work of Professor Robert Pitt, author of a number of books on the interaction of storm water and ground and surface water, including *Groundwater Contamination Through Stormwater Infiltration*, cited in the Task One Report (Chapters 1–6), and other works on water contamination via urban runoff.

The design literature on storm water is becoming richer with the development of new technologies and new, constructed applications. At the head of the design curve, is Herbert Dreiseitl, who has lectured at the University of Minnesota, and who has executed a number of urban and community storm water projects at various scales, the best known being perhaps Potsdamer Platz in Berlin done in collaboration with the architect Renzo Piano.

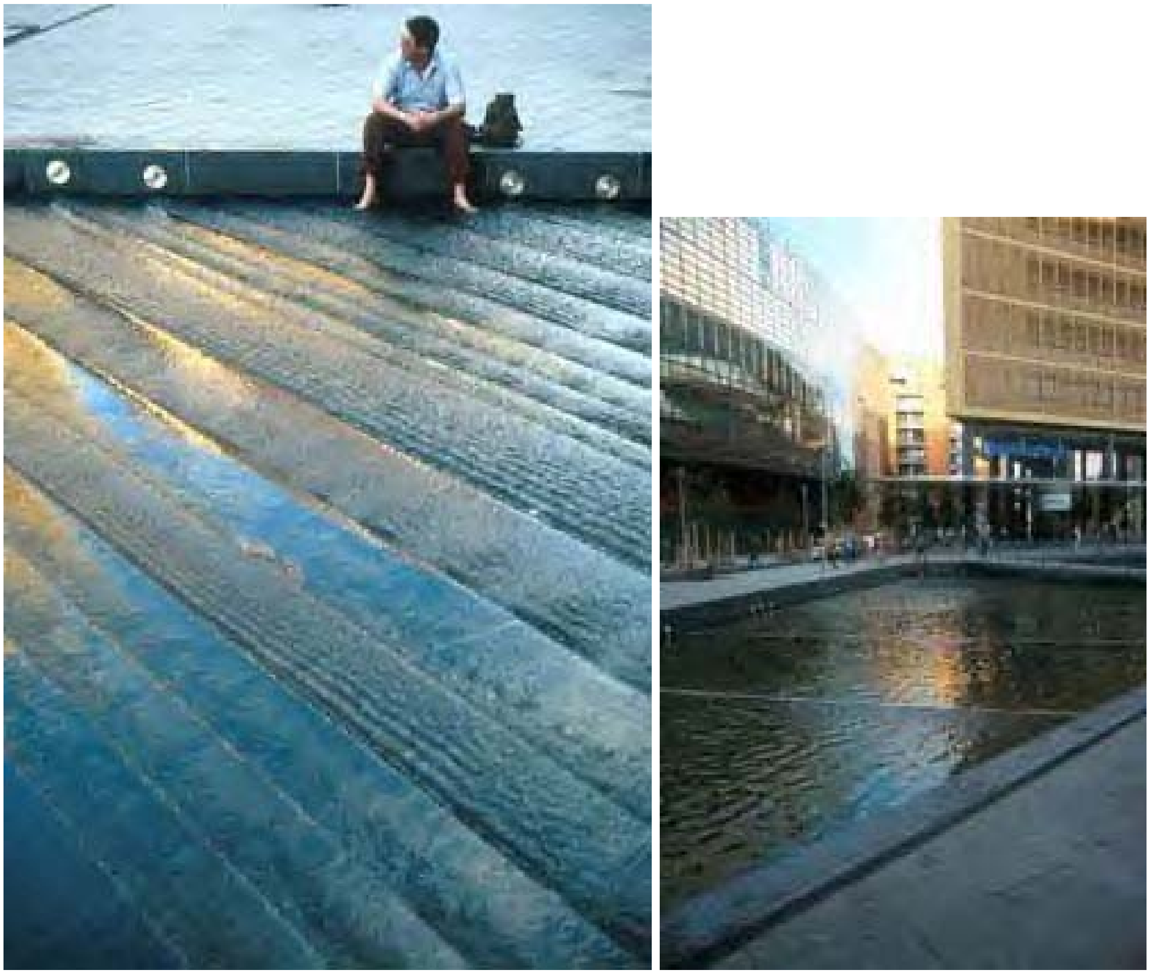


Figure 8.1 Potsdamer Platz by Atelier Dreiseitl, Herbert Dreiseitl
(from Dreiseitl's Web site http://www.dreiseitl.de/en/proj/set_proj.htm)

With the redevelopment of the Potsdamer Platz (Square), a multi-layered system of rainwater management and reuse has been created (see Figure 8.2). Three large basins of a total area of 3 acres and a shoreline of more than one mile constitute the core element. Rainwater is collected from green roofs, and this runoff is piped to storage in cisterns below ground. Storm water is also collected as runoff from pavements on the surface in so-called "urban waters." This water is also stored in the cisterns except in peak events when it is drained over a weir to a flood control canal. Water from the cisterns can also be pumped to irrigate the green roofs during dry periods.

Figure 8.2 Potsdamer Platz Multi-layered Rainwater Management and Reuse System

The principal operative technology for the surface storm water is designed to scrub the runoff water through biofilter plantings of sedges in all of the basins.(*2*) Dreiseitl also has executed a number of important infiltration projects on a residential community scale in Europe.

In the United States, James Patchett, landscape architect, who has also lectured at the University of Minnesota, has had a similar influence on our thinking. His most recent project has been the design of the storm water landscape for Coffee Creek Center in Porter County, Indiana, which provided a precedent to our design work. (See Chapter 9: Document the Physical Forms of Precedents for Sustainable Urbanization.)

A certain body of thinking has recently emerged on the regional front. Most of the work has been in applied economics and planning with some emphasis on transportation as a component of competitiveness. Some of these works explore the environment and planning; others the socio-economics of politics. The Rocky Mountain Institute has, for example, a new focus on water issues. *Natural Capitalism:Creating the Next Industrial Revolution* is an environmental advocacy title that includes an argument for water as a commodity; it is available in PDF form at www.rmi.org/site. Island Press similarly has been particularly active on the environmental side with a broad range of titles ranging from the applied scientific to the apologistic. *Planning for a New Century: the Regional Agenda* by Jonathan Barnett is a new volume as is *Community Planning: an Introduction to the Comprehensive Plan* by Eric Damian Kelly and Barbara Becker. William H. Lucy and David Phillips have written *Confronting Suburban Decline: Strategic Planning for Metropolitan Renewal*. The approach adopted in this study also has been directly influenced by recent books from the Brookings Institution including Bruce Katz's edited volume, *Reflections on Regionalism*. Similarly, *Metropolitics* by Myron Orfield has had some influence on the project's modest attempt to address social and economic equity issues on a regional basis.

Better known to popular audiences perhaps are the books by James Kunstler, the author of *The Geography of Nowhere: the Rise and Decline of America's Man-made Landcape* and *Home from Nowhere: Remaking our Everyday World for the 21st Century*. Andres Duany and his partner Elizabeth Plater-Zyberk, Dean of the School of Architecture at University of Miami, have written (with Jeff Speck) most recently, *Suburban Nation: The Rise of Sprawl and the Decline of the American Dream*. Suburbia has a large recent literature. One source used here is *Suburbia: an International Assessment* by Donald Rothblatt and David Garr. The authors look at measures of quality of life and are attentive to the role of transportation in forming qualities of suburban life. Similarly, *Shaping Suburbia* by Paul Lewis examines the political institutional framework of suburban development, comparing, for example, the differences between Denver and Portland.

While there is apparently no current synthetic study of commuter rail in the United States, an overview of the country's efforts is available at the American Public Transit Association's (APTA) Web site: www.apta.com/sites. Some interesting titles in the more ephemeral professional literature include:

- "Commuter Rail—Serving America's Emerging Suburban/Urban Economy," APTA, Sept. 1997.
- "Local Economic Impacts in Commuter Rail Station Areas," Camiros Ltd., METRA, Dec. 1994.

- “Land Use in Commuter Rail Station Areas,” NE Illinois Plan. Comiros Ltd., METRA, Nov. 1991.
- “Breaking the Sound Barrier, Sounder Commuter Rail,” Sound Transit, Seattle, WA, 1998.
- “King Street Station Redevelopment,” Washington State Deptartment of Transportation, Feb. 1998.
- “RAIL Connection,” WSDOT, Mar. 1998.(*3*)

This study has benefited greatly from work by S. B. Friedman & Company on the Chicago METRA commuter rail system, METRA Rail Service and Residential Development Study. This is a case study on six commuter rail station areas and the residential fabric within a half-mile radius.

The New American systems include planned systems here in Minnesota including the Northstar and the Red Rock corridors. Planning is also occurring in Denver, and Seattle already has a line, the Sounder, running along Puget Sound. (See Chapter 9: Document the Physical Forms of Precedents for Sustainable Urbanization.)

One of this study’s focus areas also has been the subject of a body of work on new street types to revitalize existing neighborhoods by the Design Center for American Urban Landscape (DCAUL). Much of this work has targeted parkway design and new types of arterials for suburban areas. The work has resulted in several products, one of which is “Design and Development Principles for Livable Suburban Arterials.” 2001, available through the Center for Transportation Studies as well as DCAUL.

Similarly, architecture and station site design have had a new roles in reviving areas served by rail. As railroad stations have re-emerged as new locations for mixed use and intermodal exchange, the idea from the 1970s of reusing railroad stations that spawned the first preservation efforts for such important hubs as Union Station in Washington, D.C., has begun to mature. The urban train station in Europe has already matured to a new intermodal status. Various architecture magazines have published these projects, but the literature is fragmentary at this point, and not part of the scholarly body. Older stations, such a London’s Waterloo, have been refurbished and expanded (design by Nicholas Grimshaw). Newer stations, often built in the context of large urban projects, such as Santiago Calatrava's design for the Oriente station that serves the redeveloped mixed use area of the Expo site in Lisbon, Portugal, demonstrate tried-and-true principles of pedestrian connectivity in new architectural vocabularies. However, even in Portugal, a more manageable climate than Minnesota, the open, exposed platform design has brought criticism.

As is the case for all design and politics, precedents and literature all must be eventually tied to locale. This will be the focus of Chapters 9 and 10**,** as they examine more directly precedents and designs for the Red Rock corridor.

Chapter 8 References

1. Metropolitan Council, Blueprint 2030 DRAFT, Calthorpe Associates, May 2002.

2. *Biofilters:Cconcept and Operation*
"To maintain an aesthetic water quality, the water is circulated through a series of cleansing phases in a closed system. Water clarity in the Main Basin determines the overturn parameters. The re-circulated water inflow occurs predominantly through reed beds along the shoreline in all three basins. These biotopes effect a physical as well as biological and chemical cleansing process. The outflow from the Main and South Basins occurs through bottom drains embedded in gravel filters and a skimmer. Flow simulation studies identified possible stagnation areas and determined the optimal intake and outflow ratios. During periods of high turbidity, the outflow can be routed through microfilters (15 mircometer mesh) eliminating even the smallest algae particles. Throughout most of the year, the first cleansing step in the reed bed (biofilters) is generally sufficient. During seasonal increase of algae formation, microfilters and multi-layer filters can be activated to maintain water clarity if needed, but chemical additives are not necessary. During the planning phase of the Urban Waters, there were no comparable projects or data available for a limnological evaluation. Natural bodies of water of this scale are governed by entirely different conditions and generally present highly complex eco-systems and food chains. The integrated storm water management for the Potsdam Square provides several ground and surface water protection measures: extensive and intensive green roofs to delay runoff, rainwater collected and stored in cisterns to be re-used for toilet flushing and irrigation, a buffer system for flood control, storm water retention and rainwater storage systems, and climatic regulators. During intense storm events, the water level in the three basins can be raised and runoff gradually released into the adjacent river (Landwehrkanal). The design of this segregated storm water management system required sophisticated long-term computer simulations, not mere quantitative calculations. The simulations also evidenced that thanks to the buffer capacity of the three basins, no additional storm water concentration would impact the river in spite of the almost completely impervious surfaces of the new development at the Potsdam Square."

3. http://trainweb.com/washarp/may98wpr.html Commuter Rail Workshop Proceedings - May 27, 1998. "Commuter Rail Economic Opportunities—Lessons Learned," presented by Washington Association of Rail Passengers, Commuter Rail Section.

CHAPTER 9

Document Physical Form of Precedents for Sustainable Urbanization

New Suburban Alternatives/Old Suburban Models: Rail, Open Space, and Hydrology

While new conditions have emerged in the making of a sprawled American landscape, commuter rail has been understood by most regions as to be an old technology. Can the old technology and the suburban forms it generated have new applications? Probably the best known American examples of physical design—architecture and landscape architecture—for suburban-scaled commuter rail communities are from the last half of the nineteenth and the first quarter of the twentieth centuries. This type of integrated development approach took place especially in relation to large rail hubs with a suburban commuter ridership potential embedded in a larger freight-oriented hinterland. Cities with such well-developed suburban regions include prominently New York, Chicago, and Philadelphia, and to a less degree, Boston and Baltimore. At a regional scale, the rail service overlays a radial development pattern that sometimes coincides with (and duplicates) road networks and other transit and other times intersects with them. As a result, depending largely on topography and street design, various patterns of multi-modality and access to the station are seen at the community and regional scales.

These examples include some particularly significant cases that incorporate and integrate all of the environmental issues as well as the transportation issues. These integrated approaches are embodied in the work of landscape architects, architects, and engineers who designed commuter rail suburbs in the late nineteenth and early twentieth centuries:

- Riverside, Illinois—Frederick Law Olmsted, Sr. and Calvert Vaux, 1869 (see Figure 9.1)
- Highland Park, Illinois—H. W. S. Cleveland and W. M. R. French, 1868–74 (see Figures 9.2 and 9.3)
- Roland Park, Baltimore, Maryland—Frederick Law Olmsted, Sr. & Olmsted Brothers, 1890s (see Figure 9.4)
- Forest Hills Gardens, New York—Olmsted Brothers, Frederick Law Olmsted, Jr. and Grosvenor Atterbury, 1908–09 (see Figure 9.5)

Figure 9.1 Riverside, Illinois, Aerial c. 1995

Figure 9.2 Highland Park, Illinois, Bluff-top Residential Street

Figure 9.3 Highland Park, Illinois, Original Plan, 1872

Figure 9.4 Roland Park, Residential Street Scene, c. 1910

In terms of suburban town developments, the historic examples of Riverside and Highland Park, Illinois both exemplify very strong hydrological approaches, as apparently does Roland Park, though data was not available on the details of its design. Olmsted and Vaux designed Riverside, set in a flat floodplain of the Des Plaines River, to have large open spaces such as the Longcommon Road as greens that provided both recreational space and flood storage and infiltration. The streets and house lots of the town were micro-graded to allow drainage from the houses into the curbless streets and green medians and to be piped to the river. In Highland Park, the house lots and streets were staked high on the bluffs overlooking ravines that lead to Lake Michigan before the plan was drawn. Here the ravines functioned as common drainage ways and as parks, both informal and designated public spaces. Both of these communities were designed with small urban commercial centers near the station. Local employment, such as it was, was largely confined to this urban service core, and the majority of the lands were settled at single-family (2–5 dwelling units per acre) densities. Although neither of these designs employed sophisticated drainage or ridership calculations and both have had to be modified as more urbanization has occurred, usually upstream, they nevertheless offer models for approaches that are broadly applicable and instructive in their specific successes and failures.

Forest Hills Gardens borrowed directly from British “Garden City” design thinking and ideology. The two early examples, Letchworth and Welwyn, were imagined as self-contained economies, linked by heavy rail to London, but not as commuter rail communities such as Forest

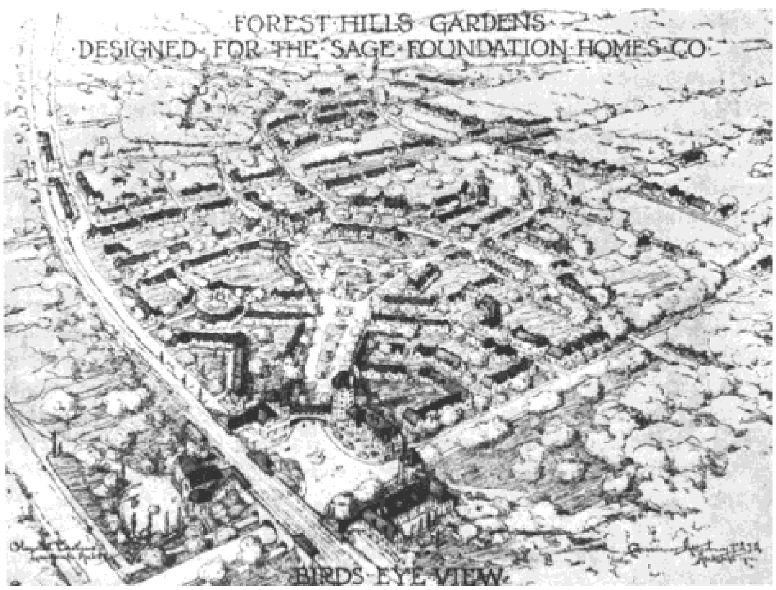


Figure 9.5 Forest Hills Gardens, c. 1909

Hills Gardens or the earlier examples. We have borrowed from the early examples extensively, especially from the street and open space design and hydrology ideas that shaped Riverside and Highland Park. Forest Hills Gardens had a highly developed station area, with grade separated access to the station and a “skyway” pedestrian overpass between principal commercial blocks. Other similar station area design patterns from that period pioneered forms still useful today (and used in our work) especially Lake Forest, Illinois, developed first in the 1850s on a plan by Jed Hotchkiss. Here, however, the retail design of Howard Van Doren Shaw just after the turn of the twentieth century, near the station area, is a model of multi-modal development. (Though not a commuter rail community, the first integrative suburban community design based on retailing historically has been attributed to the Country Club District in Kansas City.) The designs of ordinary suburban commuter towns in the Chicago, Illinois METRA system were also examined largely through the lenses of personal experience buttressed by a recent comparative study of real estate and other issues by S. B. Friedman & Company of Glen Ellyn, Deerfield, Homewood, Arlington Heights, and other towns, principally focused on their station areas.

Minneapolis is the consummate historical example of suburban-type city-scaled urban form development on the basis of connective public open space on water bodies, in this case, the Mississippi River, Minnehaha Creek (which connects the city to Lake Minnetonka), and the city's lakes. The idea of the park system is a publicly held hydrology that protects the resource while offering amenities that constitute long term taxable value for adjacent residential development. This system is primarily constituted of slender parkway-like elements, usually integrated into the city as a multi-modal network.

Crossing Scales from the Region to the Subdivision to the Station

For purposes of this study, the physical form of commuter rail-oriented design crosses scales from the region to the subdivision or, in the city, the district. Sustainability is treated here in relative terms since an absolute definition would be unlikely as a scenario given the amount of already in-place development that requires adaptation.

New American Commuter Rail Systems

The Seattle-Tacoma-Everett service on Sound Transit—the Central Puget Sound Regional Transit Authority train service—when completed, will operate along the 82 miles of track between Everett and Lakewood. This system provides a provocative new model both for a twin cities-type of service in a largely twentieth-century suburban market and for design ideas for station areas and communities that will guide a whole region.(*1*)

Figure 9.6 Sounder Commuter Rail Locomotive and Coaches

Sounder commuter trains similar to those demonstrated here on the Northstar route in the summer of 2001 (see Figure 9.6) are new bi-level passenger coaches, with a first and second floor, pulled by diesel locomotives. Trains are six to eight cars long. The Sounder will be capable of moving 6,000 people per hour (peak direction during rush hours). Service from Seattle to Tacoma, including the Tukwila Station, has been active since late 2000. Service to Everett and service to Lakewood is planned to open in 2003 (see Figure 9.7).

Figure 9.7 Sounder Commuter Rail Route

Sounder service will eventually have 18 trains, nine used during AM hours and the other nine used during PM hours. Travel time from Seattle to Tacoma is 60 minutes. Ridership in June, 2002 has hovered at about 2,400 per day.

Figure 9.8 King Street Station, Seattle, Showing Platform Modifications

As in the case of the Red Rock, the Sounder has a major intermodal link to Amtrack at a historic station, the King Street Station in downtown Seattle (see Figures 9.8 and 9.9). As in St. Paul, new platforms are needed to accommodate the bi-level height of the trains. (The Technical Advisory Panel suggested that the San Diego Coaster would be a good case study. Coaster information can be found at www.sdcommute.com/service/coasterpage.htm.) Examples of the Everett station are shown in Figures 9.10 and 9.11.

Figure 9.9 Ticketing at Vending Machines on the Platform

Figure 9.10 Everett Station Design by Zimmer Gunsul Frasca

Figure 9.11 Everett Station

Northstar Commuter Rail, Minnesota

Similarly on the Twin Cities and greater Minnesota scene, the Northstar Corridor is a planned 82-mile transportation corridor now stalled. (Northstar funding had been blocked by Minnesota legislative impasse on the 2002–2003 transportation bill as of this writing, May 24, 2002.) The corridor will run along Highways 10 and 47 from downtown Minneapolis to St. Cloud/Rice (see Figure 9.12). This is currently the fastest growing corridor in the state. For example, Sherburne County is expecting a growth of 92% between 1990 and 2025. Eight trains will run during the morning rush, eight trains will run during the evening rush, and one train will run a midday round trip. Some evening, weekend, and special event service will be provided. Estimated ridership is 9,594 people per day. Northstar will run between Minneapolis and St. Cloud in less than 90 minutes.

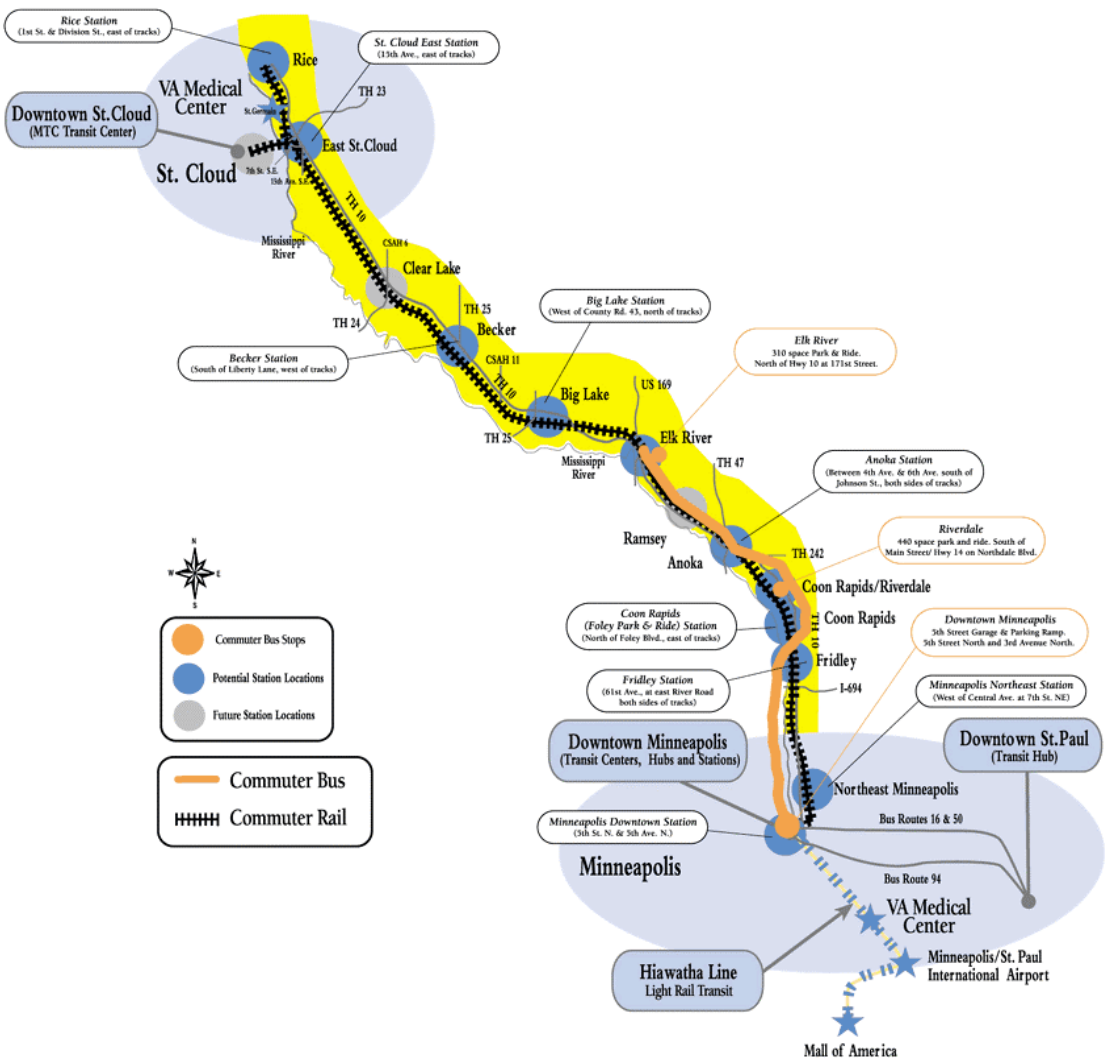


Figure 9.12 Northstar Corridor

The train will stop at 12 stations for about 45 seconds each. Maximum speed on the line is 79 miles per hour. The commuter rail line will connect to existing bus service within the corridor and to the Hiawatha LRT corridor.(*2*)

New Integrative Systems: Multi-modality, Water, and Development on the MBTA

As Boston's MBTA has extended its older subway and light rail lines, such as the Red Line, to suburban edge locations, such as Alewife station at the edge of Cambridge, Massachusetts on Route 2, this terminal station has become very suburban in function. The design of the Alewife station in the midst of an old suburban sprawl landscape of the 1950s and 1960s reflects the convergence of light rail and commuter rail design thinking on the radical redesign of the multi-modal environment around the station (see Figure 9.13).

Figure 9.13 Alewife Station Garage, Bus Stop and Drop-off Area

Old strip malls have been redesigned and infilled, though not radically, and bikeways, open space, and related infill office and residential developments have altered the suburban automobile rotary-driven landscape with the addition of these pedestrian- and transit-oriented urban elements.

Currently in the MBTA Red Line, there is a greenway from the 1980s extension to the station at Davis Square in Somerville to the Alewife Brook station in Cambridge. There are now plans to extend that greenway system via the Mystic Way Path, along the Mystic River. The Mystic Way is a proposed quarter-mile connector between existing paths from the Mystic River along Alewife Brook to the Minuteman Commuter Bikeway and the Alewife MBTA stop. Most of the land is owned by the Metropolitan District Commission (MDC), except for a sliver that is on an old MBTA railbed. As of March 2002, land ownership has been researched, and the MDC is looking at the connection's potential as part of the new Alewife Master Plan.(*3*)

The Grid, Linked Open Space and the MAX

The making of the MAX light rail system (see Figure 9.14) on a regional scale in Portland, has helped some to see the advantages of development opportunities related to principles of transit-oriented design (TOD) principles.

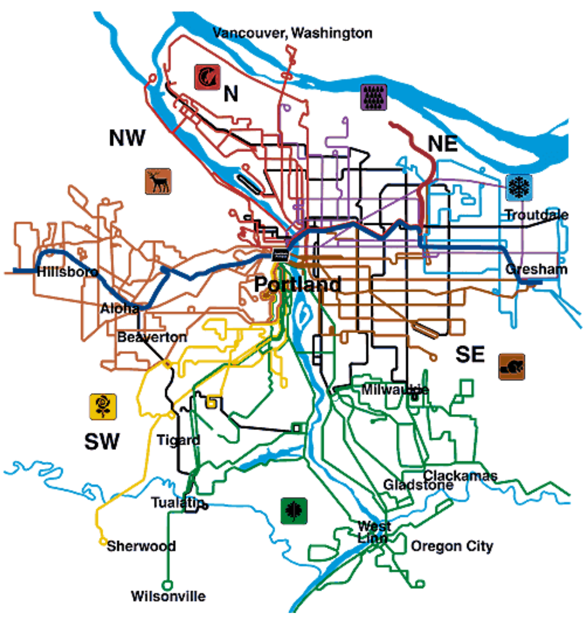


Figure 9.14 Portland MAX System

In its downtown, is the small block structure of Portland's original plat, creating a pedestrian porosity enhanced by urban pedestrian greens and greenways, including Lawrence Halprin's system from Lovejoy to Pettigrove to Ira Keller Auditorium Forecourt with its many older and current infill projects. Peter Calthorpe's writing and work has re-imbedded the British garden city notion of radial access to the suburban station in Portland. At the community and regional scale the MAX serves a wide territory from Hillsboro to Gresham, and its park-and-ride and bus/bike-and-ride mode-shifts in suburban locations commonly are seen in commuter rail systems as well as other far-flung suburban light rail systems.

Non-Rail Community Design: Storm Water Hydrology

Among contemporary projects, Village Homes in Davis, California and Seaside, Florida have had an obvious impact on our thinking about the integration of street networks, open space, and storm water infiltration. All have integrative approaches to simple infiltration techniques that combine porous paving and open swales and infiltration in streets and open space systems. Davis has also pioneered bicycle-oriented designs.

Perhaps James Patchett's design (with William McDonough, architect and planner) of Coffee Creek Center, Indiana (see Figure 9.15) has provided the most provocative new model in the Midwest of a site-specific approach to drainage, in this case on a site with difficult soils and geology for infiltration.

Figure 9.15 Water Terrace at Coffee Creek

One of the principal ideas of the community design is to introduce a leaky pipe system called a level spreader (see Figure 9.16) to recharge the aquifer via bio-infiltration swales, French drains, and other engineered water features, including wetlands. This system is designed to disperse (rather than collect) water.(*4*)

Figure 9.16 Installing a Level Spreader at Coffee Creek Center

"The level spreaders at Coffee Creek Center allow the infiltration of all storm water that falls on the site. This system of leaky pipes; installed throughout prairie and other native landscapes, replaces conventional retention ponds with a system that infiltrates and utilizes water within the landscape."(*5*)

Chapter 9 References

1. From the Sounder web site, www.soundtransit.org/sounder/RiderInfo/SdrFacts.htm

Service is planned to start in four phases:

Tacoma-Seattle	September 18, 2000
Third train from Tacoma-Seattle	April 2003
Everett-Seattle	2003
Lakewood-Tacoma	2003

Sounder commuter rail service is initially providing one-way service during peak hours between Tacoma and Seattle on weekdays. Eventually, service will be expanded.

Tacoma-Seattle:	60 minutes
Puyallup-Seattle:	47 minutes
Sumner-Seattle:	43 minutes
Auburn-Seattle:	34 minutes
Kent-Seattle:	27 minutes
Tukwila-Seattle:	20 minutes

Sound Move includes funding for 13 Sounder rail stations linking major destinations in Snohomish, King, and Pierce counties including:

- Everett Station (with connections to Amtrak and local/express bus service)
- Mukilteo Station (with connections to the Whidbey Island ferry)
- Edmonds Station (with connections to Amtrak and the Kingston ferry)
- Seattle's King Street Station (with connections to Amtrak, Link light rail and the Waterfront Streetcar, Washington State Ferries and local bus service)
- Boeing Access Road Station (with Link light rail connections to the airport and southeast Seattle)
- Tukwila Station (with transit connections)
- Kent Station (with transit connections)
- Auburn Station (with transit connections)
- Sumner Station (with transit connections)
- Puyallup Station (with transit connections)
- Tacoma Dome Station (with connections to Amtrak, ST Express buses, Pierce Transit buses and the Tacoma Link light rail to downtown Tacoma)
- South Tacoma Station
- Lakewood Station (with transit connections)

The plan also identifies three provisional stations in Shoreline, Ballard, and Georgetown. Though not currently funded, these stations could be built if funding becomes available.

2. http://www.northstartrain.org/questions_answers.cfm#TOP

3. bryce@obviously.com

4. From the community's Web site at www.coffeecreekcenter.com/community/hydrology.html:
"A primary reason that Coffee Creek Center devotes almost one-third of the acreage to greenspace is founded on innovative sustainability concepts. While the land contains only 17 acres of non-buildable areas and wetlands, more than 200 acres will be contained in the preserved greenspace, parks and constructed wetlands. In looking at the long-term, 10,000-year scale of rainwater interacting in the environment, one finds a system where water is infiltrated deeply into the ground through deep native roots systems. This rainwater is often used fully by this landscape and if not, slowly seeps into the natural waterways, creating healthy streams that better support a variety of landscape and animal habitats. In addition, this interaction helps create much more consistent flow rates and temperatures than we see in waterways following the introduction of buildings or even farming in former natural areas. Consequently, our initiatives began with setting aside critical greenspace areas, nurturing those few scattered areas where some remnant native biodiversity was still present, and, finally, beginning a ground-up restoration of native conditions in those areas where the remnant landscape was all but lost. What this accomplished was simply to begin returning the pre-settlement hydrology to substantial portions of the site—essentially reintroducing infiltration. The next and most obvious question then is what happens to water that falls on the built portions of the development. The goal here was to replicate the natural system. Water is collected, and infiltrated into native planted areas before it finds its way to the creek. A system of level spreaders helps us accomplish this. Perforated, or leaky, pipes are situated throughout the restored prairie areas through which rainwater is either infiltrated through the bottom of the pipe, or runs through the top, across prairie, and into the next level spreader. Next, a lot of the work accomplished on the site was undertaken primarily to undo the damage already done by poor hydrology. In some areas, where several hundred acres of nearby farm fields drain into the site and directly into Coffee Creek, constructed wetlands were created that begin the absorption and cleaning of this water prior to it entering the stream. Within the creek itself, areas where flow rates have been excessive, causing channelization in the creek, banks were reshaped through bioengineering processes. During this process, banks were resloped to a much less severe angle, allowing the creek to overflow its banks in large rain events. These re-sloped banks where then re-planted with native plants and temporarily protected with bio-degradable coconut fiber."

5. http://www.coffeecreekcenter.com/community/hydrology.html
See also: http://www.swcs.org/t_pubs_voices_arch_coffeecreek.htm

CHAPTER 10

Develop Physical Design Hypotheses for TOD, TND, Cluster, Storm Water

As a simplification of the design problem, from a hydrological and infrastructural perspective, the ideal situation as generalized across the region is represented by Figure 10.1.

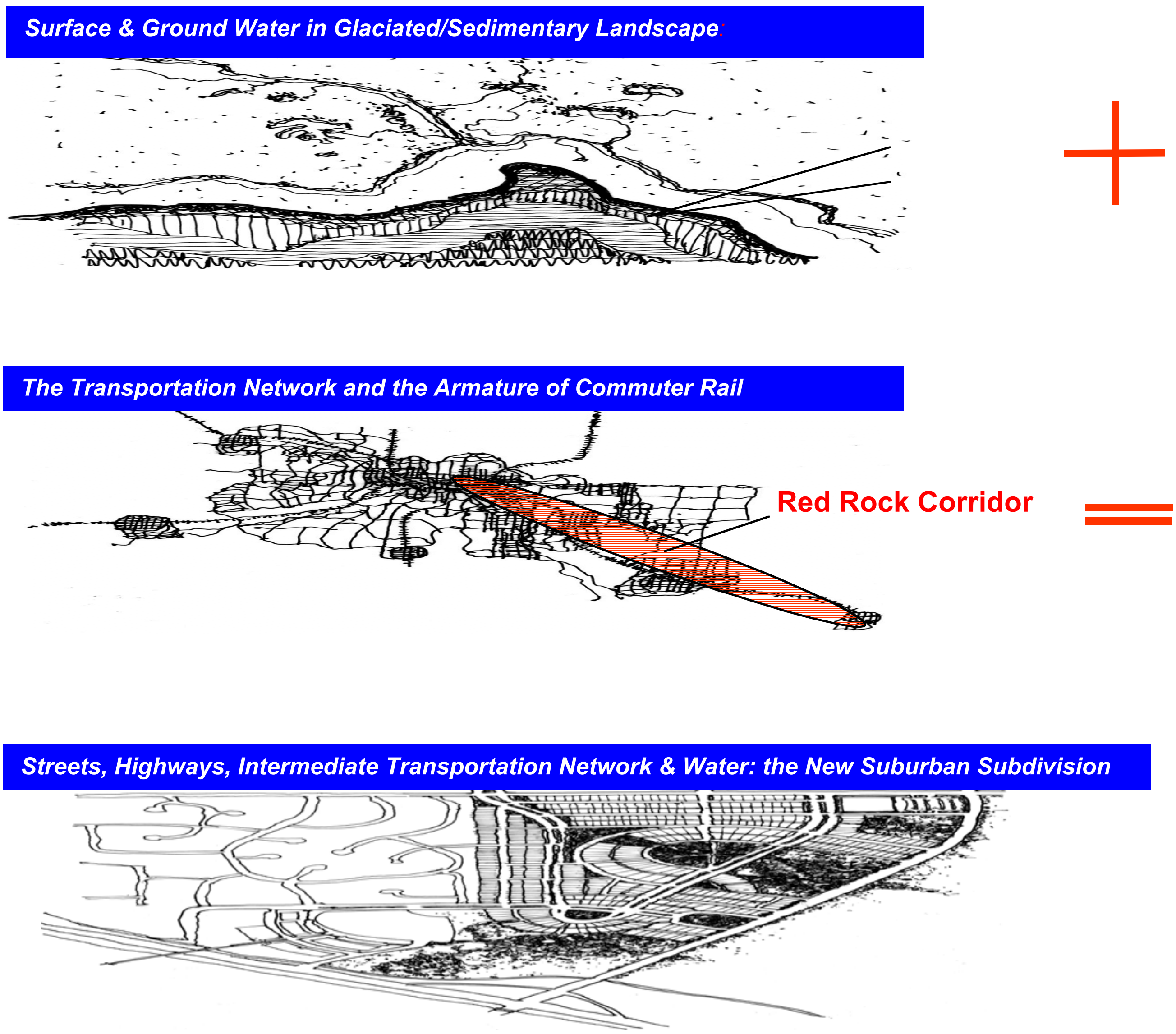


Figure 10.1 Simplified Design Problems from a Hydrological and Infrastructural Perspective

The other research framework of the project is that of applying smart growth approaches to the designs of the subdivisions (see Figure 10.2):

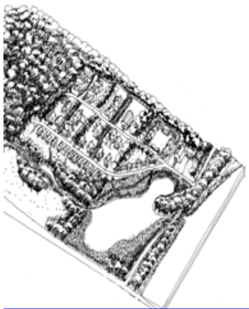
- Cluster/conservation, which in our study evolved to a “New Suburban” pattern, potentially adaptable to Commuter Rail-Oriented Design (CROD-LO) low density development.

- Traditional Neighborhood Design/Development (TND), in our study the basis for the Commuter Rail-Oriented Design (CROD-Lo), at a low to medium density.

- Transit-Oriented Design (TOD) for walkable station areas similar to light rail standards Commuter Rail-Oriented Design (CROD-Med/Hi).

- And to overlay these approaches with special attention to water resources as a kind of proxy for ecology.

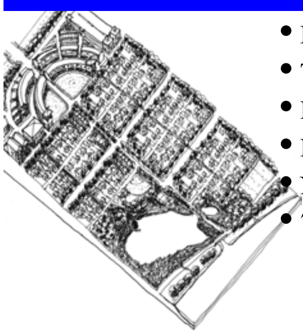
Cluster/Conservation/New Suburban



- Preserved critical habitats & natural features
- Limited forest fragmentation
- Conserved/replanted native plant cover
- Preserved critical soils
- 4 to 5 dwelling units per acre gross density

Water-Sensitive Design
Hydrology Overlay on all Approaches

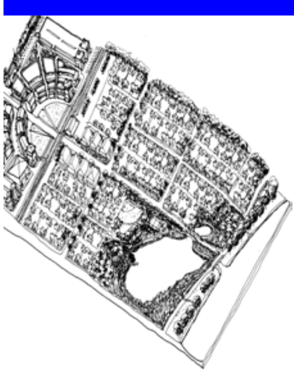
Traditional Neighborhood Design (TND/CROD)



- Pedestrian-friendly, traditional streets
- Traditional architectural space
- Multi-modal circulation system—fine grain
- Mixed uses—no industry
- Neighborhood parks, open space corridors
- 7 to 12 dwelling units per acre gross density

- Preserved critical hydrology
- No build in receiving basins
- Preserved drainage corridors
- Public open space follows drainage

Transit-Oriented Design (TOD)—Station Areas



- Pedestrian-friendly streets
- Small, permeable blocks
- Circulation-oriented to transit riders
- Mixed uses, including jobs generators, industry
- Neighborhood parks and open space corridors
- 15 to 20 dwelling units per acre gross density

Figure 10.2 Smart Growth Approaches Used in this Research

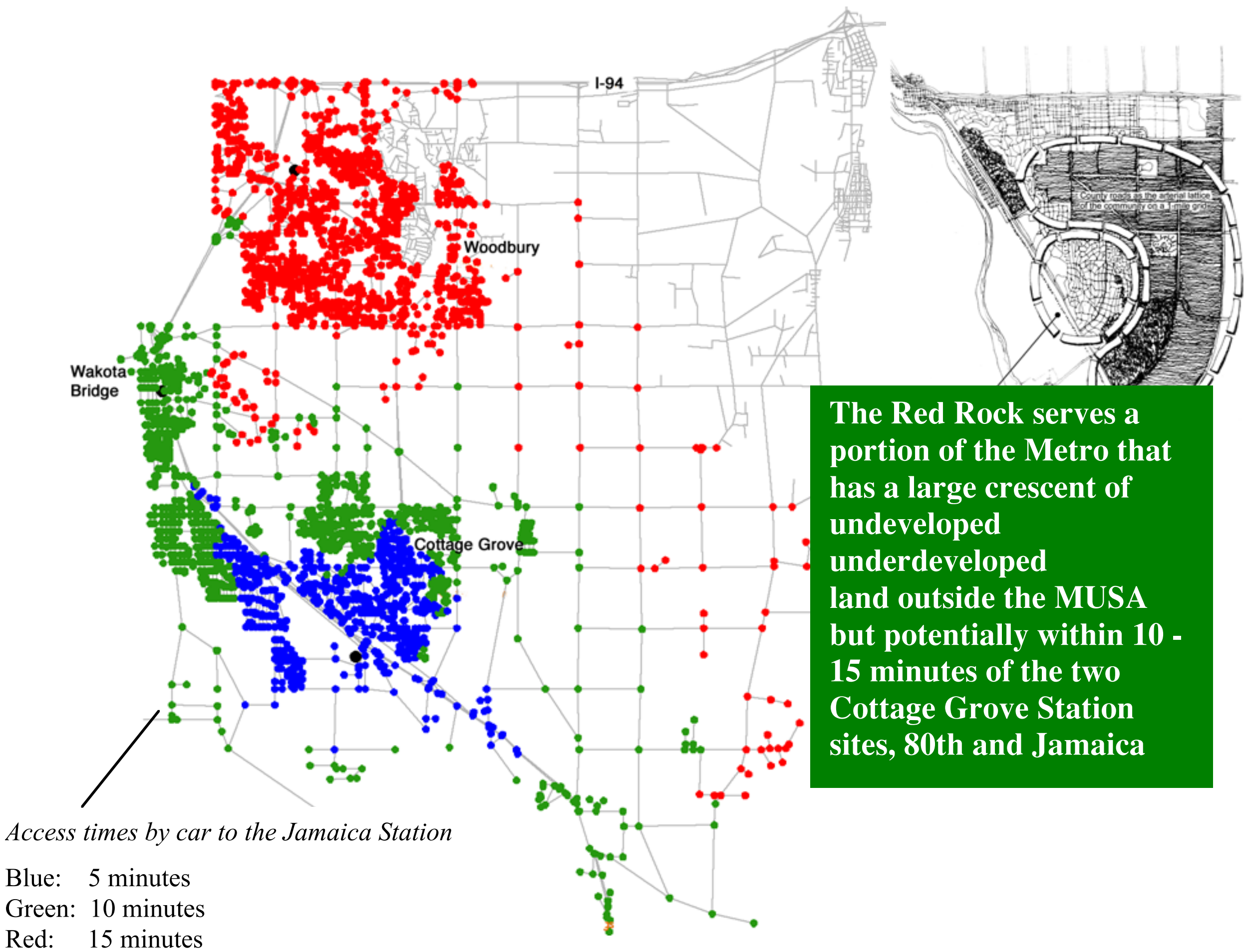


Figure 10.3 Five-Minute Interval Isochrome from Cottage Grove Commuter Rail Station

In this section of the study, the research returns to the two suburban sites in Woodbury and Cottage Grove, with particular attention to the commutershed of the potential station at Jamaica. In the last report, the research team identified a crescent of partially undeveloped land northeast of the station. In this area, based upon isochrome analysis by SRF (see Figure 10.3), it was assumed that some enhancements to the connectivity of the system of country roads and a more legible and connective system of subarterials might enhance current ridership estimates. In attempting to reconcile the highly variegated nature of the hydrogeology in this zone of potentially increased ridership and still provide connectivity, the team generated the Commuter Rail Oriented Design analysis map (see Figure 10.4).

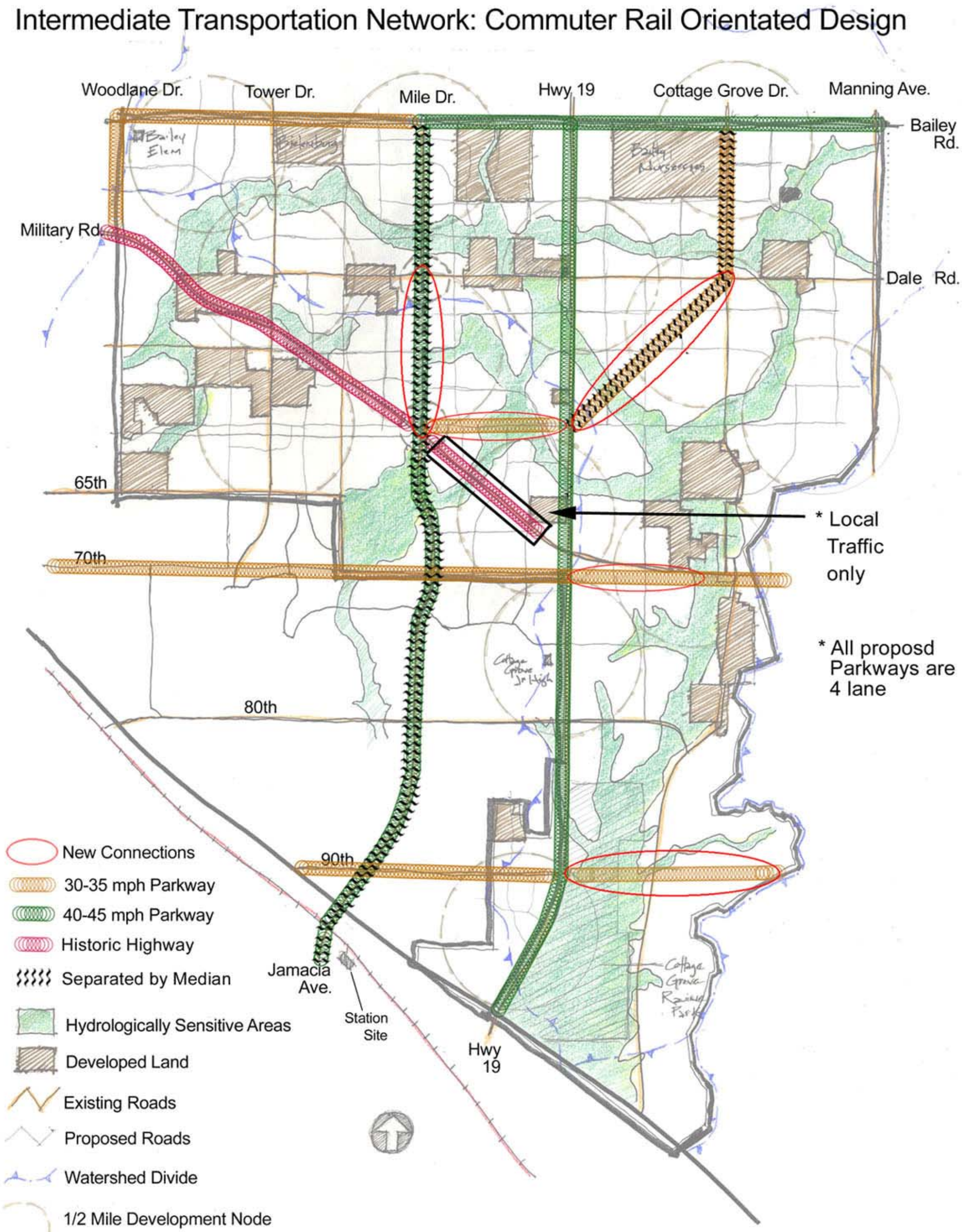


Figure 10.4 Commuter Rail-Oriented Districts & Network Enhancements Cottage Grove Station Commutershed Area(*1*)

New Segments of Minor Arterial and Subarterial Connective Network

In this CROD plan (Figure 10.4), several new types of streets have been introduced to add multi-modal characteristics to the network:

- 30 to 35 mph parkway designations are closest to the functional classification "Urban Collector."
- 40 to 45 mph parkway designations are closest to the functional classification "Minor Arterial—Urban."
- Historic Highway designation is closest to the functional classification "Rural Minor Collector."

The Region, Water, and the Subdivision

The public realm of the street and highway network as it is set forth in the acts of highway construction and subdivisions is the primary intermediate realm of human-influenced hydrology, i.e., the nexus between transportation and hydrology. Highways often recast the forms of subwatersheds. Streets and pipes carry runoff, and retention and infiltration must be designed. In a glacial landscape such as Minnesota, the variations in soil and geological conditions can be dramatic in their effects on the surface and subsurface unseen to the casual observer and uncritically assessed in much planning.

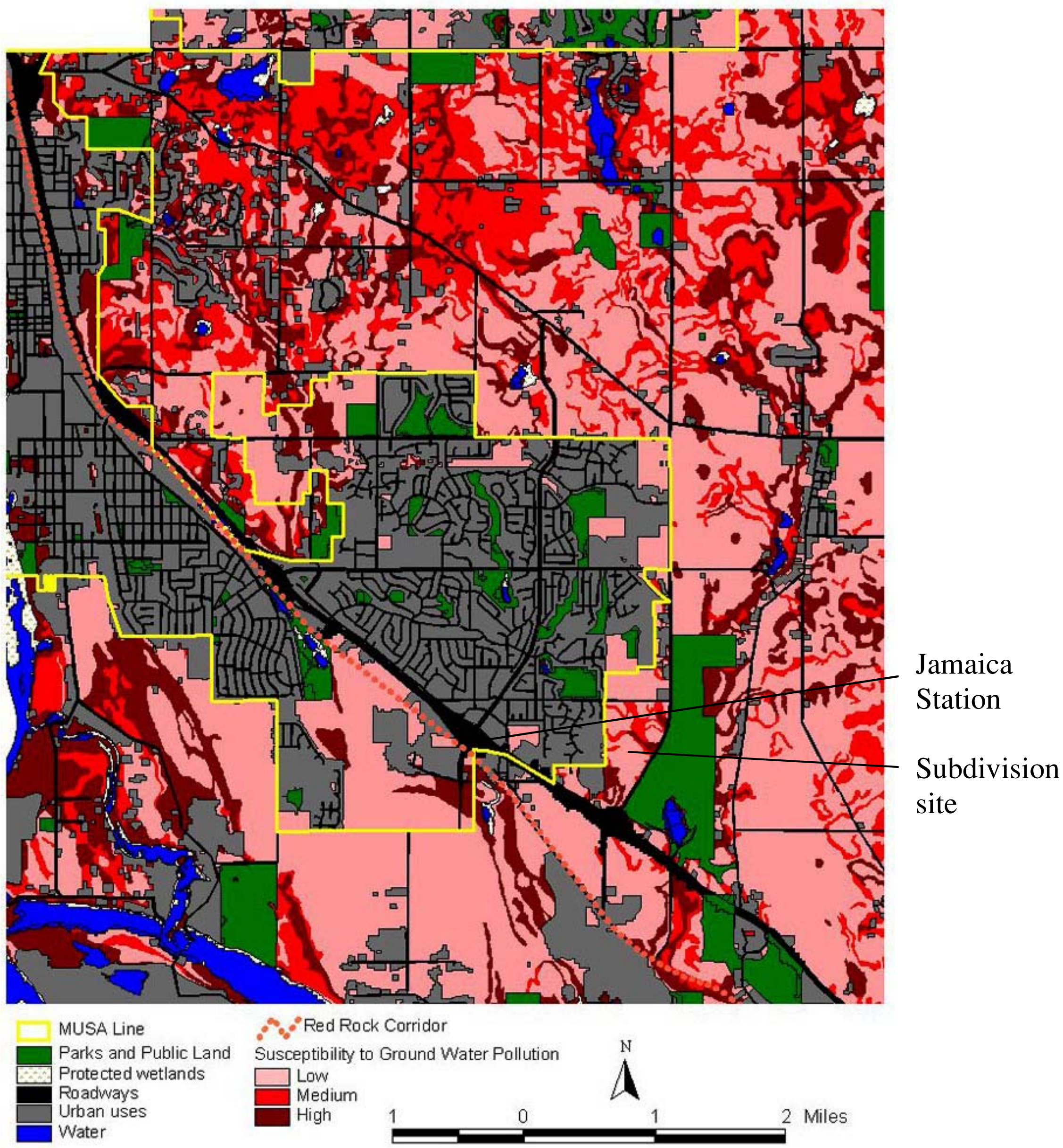


Figure 10.5 Groundwater Sensitivity in the Context of the MUSA Shown by the Green Line

The highly variegated hydrological carrying capacity of Washington County, however, makes this type approach difficult in the urbanizing areas of Cottage Grove and Woodbury. In his ongoing study of suitability of land for development for the Metropolitan Council, Professor David Pitt, Department of Landscape Architecture, has provided this study with a working analysis map of groundwater sensitivity. The map demonstrates that the sites in the crescent of land just beyond the MUSA in the area near the Jamaica station have deep groundwater overlain by relatively to very highly permeable soils. These areas designated by a light red (pink) color have a moderate to high capacity in the soil profile to infiltrate runoff from development without damage to ground water. Areas of darker reds have less capacity.

In general, this map would seem to argue for the opportunity for various storm water infiltration techniques in subdivision design to be applied such as the ones shown here. This is still a coarse reading of a diverse landscape, and when taken to the site scale, this type of analysis needs to be resolved with more specific data, such as soils data and related infrastructure design. On the subdivision site selected here, for example, the soils (according the Washington County Soil Survey) are very deep and contamination susceptibility is very low.

Commuter Rail: Integrating Issues of Public and Private Space, Connectivity, Hydrology, and Suburban Density

The Cottage Grove station is projected to have the greatest ridership because of its position in the system as the first suburban station and the corresponding potential of reach into a hinterland in the CROD area (and beyond). Its position near the MUSA suggests further that this subregion and the station area embody a richness of issues for this report at both that and the subdivision scale.

In the two types of new Cottage Grove proposals (as well as the Woodbury TND) presented here, are designs that integrate a number of issues that re-shape the public and private realms. These designs are embodiments of the reconsideration of the following elements, or design variables of the urban and suburban fabric, that relate the investments in the private realm to the shape of investment in the private:

Public Realm

- Street networks—subarterial connection
- Small blocks, alleys
- Street design—street width, curb and gutter versus swale, path, trail, and sidewalk design—technology, soils, regional hydrology
- Path and Trail connections
- Connective open space—infiltration capacity and size versus/and connectivity

Private Realm

- Mixed use types
- Residential lots
- House/dwelling types

Design Principles at the Subregional/Commutershed Scale: Intermediate Transportation Network

One of the principal realizations of the Task One (Chapters 1–6) work was the decline of a connective multi-modal, multi-use intermediate transportation network of arterial streets in suburban development. The CROD map is a plan for the reinvigoration of that typology at the commutershed scale.

Three principles underlie the strategy for subdivision design, the principles and densities of which could be replicated in the area of the 10–12 minute commutershed:

1. *Use the formal, spatial, and hydrological qualities of spaces to design watershed-based corridors of open space.*

The CROD map as a diagram of water-based corridors of open land protection also with the potential for bicycle connectivity to the station and other destinations.

2. *Organize spatial design around the resolution of community design, water issues and transportation issues.*

The CROD map as a diagram of a radially configured network to the Jamaica station with multi-modal system of access based on 10–12 minute automobile access to park-and-ride lots.

3. *Define the flexibility of the MUSA in terms of the commutershed.*

This hypothesis, also shown in the CROD map and referenced in the ridership analysis, lies at the heart of the difficult problem of matching the transportation and suburban form with hydrological objectives in this study. This principle, of course necessitates a new type of joint advisory structure or authority and special joint powers of official mapping, comprehensive planning, and approval and/or development review such as might be constituted in a metropolitan rail authority working in collaboration with the effected units of local government.

Design Principles at the Subdivision Scale: Balancing Multi-modality, Hydrology, and Density

On the suburban sites in Cottage Grove and Woodbury, the principal issue is the integration of the subarterial/multimodal, mixed use destination-oriented connectivity with hydrological issues. Again this framing of the design is cast as an alternative to baseline dispersed and single-use zoned development.

The two primary quantitatively measurable aims of the study have focused on reducing the expansion trend of VMT as a measure of compactness, mixed use and pollution reduction, and the reduction in water quality degradation as a result of hydrologically-sensitive and connective design strategies. Smart growth in the context of these variables extends these general principles to address the specific qualities of sites and watersheds.

The central articles of smart growth target reduction in land and resource consumption in urban and suburban development with three approaches:

1. *Compact development/redevelopment—Land and resource conservation via hydrological protection*

A critical component of smart growth in Minnesota is the relationship between urban form and the specific types of water resources, both surface and ground. The designs predicated here conserve water resources as a central aspect of the designs and the technologies, especially as applied to storm drainage and infiltration. This idea postulates corresponding new suburban density levels for development to protect hydrologic function.

2. *Mixed Use*

Small, walkable service and retail centers targeted to daily needs lie at the core of neighborhoods and districts.

3. *Multi-modality/transit*

Implicit in this compactness is the idea of reducing automobile dependence and increasing pedestrian, bicycle, and transit connectivity. The relationship of smart growth to transportation in this study postulates new development patterns that relate to commuter rail transit service on the Red Rock Corridor, including, eventually a just-in-time shuttle.

New Suburban Design: TOD or Cluster and the Issue of VMT

The central transportation issue of this study has been to examine the stabilization of increases in VMT. This issue has generally been cast in the context of transit service—in the Twin Cities—bus service, which is benchmarked at 7 dwelling units per acre gross density. In part, this assumption is based on a ridership within one-quarter to one-third of a mile of a stop or station. In other words, it is a pedestrian-based standard. However, commuter rail is accessed by multiple modes, with the greatest number of commuters arriving at the station by car. Further, there is a presumed local sentiment to 'let the suburbs be suburbs.' In this construct of the world, the single-family house as private *domus* and primary life investment is a foundation. This leads to the hypothesis that a cluster density roughly equivalent to the baseline of 3–4.5 dwelling unites per acre would be feasible in terms of ridership if the road network were multi-modal (especially routes leading to the station) and were connective to intermediate destinations, including services (banking, cleaning, daycare, restaurant, and fast food) and retail (grocery, hardware, durable goods, and clothing) and local destinations such as jobs. In this hypothesis, the maximum distance to the station from the perimeter of a new development should be something less than a 12-minute trip.

Even this 12-minute definition is expanded in certain types of situations.(*2*) Density, too, seems relatively less important than other factors such as job connectivity, shuttle service, local land use, and street design. In "METRA Rail Service and Residential Development Study: Summary of Findings," prepared for METRA, the agency that runs the comprehensive Chicago commuter rail service, S. B, Friedman & Company, offers several case studies of urban design in well-established and revitalized commuter rail towns. In their study of Glen Ellyn, Illinois, an old commuter town with a predominant gross density of approximately 3.3 dwelling units per acre within the half-mile radius of the station, pedestrians constitute 32% of the ridership. This situation combined with special "just-in-time" and normal shuttle services has contributed to a downsizing of the station parking to 666 spaces. Normal parking requirements for similar ridership of 1,889 per day would be over 1000 spaces.(*3*)

The question of density and its relationship to other factors such as connectivity and mixed use in commuter rail communities such as Riverside, Illinois, one of the precedents for this work, shows a different picture than is painted in the standard TOD approach. Riverside is located around the station area. Commercial and mixed use (4% total of land area covered) and multi-unit dwellings (duplexes and apartments constitute 6.47% of the land cover) are near the station. However, the majority of dwellings, which cover 67.4% of the land in the corporate limits, are single family houses at a gross density of 4 dwelling units per acre. While many people in neighboring Berwyn, Brookfield, and Lyons live in denser patterns, it is nevertheless instructive to see that variable; lower-density patterns can work if there is also connectivity to the station area and mixed use near the station.

Figure 10.6 TND Commuter Rail—CROD-Med/Hi Density: 7 dwelling units per acre

This subdivision design, illustrated in Figure 10.6, emphasizes transit accessibility, mixed uses, and density to support walkable access to shuttle service to the station. This design, based on the gross density for bus ridership, assumes that there would be an MTC loop shuttle bus to the station running on the hairpin route with the multi-family housing lining it. This scheme shows how the forms of LRT-like TOD design would be adapted to a medium density scheme served by bus. Access to the station area by bus and by bicycle would be via the frontage road to Jamaica (see Figure 10.7). A pedestrian/bicycle overpass at Highway 61 (not shown) would improve connectivity for those modes.

Cottage Grove Design #1

RESIDENTIAL	Units	Area(acre)	Density
Single Family	205	31.82	6.44
Town Homes (3 BR)	715	49.19	14.54
High Density (2 BR)	660	15.13	43.61
Mixed Use (2 BR)	152	3.49	43.61
Totals	1540	93.12	16.54

RETAIL/COMMERCIAL/OFFICE
369971 sq. ft.

Net Density	16.44 D.U./Acre
Gross Density	7.00 D.U./Acre

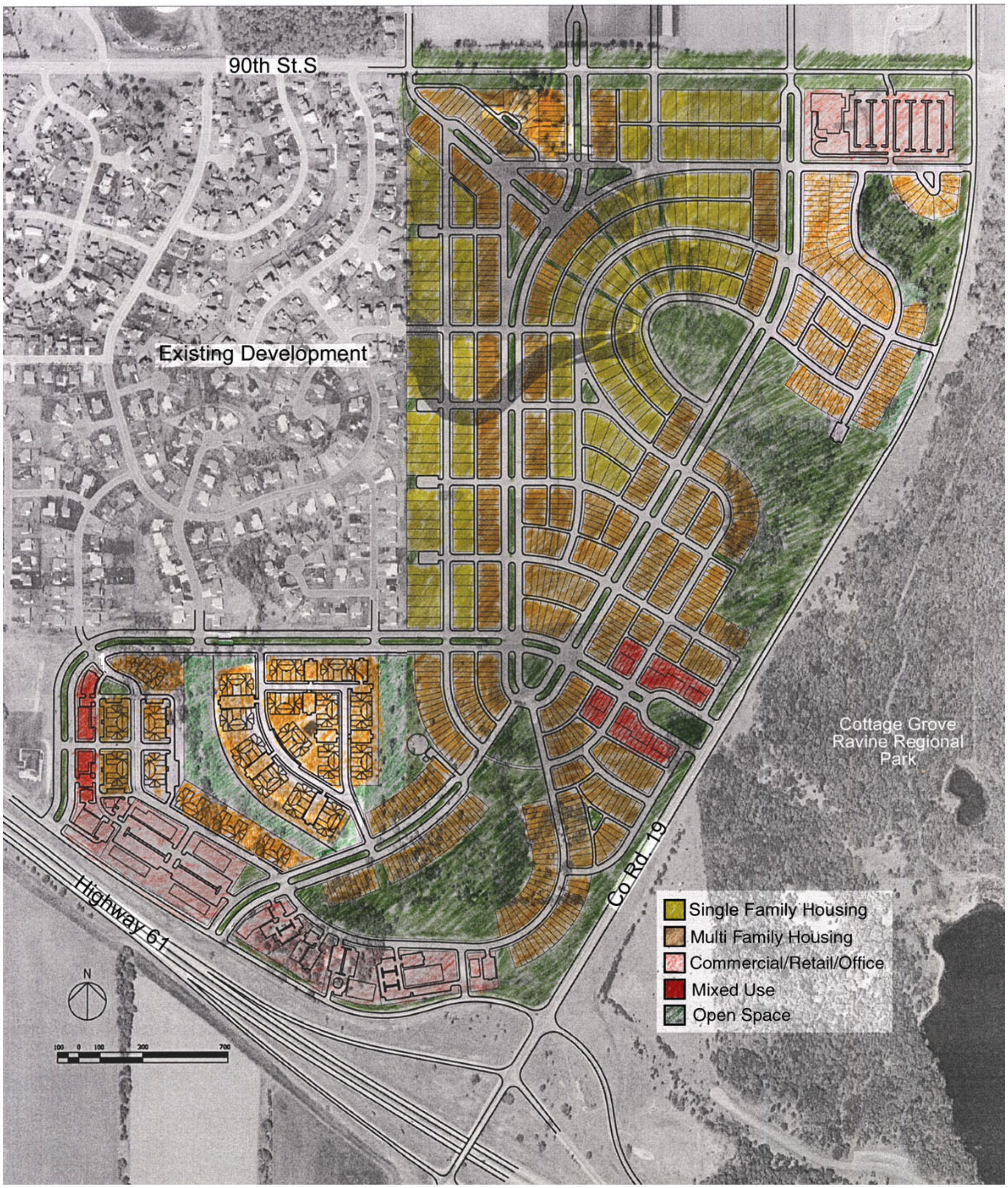


Figure 10.7 Cottage Grove Design Number One

Figure 10.8 Cluster Design for Hydrology—CROD-Lo Density: 3.5 dwelling units per acre

The subdivision design illustrated in Figure 10.8 emphasizes open space and hydrological connectivity and protection with greater connectivity in the street system than in the baseline developments in Cottage Grove. This design preserves the essential single-family dominated fabric of conventional nineteenth-century commuter rail suburbs. Connectivity to the station and destinations within the subdivision is enhanced by the armature of multi-modal parkways. A commuter rail passenger shuttle of a smaller scale than MTC bus could run along these parkways at peak commute periods and gain access to the station via the frontage road to Jamaica (see Figure 10.9). Similarly, access to the station by bicycle would either be via the frontage road to Jamaica or via an overpass on Highway 61 into Langdon (not shown).

Figure 10.9 Cottage Grove Design Number Two

Subdivision Residential Street & Parkway for Infiltration in Section

Narrow Local/Residential Street with Alley—25 mph—infiltration in perforated pipe

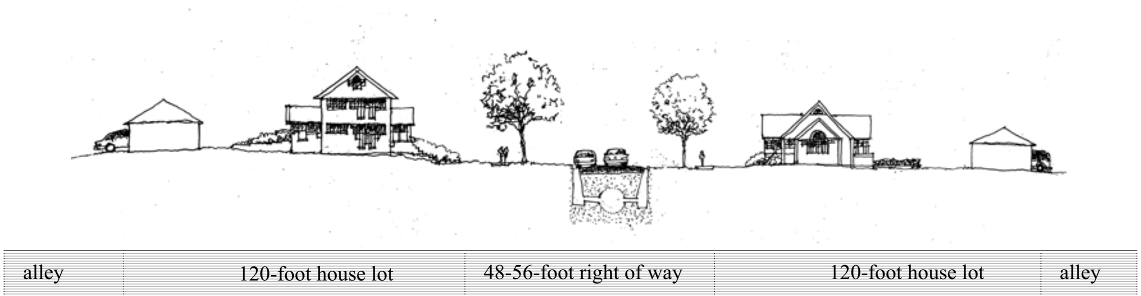


Figure 10.10 Local/Residential Street—Leaky Pipe with Curb and Gutter

In areas of ordinary streets, in the deep soils (sands and gravels in stratified layers) the application of a leaky pipe system represents a hybrid approach to partial dispersal and infiltration of storm water (similar in logic the idea of the level spreader) rather than total conduction (see Figure 10.10).

2-lane divided Residential Parkway CROD-Lo—30 mph—infiltration in median swale

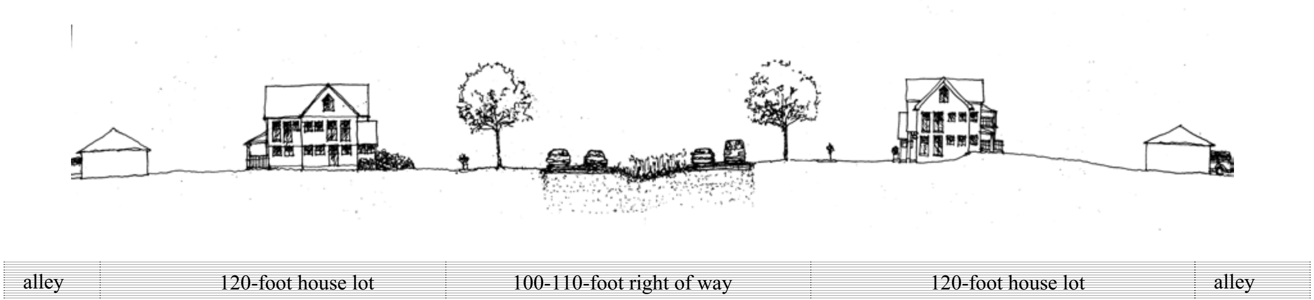


Figure 10.11 Residential Parkways

Residential parkways would have no curb, but would be edged with a scored warning strip. Parking would be allowed on a short term and neighborhood permit basis. Single family houses would predominate in the CROD-Lo scheme (see house on left side of street, Figure 10.11) but duplexes (see house on right side of street) or town houses would predominated in the CROD-

Med/Hi alternative. Bikes would move on the street lanes and pedestrians would occupy separate sidewalks on both sides of the street. In a four-lane scenario designed for CROD-Med/Hi, five-foot striped bike lanes would have to be dedicated as would transit stops. Although they would operate functionally as urban collectors at peak in the network, depending on parking configurations, their cross sections would be similar to rural minor collectors. This hydbridized design type would allow infiltration in the central medians.

Subregional Intermediate Transportation Network Connectivity and Use in Section

The idea of the intermediate street types is to provide a medium speed subartertial network with houses fronting a generous suburban setback as an alternative improvement to county highways now converted to arterials of greater dimensions and speeds.

Both types shown here (Figures 10.12 and 10.13) have curbless edges with storm water infiltration as part of the road section

Four-lane divided CROD-Lo and CROD-Med/Hi parkway—35-45 mph

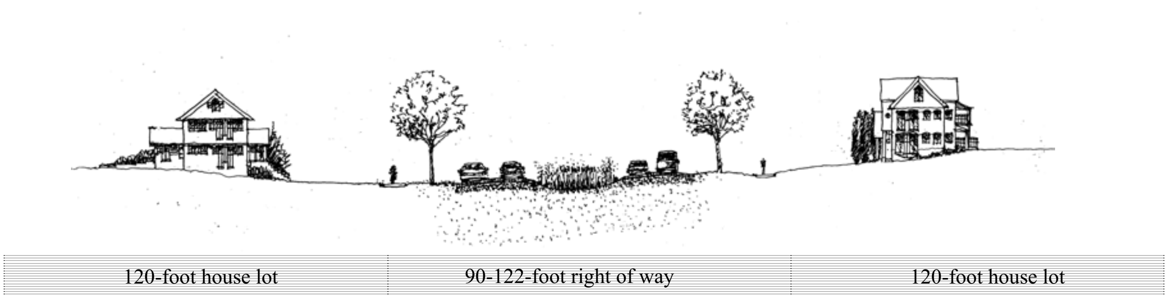


Figure 10.12 Intermediate Street: Four-lane Divided CROD-Lo/CROD Med/Hi Parkway

These streets would be a wider version of the 2-lane Residential Parkway with greater capacity and would function, therefore, as a “Minor Arterial.” This design promotes infiltration in a median swale and has separated bike/pedestrian paths. Housing could be multiple unit, or single-family; mixed use is permitted.

4-lane CROD Rural-Section Parkway—35-45 mph

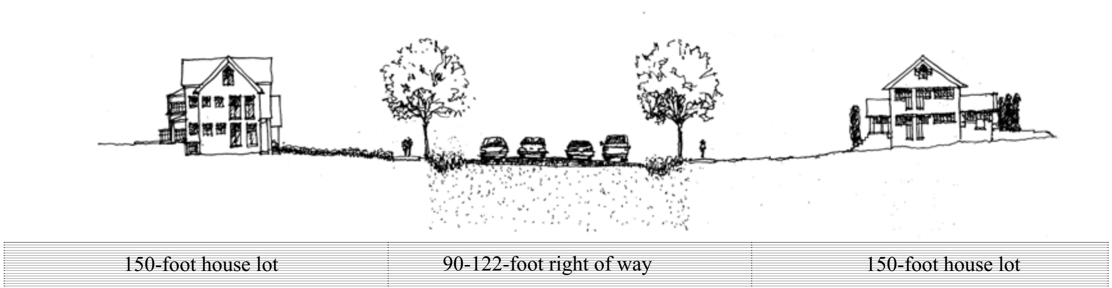


Figure 10.13 Intermediate Street: Four-lane CROD Rural-Section Parkway

Here infiltration is achieved in the side swales and bike/pedestrian paths are separated from lanes. These rural section parkways would be very similar to “Minor Arterials” in appearance and function. The major difference would be the nature of the lot frontage on these roadways. Access to each house lot would be achieved via alleys. No on-street parking; therefore, guest parking would have to be provided in deeper lots.

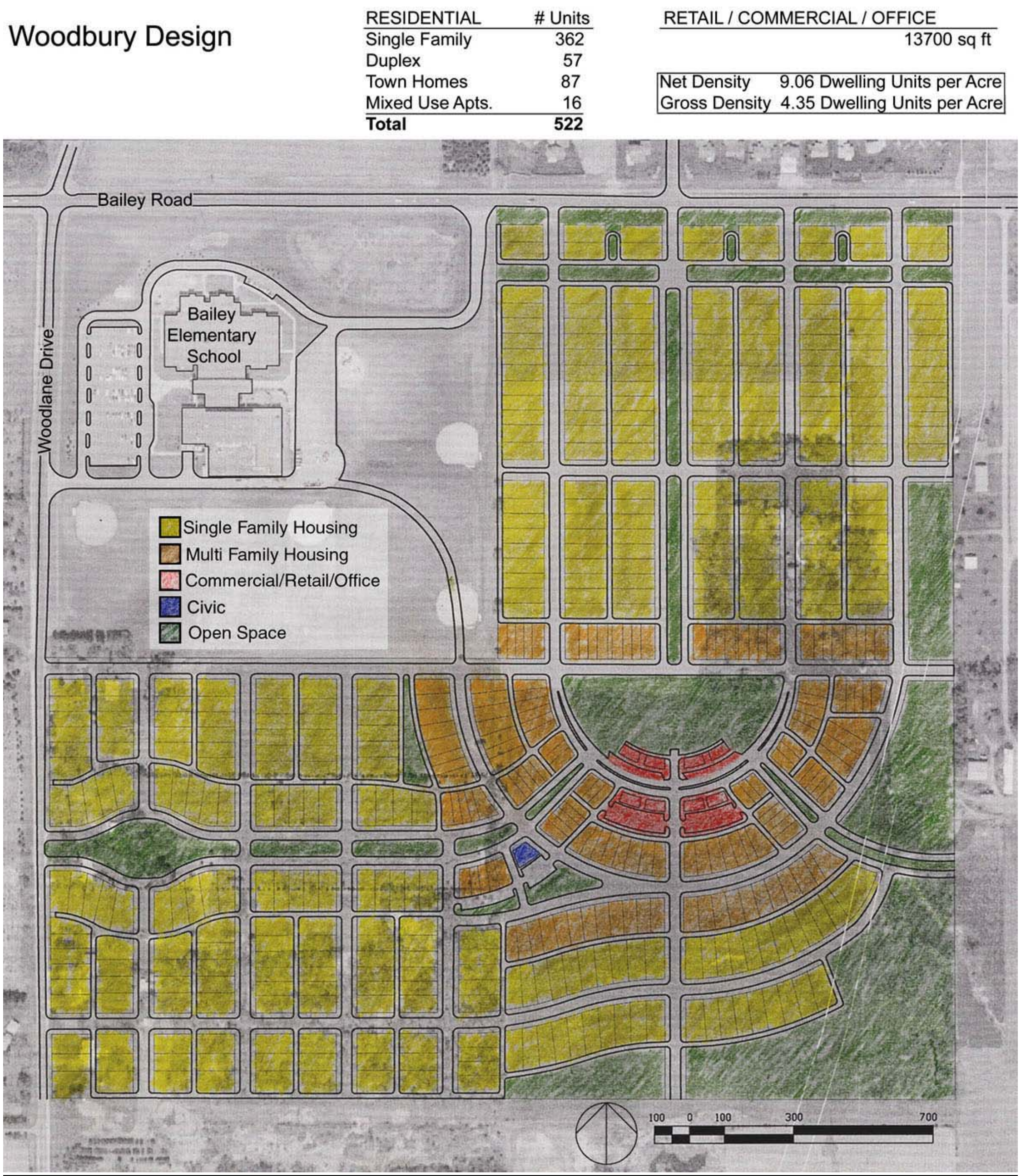


Figure 10.14 Woodbury TND—4.35 Dwelling Units per Acre

The TND development for Woodbury (see Figure 10.14) is designed similarly to affect VMT, regardless of access to a commuter rail station, assuming, in fact, that Woodbury residents perceive themselves to be so close to Interstate 94 to not regard commuter rail transit as competitive either with bus service or automobile commuting.

The Downtown Lowertown Station District

The St. Paul Station site embodies issues associated with older urban stations that are embedded in the fabric of a city, a neighborhood, and the riverine landscape that often characterizes urban stations and trackage. A large part of the facility design challenge will involve balancing these issues in the context of adapting a former terminal and track deck and concourse (which are currently owned by the U. S. Postal Service) and converting these spaces to commuter rail service, Amtrak, and potentially a high speed train service to Wisconsin and Chicago.

Station area design issues have larger ramifications. The Union Depot is seen by some as an intermodal transit hub with a direct connection to the central LRT corridor; also, the St. Paul site for the potential Twins stadium lies on the old Gillette parcel just east of the station.

An institutional challenge for the ultimate shape of this station, the riverfront, and for Lowertown is the coordination of split or shared authority for planning and design in this area. The Ramsey County Regional Railroad Authority has been empowered to steer the transit issue for the county. The City of St. Paul has a vested interest in critical issues related to the regulatory and development frameworks for downtown and Lowertown, including height restrictions related to protecting the flight path into the St. Paul Airport. Riverfront projects and overall framework planning in the downtown area have become the province of the Riverfront Corporation in cooperation with the City. Similarly, the redevelopment of Lowertown, including that portion of the riverfront, has been inextricable from the design of the district and the historic preservation and arts and housing promotional efforts mounted by the Lowertown Redevelopment Corporation.

Operational Challenges—Transit

- A portion of the line lies in the floodplain above Pigs Eye Lake, south of the Depot
- Resolution of access out of St. Paul on the Riverview Corridor and up the Amtrak/Ayd Mill route (vs. the Great Northern Corridor)
- Coordination with the LRT and/or other transit—Intermodal Transit Hub

Costs of Re-establishing the Depot

- Depot acquisition costs

- Track deck acquisition and post office relocation costs
- Depot renovation and/or addition costs

Jobs/Housing: Open Space Connectivity and Hydrology

A fundamental land use debate about development directions would also follow on a decision to implement the Red Rock line. As indicated, commuter rail is most feasible in central cities when jobs lie near the station. In fact, the job core in St. Paul has shifted uptown as the loss or conversion (generally to housing) of warehouses and factories has occurred, and the redevelopment of Lowertown has shifted much of the redevelopment focus to housing and supportive commercial uses such as have been built in the north quadrant project.

Can Lowertown survive a job redevelopment approach? Inevitably housing costs will go up as competition with commercial lessees for space will ensue. In significant part, any strategy for preserving Lowertown as a residential and artists' community will involve some sort of rent control or other program of subsidy for current residents. Even with this, careful attention must be paid to balancing the amenities offered by redevelopment against their potential effects in isolating or fencing out neighbors from privately developed open spaces.

One strategy to overcome this potential for division lies in the connectivity of the hydrology and pedestrian streets as a device to add value to both residential and commercial developments. Potsdamer Platz, of course, provides the most enlightened hydrological version of this model, which, not unlike the St. Paul District energy model, could 'process' storm water infrastructurally as a district-wide resource. The basic plan would be to capture roof water from all new infill buildings, and, if feasible, from other large-scale renovations to be used in a scheme of rain gardens, for example, on plazas of buildings, and on the old track/parking deck of the station (see Figures 10.15 to 10.18).

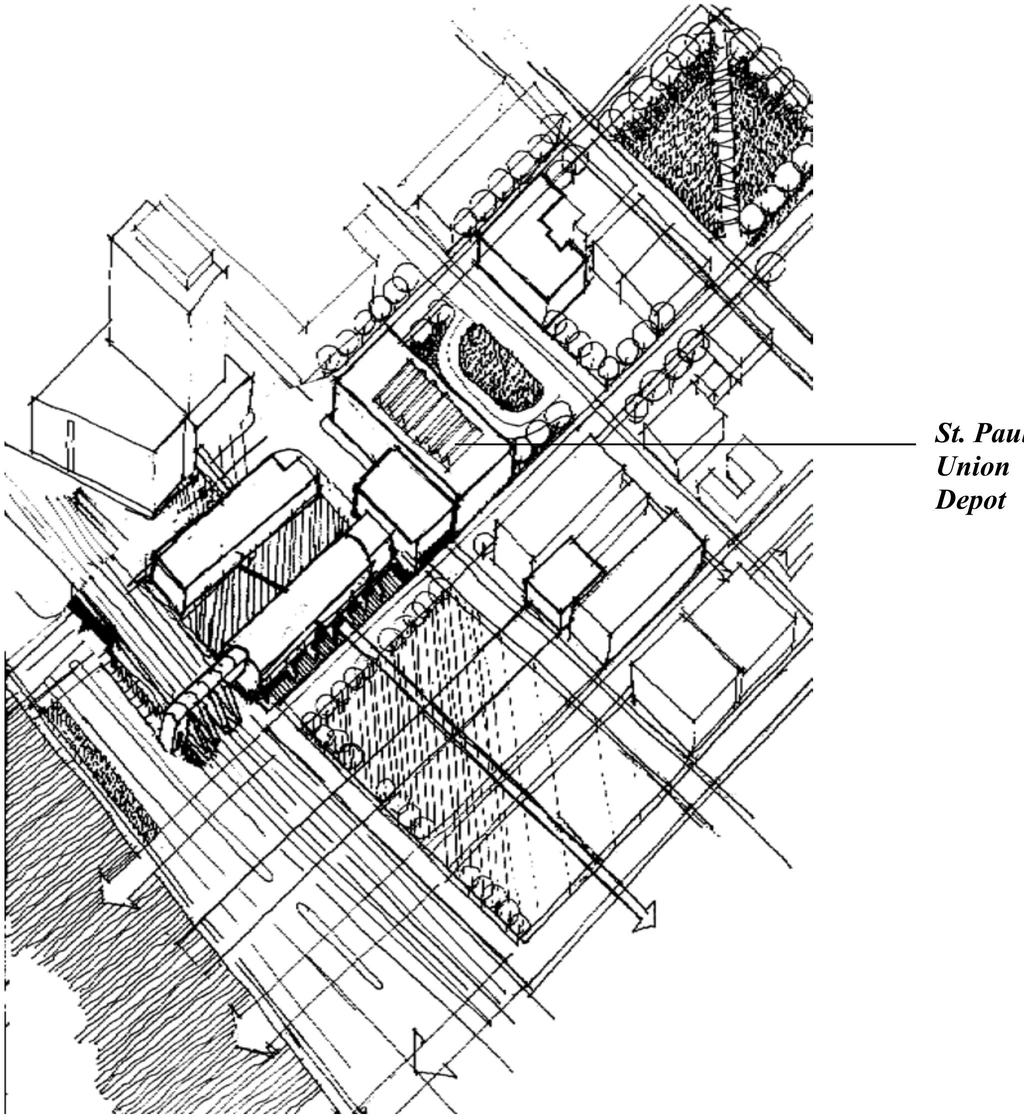


Figure 10.15 St. Paul Union Depot and Parking Deck

- No change in ownership of Post Office parcel
- Lease of concourse to commuter rail and Amtrak
- Extension of concourse at higher level to accommodate bi-level cars of commuter rail trains
- Retain parking on deck and below
- Individual access to platforms

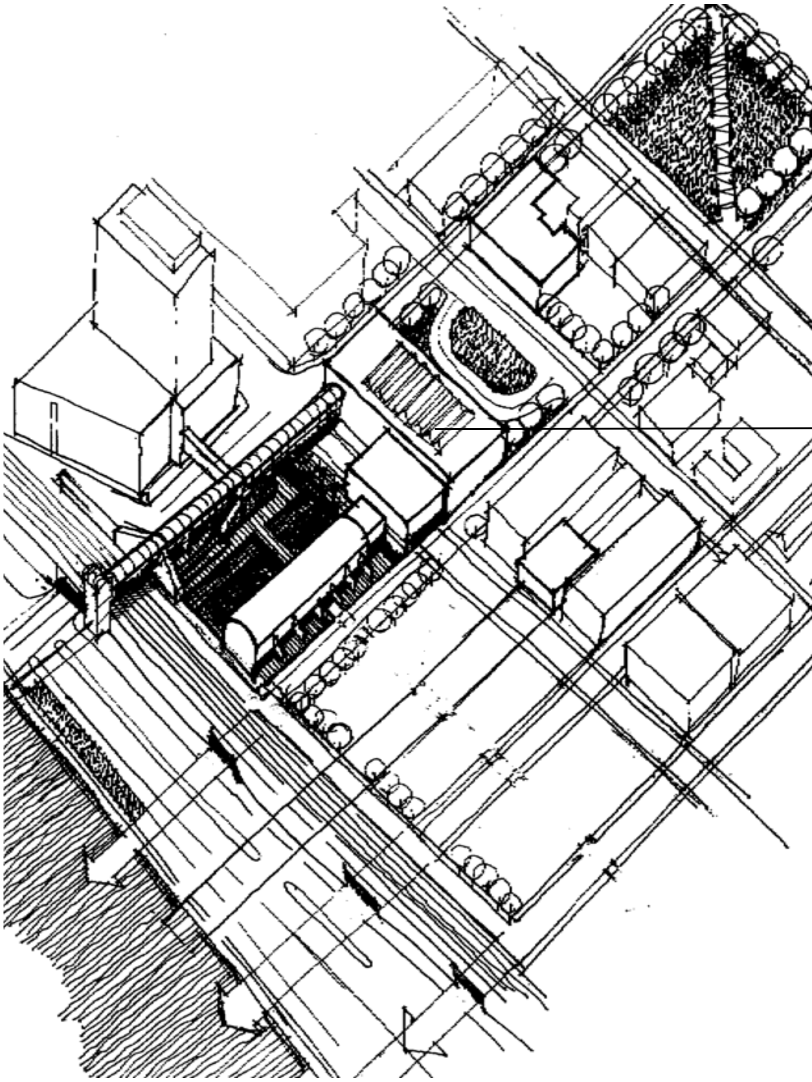


Figure 10.16 St. Paul Union Depot and Parking Deck Scheme B: New Transit Concourse—Minimum Redevelopment, Post Office Acquisition and Relocation

- New Concourse—adaptive reuse of historic concourse
- Minimum development of parking deck
- Open all streets to river for pedestrians and vehicles
- Extension of concourse to tracks and to Warner Road/riverfront
- Elevator access to tracks from concourse
- Storm water gardens on part of parking deck
- Use roof water and other runoff from new structures
- Office space connected to converted post office

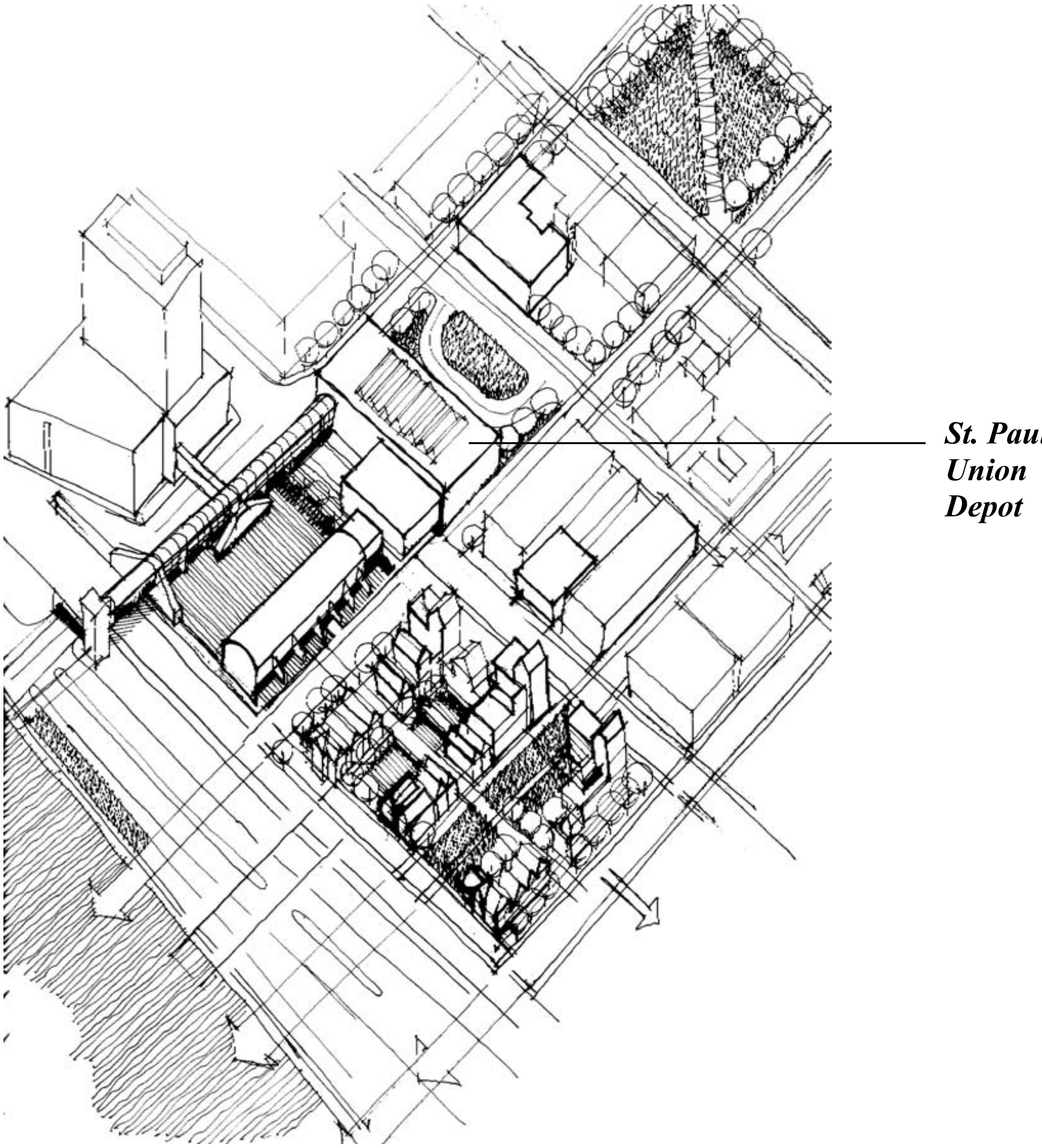


Figure 10.17 St. Paul Union Depot and Parking Deck Scheme C: New Transit Concourse—Medium Redevelopment, Post Office Acquisition and Relocation

- New Concourse—adaptive reuse of historic concourse
- Maximum Mixed use development of parking deck
- Parking below
- Infill buildings at scale of existing historic fabric
- Develop connective open space across uses
- Maintain views of river to historic buildings
- Extension of Concourse to tracks and to Warner Road/riverfront
- Elevator access to tracks from concourse
- Storm water gardens on parking deck
- Use roof water and other runoff from new structures
- Office space connected to converted post office

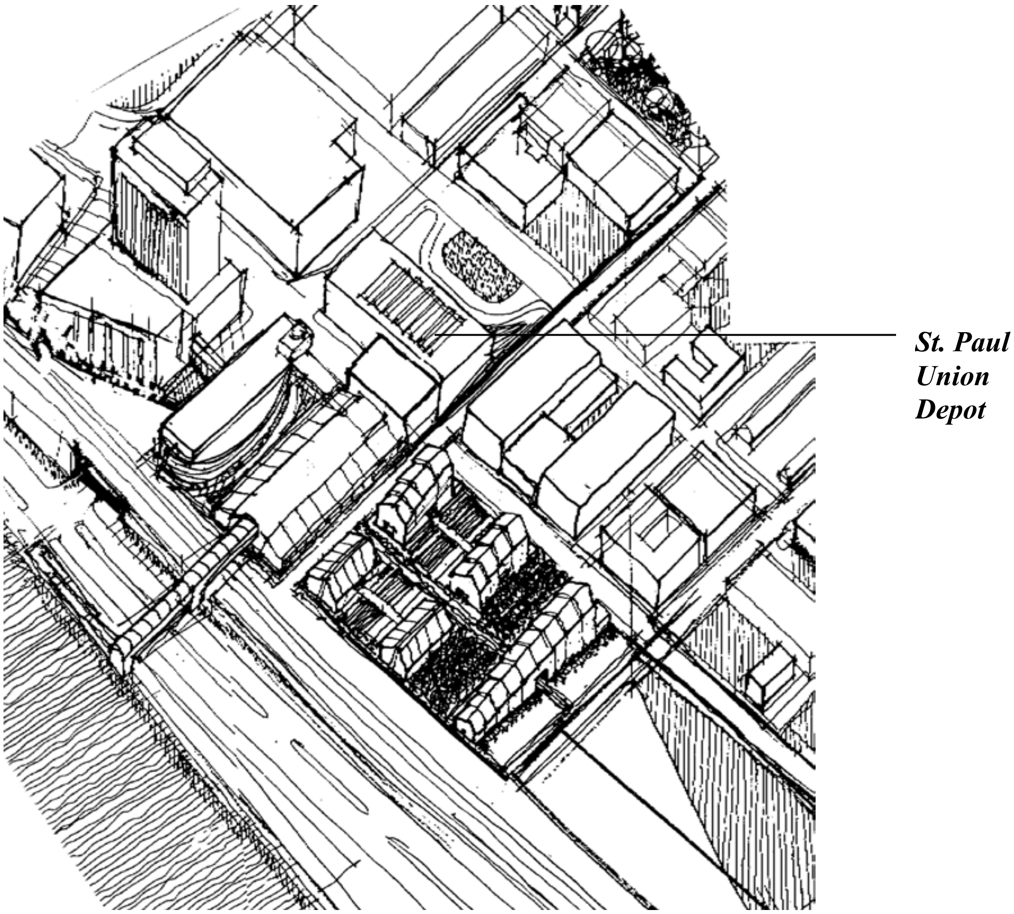


Figure 10.18 St. Paul Union Depot and Parking Deck Scheme D: Transit Use of Existing Concourse—Maximum Redevelopment, Post Office Acquisition and Relocation

- Maximum mixed use infill development of parking deck
- Parking below
- Building forms oriented to river
- Protect historic views to river
- Infill buildings at heights of historic fabric
- Develop connective open space across uses
- Extension of Concourse to tracks and to riverfront
- Addition to Concourse at track deck level for mixed use
- Elevator access to tracks from concourse
- Storm water gardens on parking deck
- Use roof water and other runoff from new structures
- Office space connected to converted post office

Chapter 10 References

1. Because of the County's future intention for the highways, it is imperative that its objections to the labeling of its highways in this study be memorialized here.

General Highway Comments

- Showing a slow speed facility gives the public wrong expectation of what the road will become and as such hinders the ability of Washington County to properly address the traffic demands placed on its highway system.
- Washington County has a policy of not building four-lane undivided highways. This is primarily for safety reasons. Once a highway is divided it becomes much safer to its users and the median allows for the addition of turn lanes. Turn lanes allow for conflicting turning movements to be done outside of the through lanes, which increases the safety for both through and turning traffic.
- The County does not agree with its highways being designated as 'Parkways'. This designation has too many separate interpretations that lead to confusion. The County does not rule out the ability to add landscaping along its highways, however in the interest of meeting projected traffic types (regional or local), volumes and their associated safety needs, there will not be a downgrading of the County highways to what is depicted in the study.
- The County does not agree with the amount of access being shown along its highways as part of the study. Current County policy is to allow access every _ mile with adjustments made for sight distance needs along its highways. This policy is in place to so that the highway maintains its ability to move traffic. The _ mile spacing also allows for the inclusion of left and right turn lanes, which increase the safety of the highway.

CSAH 18 (Bailey Road)

- The future of this road is a four-lane high-speed (55-mph) divided facility. It will function similarly to Radio Drive from I-94 south to Valley Creek Road. With the growth in traffic and signalization, the speed limit may need to be lowered.
- Access to CSAH 18 from the proposed development will not be provided as shown.

CSAH 19

- This highway is utilized as a regional route between I-94 and TH 61. This is intuitive along with being documented by turning movements along the highway. These turning movements show a large majority of the traffic on this road as being through traffic. The future of CSAH 19 from Valley Creek Road to TH 61 is as a 4-lane divided facility, as it currently exists from I-94 south to Valley Creek Road in Woodbury. The upgrading of this highway will be done to accommodate the additional traffic and its regional nature. The highway will maintain a 55 mph speed limit and have turning lanes added to improve its safety.

Ninetieth Street

- Washington County Parks would not allow for a road to be built through Cottage Grove Ravine Regional Park. Not only will this road disrupt the integrity of the park, its building would cause many environmental issues associated with the construction of the highway through a significant ravine.

Intersection Spacing
Washington County does not agree with the amount of access and its spacing shown along CSAH 19. Spacing on this highway is designated at _ mile intervals with additional care being taken so that safe sight distances can be maintained. Spacing that is closer than _ mile on this highway would make it difficult to implement turn lanes where necessary. If spacing is too close and turn lanes are required, then turn lanes end up being shared. This leads to an unnecessarily dangerous situation where pedestrian and vehicular traffic have to guess as to where the turning traffic is intending to turn.

2. Jim Prosser, Ehlers Corporation, has described the shuttle service developed and used in Glen Ellyn, Illinois since the mid-1970s. The METRA commuter rail line there is served by just-in-time small shuttle buses at peak periods that deliver passengers to the platform within 15 minutes of the pickup time of the most distant passenger. This service has been so successful that some families in this suburban town—approximately 3.5 dwelling units per acre in many neighborhoods—have elected not to buy a second car.

3. "METRA Rail Service and Residential Development Study: Summary of Findings," Prepared for METRA (Chicago Commuter Rail Service), S. B, Friedman & Company, Chicago, Illinois, 2000. Appendices include "Rider Survey Findings."

CHAPTER 11

Project Traffic Patterns, Trips, Modal Shifts for New Pattern

by
Steve Wilson & Jonathan Ehrlich, SRF Consulting

Transit Modeling for Commuter Rail-Oriented District (CROD)

The first part of this section (prior to the Commentary on Analysis), provided by SRF Consulting, is based on the Twin Cities Regional Model developed by the Metropolitan Council in 1994, except where noted the analysis. It explores the transportation impacts of the proposed commuter rail-oriented design (CROD) in the Cottage Grove and Woodbury area. Two components are considered:

- a small scale analysis studying the impact on commuter rail-oriented development alternatives at two small undeveloped sites in Cottage Grove and Woodbury, and
- an intermediate scale analysis studying the impact of a roadway network design modifications in Woodbury and Cottage Grove south of Bailey Road and west of Manning Trail.

The impact of these designs is analyzed regarding the following three elements:

- Commuter rail ridership
- Automobile travel (measured in daily vehicle-miles-traveled)
- Multi-modal accessibility

Small-Area Subdivision Designs

The site designs are proposed development scenarios at two locations: One in Cottage Grove near 90th Street South and CSAH 19; the other in Woodbury south of Bailey Road and east of Woodlane Drive. In both locations, the CROD alternatives plan increased density and a mixture of different residential types and mixed-use development as shown in Table 11.1. The site plans would also promote a better walk-access proximity to the commuter rail feeder system and better auto-access connections to the commuter rail park-ride stations.

Travel Characteristics/Commuter Rail Ridership

Table 11.1 also shows the effect of the alternative designs on commuter rail and vehicular (auto) traffic. The increase in density and mixed-use development would increase traffic generated in the alternative designs for the small area in Woodbury and Cottage Grove results in higher trip-making. In Cottage Grove, design #1 produces 30 more daily commuter rail trips while generating 3,075 more automobile trips and design #2 produces 20 more daily commuter rail trips while generating 1,050 more trips than the baseline. In Woodbury, design #1 produces five more commuter rail trips while generating 1,350 trips. However, each of the alternative designs produces an increase in the percent of trips using commuter rail. While commuter rail represents a small percentage of overall trips (0.6% or less), it represents a more noticeable proportion of trips in the peak hour, when the need to mitigate congestion is the greatest.

Based on this analysis it can be concluded that the alternative site designs produce positive effects on commuter rail ridership.

The Task 1 report analysis documented that commuter rail ridership and market share are highly influenced by work-trip destination. Commuter rail captures high market share from both the Woodbury and Cottage Grove sites to major transit destinations (25% of work trips destined to downtown St. Paul and 39% of trips destined to downtown Minneapolis). However, commuter rail captures less than one percent of non-downtown work trips; which is a function of the location of commuter rail stops in generally residential or park-ride environments rather than work trip concentrations.

Year 2020 forecasts show that about one percent of all commuter trips from the southeast metro area are forecast to be destined to downtown Minneapolis (54 minutes away by commuter rail), and only 10% of all work trips will be to downtown St. Paul. The remaining work trips are destined to be geographically dispersed, both local, subregional (3M Center and Woodbury), and regional (such as I-494 in the Eagan or Bloomington area). Therefore, it can be seen that the most likely commuter rail markets are a small part of the overall commuter market in the southeast Metro area.

As currently planned, the commuter rail service would not operate in the off peak time periods and therefore would not be a factor for non-work travel; however, it also should be noted that non-work travel is less downtown-oriented than work travel and less likely to find transit a desirable option. These factors make non-work travel a marginal commuter rail travel market.

Table 11.1 Design Site Residential Trip Generation

Alternative	Gross Acres	Residential Units	Daily Trips		AM Peak Hour Trips	
			Auto (1)	Commuter Rail	Auto (1)	Commuter Rail (2)
Cottage Grove						
Baseline(3)	2.50	550	4,350	15 (0.3%)	375	10 (2.6%)
Design #1	5.10	1,117	7,425	45 (0.5%)	625	20 (3.1%)
Design #2	4.10	891	5,400	35 (0.5%)	475	15 (3.1%)
Woodbury						
Baseline(3)	2.68	321	2,175	15 (0.5%)	175	5 (2.8%)
Design #1	4.35	522	3,525	20 (0.6%)	300	10 (3.2%)

(1) Source: Institute of Transportation Engineers, Trip Generation, 6th Edition (1997); also includes commuter-rail park/ride access trips and discount for mixed-use commercial (neighborhood shopping).
(2) Source: Regional Travel Demand Forecast model, using Red Rock Corridor
(3) Estimated from comprehensive plans

Overall Vehicle-Miles-Traveled (VMT)

Mode shift (to transit) of a work trip to downtown St. Paul from the Cottage Grove site results in an auto-trip mileage reduction from 14.6 miles per rider to downtown St. Paul to approximately 1.5 miles to the Jamaica Avenue station (including savings for feeder bus users or walk-access users). Based on this analysis, the Cottage Grove Design #1 would save 364 VMT daily and Cottage Grove Design #2 would save 242 VMT daily due to additional modal shift.

At the Woodbury site, the reduction is from 9.9 miles to downtown St. Paul to 2.2 miles to the Newport station, and the site design option would save 50 VMT daily over the baseline. The commuter rail operations are oriented toward peak period work trips; therefore, these travel savings would be concentrated during the most congested hours of the day.

In addition to the above mode-related, the transit-oriented mixed-use development pattern can be expected to reduce VMT by an estimated 10%. (See next page for per household reduction estimate.)

Travel behavior is affected by two elements: changes in access and mobility, and changes in the amount of activity in an area. The CROD design demonstrated that increases in transit market share can occur with accessibility improvements. However, the positive effect of this will be limited by the size of the major commuter rail market for this area. While CROD can increase the **modal share** (transit percent), its benefits will be diluted unless the travel **market share** is increased. As previously noted, downtown Minneapolis represents a limited commuter market (one percent of work trips) for the Cottage Grove area, but the downtown St. Paul market is significant (forecast is 10% for the year 2020). Additional commercial development in downtown St. Paul would create an increase in the travel market from Cottage Grove to downtown St. Paul and therefore result in additional commuter rail trips (whereas commercial development in the suburban areas does not provide a commuter rail market increase). For the purpose of this analysis, however, no additional downtown St. Paul development is included beyond the baseline assumptions.

The CROD concept increases the density of residential development by 50% to 100% over the baseline. Including trip reductions for mixed use development and increases in transit use, the CROD design itself would have no more than 15% reduction in VMT per household. Therefore, it can be seen that the CROD development pattern would result in a net increase of 35% to 85% for a given development site. This condition could be alleviated only if the increase in density was commensurate with the decrease in travel.

Although the CROD densities would increase VMT in the southeast portion of the region, the opportunity exists for a positive effect on overall regional VMT in the peak hours by providing a residential location that is more travel-efficient than other locations in the developing portion of the region. Under the 2020 baseline forecast model, Metropolitan Council TAZs 1082 and 1097, which include the Cottage Grove and Woodbury sites respectively, average 22.4 and 21.9 vehicle-miles per day per household, which would be higher than 65% to 75% of households in the rural or developing portion of the Twin Cities, as in shown in Figure 11.1. Because commuter rail attracts longer-distance work trips, the potential exists to reduce the per-household VMT by 15%, which would place the study area closer to the mean (55% to 60%). It also should be noted that in terms of acreage of rural or developing areas, the study area has lower VMT per household than approximately 80% of the region.

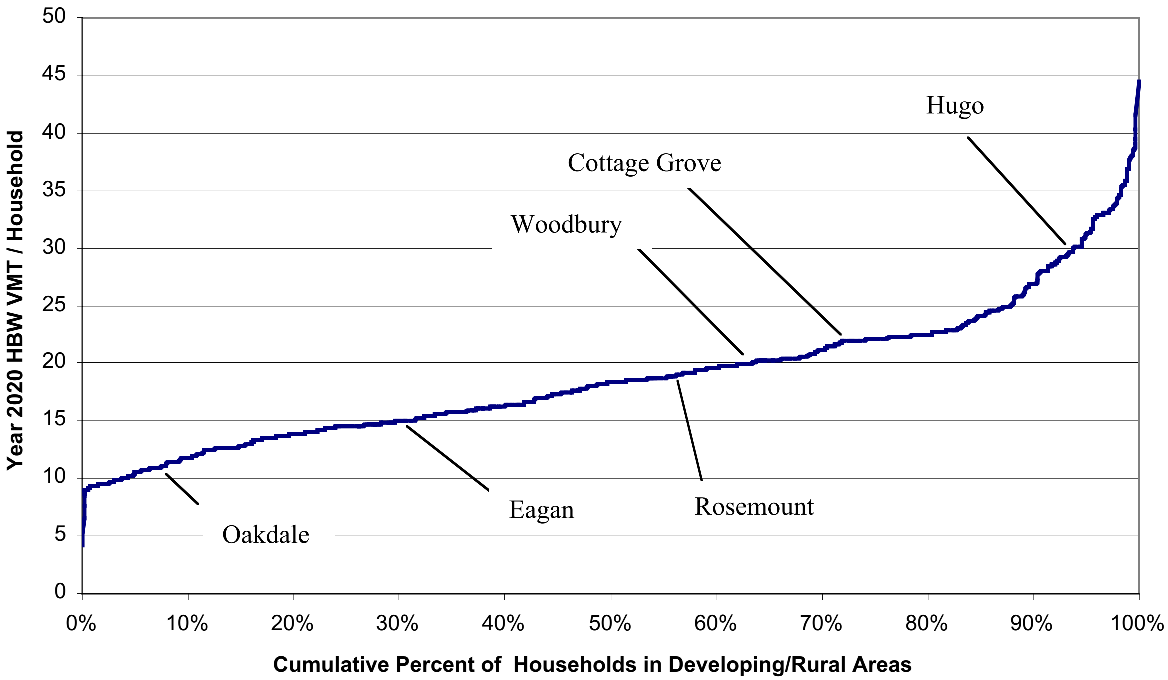


Figure 11.1 Home Based Work VMT Comparison by Zone and Household

The redesign of the intermediate transportation network to a commuter rail-oriented design introduces new connections along Mile Drive, Cottage Grove Drive, 60th and 70th Streets, and 90th Street, and modifies the speed along some routes. This purpose of this is to increase access to the Cottage Grove commuter rail station from portions of Cottage Grove and Woodbury north and east of the station, hopefully increasing ridership and reducing vehicle travel in the region.

Impact on Commuter Rail Ridership

Assuming a baseline land use in southeast Washington County, the regional model estimates that a total 50 new commuter rail work trips would be generated daily by the increased roadway connections. Thirty-five these trips will be from travelers who would otherwise drive alone; 15 of them would otherwise be drivers or passengers of high-occupancy vehicles (HOV). If a higher density of development (comparable to the site designs previously discussed) were assumed in the Cottage Grove commuter rail travelshed, it is estimated that the increased roadway network connections would generate a total of 120 additional commuter rail trips. Increased commuter rail ridership is due to (or limited by) several factors:

- For some potential users of the new roadway connections, the change in access time is a small portion of overall travel time and not enough to induce a change of mode to transit (e.g., a one minute savings on a 40 minute total trip);
- The 90th street connection does not significantly decrease travel times to the station from the east; development areas to the east of the commuter rail station have better access via TH 61 and County Road 19 or TH 95, even with the new roadway connections;
- Development areas significantly to the north would have to backtrack significantly to use the Cottage Grove station. Areas in Woodbury generally have adequate access to the planned commuter rail station in Newport (plus shorter on-train times); despite the improvement in travel time to the Jamaica Avenue Station.

Figure 11.2 shows, the areas with significantly faster travel times to the station are mostly clustered north of the Jamaica Avenue station.

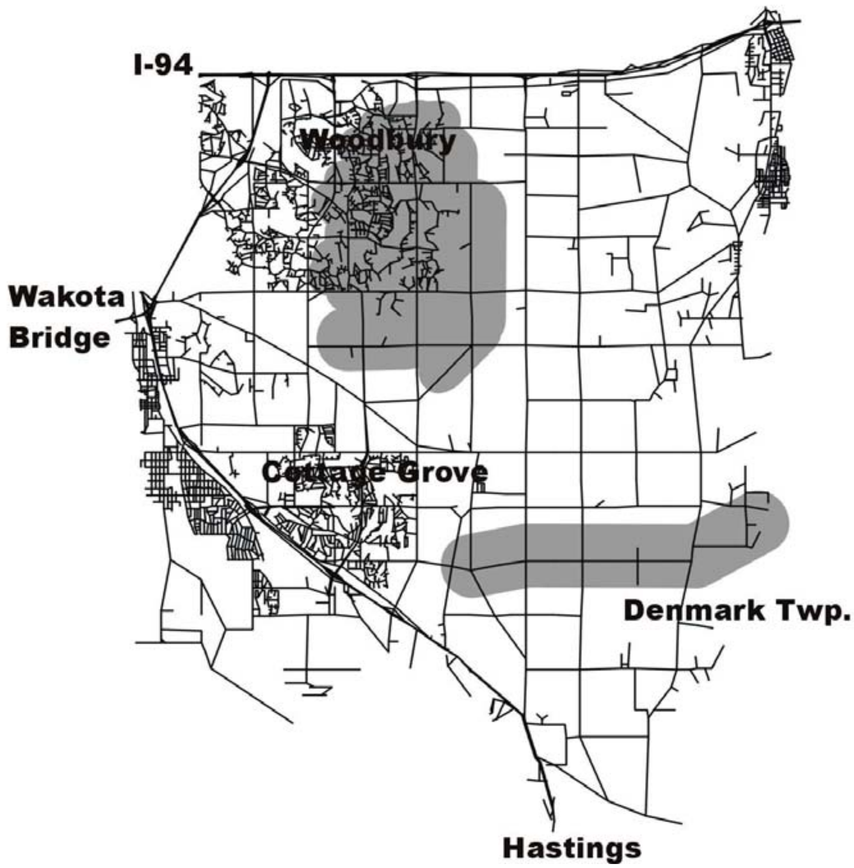


Figure 11.2 Thirty Second or Greater Travel Time Savings to Cottage Grove Commuter Rail Station due to New Roadway Connections

Overall Vehicle-Miles-Traveled (VMT)

The roadway connections would reduce regional VMT by 5,300 VMT per day relative to the 2020 baseline. Approximately 800 VMT of this reduction is due to increased commuter rail ridership. The remainder is attributable to reduced auto trip length due to reduced circuity, particularly along the new connection instead of Woodlane Road (saving about 1,400 VMT daily). In other words, most of the VMT reduction due to the new connectivity is not related to commuter rail, but rather the alignment and other trip shortenings as a result of increased general connectivity (not necessarily relating to the Jamaica Avenue commuter rail station).

Total daily travel in the city of Cottage Grove in 2000 was 489,500 vehicle-miles, 242,900 (49%) of which were on the minor arterial system. In all of Washington County, daily travel was 5,346,400 vehicle miles, 1,503,200 (28%) of which were on the minor arterial system. Taken in perspective, while the commuter rail-oriented design decreases total travel, its impact even with respect to the total travel in Cottage Grove is quite small. Traffic in Cottage Grove is expected to increase significantly between 2000 and 2025. For example, the volume on Jamaica Avenue just north of TH 61 is forecast to grow from 4,100 to 14,100, an increase of over 300%. Neither commuter rail ridership nor small increases in connectivity are likely to have a significant effect on these larger trends.

Multimodal Access Issues

The regional model is not equipped at this time to deal with bicycle access or with the effect of changing speed limits other than its direct impact on travel time. Research in the San Francisco Bay Area by Dr. Robert Cervero and Jeffery Zupan for the Transit Cooperative Research Program (TCRP Project H-1, page 86 available online at: www.tcrponline.org/publications_home.html) in 1996 suggests that bicycle access to commuter rail stations is never more that about 5% of trips and is negligible when the station is more that two miles from home. (What types of bike routes were analyzed could be a factor here, but of course, there is also the limiting factor of weather in Minnesota.) Walk access dominates trips within half a mile of the station, and feeder buses are used for generally 10% to 20% of the trips regardless of distance from station. The remaining approximately 70% of the trips (beyond a half mile) are auto-access. Data in the same study found the average Chicago METRA feeder bus and auto access trips to be comparable (3.44 and 2.99 miles, respectively). However, station spacing and proximity to other transit corridors or options would affect these statistics. The study also found that use of percentage of automobile access increased with the availability of parking.

Connections to County and Regional Roadway System

Washington County has adopted functional classification and access spacing guidelines (Transportation Chapter, *Washington County Comprehensive Plan*, 1996 available online at: www.co.washington.mn.us/). These policies help to maintain a balance among access, mobility, and safety on the roadway system. Minor arterials are typically spaced every mile in the suburban area, which presents a one-square-mile opportunity for a walk-accessible neighborhood development. Pedestrian and bicycle facilities are typically provided separate from the arterial to provide a safer pedestrian/bike environment. Excessive access to minor arterials can diminish safety and air quality and increase travel time and delay for cars and drivers. This results in the need for more arterial capacity for a given level of development density than would be necessary under a well-managed arterial system. The guidelines for access to minor arterials are that for minor arterials with greater than 7,500 average daily traffic (ADT), local access should be provided no closer than every eighth-mile (660 feet) for non-continuous local streets; if a median exists, access would be limited to right-in/right-out. Though not stated in the guidelines, if no median exists, a similar restriction should apply. Access to continuous local streets or collectors should not be closer than a quarter-mile on those minor arterials. In general, this should not be a problem for CROD developments if they are bounded by minor arterials rather than bisected. However, this would not typically be the case in some designs as shown in the Cottage Grove designs.

Commentary on Analysis: Modeling Issues

If one of the ideas of commuter rail-oriented development is to cluster linked destinations in order to multiply the potential purposes of a trip (e.g., chained trips to or from the station, to a commercial service cluster or district in the neighborhood), the presumed effect would be a reduction in VMT as previously noted. Some gross estimates of potential VMT reduction are made here. The current state-of-the-practice in travel demand forecasting is limited in its ability to model trip-chaining such as would be promoted with the CROD concept. Fine-grained sensitivity to mixed use in such open street systems is covered here by an assumption that the pattern could decrease VMT, but little sense of the types of trips affected beyond the main transit-linked (chained) trips. This proposition raises the important issues of connectivity and grain (porosity) of the street (block) pattern.

Similarly, the modeling of 30-second travel time savings (see Figure 11.2) seems to be modeling only those developments that are (or would be directly) connected to additions to the network.

Although the analysis of modeling of potential trip behavior by SRF considers the likelihood of improved market and modal shares if the CROD systems were enacted, somewhat coarse scale, form, and land use assumptions are, therefore, embedded in the modeling. The scale assumptions are matched to the measure of the regional highway network, not to the subdivision street system, which is assumed to be designed on a suburban template, as indicated by the comments of Washington County officials on the Technical Advisory Panel (TAP) to this project. While modeling the time sensitivity of the subregional network (county highways as upgraded to new types of parkway-like arterials) is a significant measure of potential trip connectivity to the station, the model cannot really detect whether the street network design of the subdivision is a factor. The regional model assumes that there is a highly controlled pattern of access to the system with one or two points of access along the county highway system and that this efficiency will be reduced if there are more intersections. It is not applicable to the analysis of gridded or other multiple access systems that do not funnel trips to arterials via limited route choices.

CHAPTER 12

Document and Project Hydrology for New Developments

by
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Background

Urbanization of the landscape takes place in the context of the hydrological cycle. The hydrologic cycle is the global process of the earth's water movement. Rain falls to the earth; some infiltrates into the ground and wets surfaces. The water that infiltrates tends to flow underground to ultimately supply the continuing flow in streams and rivers. The rest runs off over land to streams, lakes, ponds, and ultimately the oceans. The water surfaces give off water vapor that forms clouds and then again becomes rainfall. The energy that operates the system comes from the sun and the earth's gravity.

It has been well established that urbanization locally disrupts the hydrologic cycle by sealing the ground surface with impervious surfaces and compacted soils, shifting precipitation from the infiltration and subsurface runoff path to the surface runoff path. Thus, in the process of designing urbanization, the amount of impervious surfaces and their relationship to pervious surfaces is a significant issue.

Infiltration into the ground is the primary cause of the reduction of rainfall water from becoming runoff. Soil type is the principal determinant of infiltration. Sandy soils infiltrate more water and do it faster than clay soils. Paved surfaces negate the infiltration capacity of soils under them. Urban soils can act very much like pavement because the porous structure of the soil has been destroyed by compaction necessary to provide a subbase for structures. As the number of housing units per acre increases, the amount of impervious surface required per acre also tends to increase to meet the needs for roof area and pavements.

A major impact of urbanization and development on storm water is the establishment of large areas of impervious surfaces. Imperviousness radically alters the water balance of a site by putting rainfall in a new place: surface runoff. Water that before urbanization used to infiltrate to the groundwater under the surface, after urbanization, tends to increase the volume of runoff so as to increase the risk of flooding to downstream areas.

In addition to infiltration capacity, the character of land cover also affects the volume of rainfall that becomes surface runoff. Generally, the more complex the land cover type the more precipitation will be consumed to wet surfaces (intercepted) and held until it evaporates or is absorbed. The most complex land covers are highly layered plant communities with vast amounts of leaf area that must be wetted before runoff is shed. Complex covers are typical of predevelopment conditions and certainly of pre-settlement conditions. One of the important effects of urbanization is the simplification of surfaces. Artificial surfaces tend to be substantially less complex than plant surfaces and intercept comparatively less rainfall. Again, urbanization tends to increase the volume of runoff produced by the land by reducing the "wetable" surface area per acre of land.

Predevelopment storm water systems tend to be very complex and inefficient, slowing the rate of runoff flow out of a watershed outlet. The simplification of land cover that comes with urbanization and increased density also improves the efficiency of flow through a given watershed. This enables more areas of the watershed to contribute runoff water to the outlet of the watershed faster. This means the flow from more of the watershed area will get to the outlet at the same time, making for a larger rate of flow at that location than was produced at that point under predevelopment and pre-settlement conditions. This "rush hour" effect also significantly contributes to increased risk of downstream flooding.

Since the Federal Clean Water Act of 1972 (as amended), Federal and State regulations have been developed to reduce the pollution of waters receiving runoff, including streams, rivers, ponds, lakes, wetlands, and the oceans. In 1989, the United States Environmental Protection Agency found that nonpoint source pollution contributed more than 65 percent of the total pollution load to inland surface waters. Nonpoint sources (runoff from land areas to receiving waters) are distinguished from point sources (pipe discharges to receiving waters). Since then, significant regulatory efforts have been made to reduce nonpoint source contamination of surface waters based on sections 401 and 402 of the Clean Water Act.

In urban areas, pollutant particles tend to accumulate on impervious surfaces between rainstorms and then get washed into the storm water system and receiving waters by rainstorms. Pollutants include fertilizer residue, waste organic material, and particles of heavy metals such as copper (Cu), lead (Pb), zinc (Zn), arsenic (As), cadmium (Cd), chromium (Cr), iron (Fe), mercury (Hg), nickel (Ni), and selenium (Se). Other pollutants also tend to cling to the particles and the paved surfaces. These include chemical contaminants, oils, salt, bacteria, parasites, and viruses. Again, as the quantity of paved surface increases, so too does the quantity of pollutants that accumulates on them and can get washed off into the runoff water.

Another runoff issue associated with urbanization and higher densities is thermal pollution. In the summer, sustained water temperatures above 21^{o} C. (70^{o} F.) can be stressful if not lethal to cold water organisms such as trout and salmon. Such temperature changes are commonly associated with the influx of impervious surfaces into a watershed. In the summer, unshaded impervious surfaces can have local air and ground temperatures 5.5^{o} to 6.7^{o} C. (10^{o} to 12^{o} F.) above vegetated fields and forests. Runoff passing over these surfaces is heated and delivered to surface water bodies.

Over the past 25 years, artificial infiltration techniques of various types have been devised and implemented to reduce storm water runoff volume, treat runoff to improve water quality, and to recharge groundwater resources (Claytor and Schueler, 1996). These techniques have been studied to determine their effectiveness and are still being studied in terms of best design practices (Ferguson, 1994). It is clear that such techniques can both reduce runoff volume and improve water quality. These techniques are being used with conventional or baseline development approaches to improve water quality to meet National Urban Runoff Program (NURP) standards and to conform to regulatory requirements to treat runoff to remove pollutants (including thermal pollution) attributable to urbanization.

This study proposes denser alternatives to the baseline or typical land development controls. As density increases above these two benchmarks, the quantity of paved surface area and the area of roofs tends to increase on a per-acre basis. Along with the increase in impervious surface area per acre come impacts to storm water runoff as previously discussed. As these impervious surfaces cover increasing amounts of land area, the shift of rainwater deposits from infiltration to runoff also increases. It is therefore important that the denser development proposals include a strategy and infrastructure that work to reduce the impacts on surface water runoff previously discussed.

Question for Investigation

Minnesota Pollution Control Agency regulations require all new developments to treat the runoff volume produced by a 1.25-inch rainfall before releasing the runoff from the site. This volume is designated the Water Quality Volume (WQV). Of interest to this research team is seeing what the effect would be on both runoff volume and peak discharge if an infrastructure was built into the denser schemes that would infiltrate the entire WQV into the soil.

Since the proposed designs included more units per acre than the baseline development standards, it was recognized the importance of comparing the runoff performance per housing unit rather than on straight area. This would give an expression of environmental cost per housing unit in terms of runoff impact. Such a measure is based on the observation that baseline housing development standards would have lower runoff effects on a per acre basis; more land would have to be consumed to get the same number of housing units as the denser schemes. It was further observed that more houses per unit area of land would mean more acreage somewhere that would not be occupied by the houses. A pure area basis of comparison would skew the comparison in favor of a less efficient land development scheme that dilutes the impact on a regional scale.

The question for investigation can be stated thusly: Can a denser development, with a storm water runoff infrastructure designed to slow and infiltrate the WQV, compare favorably with baseline development in terms of runoff impact?

New Storm water Runoff Strategy and Infrastructure Design

The strategy proposed is a biomimicry strategy similar to those discussed by Benyus. Biomimicry is from the Greek *bios* meaning life, and *mimesis* meaning imitation. Two of Benyus' definitions of biomimicry were used in developing the storm water infrastructure scheme for the new development design approaches presented in this study. These two definitions are as follows:

"1. Nature as model: Biomimicry is a new science that studies nature's models and then imitates or takes inspiration from these designs and processes to solve human problems…

"2. Nature as a measure: Biomimicry uses an ecological standard to judge the "rightness" of our innovations. After 3.8 billion years of evolution, nature has learned: what worksk what is appropriate, what lasts."

In this project, it might be more properly termed "natural hydrology mimicry." In any case, the idea is to create a storm water handling system that mimics a natural system in function and performance, not merely in appearance.

In examining the hydrological system used by nature, we observed that water is removed from the runoff flow at every opportunity along the runoff path. Rain falls on plant leaves (grasses, forbs, trees, and shrubs) and is consumed to wet the surfaces. Plants on the ground surface filter runoff and direct it downward along root tendrils that extend deep into the ground. Water is filtered and infiltrated downward into the soil at every opportunity. Water movement is slow and efficient flow constantly interrupted by stones or depressions temporarily holding up and delaying flow to the receiving body of water. Ultimately, flood flows are allowed to back up and fill dry areas (flood plains) temporarily, preventing catastrophic erosion further downstream.

The general architecture of the infrastructure scheme is best described in the sequence in which water flows from where it falls to the ground as rain to where it leaves the site as storm water runoff discharge:

- Where rain falls to the ground. As far as possible, lots and parcels are designed so that water flows first from impervious surfaces to absorptive vegetated surfaces. The absorptive surfaces allow water to infiltrate into the ground through the vegetative cover (grass and gardens). In a dense development, this is not always possible. The importance of this technique is discussed fully in Claytor and Schueler (1996).

- Where runoff flows into a storm water inlet. In every case, the inlet is one designed to filter and remove larger particles of sediment from the flow before it enters the larger system. This is to reduce the propensity of infiltration facilities to fill up with sediment and then require shoveling out. There are many proprietary devices that can be inserted into standard drain inlet designs. One old device such as this is the catch basin, which has a sump in the bottom of it to hold a small amount of runoff so that the waterborne sediments settle out before overflowing into the storm sewer or open channel system. There are also a number of proprietary devices invented and manufactured to remove large sediment particles from the runoff flow before the flow is admitted to sewers and infiltration structures. Proprietary devices use various techniques to remove sediment, including filter fabric, filters, and baffles.

In some cases, the inlet might even be a small rain garden or bio-retention pond, depending on space available for such a facility to be constructed (Claytor and Schueler, 1996). In any case, all entry points to the underground storm water system are designed to filter and delay runoff through artificial techniques.

- Where runoff flows into a "leaky" storm sewer. In new developments, storm sewers are invariably required. In this case, the storm water sewer pipes are designed to delay runoff flow and infiltrate it all along the way as water moves through the system to a site outlet point. The idea of a leaky sewer was gleaned from *Modern Sewer Design* (A.I.S.I.). In this case, an oversize perforated sewer pipe is used. The oversized pipe provides "in channel" storage volume to slow and hold runoff, as well as to infiltrate it. The pipe itself has check dams (blocking the bottom half of the pipe) along the way to trap, hold, and infiltrate the water from small rainstorms and the volume of WQV storm. Thus the WQV storm is entirely captured and treated in the sewer pipes. The check dams are placed in the bottom of manholes to promote the sediment trapping and to make its removal more feasible for maintenance. The upper portion of the pipe cross section is thus available to carry storm water flows in excess of the WQV similar to normal storm water. The leaky pipe rests in a bed of crushed stone meeting specifications for drainage rock. The crushed stone bed provides water storage in the spaces between the stones and support for the street. Essentially, the crushed stone bed provides a good foundation for the sewer pipes and the street above, by keeping infiltration going on while the stones provide support. Such a scheme should prevent the undermining and movement of soil often associated with saturated soil under roadways. The stone bed and the outside walls of the perforated pipes are swathed with geotextile filter fabric to keep the stone void spaces from filling up with sediment and other issues.

- Connective open space system. The development schemes were planned with connective open space systems that hold and convey storm water. The conveyance type principally used is the biofilter or enhanced swale. These swales are integrated into the street network and provide temporary storage areas for large runoff flows. They also have check dams built into them to hold, filter, and infiltrate flow from the WQV storm. Wherever possible, the bottom of the swale is constructed to capture and infiltrate the WQV into the soil. It absorbs some of the water delivered to it using a "leaky" bottom of the swale or channel. This idea mimics the natural stream bed with all its plantings and rough bottom, but with a neater, more urban physical appearance. The storage capabilities of such an integrated system of channels or swales were identified by Jones (1967 and 1971). Jones described how until about 1946, suburban streets were constructed with rural road sections—with open swales on each side. Prior to that time, the conversion of agricultural land to urban land produced a net reduction in runoff peak discharges. This was because a square mile of developed land typically contained about 40 miles of open grassed swales that acted to temporarily store runoff with a slow release. The swales also provided significant infiltration function. After 1946, new developments started to include curb and gutter streets and storm sewers as standard items, which eliminated the storage capacity of the swales, and produced sharp rises in peak discharges from newly developed lands, far above those produced by the agricultural uses that preceded them.

- Surge areas. This technique is used just before every outlet from the site. They are typically dry basins that, with major storms, are allowed to temporarily fill with water to delay flow downstream and protect against flooding. In this way, the surge areas function much like a floodplain. Excessive amounts of water are temporarily stored and slowly released to help protect downstream areas from flooding.

- Wet detention ponds (National Urban Runoff Ponds or NURPs). The use of wet detention ponds is avoided in this approach. By relying on filtration and infiltration, the WQV normally handled by such ponds is infiltrated, avoiding the commitment of land area for this type of ponding. The surge areas previously mentioned attend to the peak discharge reduction function typically built into wet detention ponds.

Three design case studies were developed using the Smart Growth Storm Water Runoff Strategy and Infrastructure Design Framework just described. These are more fully described elsewhere in this report. For the purposes of this chapter, it is important to understand the designations used for them in reporting runoff performance:

1) Traditional Neighborhood Development (TND) design approach with a density at the lower end of TND density range. This design is designated "TND/CROD-LO" (Commuter Rail-Oriented Design—Low Density) development. This is a "new suburban pattern." It was designed for the Cottage Grove site.
2) Transit-Oriented Development (TOD) design approach with a density at middle to higher end of TND density range. This design is designated "TOD/CROD-Med/Hi "(Commuter Rail-Oriented Design—Medium to High Density) development. This design was also developed for the Cottage Grove site.
3) Cluster/Conservation approach that evolved into another "new suburban" pattern. This design is designated "Cluster" development and was developed for the Woodbury site.

Hydrology Modeling

Water, along with carbon, is a universal nutrient for living systems on the Earth's surface. Water and carbon in combination with solar energy (photosynthesis) are essential to the primary production of biomass in natural ecology, worldwide (Krebs, 1972). The measurement aspect of biomimicry used in this study is the idea that the storm water flows provide a convenient proxy indicator of environmental performance with respect to biomass production and pre-settlement hydrological function. The relative ability of designs to hold and detain water volume on the land tells us about capacity to provide water volume for biomass production and the capacity to restore pre-settlement hydrological function with respect to base flows (the continuous flow of streams and rivers between storm events due to groundwater runoff flow). The relative ability of designs to match peak discharge levels tells us about the capacity to restore hydrological function with respect to flood flows. Standard storm water runoff models used in the design of new developments provide measures of both volume and peak discharge.

Each case study site was modeled for hydrologic performance for comparing storm water runoff performance. Modeling was done assuming four different land cover scenarios: (1) pre-settlement vegetation; (2) pre-development land use (generally rural-agricultural) conditions; (3) base line development cover; (4) a new-suburban development case study design approach devised in this study.

Hydrological modeling was designed to produce standard measures commonly applied in urbanizing areas in Minnesota, which include runoff quantities for both water quality treatment and flood protection concerns. The rainstorms used for modeling were standardized rainfall events (design storms) developed by the U.S. Weather Bureau (Herschfield, 1961) as risk probabilities using historical rainfall records, not actual historical rainstorms. This is in keeping with the use of standardized rainstorms normally required by government agencies that have permitting and review authority over new subdivisions with respect to storm water systems design. The rainfall events (design storms) selected for use in this study are the three most commonly required by Minnesota municipalities for the design of new developments. The design storms used were as follows: the Water Quality Volume (WQV) rainfall event, the ten-year, 24-hour rainfall event, and the 100-year, 24-hour event. A separate modeling protocol was used for each design storm.

The WQV storm is generally set to correspond to a rainfall amount that accounts for about 90% of the rainfall occurring year in year out. That is to say, if all the rainstorms equal to or less than the WQV amount are added up over the historical rainfall records, they account for 90% of the rainfall volume in the records. The Minnesota Pollution Control Agency (MPCA) rules establish a 1.25-inch rainfall as the WQV storm to be used for the design of storm water treatment ponds used to clean storm water in order to meet federally mandated water quality objectives. By designing facilities to treat the runoff from this storm, those facilities will treat about 90% of the runoff volume produced by the land area they serve. Also, this design standard better represents the category of runoff flows that nourish plant and animal communities.

The 10-year, 24-hour rainfall event is the most common standard required by municipalities in the Metropolitan Twin Cities convenience storm water system design. The convenience system is intended to remove runoff from the streets and sidewalks quickly after a rainstorm in order to restore normal traffic movement (both foot and vehicle). With facilities designed for this type of storm, gutters will flow full to the curb top, water will pond up over drain inlets, and water can pool up on roadsides to cover half of the pavement width. In most municipalities, the convenience system is the storm sewer system. It is not a flood protection criterion. In the Twin Cities, the 10-year, 24-hour rainfall is 4.15 inches.

The 100-year, 24-hour rainfall event was not modeled, as this is usually well controlled with on-site or regional detention ponds. The approaches tested here would not be likely to eliminate the need for such ponds, but merely reduce them. Instead the focus was placed on how water quality and convenience storm water systems performance would be affected. It is these storm water systems that must be closely integrated into urban design.

Water Quality Volume (WQV) Storm Modeling

The runoff produced by the water quality volume (WQV) storm was calculated on a volume basis using Dr. Robert Pitt's (Pitt, 1999) Small Storm Hydrology Method (the method recommended by the MPCA for water quality treatment facility design). In this method, WQV = PRv. Where P is the depth of rainfall in inches and Rv is a coefficient of runoff. Rv is developed using standardized tables created by Pitt from empirical data on runoff from surfaces categorized by soil type, surface cover type, and critical spatial relationships among land surface cover types. WQV is depth of runoff in inches produced by the land area of concern from 1.25 inches of rainfall. The WQV is then multiplied by the area (in acres or square feet) of the site, catchment or other area of concern, to determine the actual runoff volume for the area. The volume is then typically converted to acre-feet or cubic feet. This method was applied to all four alternative scenarios for each case study site.

In addition to volume, Pitt's Small Storm Hydrology Method can also be used to determine a peak discharge in cubic feet per second for rainfall events producing less than 2.5 inches. This is done using a conversion equation developed by Pitt to adjust curve numbers (CNs). The Soil Conservation Service (SCS) method typically is used to develop peak discharges for larger less frequent storms. The CNs typically used with the SCS Method are not calibrated for accurate use for storms producing less than 2.5 inches of rain (SCS 1972). This adjustment was made and WQV peak discharges were calculated for all four scenarios for each case study site. Times of concentration were estimated using the same standards used for the 10-year, 24-hour rainfall models, except that for vegetated channel flow, an average velocity of 1.5 feet per second was assumed.

Peak discharge calculations require the development of a time of concentration at which the peak can be calculated. A planning level estimation of time of concentration was made for all the scenarios modeled. Standard velocities and distances were established for the component flow types found along mapped time of concentration paths. These standards were applied consistently among the scenarios to ensure balanced comparisons. The standards were set by flow type to approximate probable conditions for purposes of scheme comparison, not for definitive detail modeling one would expect for design and construction of a storm water system.

Sheet flow portions of time of concentration calculations were standardized. For pre-development and pre-settlement conditions, a maximum sheet flow length of 150 feet was established. For developed conditions, sheet flow maximum lengths used were 100 feet over grass and 25 feet over impervious surfaces. After sheet flow maximums were reached, shallow concentrated flow conditions were assumed to occur. Shallow concentrated flow lengths were assumed to be no more than half a gutter length up to a maximum of 150 feet (half the spacing between manholes).

Storm sewer reaches were assumed to flow at 3.0-feet-per-second (fps) for WQV and 10-year events. For planning purposes, a storm sewer flow rate of 3.0 fps is commonly assumed by Twin Cities engineers.

Grassed channel reaches were assumed flow differently for each design storm. A velocity of 1.5 fps was used for the WQV storm because it corresponds to the maximum velocity at which a biofilter or natural swale would flow. For the 10-year event, a flow rate of 2.0 fps was assumed because it is the velocity at which sediment will be transported.

Runoff produced by a 10-year, 24-hour rainfall event was modeled using HydroCAD, (Applied Microcomputer Systems, 1998) a proprietary adaptation of the TR-20 computerized runoff modeling program developed by the Soil Conservation Service. Curve numbers were assigned based on land cover types. Soil types were assumed to be constant over the entire site. Both runoff volume and peak discharge were calculated for each scenario of each case study site.

For the TND/CROD-LO, TOD/CROD-Med/Hi, and cluster scenarios, additional modeling efforts were made with HydroCAD to account for the infiltration from the leaky sewers and other infiltration devices deployed in the designs. This was done by using HydroCAD's "Pond" subroutine: A two-foot deep pond holding the equivalent volume of runoff that would infiltrate from the devices (essentially, the WQV). The pond was set to be empty at the start of a storm. As the pond filled, the HydroCAD exfiltration option was used to account for the infiltration function of the devices.

For the 10-year and 100-year storms, a weir was set in the model at two feet above the pond bottom to allow flows in excess of the WQV to leave the site. It is these flows that appear as peak discharges and volumes for the 10-year TND/CROD-LO, TOD/CROD-Med/Hi, and cluster scenarios.

For the baseline, TND/CROD-LO, TOD/CROD-Med/Hi, and cluster scenarios, the flows and volumes were calculated before any flow into mitigation ponds. The reason for this is that the use of the pond (which is a standard mitigation device in today's development) would have concealed the effect of land pattern on the flows. This is because these ponds are designed to mitigate the ill effects of land pattern on the flows.

Figure 12.1 shows the predevelopment catchments of the Cottage Grove site. In Tables 12.1 to 12.2, columns are provided that identify the number of dwelling units and runoff volumes per dwelling unit. The TND/CROD-LO, TOD/CROD-Med/Hi, and cluster scenarios include mixed uses of retail and commercial/office space on the first one or two floors of mixed use buildings with apartments above. To provide an approximate basis of comparison, commercial/office and retail square footage was divided by the standard apartment square footages to arrive at a reasonable number of residential unit equivalents for the retail and commercial/office space. While this still does not account for the higher quantities of pavement for parking associated with retail and commercial/office space, it does get us gross measure for per-unit calculations. This means that if anything, the per-unit runoff figures for the TND/CROD-LO, TOD/CROD-

Med/Hi, and cluster scenarios are somewhat higher than they would actually be if only dwelling units were developed.

Figure 12.1 Cottage Grove Site Showing Predevelopment Catchments

Table 12.1 Runoff Data: Cottage Grove Site WQV Storm Event Data

Catchment 1

	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	85.10	79	103.8	2.89	37,026.00	435	-2,413.79	0	0.00	NA	NA	33.85%
Existing	85.10	79	47.50	4.80	39,204.00	461	-2,388.21	1	0.01	39204	38,041.03	33.85%
Baseline	86.54	95	17.30	78.10	246,549.60	2849	0.00	212	2.45	1163	0.00	34.42%
CROD Low	76.53	92	16.60	0.00	0.00	0	-2,848.88	263	3.44	0	-1,162.97	30.44%
CROD Hi/Med	74.41	90	21.00	0.00	0.00	0	-2,848.88	401	5.39	0	-1,162.97	29.60%

Catchment 2

	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	24.53	78	53.4	1.03	9,583.20	391	-598.10	0	0.00	NA	NA	9.76%
Existing	24.53	80	43.20	2.65	13,068.00	533	-456.03	0	0.00	NA	NA	9.76%
Baseline	24.23	84	10.80	9.29	23,958.00	989	0.00	30	1.24	799	0.00	9.64%
CROD Low	31.93	87	8.40	0.00	0.00	0	-988.77	62	1.94	0	-798.60	12.70%
CROD Hi/Med	31.56	90	12.10	0.00	0.00	0	-988.77	73	2.31	0	-798.60	12.55%

Catchment 3

	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	4.71	77	51.6	0.16	1,742.40	370	-484.18	0	0.00	NA	NA	1.87%
Existing	4.71	81	40.20	0.44	3,049.20	647	-206.73	0	0.00	NA	NA	1.87%
Baseline	5.10	83	11.40	1.50	4,356.00	854	0.00	6	1.18	726	0.00	2.03%
CROD Low	6.19	92	21.10	0.00	0.00	0	-854.12	42	6.79	0	-726.00	2.46%
CROD Hi/Med	7.05	87	10.70	0.00	0.00	0	-854.12	31	4.40	0	-726.00	2.80%

Catchment 4

	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	5.59	77	77.4	0.15	1,742.40	312	-697.41	0	0.00	NA	NA	2.22%
Existing	5.59	81	60.00	0.40	3,484.80	623	-385.71	0	0.00	NA	NA	2.22%
Baseline	5.18	84	13.20	1.63	5,227.20	1009	0.00	1	0.19	5227	0.00	2.06%
CROD Low	6.63	94	11.50	0.00	0.00	0	-1,009.11	28	4.22	0	-5,227.20	2.64%
CROD Hi/Med	4.70	94	4.20	0.00	0.00	0	-1,009.11	25	5.32	0	-5,227.20	1.87%

Catchment 5

	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	49.71	77	100.8	1.17	16,117.20	324	-1,646.23	0	0.00	NA	NA	19.77%
Existing	49.71	77	87.00	1.24	16,552.80	333	-1,637.46	0	0.00	NA	NA	19.77%
Baseline	49.74	91	10.20	38.43	98,010.00	1970	0.00	50	1.01	1960	0.00	19.79%
CROD Low	53.68	87	48.86	0.00	0.00	0	-1,970.45	204	3.80	0	-1,960.20	21.35%
CROD Hi/Med	56.36	91	27.56	0.00	0.00	0	-1,970.45	328	5.82	0	-1,960.20	22.42%

Catchment 6

	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	69.37	72	67.8	0.48	9,147.60	132	-1,839.62	0	0.00	NA	NA	27.59%
Existing	69.37	84	57.00	8.35	58,806.00	848	-1,123.77	0	0.00	NA	NA	27.59%
Baseline	69.82	91	10.80	54.43	137,649.60	1971	0.00	160	2.29	860	0.00	27.77%
CROD Low	65.73	90	22.71	0.00	0.00	0	-1,971.49	120	1.83	0	-860.31	26.15%
CROD Hi/Med	68.31	94	22.07	0.00	0.00	0	-1,971.49	716	10.48	0	-860.31	27.17%

Catchment 7

	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	12.39	79	102	0.43	5,227.20	422	-789.23	0	0.00	NA	NA	4.93%
Existing	12.39	80	102.00	0.51	6,098.40	492	-718.92	0	0.00	NA	NA	4.93%
Baseline	10.79	86	13.20	4.45	13,068.00	1211	0.00	18	1.67	7834	0.00	4.29%
CROD Low	10.71	96	17.97	0.00	0.00	0	-1,211.12	29	2.71	0	-7,833.54	4.26%
CROD Hi/Med	8.71	92	18.50	0.00	0.00	0	-1,211.12	42	4.82	0	-7,833.54	3.46%

Site Totals Cottage Grove Site WQV

	Acres				Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du
					(cf)	(cf/acre)					
Pre-settlement	251.40				80,586.00	321	-1,782.92	0	0.00	NA	NA
Existing	251.40				140,263.20	558	-1,545.55	1	0.00	140263	139,154.57
Baseline	251.40				528,818.40	2103	0.00	477	1.90	1109	0.00
CROD Low	251.40				0.00	0	-2,103.47	748	2.98	0	-1,108.63
CROD Hi/Med	251.10				0.00	0	-2,103.47	1616	6.44	0	-1,108.63

Table 12.2 Ten-Year Storm Event Data

Catchment 1

	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	85.10	46	103.8	3.44	59,241.60	696	-6,043.52	0	0.00	NA	NA	33.85%
Existing	85.10	71	47.50	79.63	432,550.80	5083	-1,656.94	1	0.01	432551	429,799.53	33.85%
Baseline	86.54	75	17.30	182.50	583,268.40	6740	0.00	212	2.45	2751	0.00	34.42%
CROD Low	76.53	78	16.60	150.30	365,032.80	4770	-1,969.86	263	3.44	1388	-1,363.31	30.44%
CROD Hi/Med	74.71	78	21.00	147.30	287,931.60	3854	-2,885.67	401	5.37	718	-2,033.24	29.72%

Catchment 2

	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	24.53	44	53.4	0.78	13,503.60	550	-3,710.23	0	0.00	NA	NA	9.76%
Existing	24.53	66	24.70	26.55	98,445.60	4013	-247.45	0	0.00	NA	NA	9.76%
Baseline	24.23	65	6.20	42.87	103,237.20	4261	0.00	30	1.24	3441	0.00	9.64%
CROD Low	31.93	67	11.60	30.83	96,703.20	3029	-1,232.12	62	1.94	1560	-1,881.51	12.70%
CROD Hi/Med	31.56	71	15.20	41.58	73,616.40	2333	-1,928.13	73	2.31	1008	-2,432.80	12.55%

Catchment 3

	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	4.71	45	51.6	0.2	3,049.20	647	-3,196.14	0	0.00	NA	NA	1.87%
Existing	4.71	61	40.20	2.55	13,939.20	2959	-884.04	0	0.00	NA	NA	1.87%
Baseline	5.10	63	11.40	6.98	19,602.00	3844	0.00	6	1.18	3267	0.00	2.03%
CROD Low	6.19	78	21.10	14.16	29,185.20	4715	871.36	42	6.79	695	-2,572.11	2.46%
CROD Hi/Med	7.05	71	10.70	16.66	27,442.80	3893	49.07	31	4.40	885	-2,381.75	2.80%

Catchment 4

	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	5.59	44	77.4	0.16	3,049.20	545	-2,650.05	0	0.00	NA	NA	2.22%
Existing	5.59	67	60.00	3.50	23,086.80	4130	934.50	0	0.00	NA	NA	2.22%
Baseline	5.18	60	13.20	5.25	16,552.80	3196	0.00	1	0.19	16553	0.00	2.06%
CROD Low	6.63	79	11.50	18.56	29,620.80	4468	1,272.17	28	4.22	1058	-15,494.91	2.64%
CROD Hi/Med	4.70	78	4.20	21.83	14,810.40	3151	-44.37	25	5.32	592	-15,960.38	1.87%

Catchment 5

	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	49.71	42	100.8	0.81	16,988.40	342	-5,604.62	0	0.00	NA	NA	19.77%
Existing	49.71	61	87.00	15.33	143,748.00	2892	-3,054.64	0	0.00	NA	NA	19.77%
Baseline	49.74	72	10.20	115.50	295,772.40	5946	0.00	50	1.01	5915	0.00	19.79%
CROD Low	53.68	70	48.86	51.35	208,216.80	3879	-2,067.52	204	3.80	1021	-4,894.78	21.35%
CROD Hi/Med	56.36	78	27.56	93.18	205,167.60	3640	-2,306.06	328	5.82	626	-5,289.94	22.42%

Catchment 6

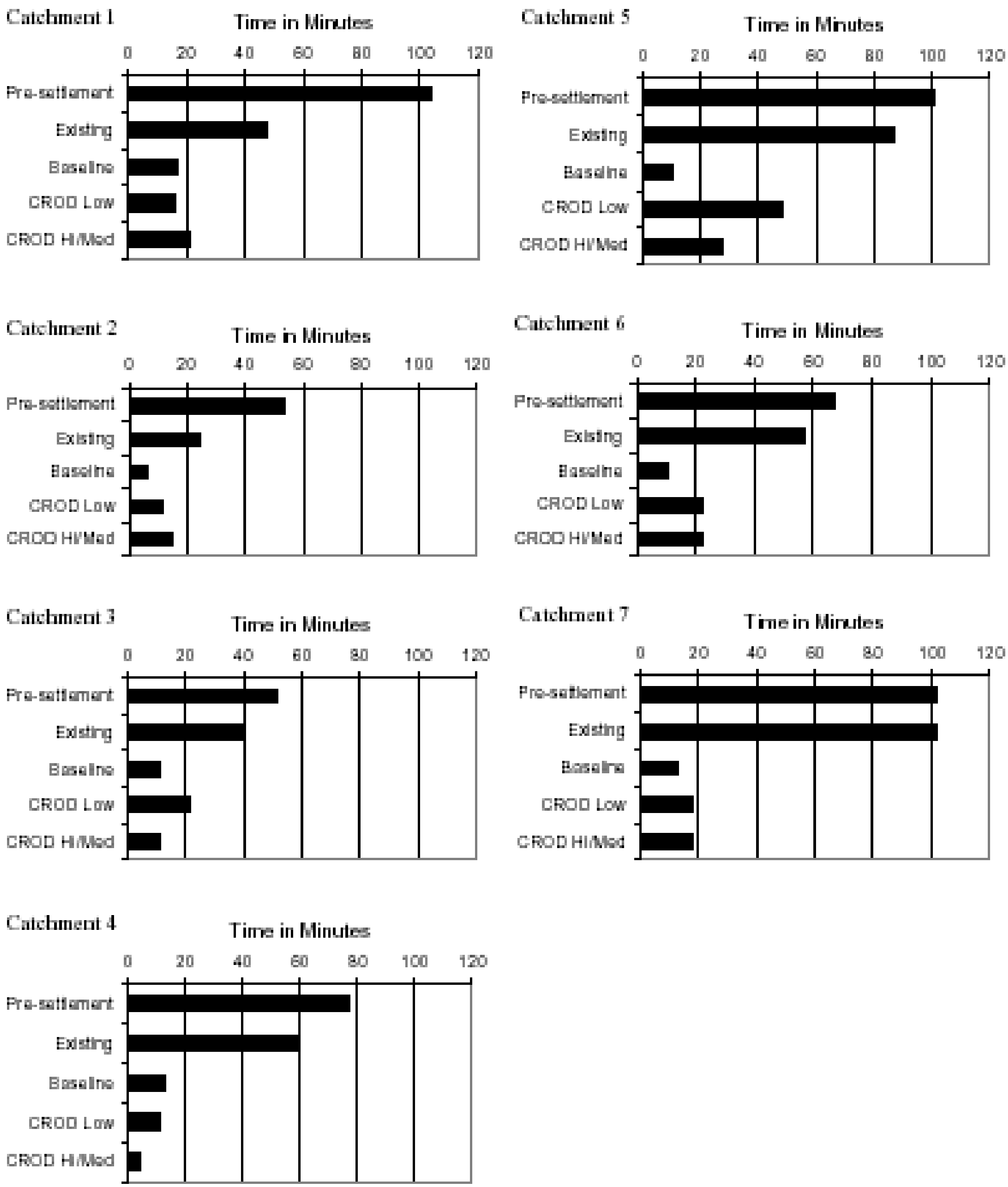
	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	69.37	40	67.8	0.7	15,246.00	220	-7,123.41	0	0.00	NA	NA	27.59%
Existing	69.37	52	57.00	11.01	102,366.00	1476	-5,867.54	0	0.00	NA	NA	27.59%
Baseline	69.82	77	10.80	199.70	512,701.20	7343	0.00	160	2.29	3204	0.00	27.77%
CROD Low	65.73	72	22.71	58.80	239,580.00	3645	-3,698.28	120	1.83	1997	-1,207.88	26.15%
CROD Hi/Med	68.31	82	22.07	127.70	268,765.20	3934	-3,408.70	716	10.48	375	-2,829.01	27.17%

Catchment 7

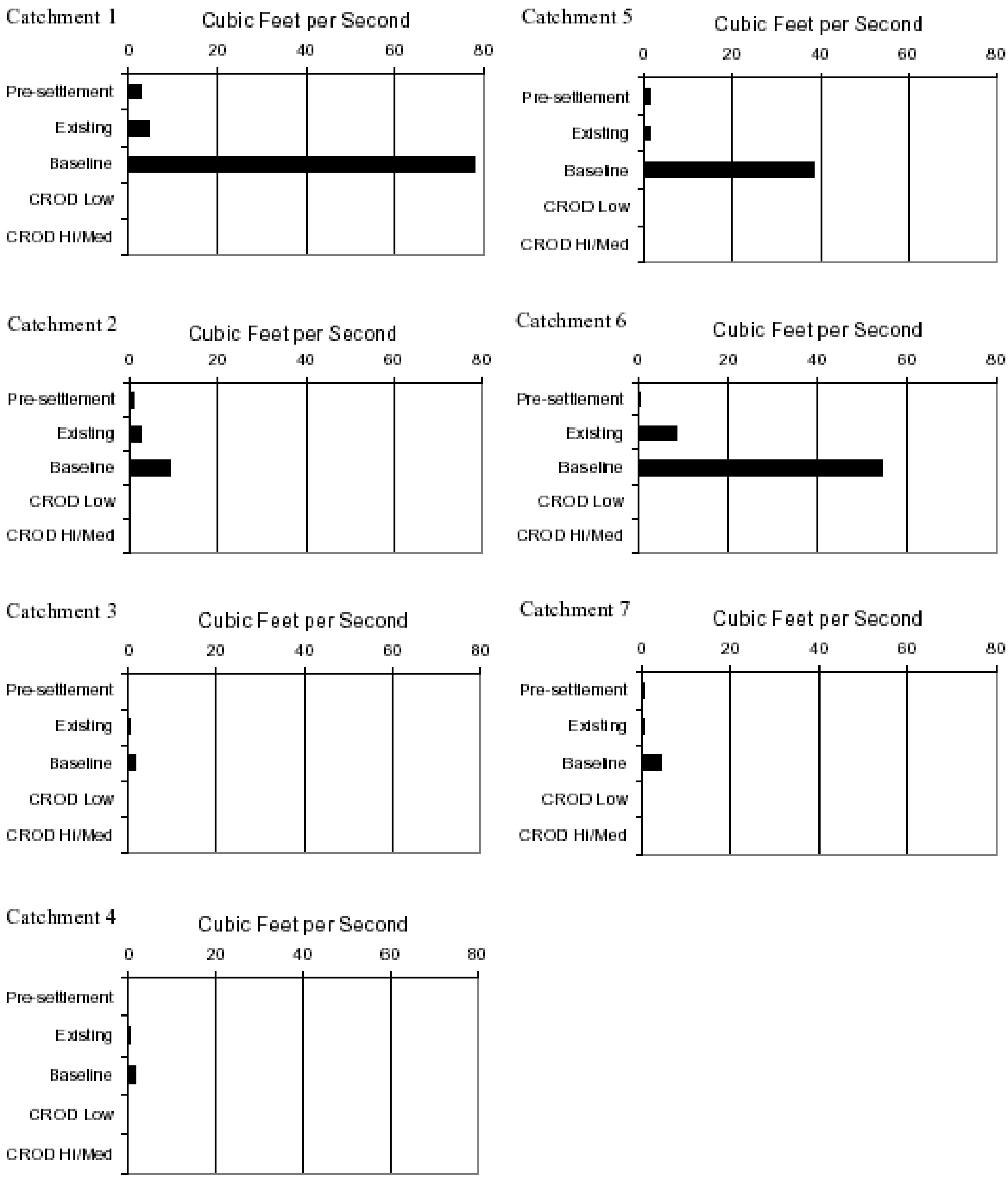
	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	12.39	48	102	0.74	11,325.60	914	-4,778.18	0	0.00	NA	NA	4.93%
Existing	12.39	75	102.00	8.02	73,180.80	5906	214.17	0	0.00	NA	NA	4.93%
Baseline	10.79	71	13.20	22.03	61,419.60	5692	0.00	18	1.67	3412	0.00	4.29%
CROD Low	10.71	83	17.97	31.08	53,578.80	5003	-689.58	29	2.71	1848	-1,564.66	4.26%
CROD Hi/Med	8.71	82	18.50	27.07	39,204.00	4501	-1,191.24	42	4.82	933	-2,478.77	3.46%

Site Totals

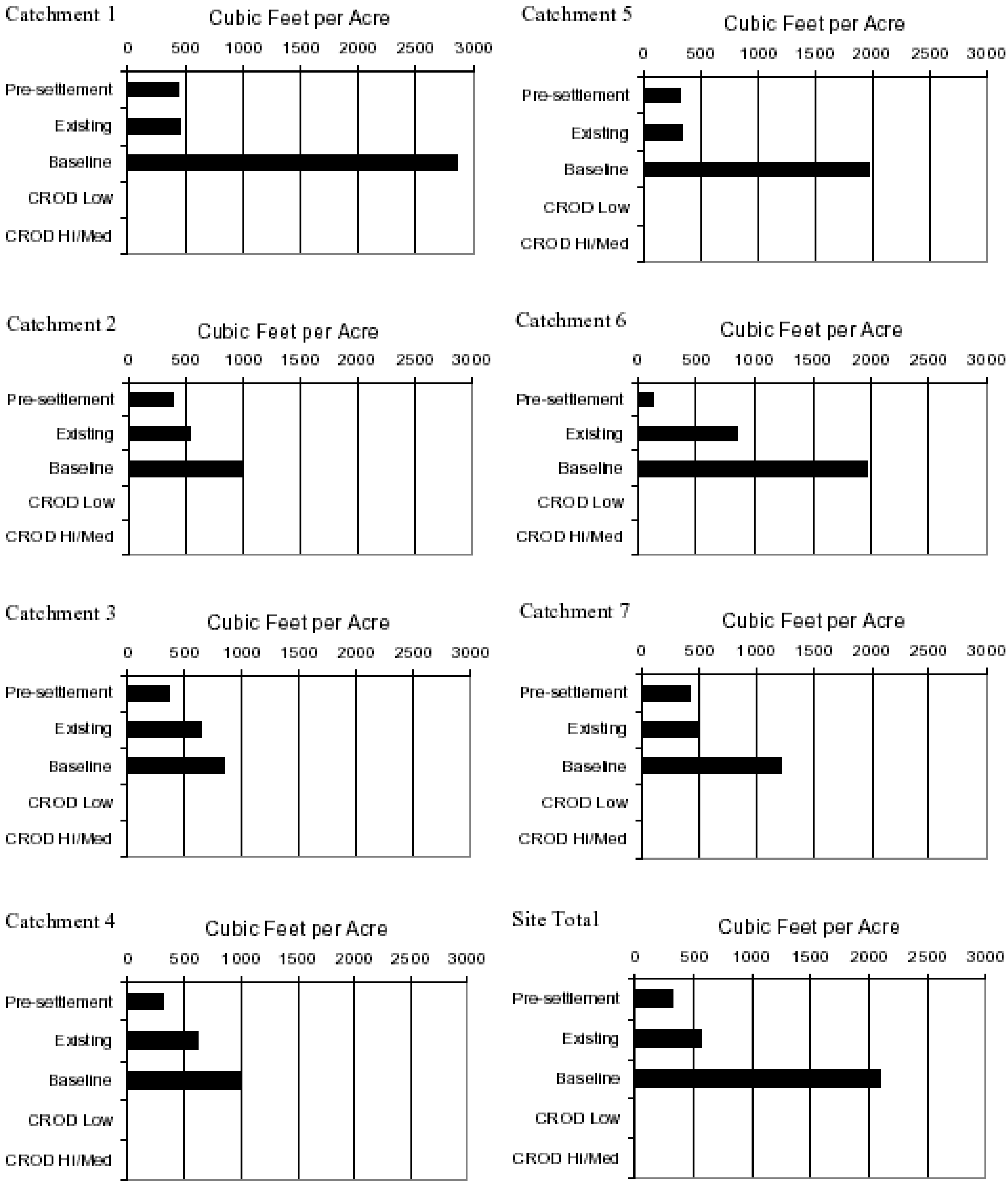
	Acres				Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du
					(cf)	(cf/acre)					
Pre-settlement	251.40				122,403.60	487	-5,847.78	0	0.00	NA	NA
Existing	251.40				887,317.20	3529	-2,805.20	1	0.00	NA	NA
Baseline	251.40				1,592,553.60	6335	0.00	477	1.90	3339	0.00
CROD Low	251.40				1,021,917.60	4065	-2,269.76	748	2.98	1366	-1,972.49
CROD Hi/Med	251.40				916,938.00	3647	-2,687.34	1616	6.43	567	-2,771.28



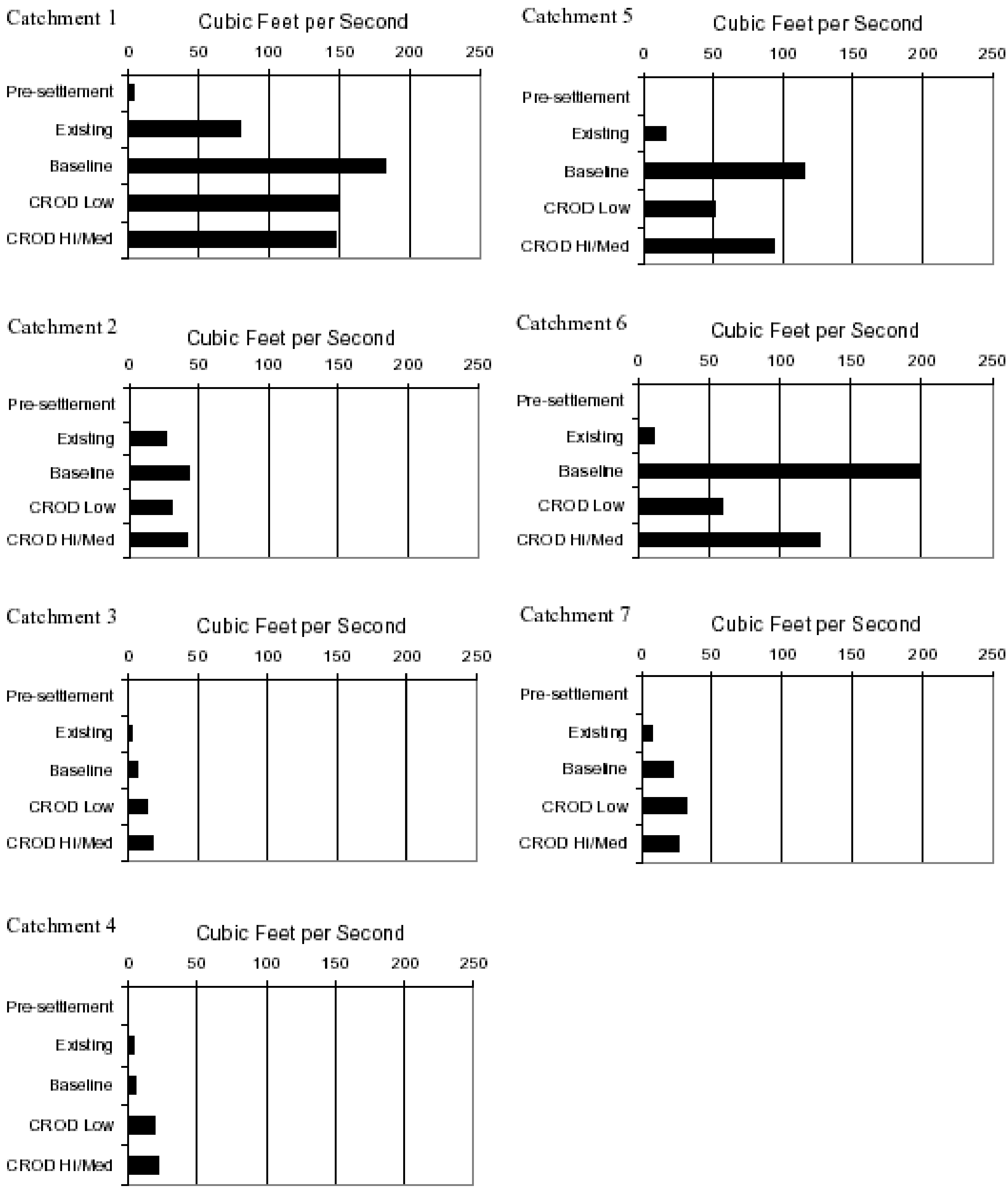
Graph 12.1 Cottage Grove Hydrology Comparison:
Time of Concentration for Water Quality Volume and 10-Year Storm Event



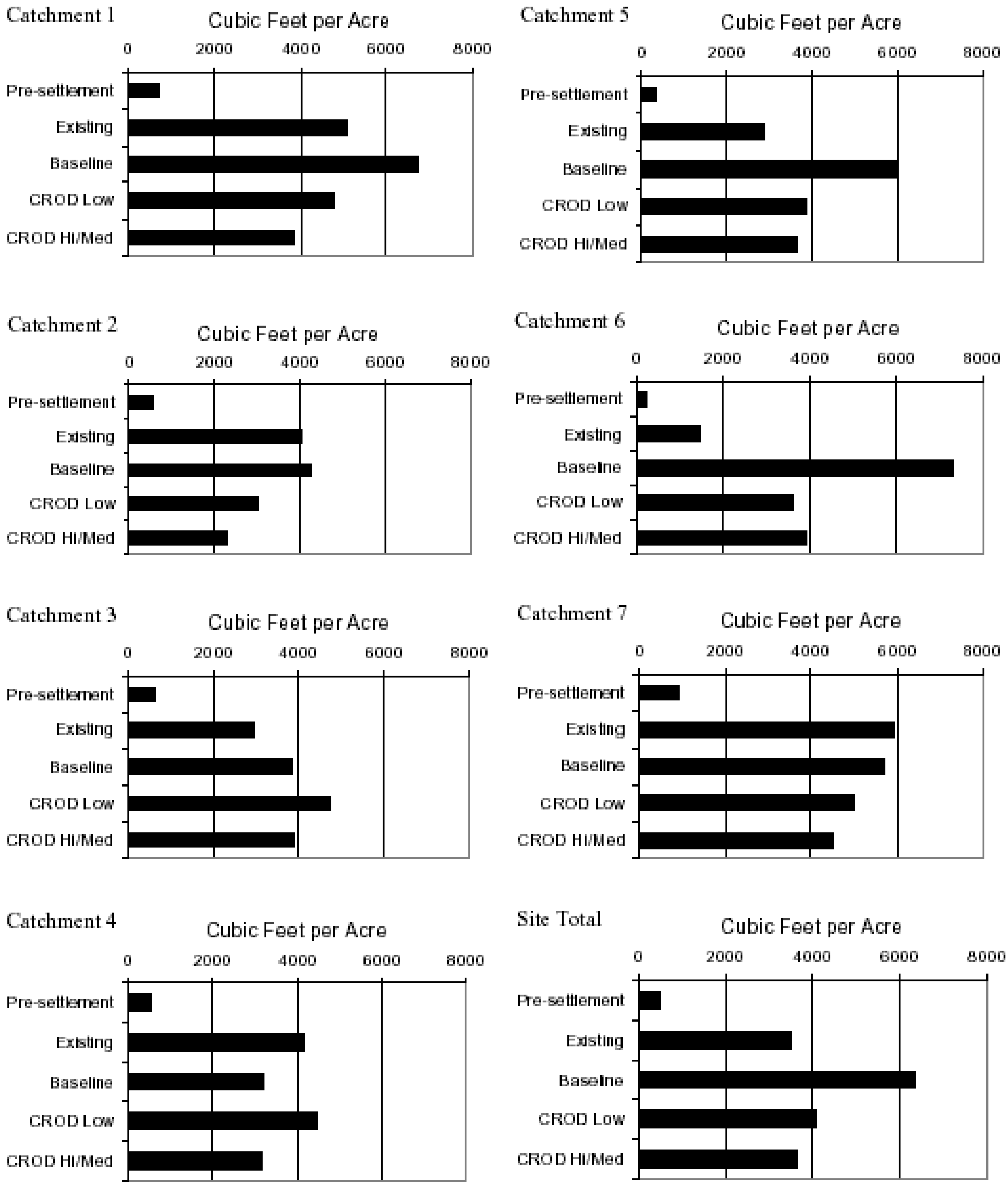
Graph 12.2 Cottage Grove Hydrology Comparison:
Peak Discharge for a Water Quality Volume Storm Event



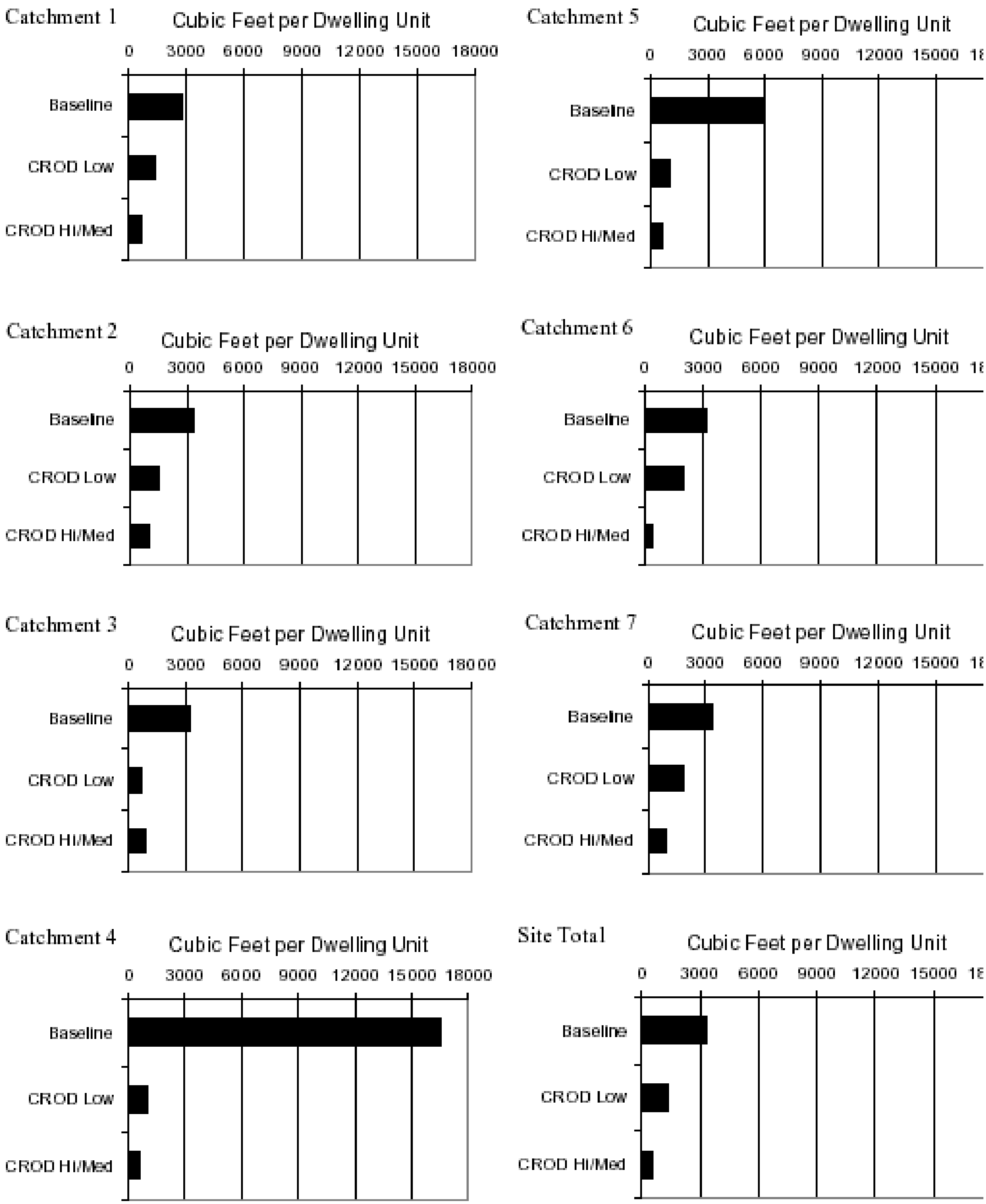
Graph 12.3 Cottage Grove Hydrology Comparison:
Cubic Feet of Runoff per Acre for a Water Quality Volume Storm Event



Graph 12.4 Cottage Grove Hydrology Comparison: Peak Discharge for a 10-Year Storm Event



**Graph 12.5 Cottage Grove Hydrology Comparison:
Cubic Feet of Runoff per Acre for a 10-Year Storm Event**



Graph 12.6 Cottage Grove Hydrology Comparison:
Cubic Feet of Runoff per Dwelling Unit for a 10-Year Storm Event

Discussion of Results: Cottage Grove Site

For the Cottage Grove site, the Water Quality Volume (WQV) of runoff is summarized in Tables 12.1 to 12.3. CROD-LO and CROD-Hi/Med scenarios show substantially better performance than baseline development. Both the CROD scenarios infiltrate the entire WQV so they show no water leaving the site from the WQV storm. This compares well to the baseline at 528,818 cubic feet of runoff. This also compares well to the existing conditions at 140,263 cubic feet and pre-settlement at 80,586 cubic feet. Where the baseline produced 1109 cubic feet of runoff per dwelling unit, the CROD-LO and CROD-Hi/Med scenarios show none.

The 10-year storm showed comparable performance for the CROD-LO (1,021,918 cubic feet) and CROD-Hi/Med (916,938 cubic feet) scenarios compared to the baseline scheme with 1,592,533 cubic feet of runoff. On a per dwelling unit basis, CROD-LO produced 1,972 cubic feet less runoff than the baseline and CROD-Hi/Med produced 2,771 cubic feet less runoff than the baseline.

Peak discharges cannot be compared on a site basis but can be compared on a catchment basis within the site, using the same outlet points as the location for measurement. The graphs showing comparison among the peak discharges from the WQV storm event (Graphs 12.2) shows the CROD-LO and CROD-Hi/Med scenarios producing no peak discharge. This, of course, is significantly less that the baseline and the existing and pre-settlement scenarios. This difference is due to the infiltration standard used in the CROD-LO and CROD-Hi/Med design criteria.

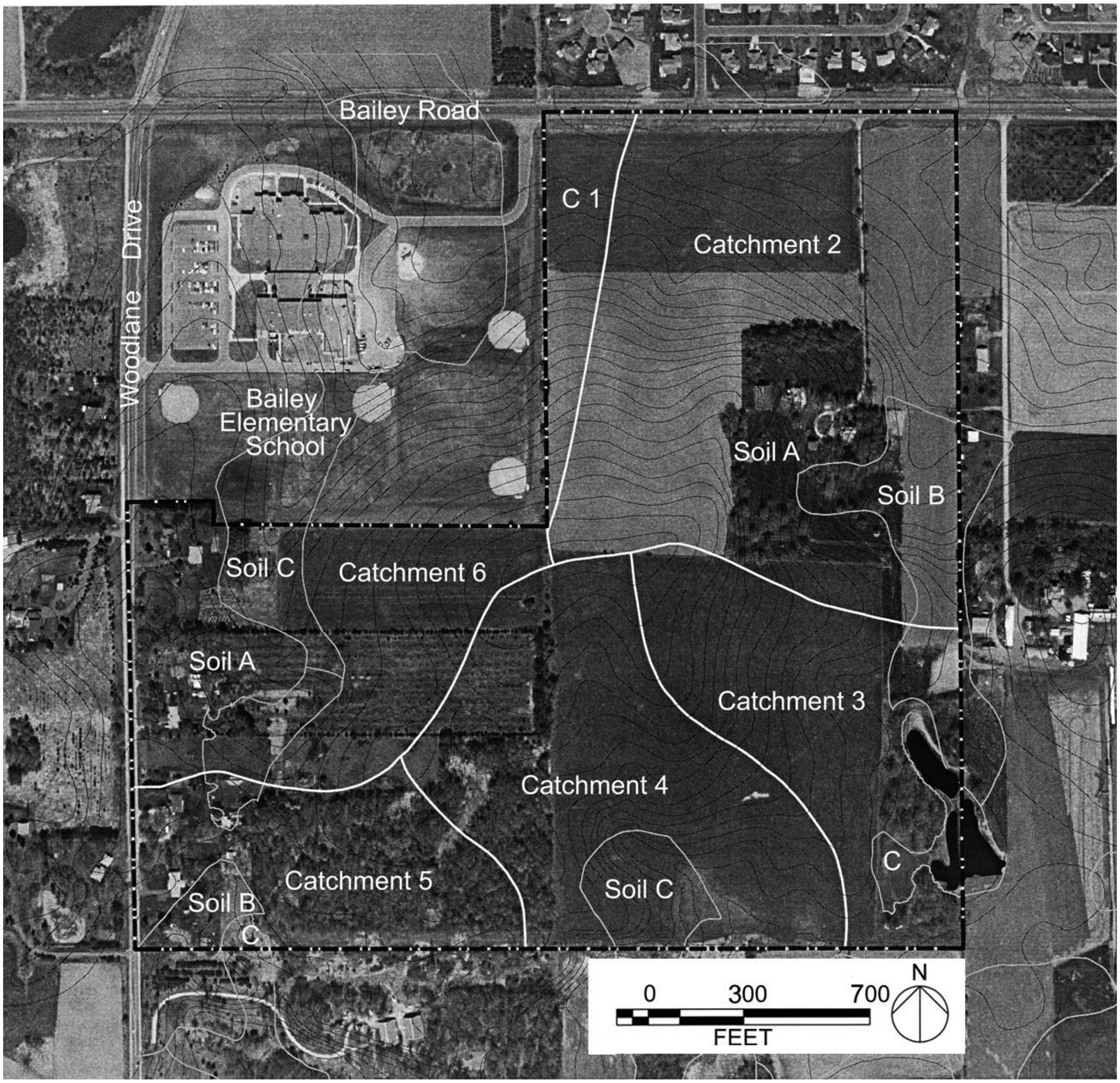


Figure 12.2 Woodbury Site Showing Predevelopment Catchments

Table 12.3 Runoff Data: WQV Storm Event Data

Catchment 1

	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	4.47	79	68.4	0.2	2,178.00	487.25	-960.73	0	0	N/A	N/A	4%
Existing	4.47	81	53.40	0.35	2,613.60	584.70	-863.28	0	0.00	N/A	N/A	4%
Baseline	3.61	89	13.80	2.06	5,227.20	1,447.98	0.00	17	4.71	307.48	0.00	3%
Cluster	3.52	95	11.60	0.00	0.00	0.00	-1,447.98	28	7.95	0.00	-307.48	3%

Catchment 2

	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	39.91	79	81.00	1.61	17,859.60	447.50	-2,125.52	0	0.00	N/A	N/A	33%
Existing	39.91	81	61.80	2.77	23,522.40	589.39	-1,983.63	1	0.03	N/A	N/A	33%
Baseline	38.43	95	24.30	29.45	98881.20	2,573.02	0.00	86	2.24	1,149.78	0.00	32%
Cluster	42.22	94	12.50	0.00	0.00	0.00	-2,573.02	188	4.45	0.00	-1,149.78	35%

Catchment 3

	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	17.73	79	67.20	0.8	7,840.80	442.23	43.09	0	0.00	N/A	N/A	15%
Existing	17.73	79	51.60	0.95	8,276.40	466.80	67.66	0	0.00	N/A	N/A	15%
Baseline	16.37	78	16.90	1.44	6,534.00	399.14	0.00	24	1.47	272.25	0.00	14%
Cluster	16.83	87	25.80	0.00	0.00	0.00	-399.14	56	3.33	0.00	-272.25	14%

Catchment 4

	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	24.35	79	66.6	1.11	10,890.00	447.23	-1,916.25	0	0.00	N/A	N/A	20%
Existing	24.35	79	51.00	1.32	11,325.60	465.12	-1,898.36	0	0.00	N/A	N/A	20%
Baseline	27.83	94	18.90	1.51	65,775.60	2,363.48	0.00	59	2.12	1,114.84	0.00	23%
Cluster	22.49	94	25.10	0.00	0.00	0.00	-2,363.48	94	4.18	0.00	-1,114.84	19%

Catchment 5

	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	13.72	79	103.2	0.47	6,098.40	444.49	-1,042.62	0	0.00	N/A	N/A	11%
Existing	13.72	81	100.20	0.69	7,840.80	571.49	-915.62	2	0.15	N/A	N/A	11%
Baseline	14.06	89	15.20	7.59	20,908.80	1,487.11	0.00	22	1.56	950.40	0.00	12%
Cluster	10.36	87	19.00	0.00	0.00	0.00	-1,487.11	40	3.86	0.00	-950.40	9%

Catchment 6

	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	19.93	77	69	0.57	6,534.00	327.85	-1,145.41	0	0.00	N/A	N/A	17%
Existing	19.93	79	48.00	1.12	9,147.60	458.99	-1,014.27	3	0.15	N/A	N/A	17%
Baseline	19.81	89	20.20	9.30	29,185.20	1,473.26	0.00	41	2.07	711.83	0.00	16%
Cluster	24.69	79	19.00	0.00	0.00	0.00	-1,473.26	116	4.70	0.00	-711.83	21%

Site Totals

	Acres				Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du
					(cf)	(cf/acre)					
Pre-settlement	120.11				51,400.80	427.95	-1,457.92	0	0.00	N/A	N/A
Existing	120.11				62,726.40	522.24	-1,363.63	6	0.05	N/A	N/A
Baseline	120.11				226,512.00	1,885.87	0.00	249	2.07	909.69	0.00
Cluster	120.11				0.00	0.00	-1,885.87	522	4.35	0.00	-909.69

Table 12.4 Ten-Year Storm Event Data

Catchment 1

	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	4.47	48	68.40	0.33	4,356.00	974.50	-4,696.75	0	N/A	N/A	N/A	3.72%
Existing	4.47	75	53.40	4.71	27,007.20	6,041.88	370.63	0	0.00	N/A	N/A	3.72%
Baseline	3.61	73	13.80	7.93	20,473.20	5,671.25	0.00	17	4.71	1,204.31	0.00	3.01%
Cluster	3.52	81	11.60	11.04	26,136.00	7,425.00	1,753.75	28	7.95	933.43	-270.88	2.93%

Catchment 2

	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	39.91	49	81.00	3.26	42,253.20	1,058.71	-3,837.96	0	0.00	N/A	N/A	33.23%
Existing	39.91	71	61.80	30.85	201,247.20	5,042.53	145.86	1	0.03	NA	N/A	33.23%
Baseline	38.43	70	24.30	53.78	188,179.20	4,896.67	0.00	86	2.24	2,188.13	0.00	32.00%
Cluster	42.22	81	12.50	108.40	204,732.00	4,849.17	-47.50	188	4.45	1,089.00	-1,099.13	35.15%

Catchment 3

	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	17.73	50	67.20	1.80	20,473.20	1,154.72	-2,118.27	0	0.00	N/A	N/A	14.76%
Existing	17.73	70	51.60	14.34	82,764.00	4,668.02	1,395.03	0	0.00	N/A	N/A	14.76%
Baseline	16.37	63	16.90	17.34	53,578.80	3,272.99	0.00	24	1.47	2,232.45	0.00	13.63%
Cluster	16.83	85	25.80	31.22	78,843.60	4,684.71	1,411.72	56	3.33	1,407.92	-824.53	14.01%

Catchment 4

	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	24.35	51	66.60	3.03	32,234.40	1,323.79	-4,561.43	0	0.00	N/A	N/A	20.27%
Existing	24.35	73	51.00	24.06	135,036.00	5,545.63	-339.59	0	0.00	N/A	N/A	20.27%
Baseline	27.83	74	18.90	54.34	163,785.60	5,885.22	0.00	59	2.12	2,776.03	0.00	23.17%
Cluster	22.49	86	25.10	59.47	142,876.80	6,352.90	467.68	94	4.18	1,519.97	-1,256.06	18.72%

Catchment 5

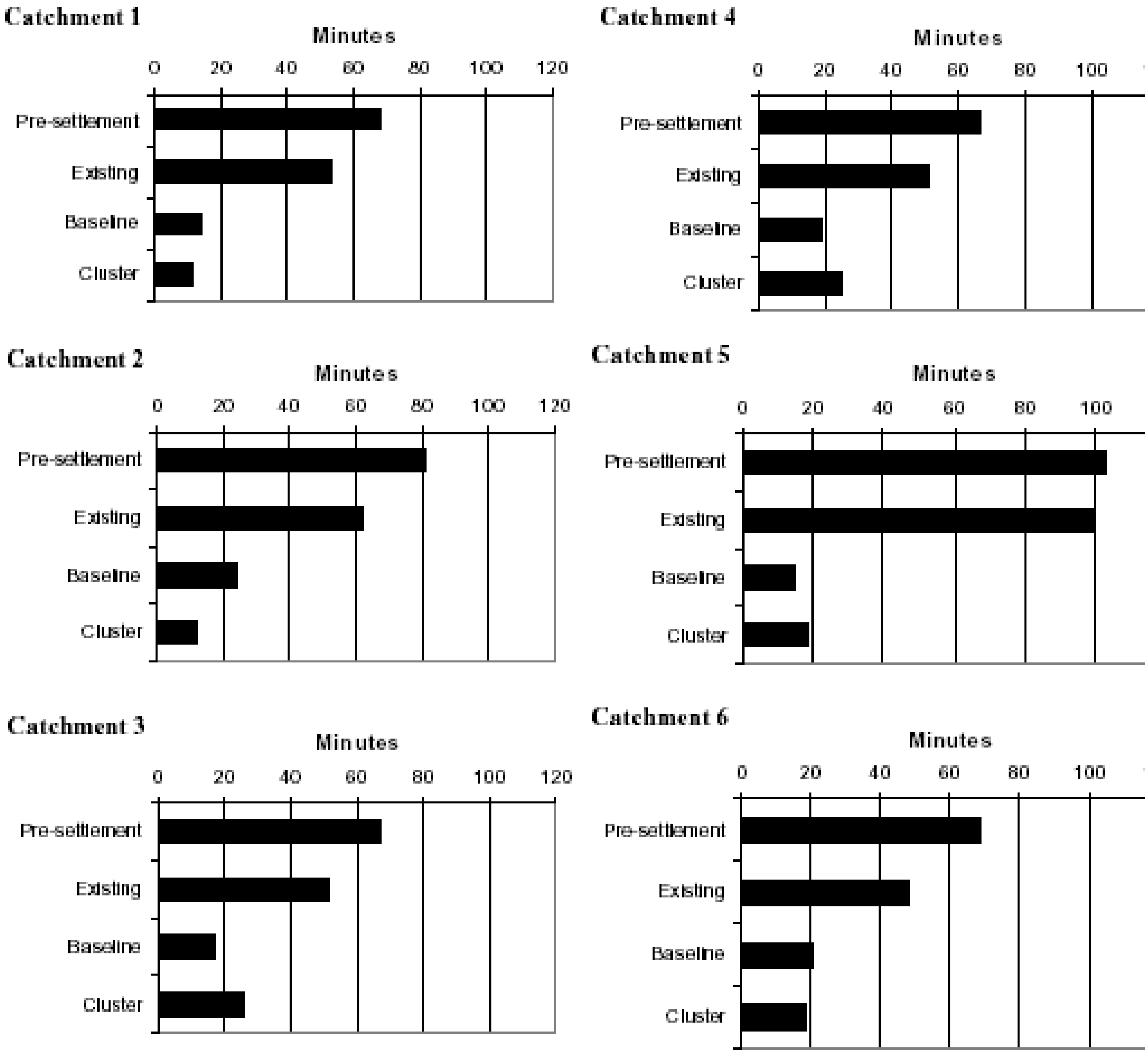
	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	13.72	53	103.20	1.69	21,344.40	1,555.71	-4,082.92	0	0.00	N/A	N/A	11.42%
Existing	13.72	56	100.20	2.43	27,442.80	2,000.20	-3,638.43	2	0.15	N/A	N/A	11.42%
Baseline	14.06	73	15.20	29.28	79,279.20	5,638.63	0.00	22	1.56	3,603.60	0.00	11.71%
Cluster	10.36	81	15.70	33.10	55,756.80	5,381.93	-256.70	40	3.86	1,393.92	-2,209.68	8.63%

Catchment 6

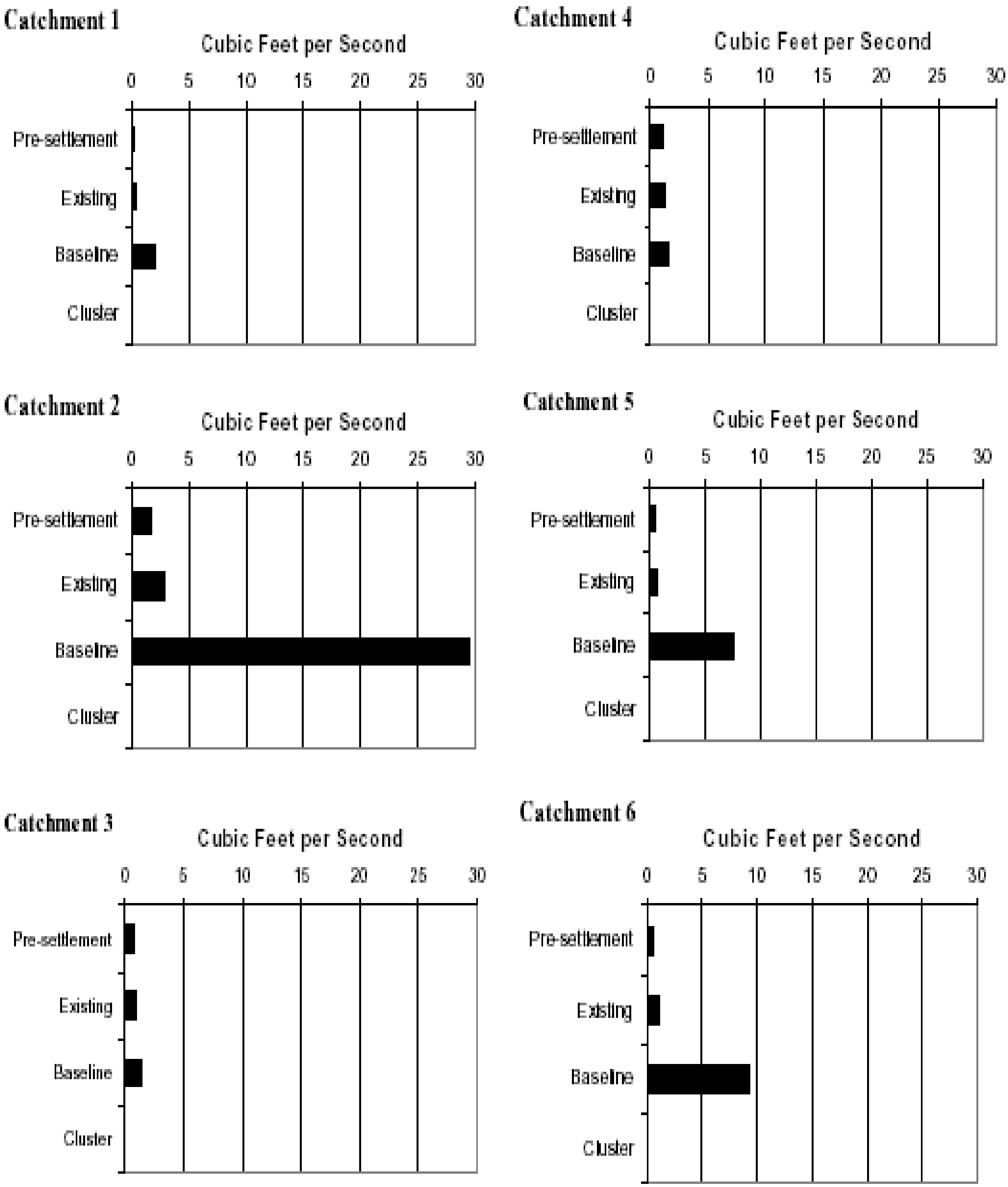
	Acres	CN	TOC	Peak Disch.	Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du	Percentage of Total Site Area
			(min)	(cfs)	(cf)	(cf/acre)						
Pre-settlement	19.93	52	69.00	2.79	29,185.20	1,464.39	-4,428.63	0	0.00	N/A	N/A	16.59%
Existing	19.93	56	48.00	5.87	41,817.60	2,098.22	-3,794.80	3	0.15	N/A	N/A	16.59%
Baseline	19.81	74	20.20	37.61	116,740.80	5,893.02	0.00	41	2.07	2,847.34	0.00	16.49%
Cluster	24.69	79	19.00	65.96	142,005.60	5,751.54	-141.48	116	4.70	1,224.19	-1623.15	20.56%

Site Totals

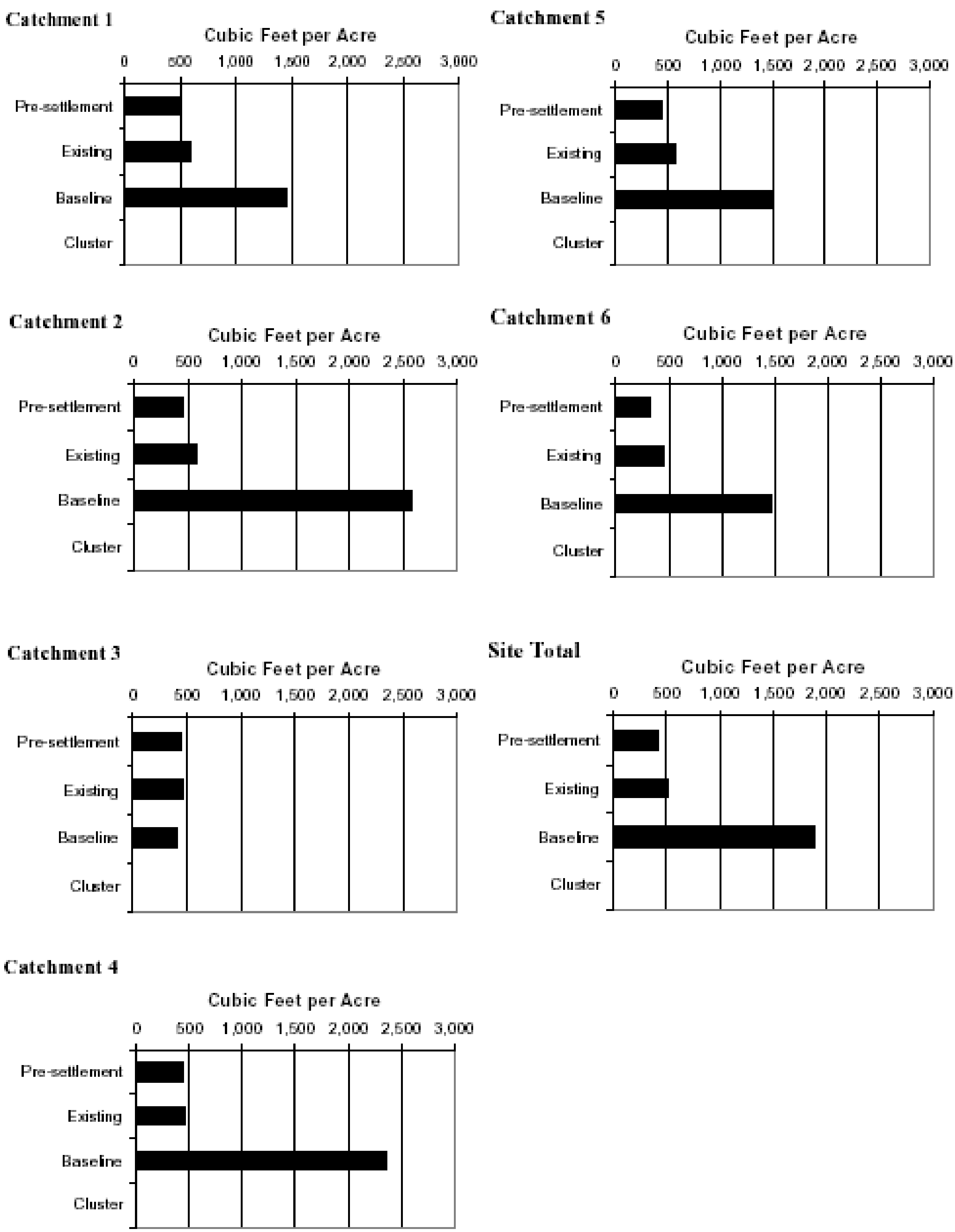
	Acres				Runoff Vol.	Runoff per Acre	Diff. From Baseline Runoff per acre	Dwelling Units	Dwelling Units per Acre	Cubic Foot Runoff per Dwelling Unit	Diff. From Baseline cf/du
					(cf)	(cf/acre)					
Pre-settlement	120.11				149846.40	1,247.58	-3,931.31	0	0.00	N/A	N/A
Existing	120.11				515314.80	4,290.36	-888.53	6	0.05	N/A	N/A
Baseline	120.11				622036.80	5,178.89	0.00	249	2.07	2,498.14	0.00
Cluster	120.11				650350.80	5,414.63	235.74	522	4.35	1,245.88	-1,252.26



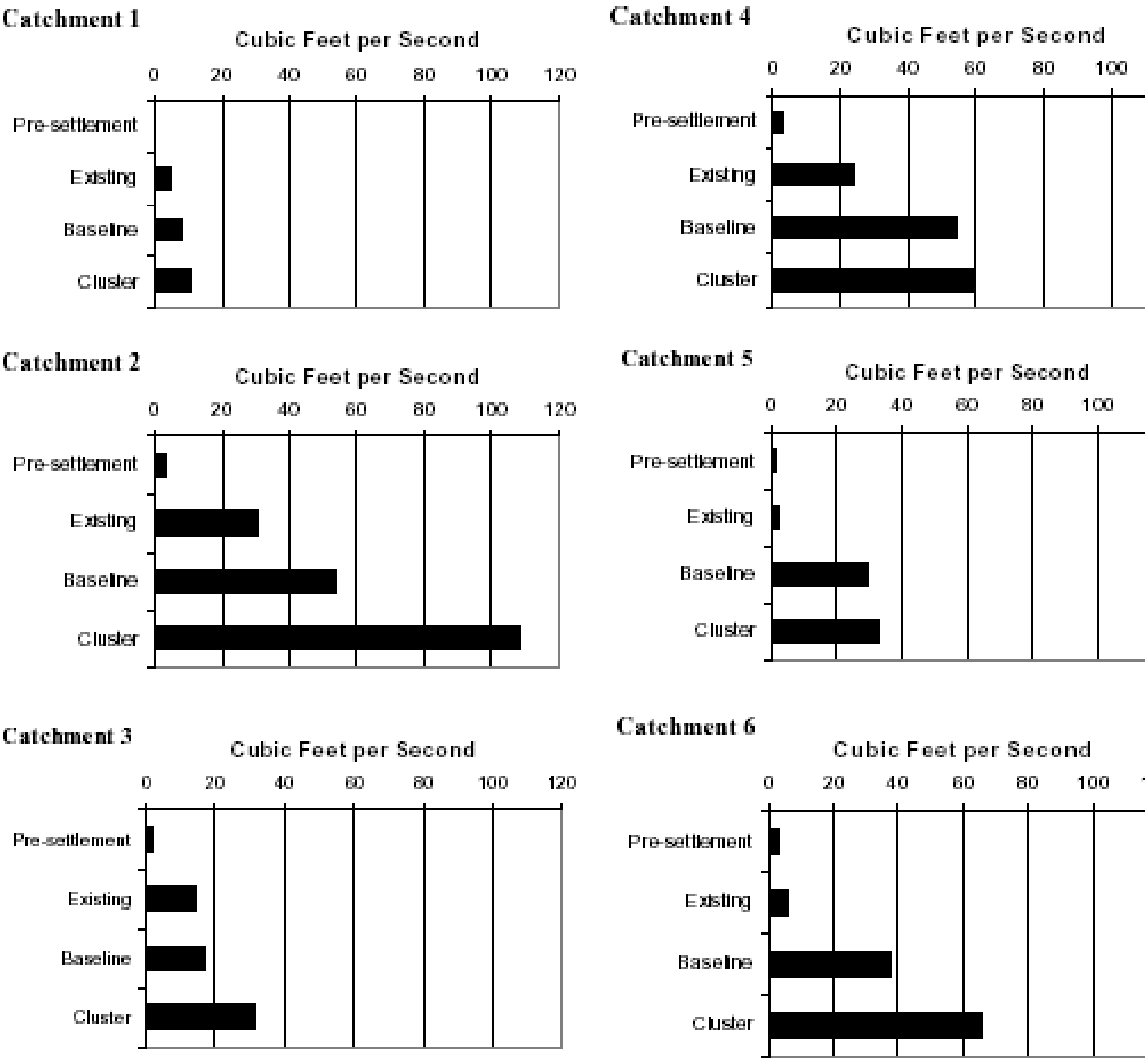
Graph 12.7 Woodbury Hydrology Comparison:
Time of Concentration for Water Quality Volume and 10-Year Storm Event



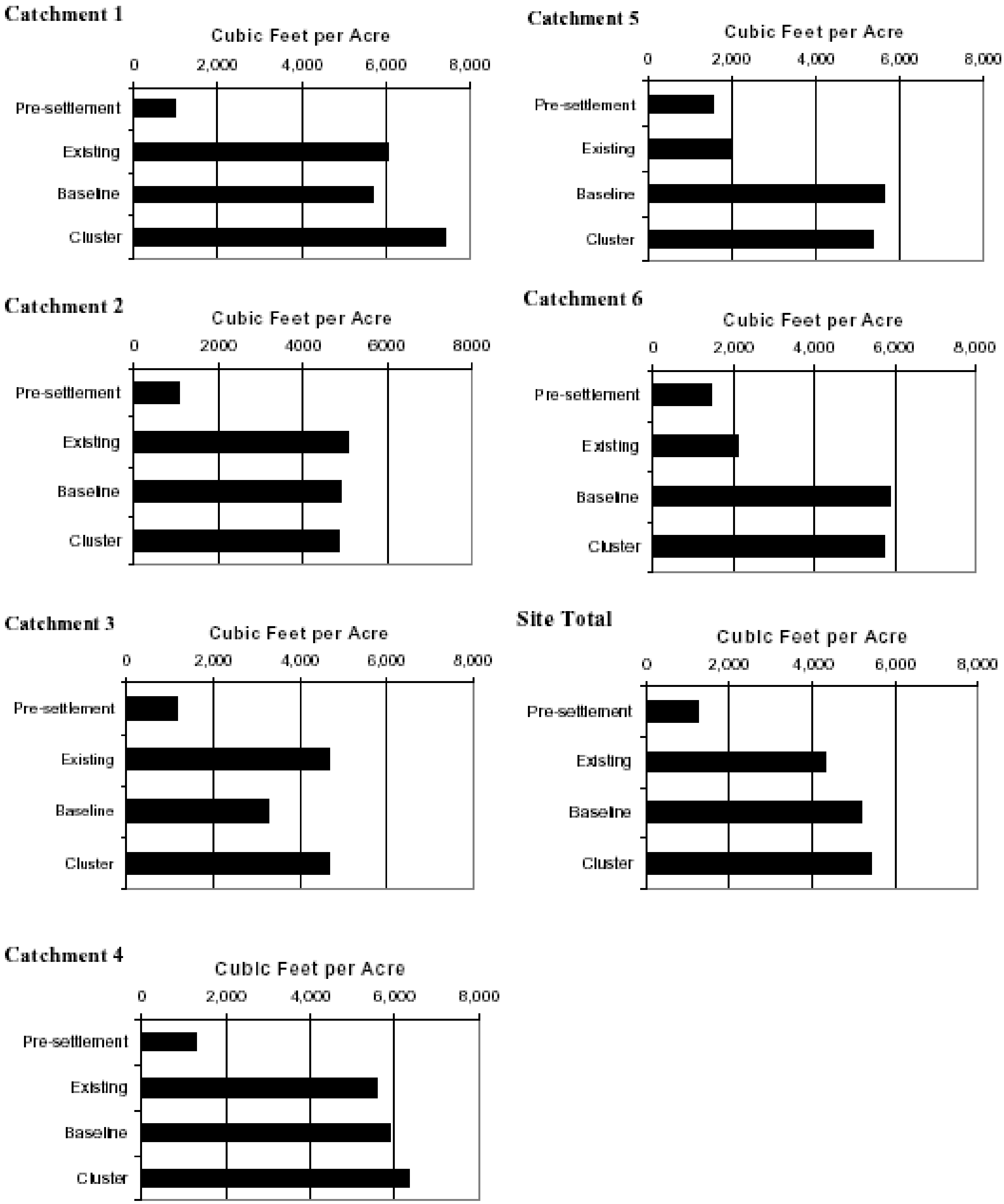
Graph 12.8 Woodbury Hydrology Comparison:
Peak Discharge for a Water Quality Volume Storm Event



Graph 12.9 Woodbury Hydrology Comparison:
Cubic Feet of Runoff per Acre for a Water Quality Volume Storm Event

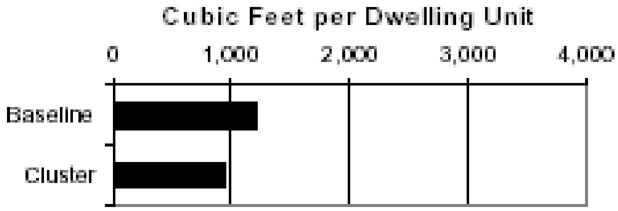


Graph 12.10 Woodbury Hydrology Comparison: Peak Discharge for a 10-Year Storm Event

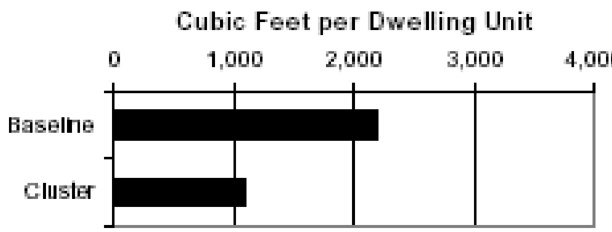


Graph 12.11 Woodbury Hydrology Comparison:
Cubic Feet of Runoff per Acre for a 10-Year Storm Event

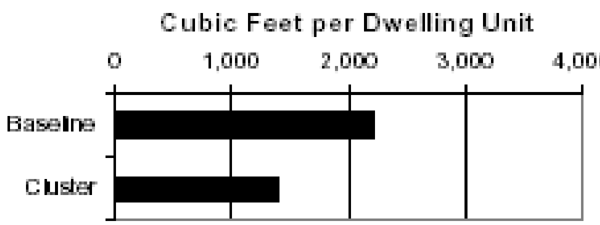
Catchment 1



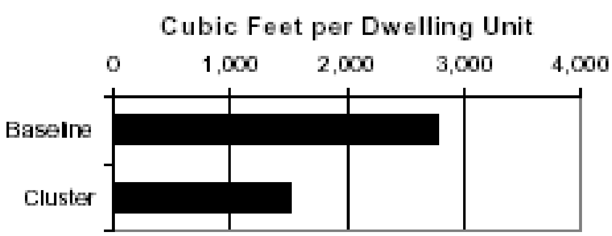
Catchment 2



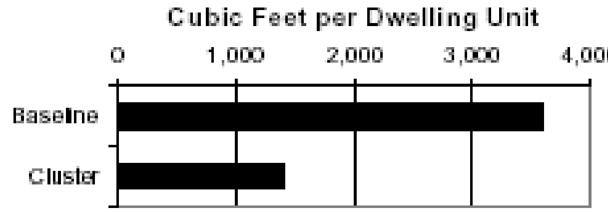
Catchment 3



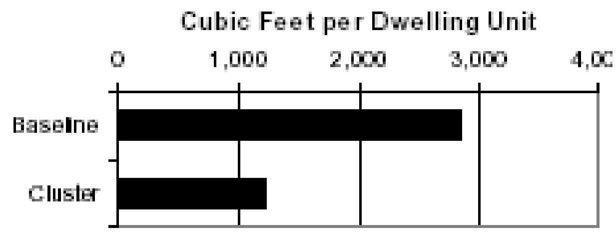
Catchment 4



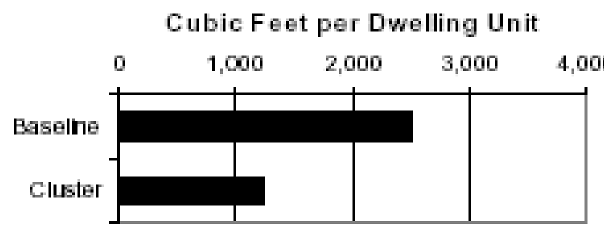
Catchment 5



Catchment 6



Site Total



Graph 12.12 Woodbury Hydrology Comparison:
Cubic Feet of Runoff per Dwelling Unit for a 10-Year Storm Event

Discussion of Results: Woodbury Site

For the Woodbury site, the Water Quality Volume (WQV) of runoff is summarized in Table 12.3. The cluster scenario shows substantially better performance than baseline development. The cluster scenario infiltrates the entire WQV so it shows no water leaving the site from the WQV storm. This compares very well to the baseline at 226,512 cubic feet of runoff. It also compares well to the existing conditions at 62,726 cubic feet and pre-settlement at 51,401 cubic feet. Where the Baseline produced 909 cubic feet of runoff per dwelling unit, the CROD-LO and CROD-Hi/Med scenarios show none.

The 10-year storm (Table 12.4) showed similar performance between the cluster scenario at 650,351 cubic feet and the baseline scheme at 622,036 cubic feet of runoff. On a per dwelling unit basis, cluster produced less runoff than the Baseline with 1,246 cubic feet per unit and 2,498 cubic feet per unit respectively

As with the Cottage Grove site, peak discharges cannot be compared on a site basis but can be compared on a catchment basis within the site, using the same outlet points as the location for measurement. The graphs showing comparison between the peak discharges from the WQV storm event show the cluster scenario producing no peak discharge (Graph 12.8). This, of course, is also significantly less that the baseline and even the existing and pre-settlement scenarios. This difference is due to the infiltration standard used in the cluster design criteria.

Overall, at the WQV and 10-year storm levels, the alternatives proposed in the design scenarios developed for this study significantly reduced the amounts of runoff produced on a per dwelling unit basis. This raises the question with respect to storm water performance: Why continue to roll out new developments designed with baseline standards and approaches? It also suggests that with appropriate technology and the networks of open space shown in the applications presented here, traditional neighborhood development, as well as cluster development, can significantly reduce the impact of development on storm water runoff.

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CHAPTER 13

Compare and Contrast Impact Issues Across Baseline to Alternative Approaches

Integration: Altering the Genes and the Code

If there is a genetic code that defines the genus "suburb" and the species "sprawl" as hypothesized in Task One (Chapters 1–6), one could imagine that a new suburban species could be created only by intervening in the genetic line and altering the genetic code.

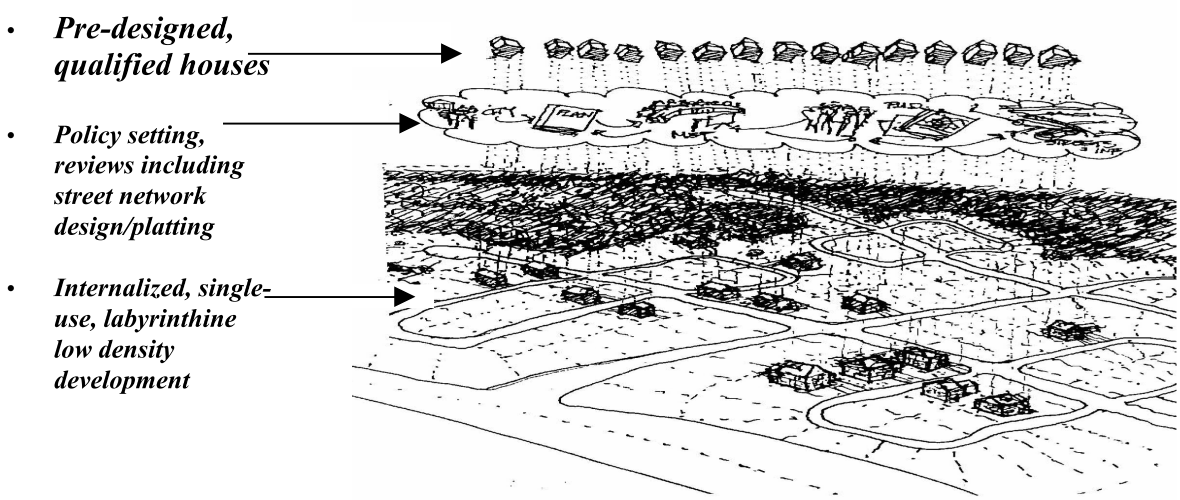

Figure 13.1 Genetic Code of Sprawl: the Subdivision

Chapters 1–6 demonstrated that current measures related to multi-modal development and environmental sustainability is not particularly promising. The questions in trying to design a better, smarter approach were usually questions of why? and how? It seems in offering the answers one of the problems is that the institutional framework—laws and administrative processes—is fragmented. Another problem, embodied in Figure 13.1 by the "cloud" was that they were obscured from clear view.

Suburban Sprawl: Seven Questions about its Genetic Code

In preparing for a workshop as a part of writing this report, in making the transition from the completion of Task One (Chapters 1–6) to Tasks 2 and 3 (Chapters 7–14), the primary investigator (P.I.) prepared the following list of related (and pointedly leading) questions as a demonstration of why and how planning and design for suburbanization are framed and executed in such an apparently fragmented manner, yielding the sameness of effect. The net effect of fragmentation is that the review process is partitioned. Each level and unit of government reviews the element or elements over which it has authority, often in isolation from the others. Focused and separate deliberations tend to leave issues such as transit and the health of the environment, difficult to quantify and hard to assign responsibility for, in a secondary or tertiary position compared with more tangible issues of capital cost. They become fuzzy. The combined effect of disintegrated review and fuzziness allows the genetic code of sprawl, which is so deeply embedded in cultural, economic, legal, and administrative practices, to thresh out a dispersed scale of development. While largely unexamined in an integrated manner prior to execution, this development, once constructed, is no great surprise to anyone and apparently perceived to be largely innocuous.

Here are the seven questions that the P. I. asked of his Technical Advisory Panel members and, later, workshop participants, and the answers:

1. What is the threshold density for bus transit? Is that net density (with open space not included) or gross density with open space included? The lowest threshold density for regular service bus transit in the Twin Cities metro area is 7 dwelling units/acre. That is gross density, with open space included.

2. What is the threshold density for commuter rail? There is none, although the research team had been initially working with 7 dwelling units/acre as standard for new commuter rail-oriented (CROD-Med/Hi) design proposals at the subdivision scale for a site in Cottage Grove. In looking at the CROD-Lo scenario as a cluster approach, however, it became clear that, with some modifications to the design shown, the basic single-family look of this area of Cottage Grove could be retained at about 4 dwelling units/acre while also improving hydrological function. (see *Density/Connectivity/Hydrology/Transit* on page 237) Again, the question of density and its relationship to other factors such as connectivity and mixed use in commuter rail communities such as Riverside, Illinois, one of the precedents for this work, show a different picture than is painted in the standard light rail-oriented TOD approach.(*1*)

3. How are transit plans integrated with other plans for suburban growth?
Basically, transit plans are made only after suburban growth occurs; in some ways, this situation should not be surprising since most communities (as confirmed by their adopted comprehensive plans and the resulting subdivision and zoning practices) do not require new development at the gross threshold bus transit density of 7 dwelling units/acre.

4. Who funds the improvement of collector streets? Developers tend to build new collector streets. Although there may be some county or municipal state aid eligibility, the funds tend to go to arterial reconstruction. A consequence of this situation is that although new collector streets show (diagrammatically at least) on the official maps of some growing cities, most developers' incentives are to make these streets look as much like residential streets as possible since they have to sell the lots on the street to build it. While urban collectors are eligible for municipal state aid for improvements, one respondent alluded that most never receive it as the funds are never adequate.

5. Who funds the improvement of arterial streets? When county roads are converted to arterial streets in a growing community, their designation of eligibility for county and/or state aid has much to do with non-local financial participation in their improvement. Beyond these conditions, other variables can also be active in financing such improvements. County requirements vary slightly across the metropolitan area. With improvement come standards for redesign that insure little concern for multi-modality with the possible exception of bike trails—streets are widened, usually to four lanes plus turning lanes at intersections to increase capacity for peak, and curbed. Signals are sometimes used, but sidewalks rarely are built.(*2*)

6. What role does the Metropolitan Urban Service Area (MUSA) have? Who plans and designs the extension of the MUSA? Who designs the street systems of new subdivisions within municipal limits vs. beyond municipal limits? Who approves these designs in each of these cases and on what criteria? This group of questions is designed to provoke some thinking about the potential for funding integration of arterial and subarterial streets that also accomplish designed transit and hydrological objectives. Currently street systems are largely designed by developers in large part because in Minnesota we have a weak application of the official map law. The policy to provide for extension of the MUSA (sanitary sewerage) to a new area is a matter of Metropolitan Council approval. Metropolitan Council works with localities to forecast population growth based on approved local comprehensive plans. Normally, in the past, these approved plans have been projected at residential densities and on a pattern of land use and zoning common to the area. Sewer design up-sizes these proposals, often regardless of external conditions related to variables such as proposed regional transit. It is usually argued that it is cheaper to build at a higher capacity than retrofit later. Storm sewers get bundled into the sanitary projects also for cost reasons. The result is a standardized, one-size-fits-all treatment of the principal hydrological infrastructure built into the street right-of-way.

7. Who reviews applications for new municipal wells? There are two points to this question. The first was to suggest that the development of new wells to serve new urbanization is (from a growth perspective) largely a local matter having to do with the city or town and its water authority. A second point was to suggest that no one had a regional purview, on the nature, extent, or position of the growth that would be supported by these wells. Quality is measured, but not quantity. Apparently it is our assumption that we have virtually endless groundwater resources in the Prairie du Chien/Jordan aquifer. Only the Department of Health and the Department of Natural Resources have authority beyond the 110 local water authorities in the Twin Cities metro to review plans for new wells.

Density/Connectivity/Hydrology/Transit

A critical difference between the baseline and the new designs can be seen by also examining the differences CROD-Lo and CROD-Med/Hi alternatives. One difference is density. The preponderant feeling of the space of the central portion of the cluster scheme is of single-family development and a relatively high proportion of open space to built space—more like Riverside with an intense station area and spacious residential environs than a Calthorpe-inspired TOD. While the more transit-oriented density in the CROD-Med/Hi has generous connective open space, some of it on undisturbed terrain, the preponderant feeling of the subdivision will probably be that of town houses or duplexes since these will line the principal residential parkways which also will serve as transit streets. As noted in Chapter 10, hydrological function in the main subdivision fabric is exactly the same even the though the gross density is almost doubled in those catchments.

The gross density in CROD-Med/Hi (7 dwelling units/acre) cannot be built without substantially changing the single-family dominant pattern of suburban growth in this area of Cottage Grove. Although multi-unit housing has been constructed in some parts of the city, this high bluff area has been primarily zoned for single family. If then, one argues also that the 7 dwelling units/acre standard does not apply to commuter rail because it does not depend on pedestrian traffic for ridership, then the question becomes political: “what density?” and “under what conditions?” Unless there was a clear intention to develop a shuttle or feeder to the station at peak for the CROD-Lo design, the baseline density of 4 to 4.5 dwelling units/acre might prove to be a politically acceptable compromise. If the CROD-Lo design could be adapted to a similar commuter rail-oriented gross density enhanced by the street connectivity, it might be an acceptable alternative. Although modeling cannot detect any overall VMT reduction benefit in the more connective street patterns and clustered mixed uses, it seems possible that these effects might occur. For this scenario to occur, apartments must be built on the Cottage View outdoor theater site as a modification to the CROD-Lo alternative design.

Cluster, Hydrology, and EcoSprawl

What business does the region have in creating fabric at 3 to 4.5 dwelling units/acre? Isn't this clustered new suburban pattern just a more appealing version of hydrologically-attuned sprawl, a kind of ecosprawl? If, as demonstrated,

- the hydrological performance of the CROD-Med/Hi is equal to CROD-Lo; and if
- CROD-Med/Hi is both more efficient per-unit hydrologically and in terms of transit share in the commutershed of the Jamaica station, it seems true, therefore,
- that a cluster approach, when aggregated at the large subdivision scale in the context of transit, constitutes ecosprawl.

As confirmed by the culture of the trend growth in the Twin Cities region, low-density development must be good. Per capita income went up in the 1990s. Real estate values are soaring in spite of a demographic bubble that will soon deflate as baby-boomers dump their "high-value" single-family homes onto the market. What costs that may lie ahead to fix some of the problems resulting from delayed reinvestment in the public realm are also unknown. "Fixing" congestion and air quality may be possible with a commuter rail system. But if non transit-oriented densities continue to be built region-wide as per existing trend, even in the connective street pattern and open space designs shown here (such as the CROD-Lo), it seems likely that the region will not realize the highest possible return on its investment in the system.

The dollar value of commuter rail enhanced ecosprawl can be debated, but its effect is clear: low-density development will be subsidized not only by highway development, but also by transit development. This said, it is not politically feasible to assign to Cottage Grove (or any single community) the responsibility in the region to absorb densities over the comprehensive plan levels. This policy would probably be addressed as a regional compact with the localities that would be empowered to apply the types of design and planning approaches (embodied as place-specific toolkits) presented here. Though politically problematic at the local level, ecosprawl cannot prevail in places of transit investment, especially those endowed with employment connectivity and high environmental carrying capacity for density if the resources of the region, including its water richness, are to be marshaled to sustain projected growth and to compete globally.

Employment and Housing Assumptions for Red Rock

Another key variable (not part of the traffic modeling work) is related to the potential in the Red Rock corridor to change the employment geography. Three strategies could address this employment opportunity situation in the Red Rock corridor and also integrate the need for affordable housing:

1. Job Development at the Core

In the context of the Twin Cities, the Red Rock corridor will serve, in the foreseeable future, primarily the job markets in St. Paul and Minneapolis. These markets have shrunk in the past decade. Although the Twin Cities is not the most sprawled job region, recent data by the Brookings Institution places it in a middle range of sprawled regions with only 12.6% within 3 miles of the CBD, 63.39% in the 10-mile ring, and 36.61% outside this ring.(*3*) Others, including Richard Bolan, have similarly modeled the random patterns of employment and residence in the region. In order to maximize the scenario of commuter rail-oriented design, a fundamental assumption must be made that the job bases in the downtowns will expand over the 2020 scenario to meet the demand explicitly defined by the denser, more compact (CROD-Med/Hi) development types.

2. Reverse Commuting to Jamaica/3M Campus

One of the challenges in any region served by commuter rail is the feasibility of creating values in the reverse commute.(*4*) With job development at the center, what is the suburbs' role other than serve as bedroom communities? Another challenge is the reasonable allocation of affordable housing in an era when car ownership also presents a staggering expense, even to two-income households. In the Red Rock corridor, these challenges could be converted to a solution to both problems.

Major employers along the Red Rock include:

- Jamaica/3M Campus—Langdon/Cottage Grove Station
- 3M
- Renewal Windows (Andersen)
- Up North Plastics, Inc.
- Smaller employers clustered in Cottage Grove Industrial Park
- Newport/St. Paul Park
- Marathon (Ashland)/SuperAmerica/SuperMoms

3. Affordable Housing

If workers could be housed affordably in Minneapolis, St. Paul, or near the station site in Newport, for example, they would have a short (10 to 50 minute) commute in relatively empty trains to jobs on the Jamaica/3M Campus. The political costs of affordable housing are still uncertain, of course, although the relative sustainability of a jobs-commute infrastructure-home linkage seems promising.

Chapter 13 References

1. Riverside is located around the station area. Much of it is commercial and mixed use (4% total of land area covered) and multi-units (duplexes and apartments constitute 6.47% of the land cover) near the station. However, the vast majority of dwellings which cover 67.4% of the land in the corporate limits are single family houses, and they represent a gross density of 4 dwelling units/acre. While many people in neighboring Berwyn, Brookfield, and Lyons live in denser patterns, it is nevertheless instructive to see that variable lower density patterns may work if there is also connectivity to the station and mixed use, at least in the station area.

Riverside Land Use Areas			
	Square Feet	*Acreage*	
Total Tallied Village Area	###########	*1,462.15*	
Minus corrections for Water and Forest Preserve	###########	*1,236.92*	
Total Published Village Area	###########	*1,280.00*	
Total Published Village Housing Units	***3,668***	***Net Density***	***4.09***
Single Family Units	*2,495*	*Density*	*2.99*
Duplex Units	*246*	*Density*	*8.15*
Multiple Family Units	*621*	*Density*	*12.47*
Mixed Use Units	*306*	*Density*	*22.17*
		Gross Density	***3.08***

Tallied Results							
Commercial Areas	***2.87%***	*Mixed Use Development*	***1.12%***	*Residential Blocks*	***67.37%***	*Duplexes*	***2.44%***
1,547,581.86	35.53	601,325.04	13.80	36,299,531.64	833.32	1,315,057.19	30.19

Tallied Results							
Multi Family Residential	***4.03%***	*Parks & Open Space*	***9.27%***	*Residential Streets*	***10.37%***	*Medians*	***0.06%***
2,169,637.21	49.81	4,994,506.25	114.66	5,586,145.15	128.24	33,824.47	0.78

Tallied Results					
Rail ROW	***0.62%***	*Forest Preserve*	***13.67%***	*Civic Areas*	***1.69%***
419,698.64	9.63	7,366,225.76	169.11	912,894.19	20.96

2. Washington County highways in the study area are Class A minor arterials and Federal and State Aid is sought for the maintenance and upgrading of highways that are designated at County State Aid Highways (CSAH). In fully developed areas, county highways see their peak traffic volumes from 6 a.m. until 8 p.m. with the peak of the peak at noon. In regards to the multimodality of Washington County highways, the County evaluates the need for the inclusion of pedestrian/bike trails along its highways on a case-by-case basis. When trails are placed along high volume highways, crossings are provided for at traffic signals. These signals are timed to allow for safe crossing of the highway for pedestrians, bikers, and etc. allowing for the multimodal use of the right-of-way.

3. www.brook.edu/es/urban/publications/glaeserjobsprawl.pdf

4. www.transact.org/Reports/5yrs/shuttle.htm

ISTEA FUNDING CATEGORY: CMAQ

PROJECT COSTS:
Total: $750,000
ISTEA CMAQ Funds: $600,000
Private Contributions: $120,000
Village of Deerfield and Metra Commuter Rail: $30,000

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http://www.metroplanning.org/resource.asp?objectID=450
http://www.metroplanning.org/cmaimages/BLT-MP2.pdf

Shuttle bug Project--Connecting Commuter Rail to Suburban Employers
Project Lead: Transportation Management Association of Lake-Cook
Project Background: The Shuttlebug was started in 1996 as a CMAQ "demonstration" project that used shuttle buses to connect commuter rail riders with suburban employers. Now in its third year of funding, the project has proven to be a success, with increases in daily ridership necessitating a shift from 15-seat to 26-seat buses, and new routes planned.

METRA, the Chicago region's rail service, has nearly 1.5 million boardings per week. Most of METRA's riders travel to downtown destinations. For those who work in fast growing suburbs, like the Lake Cook Road area and campus-style office and industrial parks, often require automobile transportation, even in areas served by rail transit. And as travel grows, traffic corridors such as Lake Cook Road are clogging up quickly.

Growing traffic problems have led several employers in the area to form the Transportation Management Association (TMA) of Lake Cook. The TMA's support for innovative solutions to congestion provided the catalyst for establishing a free shuttle that connects a new local METRA station to major employers nearby, like Underwriters Laboratories, Walgreen's, and Morgan Stanley Dean Witter. In fact, employer contributions help to make up the local match for the CMAQ grant used to meet the cost of operating shuttles. The Shuttlebug also receives support from METRA. The Shuttlebug is operated by Pace, Chicago's suburban bus service, and CMAQ funds are used to help cover the cost of operations. The Shuttlebug serves six routes, and a seventh route is planned. The buses offer high frequency, door-to-door service to about half of the 25,000 employees in the area. Target riders include those who commute out of Chicago to jobs in the suburbs, but significant ridership also comes from suburban residents. The air quality benefits of the Shuttlebug get a boost because many riders have commutes of more than 15 miles one way. Even more importantly, surveys show that 60% of those who take the shuttle previously drove to work alone. Daily ridership now stands at about 550 trips.

Qualitative Ancillary Project Benefits:
In addition to the quantified emission reductions, the Shuttlebug project sponsors note a variety of non-quantified ancillary benefits that include the following:

- Increased mobility—makes suburban jobs accessible to workers without cars;
- Economic development—employers support the service as a means for attracting workers;
- Congestion relief—the region affected by the project is experiencing increasing congestion problems;
- More efficient transit infrastructure use—the shuttle is generating ridership on the return leg of the region's commuter rail service that would otherwise be empty, thus reducing operating costs;
- Energy efficiency—the service replaces auto trips with a more energy efficient mode of travel.

Chapter 14

Develop a Cost-Benefit Issues Analysis

Costs and Benefits of Institutional Change: Findings Implications

In assessing costs and benefits, it would be impossible in the framework of this study to assign values to all of the variables considered. As work unfolded and meetings with the Technical Advisory Panel progressed, it became clear that whatever cost-benefit analysis might be achieved would be general in its scope. The findings here clearly cast environmental benefits as the main increment of value gained by these changes, but there is an increasing literature documenting the positive effect of commuter rail on private property values as well.

Costs are primarily in the public realm. The primary quantifiable costs of implementing these findings in the public realm are direct, and they lie largely down the road. Various projections of these costs have been made, and with these projections have come the indeterminate projections of political costs incurred with change. Agencies will have to change to effect change. Policy makers will have to change to effect agency change. Direct costs become directly linked to political costs in this policy shift: finite pools of dollars mean that other transportation projects will be postponed, especially conventional highway and road improvement projects.

Much of the balance of this chapter is dedicated to the broad assessment of institutional (legal, structural, and procedural) changes necessary to achieve alternatives to the baseline conditions (see Chapters 1–6) such as those outlined in this study.

This study asks important questions about the planning and design of suburban and urban growth and offers answers in terms of new paradigms with legal, policy, and administrative implications. There are direct and indirect costs and benefits at stake in a complex matrix crossing many issues of wide-ranging academic disciplines and realms of practicality. (At projected ticket prices of $4 to 6$ per ride, most economists project that the proposed Northstar line between St. Cloud/Rice and Minneapolis will never pay for itself; this fact is not surprising since all commuter rail lines, even those in place for more than a century, receive subsidy to operate as a public good. Currently, Northstar is stalled in the legislature which has balked at funding in the current budget deficit cycle.)

In examining the parameters of these propositions, then, the overall questions of cost-benefit that can be outlined are ones of integration across institutional frameworks as they might provide answers to questions of design and planning such as:

Should there be administrative coordination and integrative policy across transportation investments, water (and other) resources, and subdivision design to shape a regional approach to growth via public policy and a revised structure of governance?

The types of benefits proposed here will accrue political costs (since they have long-range but not always short-range benefits) and institutional and procedural costs since almost none of these issues can be addressed in ways suggested here given the current regimen. Assuming the legislature, the Governor, and the Metropolitan Council were in agreement to some measure of change, since the baseline is already deemed to be unaffordable on several critical measures (such as the capacity of the taxation structure to continue to build roads that keep up with use trends), scenarios for change would have to be floated in front of them (such as the ones here and in the Calthorpe Associates plan). It is and will be difficult to assess direct implications, until projects such as the Red Rock have a more defined scope and communities, designers, planners, and developers begin to respond (perhaps such as has already happened in Everett, Washington, or Alewife Brook, in Cambridge, Massachusetts, documented earlier). But questions will follow: how much would it cost, who would pay, who would benefit, how and when? Those answers are farther down the road (or the rail) than this study can go. This study is a probe that reveals the complexity of the issues and suggests some integrative measures, albeit assumes incremental actions.

Private Benefits

While this study has concentrated on environmental benefits that accrue to the region, the economic benefit to property owners—individuals and families—would, according to most case studies, be substantial. The S. B. Friedman and Company 2000 study for METRA cited previously, for example, shows that the median value of a single-family house in the 1/2-mile radius of the Glen Ellyn station is $208,000; and in Arlington Heights, which has built a mixed-use buffer zone between the central station area and the surrounding single-family neighborhoods, the median value is $199,000. The patterns of use can vary by location, as long as there is a logic based on transit-linked trip behavior or multi-modal connective streets. There is a growing body of research within the American Public Transit Association (APTA), which generalizes this effect across unit types and possibly even uses.(*1*)

In order to achieve some level of integration, a new order of joint effort across agencies would have to be modeled and supported by policymakers in a corridor such as the Red Rock:

Overall Strategy Options

1. Re-position water and transit in the policy framework of comprehensive plan approval in regional transit corridors as critically related elements of metropolitan growth.

Joint efforts across agencies:

- Continue rigorous, finely-grained geographic information system (GIS) data base construction and analysis especially for hydrographic, land use, and transportation coverages metro-wide such that subregional suitabilities for development of various types can be seen.(*2*)
- Leverage buy-in by creating joint authorities for corridor planning and construction. With Mn/DOT positioned to build rail projects, consider financing opportunities available through joint corridor authorities or other means on an integrated local and regional approach; transit-oriented development would benefit from regional investments and taxable improvements would accrue revenues to state and local units.(3)
- Require joint authority approval of comprehensive plans to include impact assessments of development on surface and ground water resources at the subregional or regional scale.
- Require expanded transit corridor assessments (reflective of commutershed) of transit-orientation in subdivision and street and infrastructure design.

Comprehensive Plan Review

For the Metropolitan Council and localities, the Comprehensive Plan is a central instrument of change. Suggested here are new transportation planning standards and related incentives. These suggest revised performance standards (and some tools) for comprehensive plan approval based upon commuter rail-oriented design and planning criteria and MUSA extension in these corridors. All subdivision-scaled development planning and proposals would be evaluated with respect to environmental cost in the context of regional dollar costs of development (including health and engineering costs related to cleanliness of water and air as related to VMT reduction and/or concentration). Again, since the MUSA as a device is currently a generator of urbanization at comprehensive plan approved density levels and, therefore, not currently a growth regulator in the context of transit-oriented ideas, the costs of change and potential projected benefits in VMT reduction and water quality improvement must be figured into the analysis. Among the critical issues (variables) addressed in the designs for stabilizing VMT and hydrological carrying capacity in commuter rail-oriented development in the Red Rock corridor in this document were:

- medium to high suburban density residential development (3 to 7 dwelling units/acre gross density)
- mixed use development in walkable, bikeable clusters
- new types of multimodal minor arterial-like parkways and other subarterial corridors with rapid (12-minute) access to the station
- new types of residential parkways that act as transit collector streets within subdivisions to establish greater connectivity and access to destinations by multiple modes
- water-sensitive design approaches to subdivision and street and road and open space design with little-to-no net runoff, better quality of surface water, and more groundwater infiltration
- linked open lands for recreational, hydrological, and potential ecological connectivity for long term value-added development

Agencies: Metropolitan Council, Minnesota Pollution Control Agency, Mn/DOT potential transit or corridor authorities, local units of government

2. A transit system with a commuter rail system, not just a line, is needed to frame policy and resources to relate the system to job locations. Even though we build one line at a time, the objective is a commuter rail system that is integrated with the larger transportation system to *support the economy including multi-modal access to jobs. In order to address the duality of this situation here in the Twin Cities where jobs are decentralized (but arguably nodal), the idea of pilot projects including reverse commute projects may prove feasible.*

- Pilot new suburban developments that explore effects of traditional density ranges presented here on Red Rock (and the Northstar) in new suburban CROD patterns such as those shown here
- Engage employers, local units of government along the line to create shuttle systems
- Provide incentives to developers for affordable housing projects at 7 dwelling units/acre or greater (CROD-Med/Hi) in station areas of _-mile radius.

Agencies: Mn/DOT, Metropolitan Council, local units of government

The findings from the work summarized in the Task One report (Chapters 1–6) and the designs presented here clearly have pointed to three other design- and planning-based strategy options at the subdivision scale as presented here:

1. Discourage internalized, unstratified circulation systems in subdivision design. Increase incentives such as municipal, county, and state aid to plan for, design, and build new types of connective, multi-modal streets in arterial and an intermediate (subarterial) street network between and within subdivisions that:

- Improve access for all modes to transit
- Increase pedestrian and other modal connectivity to all destinations
- Provide for more vegetation and infiltration and storage of water as part of the infrastructure of the street network

Agencies: Mn/DOT, potential transit or corridor authorities, Metropolitan Council, local units of government

2. Provide communities with models of best design and planning practices for urbanization and suburbanization at the subdivision scale in the form of toolkits of approaches to meet performance standards and a clearing house on approvals.

- Provide a more conducive transportation template for pedestrian- and bicycle-oriented mixed use development

- Encourage stratified, connective, and finely-grained designs
- Integrate drainage with open space, path, and street design, including new infrastructure standards for street profiles and drainage structures
- Discourage mass grading of sites, retain soil profile and vegetation, and use more retaining walls and other slope engineering devices

Agencies: Metropolitan Council, Mn/DOT, potential transit or corridor authorities, local units of government

3. Design connective open space systems in concert with regional open space objectives and the work of key non-profits to acquire lands framed by hydrology and transportation objectives to add value to residential development while also providing for public stewardship of key regional resources.

- Design drainage infrastructure to fit land (vegetation, soils, hydrology) types and transportation and community needs including recreation
- Avoid internalizing open space systems within superblocks
- Connect diverse types of open space, including, when possible, both highly programmed space and more informal space to relate to other destinations
- Acquire ecologically strategic and other significant parcels of land to model design, planning, and management practices

Agencies: Metropolitan Council, Mn/DOT, potential transit or corridor authorities, local units of government, non-profit land conservancy groups

Financing and Funding Commuter Rail

A principal obstacle to building transit systems has been the lack of public financing structures to accomplish such large and complex transportation systems. As Rothblatt and Garr indicate, the Federal Highway Trust Fund has been a principal engine of single-mode transportation (and, by extension, sprawl, congestion, and pollution) in the United States. Pietro S. Nivola in his short, clear book, *Laws & Landscape*, suggests that if there were a way to modify the use of revenues in this Trust for transit and also to develop other transit-supportive policies, sprawl might be mitigated.(*4*). As he notes, however, even Washington D.C. with its highly land use-integrated metro system still carries only 13.7% of the daily trips in the region. Given the Twin Cities employment geography with its decentralized form, this share might be the maximum that one could hope to capture in a commuter rail system. This scenario describes, again, the nexus between dollar costs and political costs.

One of the lessons from recent work in Denver on the Transportation Expansion (TREX) project is that special districts present one vehicle to induce flexibility into transit funding. The principal idea of this arrangement is to fund the work through a combination of bonds and federal funding for highways and ISTEA improvements to transit and other multi-modal aspects of the project. The TREX project, the subject of a study by Kenneth Kriz, formerly professor of public policy at the Hubert H. Humphrey Institute of Public Affairs and Frank Douma, of the State and Local Policy Center of the Humphrey Institute, has leveraged federal funding for a combined light rail project into the suburbs parallel with a highway improvement project as a product of an intergovernmental agreement between the Colorado DOT and the Regional Transportation District.(*3*)

Until now, however, such innovative financing has not been known to be used for commuter rail. The failure of the Northstar funding bill in the legislature last session depicted the lack of flexibility to proceed when funding sources are so limited by law and by lack of experience with finance alternatives as well as political opposition to the project.

What Now?

Where does this leave the Twin Cities metro? The incentives for home ownership on a dispersed scale in the baseline pattern now present—taxation, investment, low gas prices, fully built-up, and auto-oriented transportation network—are particularly powerful in providing the value structure for the existing pattern. In the baseline trends identified in the Task One report (Chapters 1–6), there has been a central emphasis on the single-family house as an economic and cultural unit (although this trend has begun to change as new markets have gained a greater share.) Anthony Downs has argued that there is a difficulty inherent in the idea of denser, more transit-supportive development, namely that there is already so much sprawled development to adapt.(*5*) Growth has to be nested into the existing fabric, which when averaged in the most compact scenarios across the region by the Metropolitan Council and Calthorpe Associates will be less than 2 dwelling units/acre although within the urban service area could go from 4.5 to 8 dwelling units/acre.(*6*) How could commuter rail oriented design fare in this context?

- *Density:Transit:Employment*—Commuter rail depends on a strong central business district (CBD) job base. If somewhat greater transit-oriented densities were created in a region with a central place job share that is relatively low—in other words, where jobs are dispersed regionally—it will be difficult to build commuter rail. On the other hand, Minneapolis/St. Paul is, according to one source, not the most sprawled job market. In their study of "job sprawl" for the Brookings Institution, Glaeser, et. al. found that about 12% of the jobs in the metro lie within three miles of the two central cities, or about a million jobs in total for the two central cities. It is much more difficult to estimate what the combined downtowns and University of Minnesota shares would be, but optimistic estimates might put that number close to 100,000.(*7*) If the job base were kept strong in the downtowns and the University, commuter rail would have an appropriately structured centripetal regional model.

- *Transit:VMT:Access:Water:Density*—The changed physical armature of a new commuter rail suburbanism is embedded in the transportation network. Fundamentally the multi-modal character of the infrastructure is its best argument from a VMT perspective. How does density work? If there might be a reasonable political chance to adapt transit to an already sprawled landscape, it seems it is commuter rail. While lot sizes and house sizes are not as great in the CROD-Lo (cluster) schemes as in the current baseline, it might be argued that it is easier to induce these changes rather than challenge the fundamental value structures—mythic and economic—that would sustain more aggressive changes within suburbia. This proposition seems to be borne out in the Friedman data on METRA communities. As demonstrated here, commuter rail is less dependent than other transit modes that depend on riders walking to a stop or station and can function, therefore, in a less dense fabric. However, on the more generalized regional environmental balance sheet, CROD-Lo would be a failure. If the region simply needs to absorb a projected population in the most sustainable manner, on a per-capita basis this ecosprawl loses both transit riders and water quality. If communities or the region decided to mandate smaller lots and to plan for more ecologically or hydrologically sensitive open space, that policy could be made independent of transit system decisions providing that jobs and clustered commercial services also continued to be developed in some measure of proximity/accessibility to housing. But this approach will not fundamentally alter the affordable housing situation and will *de facto* apply continued pressure to sprawl, as most job development will not be proximic or accessible to workers' dwellings. The future of affordable housing in such a scenario is less clearly defined.

Twin Cities' Precedents?

Although the technology of Portland's MAX is a light-rail configuration, and it is, therefore, more agile and serves a larger fabric in downtown settings, its larger network is far-flung in it suburban settings. Portland's Tri-Met claims that its integrated transit system has made downtown more vibrant without specifically enumerating jobs.(*8*) The resolution of a region-wide policy has been as central advantage for Portland.

Seattle, where the Sounder is perhaps the most similar type of service to that of the Twin Cities, projects an 82-mile system between Lakewood and Everett, Washington, with Seattle and Tacoma as its principal urban stations. The communities served are predominantly low-density markets. There have been significant setbacks in the development of the system, and the proposed $104 million dollar extension to Everett is currently in the balance, even though the Everett station and its mixed-use center have been built. Most of these setbacks have been related to unpredictable events related to lack of transportation funding, but also important concerns by environmentalists who are concerned about salmon habitat along the route.(*9*)

Portland has been much touted by smart growth advocates as a model for the Twin Cities, and there are some applicable lessons to the Twin Cities. However, the Twin Cities is arguably more like Seattle or Chicago than Portland. Seattle is a new city with a high-tech economic base overlaid on a traditional economy based in transportation. Like Seattle, single-issue opposition has been a major obstacle to many smart growth and transit-oriented proposals in the Twin Cities. With 22.3% of their one million jobs in the CBD, Seattle is actually better positioned than the Twin Cities (with only 12%) to take advantage of commuter rail. Chicago too, though much larger and with an older in-place system that has guided suburban growth, is also a model for the Twin Cities. Chicago is a classic Midwestern urban center, with a strong railroad base and a similar traditional ethnic mix to the Twin Cities. It is easy to imagine that there is some demographic comparability between the two regions and there is a similar pattern of job sprawl in the region. The built fabrics of the two regions are comparable. The Friedman study of METRA communities shows many of these similarities. As noted elsewhere, some of the suburban job clusters such as are present in Cottage Grove (and Newport/St. Paul Park) have been adapted to reverse commuting via shuttle service to suburban job campuses. Exigencies of growth have already shaped the Chicago metropolitan region.

Diversities of opinion, probably similar to those found in these lively metropolitan areas, will shape the Twin Cities as they have contributed to the current state of metropolitan and regional thinking elsewhere. There is a lesson in these metropolitan areas. Pessimists have argued that the baseline pattern may change only when forced by exigency; in fact, there is a broad perception that seems to suggest that the situation is not broken, so why fix it. The ‘American Dream,’ it is said, is too firmly ensconced in the mythic and metaphysical identity to change. Without a clearly framed discussion of costs and benefits (region-wide as well as local) and willingness to pilot more integrative, systemic approaches to costs, no change will bear the political costs necessary to implementation. Still some might argue that the integrative approach is the ‘third way,’ the only viable alternative to preserve the ‘American Dream.’ And that is the point of the rhetoric offered here in support of a new suburbanism of multi-modality to be built the backbone of a commuter rail system for the Twin Cities the first incarnation of which would include the Northstar and the Red Rock.

Chapter 14 References

1. http://www.apta.com/info/briefings/briefing_1.html
"Impacts of Rail Transit on Property Values." Roderick B. Diaz, May 1999. Recent studies of the impact of 12 rail projects (including both heavy rail and light rail) throughout North America are compared. In general, proximity to rail is shown to have positive impacts on property values. The relative increase in accessibility provided by the new transit investment is the primary factor in increasing property values.
Source: APTA 1999 Rapid Transit Conference Proceedings Paper

"The effect of CTA and METRA stations on residential property values. A report to the Regional Transportation Authority." June 1997
The regional benefits or comparative advantages transit provides to neighborhoods by improving accessibility, lessening congestion and reduction transportation costs make residential locations served by transit more valuable than comparable locations without transit service. Whether located in lower- or higher-income neighborhoods, proximity to CTA and METRA stations positively affects the value of single family homes. Furthermore, apartment properties located closer to train stations tend to realize higher rents and occupancy levels than comparable apartments less conveniently-located to train stations.
Source: Gruen Gruen + Associates, San Francisco, CA http://www.ggassoc.com/

"Impacts of commuter rail service as reflected in single-family residential property values." Robert J. Armstrong, Jr., 1994.
Single-family residential properties in metropolitan Boston, Mass, are examined. Results indicate that there is an increase in single-family residential property values of approximately 6.7% by virtue of being located within a community having a commuter rail station. At the regional level, there appears to be a significant impact on single-family residential property values resulting from the accessibility provided by commuter rail service.
Source: Transportation Research Record (no. 1466) pages 88-98. Transportation Research Board, Washington DC

2. Current work by Professor David Pitt, Department of Landscape Architecture, University of Minnesota, for the Metropolitan Council has adopted this basic format.

3. Ken Kriz, Frank Douma, "Urban Transportation Corridor Development Study," State and Local Policy Program, Hubert H. Humphrey Institute (HHHI), 2001-02.

4. Nivola, 52.

5. Nivola, 62.

6. Metropolitan Council, Calthorpe Associates, Blueprint 2030, Partnering for a Regional Vision Regional Growth Scenarios Smart Growth Twin Cities, DRAFT, May 16 2002, 5.

7. David Glaeser, Matthew Kahn, Chenghuan Chu. "Job Sprawl: Employment Location in U.S. Metropolitan Areas," Center on Urban and Metropolitan Policy, Brookings Institution, June 2001. http://www.brook.edu/dybdocroot/es/urban/publications/glaeserjobsprawl.pdf

8. The Land-Use Connection and the MAX in Portland: Although Portland's system is technically a light rail technology, some aspects of its far-flung suburban service mirror commuter rail. Portland has as strong transit-oriented design and development framework within Tri-Met, but Nivola has argued against Portland's urban growth boundary since it promotes higher values of land; of course, this inflation in land costs means that affordable housing is less feasible. Portland's Tri-Met Web site carries the compelling arguments for the institutional framework of their regional transit development

Portland's experience with MAX demonstrates that light rail linked with land-use planning can have a dramatic impact in shaping regional growth. Some $2.9 billion worth of investment has occurred along the MAX line since the decision to build. Projects range from mixed-use, mixed-income residential/retail developments to entirely new communities created out of greenfields. The impact of MAX has been felt from one end of the line to the other. The 15-mile Eastside MAX Blue Line, which was built mostly through existing neighborhoods, has proven a catalyst for redevelopment and infill projects along its route. More than $2 billion in development has occurred along the entire Eastside MAX line with development activity greatest in downtown Portland and the neighboring Lloyd District. MAX played an important role in revitalizing the city center. Virtually every parcel of vacant land adjacent to MAX has changed hands, been developed or had development plans announced. In contrast, the 18-mile Westside MAX Blue Line travels through stretches of undeveloped land, as well as the cities of Beaverton and Hillsboro. The line has become a magnet, attracting nearly 8,000 housing units and about $825 million in new transit-oriented communities within an easy walk of the stations. By focusing new communities around transit service, the region can grow and preserve its livability because there is less dependence on the automobile. . .

Building and Benefits of MAX: MAX, a 38-mile light rail system, runs east and west from Portland and connects the cities of Gresham, Beaverton, and Hillsboro. A new Airport MAX extension provides direct service between downtown Portland and the Portland International Airport (PDX). The system was built in three segments. Eastside MAX Blue Line, opened in 1986, stretches 15 miles eastward to Gresham; Westside MAX Blue Line, opened in September 1998, runs 18 miles west to Hillsboro; Airport MAX Red Line, opened in September 2001, runs 5.5 miles northwest from Gateway Transit Center to PDX. MAX is part of an integrated regional transit system that also includes 97 bus routes in the urbanized portion of the three counties in the Portland metro area. Eighty-four bus lines connect with MAX at various light rail stations. MAX carries about 25% of all Tri-Met's weekday riders. During fiscal year 2001 (July 1, 2000 to June 30, 2001), MAX averaged 22.3 million rides, or 69,800 rides each weekday. Combined MAX and bus ridership at Tri-Met has grown for thirteen straight years, providing more than 84.3 million trips during FY01.

Ridership Statistics: Between 1990 and 2000, Tri-Met ridership grew faster than vehicle miles traveled (VMT) and population growth. During the same period, Tri-Met ridership grew 49%. Portland is one of the few regions in the country where transit ridership is growing faster than VMT. Transit ridership in the Portland region is at historic highs: MAX ridership has grown steadily since Eastside MAX opened in 1986. In FY01, Eastside MAX averaged 42,200 weekday rides. The extension of MAX to the west side in 1998, coupled with improved bus service, led to a 46% increase in transit service. Transit use in the corridor today is 160% higher than before the extension opened. Half of the ridership increase represents new riders. Westside MAX averaged 23,600 daily riders in FY01. Just 19 months after it opened, the line surpassed 2005 projections of 25,200 average daily rides. The overall approval rating for the MAX line has been around 90% during the past several years. In all, 83% of riders choose Tri-Met over the automobile. About 77% of Tri-Met riders have a car, but choose to ride MAX or the bus, according to Tri-Met's November 2001 survey.

Benefits: MAX connects neighborhoods with major employment centers, regional shopping, and entertainment facilities. MAX works because it:

- Reduces car trips and helps keep our air clean (when completed, all four light rail lines will reduce air pollution by 1,700 tons each year by 2015)
- Continues to attract new riders, adding 22,870 new transit trips in the Westside corridor since Westside MAX opened on September, 1998
- Is a catalyst for transit-oriented development—$2.9 billion in new development within walking distance of its 54 train stations
- Serves thousands of central city and suburban jobs. Westside serves 24,000 high-tech jobs, including Intel, which offers a discount on annual transit passes to its nearly 12,000 employees
- Helps defer the need for new highway investments; downtown Portland has become a more vibrant place without adding any new road capacity in over a quarter-century
- Helps preserve livable neighborhoods and maintains our quality of life

9. The Sounder Web site Explains—
Why is Sounder only running two trains?
Initial Sounder train schedules are limited to two roundtrips each weekday. Due to construction of new signals and track between Tacoma and Seattle to accommodate full Sounder service, commuter trains currently can't operate between the hours of 8 a.m. and 5 p.m. Additional trips will be added when signal and track work is closer to completion.

Why has the schedule for the start-up of service on the Sounder Everett-Seattle line been pushed to 2003?
Two unpredictable and significant events have prolonged the implementation schedule for the Everett-Seattle commuter rail service start-up: the listing of Chinook salmon as an endangered species and the implementation of Initiative 695. Because the Chinook salmon are now listed under the Endangered Species Act (ESA), the environmental review period and approval phase took 10 to 20 months longer than the original estimates in the 1996 *Sound Move* plan. The extra time was required because the private railroad right-of-way is adjacent to the Puget Sound shoreline, and the construction of track and signal improvements needed for increased train service between Everett and Seattle could potentially affect the endangered salmon. Working closely with more than a dozen environmental agencies and other groups, we've developed a revised plan that will actually help enhance the environment of our sensitive shorelines. Sound Transit awaits final conclusion of the ESA consultation process—this process will conclude when the revised mitigation plan is completed (by Sound Transit) and accepted by the National Marine Fisheries Service (NMFS) and the United States Fish and Wildlife Service (USFWS). The passage of Initiative 695 (I-695) and subsequent codification of the initiative by the state legislature, has had an indirect, but significant, impact to Sound Transit's track and signal improvement budget and service schedule for the overall Sounder project, particularly the Everett-Seattle route. I-695 eliminated a $46 million commitment from the Washington State Department of Transportation and monies from other partners originally slated to help pay for required track and signal improvements between Everett and Seattle. While filling this budget

gap remains a challenge, Sound Transit is working hard to find new funding sources to replace this substantial share of the budget. These two unpredictable events have also delayed our negotiations with the Burlington Northern and Santa Fe Railway Company (BNSF) for the access to and use of their private railroad right-of-way between Everett and Seattle. While we have some issues still to address, we have an established working relationship with BNSF from developing our successful agreement for service between Tacoma and Seattle, and that relationship sets a sound foundation for our negotiations for service between Everett and Seattle

Overview of the Extension Project
Everett-to-Seattle Commuter Rail
Seattle, Washington
(November 2000)

Description
The Central Puget Sound Regional Transit Authority (Sound Transit) is proposing to implement peak-hour commuter rail service in the 35-mile corridor linking Everett and Seattle, Washington. The service would be part of the 82-mile *Sounder* commuter rail corridor serving 14 stations between Lakewood and Everett, Washington. The Everett-Seattle commuter rail segment would include three multimodal stations that provide connections to a variety of transportation services, including local and express bus service, the Washington State ferry system (connecting cities on the east and west sides of Puget Sound), the proposed *Link* light rail system, and Amtrak. Twelve trains per day will serve up to six stations, and by 2020 will carry 5,300 boardings. Sound Transit estimates total project costs for the Everett-Seattle segment of the Sounder system at $104 million in escalated dollars. Sound Transit is proposing a Section 5309 New Starts share of $24.9 million. <u>Because the proposed New Starts share is less than $25 million, the project is exempt from the New Starts criteria, and is thus not subject to FTA's evaluation and rating</u> [TEA-21 Section 5309(e)(8)(A)].

Proposed Project:
Commuter Rail
(35 miles, 7 stations)

Total Capital Cost ($YOE):
$104.0 million

Section 5309 Share:
$24.9 million

Annual Operating Cost:
N/A

Ridership Forecast:
5,300 avg. weekday boardings

Status:
The Draft Environmental Impact Statement (DEIS) for this project was issued in June 1999. Following extensive public outreach and ongoing coordination with tribes and federal, state, and local agencies, the Preferred Alternative was selected. The final EIS was published in November

1999, and the Record of Decision was signed in February 2000. Sound Transit will be seeking FTA authorization to enter Final Design for this project in 2000.

TEA-21 Section 3030(a)(85) authorizes the "Sound Move Corridor" for final design and construction. To date, Congress has appropriated $59.53 million to the 82-mile *Sounder* commuter rail system.

Proposed Funding Sources

Total Funding ($million)

Appropriations to Date

Federal:

Section 5309 New Starts

$24.9

($59.53 million appropriated for the 82-mile *Sounder* system through FY01)

Local:

$79.1

TOTAL

$104.0

NOTE: Funding proposal reflects assumptions made by project sponsors and are not DOT or FTA assumptions. Totals may not add due to rounding.

http://www.fta.dot.gov/library/policy/ns/ns2001/27seattleeverett.html