*Alternative Urban Areawide Review (AUAR)*
*Ramsey Town Center*
*City of Ramsey (RGU)*

## 1. Project Title
Ramsey Town Center

## 2. Proposer
Ramsey Town Center, LLC
John Feges, President
4200 Central Ave., NE
Minneapolis, MN 55421

Prepared By:
Emmons and Olivier Resources, Inc. (Gary Oberts, AUAR Project Manager)
North American Wetland Engineering, P.A. (Curt Sparks, NAWE Manager)
Meyer, Mohaddes Associates, Inc. (Fred Dock, MMA Manager)

## 3. RGU (Responsible Governmental Unit)
| | |
|---|---|
| RGU: | City of Ramsey |
| Contact: | Patrick Trudgeon, Principal Planner<br>15153 Nowthen Boulevard, NW<br>Ramsey, MN 55303<br>Direct phone: (763) 433-9843<br>E-mail: ptrudgeon@ci.ramsey.mn.us |

## 4. Reason for EAW Preparation
This task is not applicable to an AUAR.

## 5. Project Location

This site is located in Section 28; Township 32N; Range 25W, entirely within Anoka County and the City of Ramsey.

> *EQB Guidance: A county map is not required. The USGS map should be included. Instead of a site plan map, include: 1) a map clearly depicting the boundaries of the AUAR and any sub-districts used in the AUAR analysis; 2) land use, and planning and zoning maps as required in conjunction with Items 9 and 27; and 3) a cover type map as required for Item 10. Additional maps may be included throughout the document wherever maps are useful for displaying relevant information.*

The following series of project location and preliminary site feature maps are included. These maps provide the basis for later reference in subsequent Items.

- USGS map - Figure 5.1
- Site map depicting the boundaries used throughout the AUAR analysis - Figure 5.2 (City location) and Figure 5.3 (County location)
- City Land Use map – Figure 5.4 (also used in Items 9 and 27)
- City Zoning map - Figure 5.5
- Cover-type (Minnesota Land Cover Classification System - MLCCS) map – Figure 5.6 (also used in Item 10)

## 6. Description of Site

*Instead of the information required on the EAW form, the description section of an AUAR should include the following elements for each major development scenario included:*
***6a****. Anticipated types and intensity (density) of residential and commercial/warehouse/light industrial development throughout the AUAR area;*
***6b.*** *Infrastructure planned to serve development (roads, sewers, water, stormwater system, etc.). Roadways intended primarily to serve as adjoining land uses within an AUAR area are normally expected to be reviewed as part of an AUAR. More "arterial" types of roadways that would cross an AUAR area are an optional inclusion in the AUAR analysis; if they are included, a more intensive level of review, generally including an analysis of alternative routes, is necessary; and*
***6c.*** *Information about the anticipated staging of various developments, to the extent known, and of the infrastructure, and how the infrastructure staging will influence the development schedule.*
****Optional 6d.*** *Although the EQB guidance does not require an abstract to be included, one is contained in the AUAR for the purposes of any reference to nature of the document.*

**6a**. The preferred design concept drawing is presented in Figure 6.1. The progression of conceptual design to get to the preferred one is portrayed in Figure 6.2. This progression extends from the Metropolitan Council's Smart Growth Illustrative Plan developed by Calthorpe Associates through the various iterations of the City and RTC LLC design team. The preferred design resulted from discussions with City staff, citizens, community leaders, regulatory agencies and nationally recognized urban designers, as well as site visits nationwide to similar communities that have shown success.

The preferred design reflected in Figure 6.1 is consistent with the City's February 2002 *Comprehensive Plan*, as discussed in Item 27 later in this document.

The preferred design (Figure 6.1) contains the following land use breakdown:

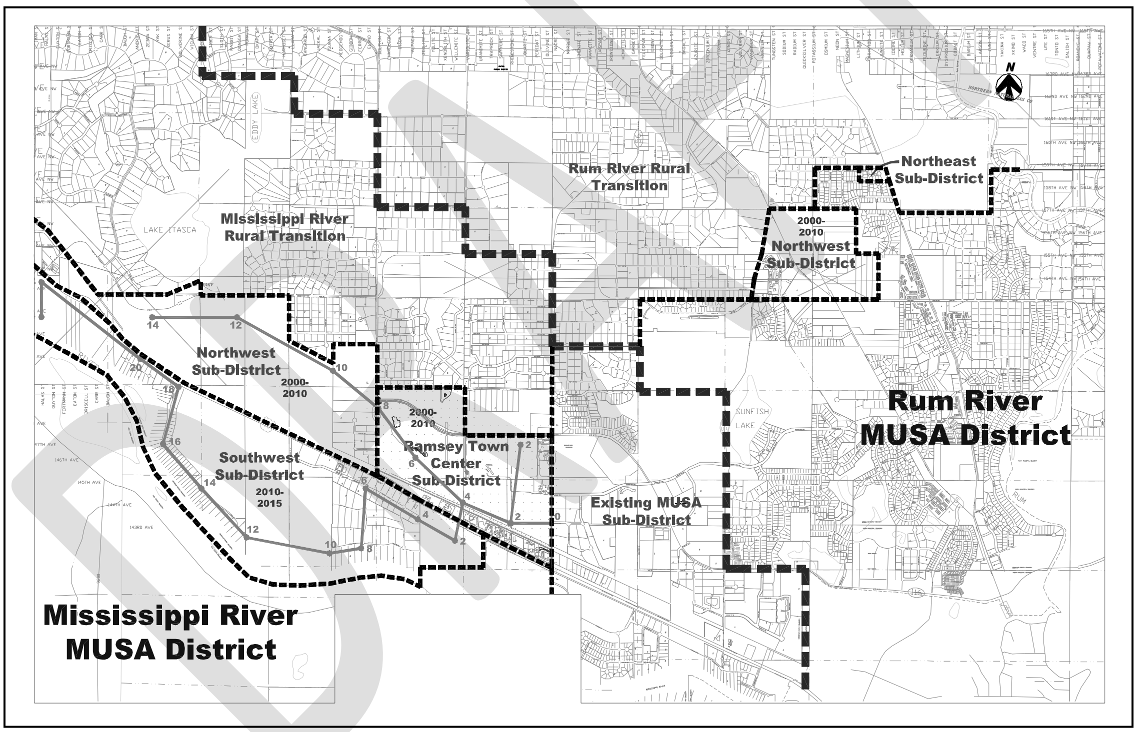
| | |
|---|---|
| Residential: | 93.64 acres |
| Mixed Use: | 56.90 |
| Business Enterprise: | 28.43 |
| Commercial Service/Convenience: | 7.97 |
| Commercial Shopping: | 11.83 |
| Retail: | 7.84 |
| Existing Highway Commercial: | 25.04 |
| Green/Public Space: | 38.31 |
| Railway: | 15.74 |
| Roads and streets: | 83.82 |
| Total Acreage: | 369.5 acres |

**6b**. The infrastructure planned to serve the development has been defined within the City of Ramsey *2001 Comprehensive Plan*, as amended in February 2002. The infrastructure components for roads/highways, sanitary sewers, municipal water supply, and stormwater follow:

*1. Roads and Highways* Details of the transportation elements related to this project are contained within Item 21. Figure 6.3 illustrates the general road and highway system serving the RTC site. The complete traffic analysis is included as Appendix B.

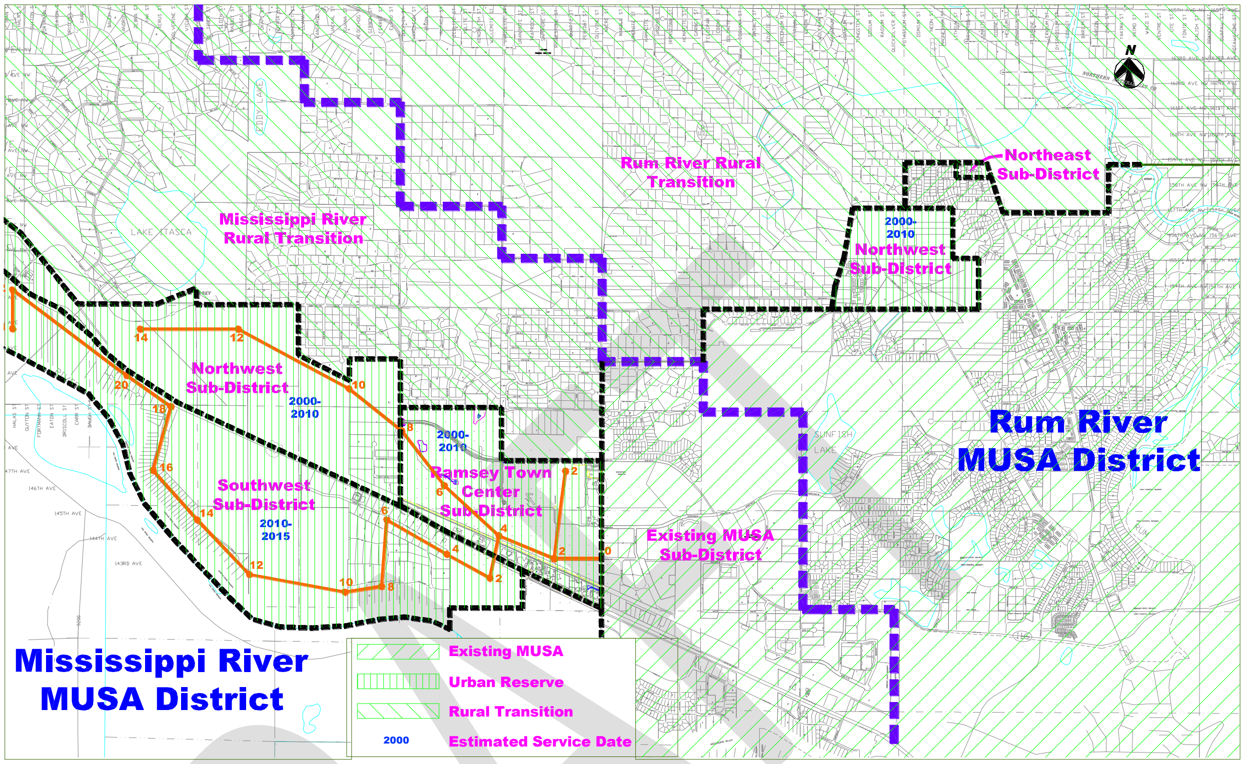
*2. Sanitary Sewer* Details of the sanitary sewer elements related to this project are contained within Item 18. Figure 6.4 displays both the staging and service areas for sanitary sewer service in Ramsey.

Figure 6.4. Sanitary Sewer Plan for City of Ramsey (see Item 18 for details).




*3. Municipal Water Supply* Details of the water supply elements related to this project are contained within Item 13. Figure 6.5 shows the water supply staging and plan for future service.

Figure 6.5.  City of Ramsey Water Supply System and Plan for Staging.




*4. Stormwater*   Details on the stormwater management elements related to this project are contained in Item 17.   Figure 6.6 portrays the general stormwater management system that is envisioned for the RTC site and for the drainage that enters the site from the north and northwest.  Installation of major water-carrying elements of this system will occur very early in the site development process to assure proper movement and treatment of runoff.  The internal site drainage system will be tied into the major stormwater management system as the site develops and design specifics are determined.  Item 17 describes the manner in which runoff volume will be mitigated through stormwater management BMPs.

**6c**. The preferred design in Figure 6.1 shows only a single development concept that will provide the framework for the RTC site.  Staging of infrastructure for the various components is addressed as part of the specific infrastructure section as follows: roads and highways in Item 21; sanitary sewer in Item 18; water supply in Item 13; and stormwater in Item 17.

**6d**. Abstract for the Environmental Quality Board *Monitor*:

*The potential environmental impacts of converting agricultural land to the Ramsey Town Center are assessed in an Alternative Urban Areawide Review (AUAR). Impacts on site drainage, traffic, connection to local and regional trails, groundwater protection and protected wetlands are the centerpieces of the evaluation. A mitigation plan has been developed that lays out the actions that the City of Ramsey will follow to assure minimum environmental impact as the project proceeds in stages, from initiation of construction in 2003, through completion in approximately 2007.*

<u>Summary of Environmental Impact.</u> The change in appearance that results from changing over 300 acres of land use from predominantly agricultural to an urban center will be dramatic. The challenge to the City of Ramsey is to implement this change without equally dramatic impacts on the environment. This AUAR lays out a plan by the City to identify and mitigate, to the extent possible, the potential detrimental impacts.

Each of the Items within the AUAR that have an associated potential for impact will include a section summarizing the impact, followed by a mitigation element that addresses how that impact will be mitigated. Obviously, developing over 300 acres of land will have some impact both during and after construction. The goal of the City is to do everything possible to minimize that impact and incorporate amenities that improve the current situation, such as standing water ponds, improved wetlands, open space and parks, trail connections and a nice place for citizens to live, work, shop and recreate.

## 7. Project Magnitude Data

*The cumulative totals of the parameters below should be given for each major development scenario, except that information on "manufacturing", "other industrial", "institutional" and "agricultural".*

- *Total project acreage:* 369.5

- *Number of residential units (Table 7.1):* 2,400 attached

- *Commercial, industrial or institutional area (gross floor space):* 1,651,000 total square feet

- *Indicate areas of specific uses (in square feet) (Table 7.2):*

Table 7.1 Residential Units by Type

| Residential Type | Units |
|---|---|
| Mixed-Use Residential | 1012 |
| Apartment | **Rural** |
| Duplex | 18 |
| Duplex (2 story) | 44 |
| Townhouse (2 story) | 704 |
| Townhouse (3 story) | 120 |
| Townhouse (4 story) | 330 |

Table 7.2 Square Footage by Use Type

| Specific Use | Square Footage |
|---|---|
| Cinema | 50,000 |
| City Hall / Police / Transit | 50,000 |
| Community Center | 25,000 |
| Convenience Retail | 20,000 |
| Fitness | 40,000 |
| Gas Station, convenience | 62,000 |
| Grocery | 60,000 |
| Hotel | 38,000 |
| Ice Rink | 38,000 |
| Live / Work | 32,000 |
| Mixed-Use Retail / Office / Clinic | 126,000 |
| Mixed- Use Retail / Restaurant | 161,000 |
| Office | 439,000 |
| Retail | 261,000 |
| School | 55,000 |
| Variety Store | 194,000 |

## 8. Permits and Approvals Required

*A listing of major approvals and public financial assistance and infrastructure likely to be required by the anticipated types of development projects should be given. This list will help orient reviewers to the framework that will protect environmental resources. The list can also serve as a starting point for the development of the implementation aspects of the mitigation plan to be developed as part of the AUAR.*

A project the magnitude of the Ramsey Town Center will require many local, regional, state and federal environmental permits and approvals. This section identifies the many permits and approvals that form the basis for implementation of the mitigation plan (Item 33). Table 8.1 lists the permits and approvals that will be needed for this project. The reader should note that the need for compatibility with plans is addressed in Item 27, and that brief descriptions of the permit requirements for some permits are listed after the table.

The cost of most infrastructure improvements will be borne by the developer. The County may improve the County road system as part of routine upgrades that accompany traffic increases with development. There is a possibility the City will pay for some infrastructure improvements, expansions or upgrades, and service enhancements that it deems appropriate to provide an acceptable quality of service. A level of commitment has not been determined at this time.

Table 8.1. Permits and Approvals

| Unit of Government | Type of Permit | Status |
|---|---|---|
| City of Ramsey | Site plan | Pre-permit review under way |
| | Grading and erosion control **(1)** | NAF* |
| | Preliminary and final plat approval | NAF |
| | Obstruction Permit **(2)** | |
| | Excavation Permit **(3)** | |
| | Sewer and water connection | NAF |
| | Building and occupancy permits | NAF |
| | Tree preservation | NAF |
| Anoka County | Access via County Highway, consistency with County standards | Pre-permit review under way |
| Metropolitan Council | Sanitary sewer connection | NAF |
| Lower Rum River WMO | Grading and erosion control | NAF |
| | Storm sewer | NAF |
| | Wetland alteration (WCA) | Pre-permit review under way |

| | | |
|---|---|---|
| Minnesota Pollution Control Agency | Sanitary sewer connection and wastewater routing | NAF |
| | NPDES Phase II construction and MS4 **(4)** | MS4 Permit application submitted 3/10/03; construction permits submitted as needed |
| Minnesota Dept. of Transportation | State Highway Access and consistency with standards | Pre-permit review under way |
| Minnesota Dept. of Natural Resources | Water appropriation for municipal system and construction de-watering | NAF |
| | Work in the bed of a public water **(5)** | NAF |
| Minnesota Dept. of Health | Water system infrastructure (wells, water mains, storage) | NAF |
| State Historic Preservation Office | Historic and archeological site preservation | No significant sites found |
| Burlington Northern Santa Fe Railroad | Access Permit **(6)** | |
| U.S. Army Corps of Engineers | Section 404 Clean Water Act | Determined not to be ―waters of the United States" (see Appendix E) |

*NAF = Permit not yet applied for

**(1)** Grading, mining and filling permits are required to control operations to minimize conflicts with adjacent land uses, to preserve good soils and to regulate the type of materials used for fill, to employ all reasonable means to reduce dust, noise, and nuisances, and to ensure that disturbed areas are restored upon completion of the operation. The following standards need to be applied during construction activities to fulfill the requirements of the permits.

- General Provisions. All equipment used for operations shall be maintained and operated to minimize, as far is practicable, noises, dust, and vibrations adversely affecting surrounding properties. The maximum noise level at the perimeter of the work site shall not exceed the levels outlined in Table 8.2. There shall be no emission of any solid or liquid particles in concentrations exceeding 0.3 grains per cubic foot of the conveying gas or air. No operations shall be allowed when wind gusts exceed thirty miles per hour. Existing tree and ground cover shall be preserved to the extent feasible.

Table 8.2 Sound levels measured at property line

| Octaves, Band Cycles/Sec. | | Residential Districts | Non-Residential Districts |
|---|---|---|---|
| 37.5 | 75 | 58 | 73 |
| 76 | 150 | 54 | 69 |
| 151 | 300 | 50 | 65 |
| 301 | 600 | 46 | 61 |
| 601 | 1200 | 40 | 55 |
| 1201 | 2400 | 33 | 48 |
| 2401 | 4800 | 26 | 41 |
| Over | 4800 | 20 | 35 |

- Water Resources. The operation will minimize impacts to surface water drainage outside of the Town Center. Excavation occurring below groundwater elevation may require an analysis performed by a hydrologist or other qualified professional.

- Safety Fencing. Safety fencing may be required around all or portions of the operation at the discretion of the Council.

- Access Roads. The location of the intersection of access roads with any public roads shall be selected such that traffic on the access roads will have sufficient distance of public roads in view so that any turns onto the public road can be completed with a margin of safety as determined by the City Engineer.

- Fill Materials. An analysis of all fill materials must be provided to and approved by the City Engineer prior to commencing any filling activities.

- Screening Barrier. To minimize problems of dust and noise and to shield operations from public view, a screening barrier may be required between the work site and adjacent properties.

- Slopes. The maximum permitted slope for any operation other than the working face shall be sloped on all sides at a maximum ratio of two (2) foot horizontal to one (1) foot vertical, unless a steeper slope shall be approved by the Engineer. Where excavations are adjacent to a public roadway or other right-of-way, the excavation shall have a maximum four to one slope. Slopes adjacent to or contiguous to bodies of water shall be sloped at a maximum of six to one (6:1).

- Earth Material. No earth material shall be imported to or exported from the work site until the haul road has been officially designated as a haul road by the City and all materials hauled from the source shall be hauled over that road. The haul road designation process shall be pursuant to §2051.3 of the Minnesota Department of Transportation's Standard Specifications for Construction, 1983 Edition. All top soil shall be retained at the work site until complete rehabilitation of the work site has taken place according to the rehabilitation plan.

**(2)** An obstruction permit is required to allow free and open passage over the specified portion of right-of-way by placing equipment, vehicles, or other obstructions described therein on the right-of-way for the duration specified therein.

**(3)** An Excavation Permit is required to allow the holder to excavate that part if the right-of-way described in such permit and/or to hinder free and open passage over the specified portion of the right-of way by placing equipment described therein, to the extent and for the duration specified therein.

**(4)** The City of Ramsey is required by MPCA to be under the NPDES Phase II Nonpoint Source Control Program for Municipal Separate Storm Sewer Systems (MS4s). Under this program, the City will need to adopt a “Storm Water Pollution Prevention Program (SWPPP)”. The City submitted an application on March 10, 2003, and will have until May 9, 2003 to have the application authorized by the City Council. Pollution prevention includes solid waste, hazardous materials, and vehicle washing. The SWPP must include or address the following:

- Six “minimum control measures”
    1) Public education and outreach on storm water impacts (including at least one public meeting per year)
    2) Public participation/involvement
    3) Illicit discharge detection and elimination - includes storm sewer map with water bodies and structural pollution control devices, outfalls, discharges to groundwater, and prohibitive ordinances
    4) Construction site storm water runoff control - need erosion and sediment control, and onsite waste control
    5) Post-construction storm water management in new development
    6) Pollution prevention/good housekeeping for municipal operations - training of operation and maintenance staff, annual and 20% inspections
- BMPs for each of the above minimum control measures will need to be described and the following will need to be identified:
    - measurable goals for each BMP
    - timeline for implementation
    - responsible party for implementation and coordination
- Analysis of Total Maximum Daily Load (TMDL) if discharge applies to an adopted TMDL plan. Of note here is that the latest (January 22, 2003) MPCA “impaired waters” (303d) list includes the Mississippi River reach from the Crow River to the Rum River as impaired for fecal coliform, PCB FCA (fish consumption advisory) and Hg FCA, with official TMDL study scheduled, respectively, for 2004-2006, 2002-2015 (regional EPA), and 2002-2015 (regional EPA). All discharges from the RTC site will be treated extensively prior to

ultimate discharge to this reach of the Mississippi River (see Item 17 discussion). The discharge is not expected to impact the existing impairment.
- Design and management strategies to minimize the discharge of pollutants from the MS4 to the Maximum Extent Practicable (MEP) with an annual report on implementation.

The SWPP must be completed at least 30 days prior to commencing construction and prior to applying for construction permits. Elements 4, 5 and 6 are directly applicable to the stormwater management approach adopted for the RTC site as it develops. The stormwater management approach is spelled-out in Item 17.

In addition to the complying with the City's MS4 requirements, essentially any construction activity that is part of this "common plan of development" must apply for a construction permit under the NPDES Phase II Construction Permit process.

Elements of this program are intended to avoid erosion and construction site pollution. To prevent this, construction at the RTC site should:

- Establish fast growing cover crops as soon as possible to disturbed soils to prevent both water and wind erosion. The sand content of the soils on site could lead to wind blown sands could be potentially hazardous, particularly to traffic on Highway 10.
- Install temporary sediment basins for any areas of disturbance, installed before discharge leaves the site or enters a surface water body.
- Install a permanent stormwater management system that assure stormwater is "…discharged in a manner that does not cause nuisance conditions, erosion in receiving channels or on downslope properties, or harmful inundation in wetlands." Maintain peak flow rates from two, twenty, and one hundred year twenty four hour events at existing conditions.
- During construction, the maximum area of disturbance shall not exceed the ability to keep up with exposed area limits on slopes. All areas with greater than 3:1 slopes must have vegetative cover by November first. Site inspections will be once every seven days during construction and within 24 hours after a quarter inch event in 24 hours. At that time, any non-functioning BMPs must be repaired.
- If stormwater discharge to a wetland has potential for significant adverse impacts to the wetland, the impacts should be addressed with BMPs and permit provisions. Appropriate rules (7050.0186) and any applicable regulations must be followed.

All of these elements would be part of the erosion and sediment control plan listed in the mitigation element under Item 16 of the AUAR.

The Mississippi River as it passes through Ramsey is an Outstanding Resource Value Water (ORVW). Prior to stormwater discharge to an ORVW, the MPCA must find that there are no prudent or feasible alternatives to the new or expanded discharge. For ORVWs the following BMPs are also required.

- Any exposed 3:1 slope must have temporary erosion control cover within three days
- For every 5 acres or more disturbed, a temporary sediment basins will be required
- An undisturbed buffer zone of 100 feet will surround the ORVW
- WQ volume treated shall be 1" from new impervious surfaces

Item 17 of the AUAR addresses the actions that will be taken to treat runoff from the site before it reaches the Mississippi River.

**(5)** DNR also regulates discharges to Waters of the State, as defined in M.S. Chapter 103G.005. Although a defined drainage path to the Mississippi River from the Ramsey Town Center does not exist at present, Items 12 and 17 lay out a recommended flow path for the City, Lower Rum River Watershed Management Organization and DNR to consider. This flow path ultimately results in a discharge of water to the Mississippi River, and will fall under the permitting provisions of the DNR. It also establishes the ordinary high water levels (OHWL) for lakes, and would be issuing a determined level if an outlet is installed on Lake Itasca or any of the public waters wetlands.

**(6)** An access agreement is required to enter BNSF property. Permits can be applied for through the Staubach Group by contacting Shane Krueger (817) 230-2625. Additionally, for safety purposes, the BNSF road and train masters should be contacted prior to the commencement of construction in the vicinity of the railroad tracks. The road master is Ron Raatike who can be contacted at (320) 267-1831 and the train master is Tom Rowley who can be contacted at (612) 865-6531.

## 9. Land Use

*Describe current and recent past land use and development on the site and on adjacent lands. Discuss project compatibility with adjacent and nearby land uses. Indicate whether any potential conflicts involve environmental matters. Identify any potential environmental hazards due to past site uses, such as soil contamination or abandoned storage tanks, or proximity to nearby hazardous liquid or gas pipelines.*

The City of Ramsey *2001 Comprehensive Plan*, as amended in 2002, contains land use maps for both existing (fall 1997) and future (2020) conditions for the site and adjacent lands. Figure 9.1 shows the existing condition, while Figure 5.4 in Item 5 illustrates the 2020 expectation. Metropolitan Council 2000 Land Use was used to portray existing land use. The information that follows characterizes the individual land uses on the Ramsey Town Center site under current conditions and future conditions based on the City of Ramsey *Plan*. Details of compatibility with the City's *Plan* occur in Item 27.

| *Current Land Use (2000 Met Council Land use)* | |
|---|---|
| Commercial: | 5.3 acres |
| Industrial | 13.4 |
| Railway | 12.4 |
| Major Vehicular Roadways | 1.4 |
| Mixed Use | 1.9 |
| Single Family Residential: | 6.0 |
| Farmstead: | 2.8 |
| Undeveloped | 19.2 |
| Agricultural: | 307.1 |
| Total | 369.5 acres |

| *Future (2020) Land Use, from Ramsey Comprehensive Plan, as amended in 2002* | |
|---|---|
| Low Density Residential | 23.4 acres |
| Medium Density Residential | 10.2 |
| Mixed Use | 205.1 |
| Places to Shop | 24.4 |
| Places to Work | 44.3 |
| Railway | 15.7 |
| Roadway | 30.7 |
| Wetlands | 15.7 |
| Total | 369.5 |

AUAR guidelines also call for an assessment of compatibility of the project with adjacent and nearby land uses, including potential impact on environmental resources. Figures 9.1 and 5.4 clearly illustrate the land uses surrounding the project site now and in 2020. Following are the narrative summaries:

*Adjacent Current Land Use:*

North: single-family residential, 149th Lane NW (CR 116), vacant land
East: Ramsey Blvd. NW, Connexus Energy, commercial and industrial properties
South: BNSF Railroad tracks, commercial properties, Hwy. 10, Mississippi Regional Park south of Hwy. 10
West: Armstrong Blvd. NW, commercial and industrial properties, single-family residential properties

*Adjacent 2020 City of Ramsey Land Use:*

North: 149th Lane NW (CR 116), rural residential
East: Ramsey Blvd. NW, Connexus Energy, commercial and industrial
South: BNSF tracks, commercial properties, Hwy. 10, commercial properties, low density residential, West Mississippi Regional Park, Mississippi River
West: Armstrong Blvd. NW, commercial and industrial properties, high, medium, and low density residential

Figure 9.2 identifies nearby environmental resources, as listed in the following descriptions:

*Nearby Environmental Resources:*

- Mississippi River (approximately 2000 ft. to the south) within the Mississippi National River and Recreation Area (MNRRA)
- Lake Itasca (approximately 1.25 miles to the east)
- Several wetlands within 0.25 miles of site
- Complex of wetlands along the drainage swale within the site boundary
- MCBS Mapped Floodplain Forest on island in Mississippi River
- Mississippi Regional Park south of the site, between the site and the Mississippi River

Soils contaminated with lead arsenate on the Southeast corner of the site are a potential hazard. Burlington Northern-Santa Fe Railroad (BNSF) has an agreement with the current landowner to remove the contaminated soils and is working with the MPCA to assure proper clean-up. BNSF should be contacted before earth-moving activities begin. An additional hazard may exist at an abandoned farmstead on the proposed Town Center. Improper handling and storage of hazardous materials at this site could pose a potential contamination hazard to soil and groundwater. Phase I investigations indicate the presence of the materials, but no soil or water samples have been collected or analyzed to date. Several abandoned vehicles at this location may pose an additional contamination hazard. More detailed descriptions and mitigation is discussed in Task 20.

<u>Summary of Environmental Impact.</u> The conversion of the RTC site from agricultural to urbanized land is consistent with the future development plans of the City of Ramsey. This change has the potential to adversely impact the environment of the site and surrounding areas if proper mitigation measures are not followed according to this AUAR. Specific potential impacts are discussed by category in following sections of the AUAR.

Mitigation element. Assuring the compatibility of development within Ramsey as growth occurs is the primary goal of the comprehensive planning process. Item 27 contains discussion of plan compatibility for a number of other planning documents that cover land in and adjacent to the RTC site. Continued planning efforts will assure that non-compatible uses do not occur as the RTC site develops.

As stated above, BNSF is currently working to address a contamination problem in the southeast corner of the site. Prior to any earth-moving activity in this area, the developer must notify BNSF, MPCA and the City to make sure that clean-up has progressed such that additional problems will not be caused.

Many of the nearby environmental resources shown in Figure 9.2 can actually be enhanced by the development of the RTC site. There is an intent to link regional, County and City trails through the site, as well as establishing a drainage corridor that could potentially increase habitat and allow movement of wildlife between Lake Itasca and the Mississippi River. Every attempt will be made to incorporate habitat suitable for this to occur.

## 10. Cover Types

*Instead of the EAW requirements, provide information on the following:*
***10a**. Cover type map, at least at the scale of a USGS topographic map, depicting:*
- *wetlands identified by Circular 30 type*
- *watercourses (rivers, streams, creeks, ditches)*
- *lakes (identify protected waters status and shoreland management classification)*
- *woodlands (breakdown by classes where possible)*
- *grasslands (identify native and old field)*
- *cropland*
- *current development*

***10b**. An "overlay" map showing anticipated development in relation to the cover types; this map should also depict any "protection areas", existing or proposed, that will preserve sensitive cover types. Separate maps for each major development scenario should generally be provided.*

Cover types based on the Minnesota Land Cover Classification System (MLCCS) are depicted in Figure 5.6 (Item 5). This MLCCS was completed to a Level 5 for the Highway 10 Corridor (Mn/DOT) and for the MNRRA Corridor (National Park Service). Figure 10.1 is the wetland delineation map prepared for this site (full report in Appendix A). Data for this map were collected by North American Wetland Engineering (NAWE) in October 2002, and reviewed by a WCA Technical Evaluation Panel (TEP) on February 4, 2003 (see discussion also in Item 12). A revision to the delineation was made on March 14, 2003 and is reflected in the current delineation document.

Figure 5.6 presents MLCCS data for all vegetative and non-vegetative land coverage, including artificial surfaces, planted/cultivated cropland, forests, woodlands (none on site), shrublands (none on site), herbaceous vegetation (including wetlands), nonvascular vegetation (none on site), sparse vegetation (none on site) and open water (watercourses, rivers, streams, creeks, ditches, lakes). Table 10.1 summarizes all of the cover types on the site to Level 5.

Figure 10.2 shows the MLCCS coverage in Figure 5.6 next to the preferred design shown in Figure 6.1. Creating an overlay, as suggested in the AUAR guidelines, created an image with details that could not be seen. This image replaces the suggested overlay. Table 10.1 provides a summary of existing and proposed cover types with both MLCCS and general cover type categories listed for existing and proposed conditions.

Figure 10.1. Wetland Delineation (NAWE, revised March 14, 2003). See Appendix A for full report.

Table 10.1. Summary of Existing and Proposed Cover Types

| Cover Type | Minnesota Land Cover Classification | Circular 39 | Acres | |
|---|---|---|---|---|
| | | | Existing | Proposed |
| Open Water | Littoral – open water (storm water ponds) | NA | 0 | 5.80 |
| | | Subtotal | 0 | 5.80 |
| Wetlands | Cropped Hydric Soils | Type 1 | 8.13 | 0 |
| | Wet Meadow/Wet Prairie* | Type 1 | 0 | 4.45 |
| | Nonnative dominated graminoid vegetation | Type 2 | 2.23 | 0 |
| | Wet Meadow* | Type 2 | 0 | 2.68 |
| | Cattail marsh, seasonally flooded | Type 3 | 0.72 | 0 |
| | Mixed emergent marsh (seasonally flooded)* | Type 3 | .20 | 0.65 |
| | Mixed emergent marsh (semipermanently flooded) | Type 4 | 1.18 | 1.18 |
| | | Subtotal | 12.46 | 8.96 |
| Forests and Woodland | Boxelder-green ash disturbed native forest | NA | 4.01 | 0 |
| | Boxelder-green ash forest with 11-25% impervious cover | NA | 7.58 | 0 |
| | | Subtotal | 11.59 | 0 |
| Grasslands | Long grasses with sparse tree cover | NA | 3.85 | 1.87 |
| | Medium-tall grass, nonnative-dominated | NA | 6.29 | 2.80 |
| | Short grasses on upland soils | NA | 0 | 2.03 |
| | Short grasses and mixed trees with 4-10% impervious cover | | 4.73 | 14.49 |
| | Mesic/Dry Prairie* | NA | 0 | 5.36 |
| | | Subtotal | 14.87 | 26.55 |
| Cropland | Cropland on up-land soils | NA | 284.27 | 0 |
| | | Subtotal | 284.27 | 0 |
| Residential, Commercial, Transportation | Short grasses with 11-25% impervious cover | NA | 13.31 | 4.84 |
| | Short grasses with 26-50% impervious cover | NA | 11.92 | 10.45 |
| | Short grasses with 51-75% impervious cover | NA | 0 | 8.49 |
| | 26-50% impervious with perennial grasses and sparse trees | NA | 2.81 | 2.72 |
| | Short grasses and mixed trees with 11-25% impervious cover | | 6.39 | 7.23 |
| | Short grasses and mixed trees with 26-50% impervious cover | NA | 0 | 75.21 |
| | Short grasses and mixed trees with 51-75% impervious cover | NA | 0 | 88.51 |
| | Buildings/pavement with 76-90% impervious cover | NA | 11.48 | 33.24 |
| | Buildings/pavement with 91-100% impervious cover | NA | 0 | 13.39 |
| | Pavement with 76-90% impervious cover | NA | 0 | 0.31 |
| | Pavement with 91-100% impervious cover | NA | 0.41 | 83.80 |
| | | Subtotal | 46.32 | 328.19 |
| **TOTAL ACRES FOR ALL COVER TYPES** | | | **369.50** | **369.50** |

****Native plant communities created as part of wetland mitigation***

Following is a general description of cover types within the project area:

*Open Water*
Figure 10.3 is a map of DNR Public Waters within the RTC drainage area. Under existing conditions, no lakes, ponds or other open water exists. It is anticipated that under proposed conditions, a total of 7.06 acres of open water will be created. This open water is expected to be created within several stormwater detention ponds proposed for the project.

*Wetlands*
Based on the wetland delineation completed for the project (Appendix A, *Ramsey Station Wetland Delineation Report),* a total of 12.46 acres of wetlands currently exists on the site. Wetland acres are distributed among five separate wetlands, designated as wetlands A though E. The location of these wetlands is shown in Figure 10.1. A breakdown of wetland types for each of the five wetland areas is summarized in Table 10.2. A detailed description of each wetland is provided in Appendix A, *Ramsey Station Wetland Delineation Report.*

Table 10.2. Wetland Inventory According to Circular 39 Classification (NAWE Delineation, October 2002).

| Wetland | Type 1 | Type 2 | Type 3 | Type 4 | Acres | |
|---|---|---|---|---|---|---|
| | | | | | Existing | Proposed |
| A | | 40% | 60% | | 0.72 | 0 |
| B | | 5% | 15% | 80% | 1.18 | 1.18 |
| C | | 50% | 50% | | 0.20 | 0.20 |
| D | | 90% | 10% | | 2.23 | 2.23 |
| E | 100% | | | | 8.13 | 1.91 |
| Total | | | | | 12.46 | 5.52 |

*Forest/Woodland*
Forest and woodland occurs on 11.59 acres of the site under existing conditions. Most of this forest/woodland is located in the vicinity of an abandoned farmstead and several shelterbelt/property line edges. The dominant tree species within these forest/woodlands are boxelder, hackberry, eastern red cedar, black cherry and the non-native Siberian elm. Dominant shrubs include honeysuckle, nannyberry, buckthorn and red raspberry. The ground cover is dominated by mostly weedy native and introduced grasses and forbs including orchard grass, smooth brome, Canada goldenrod and motherwort. In places, the shelter belts contain plantings of Colorado blue spruce. Under proposed conditions, all forest/woodland will be converted to other cover types.

*Grassland*
Grassland occurs on 14.87 acres of the site under current conditions. Grassland is present along field edges, wetland edges, the railroad right-of-way and in slopes of road right-of-ways. There are also patches of grassland with planted conifers (blue spruce, white spruce, red pine) in the northwestern portion of the project area, located to the south and

west of Wetland B. Grassland in the project area is generally dominated by nonnative species of perennial and annual graminoids including smooth brome, orchard grass, Kentucky blue grass, reed canary grass, yellow foxtail and timothy. A few weedy forbs are present including horseweed, wormwood and Canada goldenrod. In general, grassland consisting of long grass will decrease, while grassland consisting of short grass will increase as a result of the project. Grassland cover types will increase to over 26 acres under proposed conditions.

*Cropland*
A total of 292.4 acres of cropland is present on the site under existing conditions. The majority of this cropland has been planted to soybeans or corn. All cropland will be converted to other land covers as a result of the project.

*Residential/Commercial/Transportation*
A total of 46.32 acres of residential/commercial/transportation cover types are presently located on the site. The majority of these cover types contain low percentages of impervious surfaces. Under proposed conditions, the total acreage and percentage impervious will increase significantly. The total acreage of this cover type under proposed conditions will be 328.19 acres, the majority of the project area acreage.

<u>Summary of Environmental Impact.</u> The composition of cover types within the RTC will change substantially from an area dominated by row-crop agriculture with scattered forest and wetland, to urbanized land uses with no agricultural land. Item 11 of this document will discuss natural cover type changes more fully within the context of wildlife habitat. Item 12 will discuss cover type changes with respect to water resource impacts, while Item 17 will discuss how this land use conversion impacts storm water runoff quantity and quality.

<u>Mitigation element.</u> The only issue related to cover type to emerge during this review is the alteration of wetlands, which is discussed in the mitigation element under Item 12. A complete discussion of loss of cover types with respect to fish, wildlife and ecologically sensitive resources follows in Item 11.

## 11. Fish, Wildlife, and Ecologically Sensitive Resources

> ***11a.*** *Identify fish and wildlife resources and habitats on or near the site and describe how they would be affected by the project. Describe any measures to be taken to minimize or avoid impacts. The description of wildlife and fish resources should be related to the habitat types depicted on the cover types maps (of Item 10). Any differences in impacts between development scenarios should be highlighted in the discussion.*
>
> ***11b.*** *Are any state-listed (endangered, threatened or special concern) species, rare plant communities or other sensitive ecological resources such as native prairie habitat, colonial water-bird nesting colonies or regionally rare plant communities on or near the site? _X_Yes __No*
>
> *If yes, describe the resource and how it would be affected by the project. Indicate if a site survey of the resources has been conducted and describe the results. If the DNR Natural Heritage and Nongame Research program has been contacted give the correspondence reference number:* ***ERDB 20030469*** *(Dec. 5, 2002). Describe measures to minimize or avoid adverse impacts.*
>
> *For an AUAR, prior consultation with the DNR Natural Heritage program for information about reports of rare plant and animal species in the vicinity is required. If such consultation indicates the need, an on-site habitat survey for rare species in the appropriate portions of the AUAR area is required. Areas of on-site surveys should be depicted on a map, as should any "protection zones" established as a result.*

*Plant Communities*
The pre-settlement vegetation associated with the RTC was dominated by dry and mesic prairie with oak openings and barrens probably located along the north edge of the site. Today, the RTC site is largely dominated by agricultural land use with only a small portion of the overall site containing low quality native plant communities. Within a one mile radius of the proposed project site are found the following land cover types and natural communities: planted mixed coniferous and deciduous trees, perennial grasses, oak savanna, non-native short- and long-grasses, transitional land, sand and gravel pits, eastern red cedar woodlands, aspen woodlands, non-native upland shrubs, dry prairie, wet prairie, wet meadows, cattail marsh, temporarily flooded aspen forest, mixed hardwood swamps, dry oak savanna, mesic oak savanna, open water wetlands, and the Mississippi River. Table 10.1 and Figure 5.6 detailed existing and proposed cover types within the project area. Figure 11.1 identifies sensitive resources near the RTC site.

*Wildlife Resource*
Wildlife that might occur within the project area are shown in Table 11.1. Wildlife resources are broken into mammals, amphibians & reptiles, and birds. The table includes species that might be present under existing conditions and the possible future occurrence of these species. The table also shows major habitat types that each species is generally

associated with. In addition, for birds, a column is included that indicates migratory status.

Note that no formal survey has been completed for wildlife; therefore, other species not shown in Table 11.1 may be present and species shown in Table 11.1 may not be present. All of the species shown, however, are documented in Anoka County and known to occur in the types of habitat present on or near the RTC site today.

Under existing conditions, the project area provides habitat to species adapted to a mosaic of cropland, wetland, small woodlots and grassland. The most significant habitat on the site is wetland, which may provide habitat for aquatic fur-bearing mammals, such as muskrat and mink, shorebirds and waterfowl. Forest and woodland occur in the northeastern corner, and as patches and windrows in other portions of the project site. These areas would support birds and mammals that require trees for nesting and cover and provide the moist, shaded conditions favorable to amphibians. Fragmentation of these areas, however, would limit the use of these woodlands, particularly for larger mammals and birds that require interior forest habitat. The grassland habitat is generally low in diversity, but would support species that prefer more open areas. Species typically found in disturbed grassland include such species as the plains pocket gopher, red fox and American kestrel. The dry sandy conditions that occur over much of the project area provide habitat for species that prefer loose, sandy soil for burrowing and nesting. Examples include the badger, prairie skink and Blanding's turtle.

Under proposed conditions, all of the forest/woodland and portions of the wetland/grassland will be converted to non-natural cover types. For this reason, the greatest impact will occur to forest associates. Species associated with wetland and grassland will probably continue to be present, but at much lower numbers. The degree to which these species continue to exist will be a function of how fragmented remaining patches of habitat are under post development conditions. An additional factor is how good of quality these patches are.

*Rare Plant Communities*

The *Natural Communities and Rare Species of Anoka and Ramsey Counties Map* (DNR Natural Heritage Program, 1994), shows a high quality flood plain forest plant community on an island of the Mississippi River approximately ½ mile south of the RTC site. No impacts to this floodplain forest plant community area expected.

*Fisheries*

There are no permanent rivers, lakes or ponds known to support fish within the project site. The nearest water bodies supporting fisheries include Lake Itasca and the Mississippi River. No impacts to these fisheries are expected to result from this project.

**11b.** The DNR Natural Heritage Program database was checked for information concerning reports of rare plant and animal species that might be located at or within approximately one mile of the project location. The results of DNR's search of the

Natural Heritage Database©[1] showed that there were no known occurrences on site, but five known occurrences of the Blanding's turtle to the north and west. The general locations of these known occurrences are within Sections 20, 21 and 22, T032N, R25W[1]. The closest record of Blanding's turtles lies approximately ½ mile north of the RTC project area. The Blanding's turtle is a state-listed, threatened species in Minnesota.

Most of the local records of Blanding's turtles correspond to roadway sections between different elements of turtle habitat. Turtles often cross roads as they attempt to travel between different wetland and upland areas that provide for their different habitat needs. The turtles use deeper wetlands and lakes for over wintering; sandy, open areas such as dry prairie and grassland for nesting; and shallow emergent marsh and shrub swamps for forging (Oldfield and Moriarty, 1994). These key habitats can be further described as (Lang, 2002):

> 1) **Activity season wetlands**, encompassing a variety of wetland types and sizes that are typically occupied for various periods during the spring, summer and fall;
> 2) **Over-wintering wetlands**, comprising specific wetlands that provide refuge from lethal winter temperatures and protection from predators during inactivity; and
> 3) **Nesting uplands**, characterized by exposed, well drained soils, used largely during the reproductive season by reproductive females and emerging hatchlings.

Local Blanding's turtle records (DNR Natural Heritage Program, 2003), showed turtle movement during times of the year when they emerge from over wintering wetlands and disperse into activity season wetlands, or as they travel to nesting uplands during the month of June.

The wetland and grassland habitat concentrated around the northwest corner of the RTC site provides potential Blanding's turtle habitat. In particular, the constructed wetland and adjacent wetland swales (delineated wetlands A, B and C), provide potential habitat. This area provides over-wintering habitat within the constructed wetland (Wetland B). Limited activity season habitat is available due to the small size of wetlands, degree of fragmentation and agricultural land uses. Nesting upland habitat is marginal due to the fact that agricultural activities would typically disturb turtle nest before hatchlings have emerged from the nest. Areas not subject to agricultural disturbance are generally narrow or small and would tend to concentrate predators resulting in high mortality. Other possible areas of Blanding's turtle habitat include the wetlands located along the north portion of the RTC, including the two DNR Public Waters Wetlands (670W and 671W). 2.23 acres of DNR Wetland 670W, (delineated wetland D) is located within the project boundaries. Both of these wetlands would be considered activity season wetlands and do not contain sufficient depth of water (under existing conditions) to support over-wintering turtles. Nesting upland habitat is potentially available adjacent to these wetlands.

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Under post-development conditions, turtles attempting to move through or into the RTC site will encounter many physical obstacles. Examples include curb and gutter, retaining walls, discontinuous waterways, stormwater control structures such as skimmers and submerged culverts. These barriers also impact other reptiles, amphibians and mammals attempting to move though the site.

Summary of Environmental Impact.

*Natural Communities:* Table 10.1 summarizes changes in cover types, including natural communities for post-development conditions. The most significant impacts will be to wetlands and forest/woodlands. No impact to the floodplain forest community on the Mississippi River island is expected.

*Fish and Wildlife Habitat:* Wildlife that currently use the mixture of agricultural land, forest, grassland and wetland will likely be eliminated or reduced in proportion to acres of habitat converted to other land uses. Additional impacts are expected to occur due to increased mortality related to traffic and other accidents, predation by domestic animals and pesticides and other chemicals concentrated by stormwater runoff.

*Blanding's Turtles:* Blanding's turtles potentially occur within the project area, either as individuals of nearby populations passing though in route to other areas, or as individuals using specific habitats within the RTC site. Under post-development conditions, turtles may continue to use portions of the site, namely some of the wetlands clustered around the north and northwest portions of the site. These turtles will likely encounter many obstacles and hazards and for this reason the project could be a sink to nearby turtle populations.

Mitigation element.

*Natural Communities:* Item 12 of this report addresses wetland mitigation fully. Mitigation for loss of forest/woodland can be accomplished though additional tree planting within some areas of the site listed in Table 10.1 as containing grassland communities. Additional forest/woodland planting can be incorporated into planting plans for the infiltration/wetland system extending south from the RTC site to the Mississippi River. The edges of the wetlands and infiltration areas could be established as an oak savanna/woodland natural community.

*Wildlife Habitat:* Several strategies are proposed to mitigate impacts to wildlife. These include:

1). Establish Greenway Corridor Though the Site. A proposed greenway corridor is shown in Figures 6.1, 12.5 and 12.6. The corridor will incorporate a system of wetland treatment ponds, infiltration ponds and constructed wetlands. Areas of the corridor up to the 100-year flood elevation will be planted to a mixture of native short grasses and forbs. Although this corridor will not extend though the site completely, it will provide an opportunity for some species (those more tolerant of human presence, noise, etc.) to use natural areas within the site, and to move to and from larger tracks of habitat connected to the site.

2). Wetland Restoration and Creation. As described in Item 12, the combination of existing wetlands and created wetlands will provide more diverse habitat than is generally available now. Most of the existing wetlands have either been cropped or have very low vegetative diversity (primarily reed canary grass). These wetlands will be restored to native wet prairie, wet meadow and shallow emergent marsh. Wetlands within the RTC portion of the greenway will be planted to shorter species of grass and forbs, but will be un-mown, and will provide habitat for many of the wetland species currently found on the RTC site. Additional areas of riparian buffer will be established to provide some upland habitat.

3). Culverts and Road Crossings. To the extent possible, all culverts and road crossings will be designed to enable upstream or downstream passage of wildlife as they move though the greenway. During dry conditions, most of the culverts are expected to be available for terrestrial species to move though. During wet conditions, these culverts may only enable species that swim or move through water to pass through. Fences at major road crossing will be designed and placed so as to funnel wildlife though these crossing areas. These same fences may also be used to discourage larger species, such as white-tailed deer, from crossing roads where they may become a traffic hazard.

*Blanding's Turtles*
Strategies outlined for Wildlife Mitigation generally apply to Blanding's turtles. Appendix C is the DNR Fact Sheet and Hand-out on Blanding's Turtles. Several additional recommendations applying to Blanding's turtles follow:

1). The system of infiltration ponds and wetlands proposed south of the RTC site between TH 10 and the Mississippi River can be designed to provide additional turtle habitat. This system, if developed, should incorporate some deep, over-winter pond area along with a good diversity of wetland community types. Some excavated material should be retained on-site to create sandy, dune-like areas planted to sand gravel prairies. These areas could provide excellent nesting habitat for Blanding's turtles.

2). Culvert crossings should be designed so that water (when flowing) flows continuously though the pipe, with no physical barriers such as weirs or gates blocking upstream or downstream travel.

3). Fencing may be used to guide or block movement. Depending on the final design of the greenway/stormwater conveyance system, access to the site by turtles should be blocked to reduce the possibility that the site will become a sink to nearby turtle populations.

## 12. Physical Impacts on Water Resources

*Will the project involve the physical or hydrologic alteration (dredging, filling, stream diversion, outfall structure, diking, and impoundment) of any surface waters such as a lake, pond, wetland, stream or drainage ditch?* _**X**_*Yes* __*No*

*If yes, identify water resource affected and give the DNR Protected Waters Inventory number(s) if the water resources affected are on the PWI. Describe alternatives considered and proposed mitigation measures to minimize impacts.*

*For an AUAR, the information called for on the EAW form should be supplied for any of the infrastructure associated with the AUAR development scenarios, and for any development expected to physically impact any water resources. Where it is uncertain whether water resources will be impacted depending on the exact design of future development, the AUAR should cover the possible impacts through "worst case scenario" or else prevent impacts through the provisions of the mitigation plan.*

*Surface Water Hydrology*

The Ramsey Town Center site lies within the Lower Rum River Watershed Management Organization (LRRWMO) boundaries, but actually discharges south to the Mississippi River. The RTC lies within a watershed that extends from Lake Itasca, southeast to the Mississippi River. Figure 12.1 shows the sub-watersheds within this drainage area, as well as the water resource features within this watershed.

Soils on site are illustrated in Figure 12.2, and are discussed in Items 19 and 25.

The following analysis describes direct and indirect impacts to water resources associated with the RTC. A detailed description of watershed hydrology and the stormwater conveyance system is contained in Item 17.

*Description of Water Resources and Related Impacts*

A wetland delineation was performed in October 2002 by North American Wetland Engineering (NAWE) and reported in November 2002. The results of this delineation were revised on March 14, 2003 after discussion with the WCA Technical Evaluation Panel (TEP) convened to review the delineation. Figure 10.1 shows the location of delineated wetlands located wholly or partially within the RTC project area. Note that wetlands within the project area are denoted by an identifying letter (from A-E). The complete *NAWE Wetland Delineation Report* is contained in Appendix A. Figure 10.3 showed the location of DNR Public Waters within the RTC drainage area. Figures 12.3 and 12.4 show the location of all wetlands within the RTC project area with respect to wetland impacts. A description of each water resource is provided in Table 12.1 and a discussion of each of these water resources with respect to potential impacts follows.

Table 12.1 – Water Resources Potentially Impacted

| Basin Name/ID | PWI | Within Project Area* | Wetland Impact (acres) | Type of Impact |
|---|---|---|---|---|
| A | NA | T | 0.72 | Fill |
| B | NA | T | 0 | Indirect - Stormwater Discharges |
| C | NA | T | 0 | Indirect - Stormwater Discharges |
| D | 670W | P | 0 | Indirect - Stormwater Discharges |
| E | NA | T | 6.22 | Fill/Conversion to Stormwater Pond |
| Lake Itasca | 110P | O | 0 | Potential Outlet |
| Unnamed Wetland | 671W | O | 0 | Potential Outlet |
| Mississippi River | NA | O | 0 | Outfall Structure |
| **TOTAL ACRES IMPACTED** | | | **6.94** | |

** T – Totally within project area*
*P – Partially within project area*
*O – Outside project area*

*Wetland A:* Wetland A is expected to be completely filled as part of the project. A total of 0.72 acres of Type 2 and Type 3 wetland will require mitigation.

*Wetland B:* Wetland B is a 1.18 acre Type 4 wetland. This wetland was constructed in 1997 for mitigation of the Anoka County Road 116 road construction project. The mitigation site has a permanent conservation easement that encompasses both the wetland and an upland buffer area. Stormwater from the RTC has the potential to indirectly impact this wetland by altering the wetland hydroperiod and increasing the discharge of sediments, nutrients and other pollutants. No direct impacts are anticipated to this wetland.

*Wetland C:* Wetland C is a 0.20 acre Type 2 and Type 3 wetland. Stormwater from the RTC has the potential to indirectly impact this wetland by altering the wetland hydroperiod and increasing the discharge of sediments, nutrients and other pollutants. No direct impacts are expected to this wetland.

*Wetland D:* Wetland D lies partially within the RTC project and is the only public waters wetland (670W) located within the project area. This wetland is landlocked and does not outlet under existing conditions. The City of Ramsey has proposed installation of an outlet from this wetland, south into the RTC stormwater conveyance system. Any outlet installed for this wetland will be above the DNR ordinary high water (OHW) elevation. Since a key strategy for stormwater management is to maintain or provide on-site storage where possible, this outlet will consist of an emergency overflow located at or above the 100-year flood elevation of 868.0 feet. No OHW is established for this wetland, nor are wetland impacts expected from placement of this outlet pipe.

*Wetland E:* At 8.13 acres, Wetland E is the largest wetland in the RTC project area. This wetland is located within a shallow, linear, drainage swale that bisects the west central portion of the RTC project area. This entire wetland has been row cropped to soybeans or corn during recent years. A total of 6.22 acres of Type 1 wetland will be directly impacted though a combination of fill and conversion to stormwater ponds. The remaining 1.91 acres will be retained within a proposed water way corridor and 6.22 acres of Wetland E will require mitigation.

*Lake Itasca:* Lake Itasca and its direct drainage area are located approximately 1.2 miles northwest of the RTC (Figure 12.1). A lake overflow elevation of 871 was determined from a field survey of the area and two-foot contour information from development plans. An analysis of lake elevations for the 100-year, 24-hour rainfall and 100-year, 10-day snowmelt events, show that Lake Itasca does not outlet from the low point along the southeast side of the lake. This assessment held true for both existing and future land uses. Lake levels do, however; rise to within a few one hundredths of a foot for the 100-year, 10-day snowmelt event and within ½ foot for the 100-year, 24-hour rainfall events. For this reason, the City of Ramsey has proposed installation of an outlet for the lake. Since a DNR permit would be required for an outlet below the DNR OHW, it has been assumed that any outlet would be above the OHW and above the 100-year flood elevation of approximately 871.0 feet. This outlet would provide assurances that existing and future homes will not be impacted by high water. No impacts to Lake Itasca or adjacent wetlands are anticipated.

*Mississippi River:* The Mississippi River is located approximately ½ mile south of the RTC. There currently is no outlet from the RTC to the River; all flow leaving the site crosses Highway 10, flows to the southeast in a ditch, and eventually infiltrates. As shown in Figure 17.2c, an overland waterway system is proposed to convey stormwater south from the RTC to the Mississippi River. This waterway system would consist of a series of water quality treatment ponds, infiltration ponds and constructed wetlands. As discussed in Item 17 of this AUAR, a peak flow rate of 25.3 cfs is predicted under post-development conditions for the 100-year storm event. For small events (1-year and less), discharge ranges from 14.2 cfs, assuming no infiltration in the ponds, to 2.3 cfs when infiltration is included. The outfall to the Mississippi River is proposed to follow a County owned linear piece of land that extends from Highway 10 to the River (see Figure 12.5). The use of this property is not confirmed by the County at this time, but discussions continue. If built, the outlet will consist of a 21-inch pipe, enlarged near the Mississippi River to reduce velocities. Potential impacts include disturbance to the river bluff line where the outfall pipe is installed and in-stream scour and erosion where the pipe meets the river. If the County alternative outlet is not approved, an alternative alignment along Highway 10 to the southeast, with a connection to the River will be pursued.

*Groundwater-Surface Water Interaction and Wetland Impacts*

As part of the wetland delineation (Appendix A, *NAWE Wetland Delineation Report)* completed for this AUAR, aerial photography for the period 1981 – 1996 was analyzed to determine if any trends existed with respect changes in wetland hydrology. The aerial photography analysis showed that for the period 1981 though 1996, the acreage of wetlands remained fairly constant. Beginning in 1997, however, the acreage of wetlands visible on the aerial photography declined sharply. With this decline, the area of wetlands visible on aerial photos became progressively smaller each year. Since this decline, wetland hydrology (as defined by water pooling on the surface) has not returned to pre-1997 levels, in spite of the fact that in recent years, northwestern Anoka County has received normal levels of annual precipitation. Both 2000 and 2002 were determined by the State Office of Climatology to be normal precipitation years. An on-site assessment of wetland hydrology and vegetation completed as part of the wetland delineation concurs with the aerial photography analysis.

A groundwater elevation and soils study was conducted by Braun Intertec in January 2003 to evaluate if the wetlands were influenced by groundwater. Results of the study indicated the wetlands at and adjacent to the site are groundwater dependent and directly linked to the regional groundwater system. The study showed that wetland hydrology is not linked to localized conditions, such as impermeable clay lenses that function to ―perch” the wetlands above the water table.

There are several land use changes and other activities that might have had an impact on the regional groundwater system. In 1997, County Road 116 (including wetland B) was constructed along the north side of the RTC site. It is possible that this road construction interrupted groundwater flows; however, wetlands both up-gradient and down-gradient of the County Road 116 (with respect to ground water flow direction), appear to be impacted. The City of Ramsey also installed two new municipal wells (Wells No. 3 and 4) along the north side of the County Road 116. Because there are no data linking groundwater pumping to surface water response, these ―new” land uses cannot be conclusively proven to have caused the changes in hydrology. It is, however, evident that the groundwater influence, wherever it may come from, on the wetlands has changed. Additional data on the influence of land uses and groundwater appropriations is needed to conclusively determine if these activities are impacting groundwater-dependent wetlands.

<u>Summary of Environmental Impact.</u>

*Wetlands – Direct Impacts:* Table 12.2 summarizes direct wetland impacts associated with the RTC. A total of 6.94 acres of wetland impact will result from the RTC. A break down of wetland types impacted is also shown.

Table 12.2 Summary of Wetland Impacts

| Wetland Type | Acres of Impacted Wetland | | Totals (acres) |
|---|---|---|---|
| | Wetland A | Wetland E | |
| 1* | | 6.22 | 6.22 |
| 2 | 0.28 | | 0.28 |
| 3 | 0.44 | | 0.44 |
| 4 | | | |
| 5 | | | |
| **Total** | 0.72 | 6.22 | 6.94 |

**** All Type 1 Wetland is row cropped under existing conditions***

*Wetlands – Indirect Impacts:* Indirect impacts to wetlands include discharge of stormwater, interference with groundwater-surface water interactions and fragmentation of wetland and upland habitat that diminishes wildlife habitat functions.

*DNR Public Waters:* Outlet structures are proposed on two public waters wetlands and one lake. These structures are generally proposed to be installed above the OHW and 100-year flood elevation. No impacts are therefore expected within these public waters. The proposed stormwater outfall to the Mississippi River could impact the river bluff zone through alteration of shoreline vegetation, increased susceptibility to erosion, aesthetic views and water quality impacts (discussed in Item 17).

<u>Mitigation element.</u>

*Wetland Sequencing* - Minnesota Rules 8420, also known as the Wetland Conservation Act (WCA), requires specific steps (―sequencing”) be taken when evaluating mitigation for unavoidable wetland impacts. The WCA requires that wetland impacts be avoided, if possible. If wetland avoidance cannot be accomplished, impacts to wetlands need to be minimized. Finally, any wetland impacts that can not either be avoided or minimized to the extent possible, must be mitigated though wetland replacement. The wetland replacement must mitigate all wetland functions and values lost as part of the wetland impact.

The degradation present on site allows the applicant to evaluate sequencing flexibility in their mitigation plan. It also allows the Technical Evaluation Panel (TEP) the opportunity to be flexible on the sequencing provisions of the WCA rule. This process may only be applied in the event the wetlands on-site are degraded to the point where replacement of the wetland would result in a gain in functions and values. This is an item that will be considered by the TEP during the permitting process.

Wetlands located on site are described in the Wetland Delineation Report (Appendix A), and are discussed in Item 10. With a few exceptions, wetlands located within the boundaries of the RTC are either cropped or are of low quality. These wetlands have marginal functions and values due to their low vegetative diversity, partial drainage and lack of connectivity to other nearby wetlands and natural areas. Sequencing is addressed as follows:

*Avoidance:* The better quality portions of existing wetlands are generally avoided. This includes all of wetlands B, C and D.

*Minimization:* The mix of development proposed as part of the RTC requires that retail, commercial and residential land use blocks are a minimum size with adequate infrastructure to service them. The focus of minimization has been to incorporate as much of existing wetland area into a central greenway corridor, thereby lowering overall wetland loss across the project site. To avoid indirect impacts to remaining wetlands, each of the development blocks will incorporate a treatment train of stormwater best management practices designed to improve water quality and lower wetland bounce magnitude and duration. Currently, row cropping occurs into the wetlands. The RTC will incorporate wetland buffers wherever practical.

*Wetland Replacement*: The LRRWMO Stormwater Management Plan provides that the following may be eligible for wetland replacement credits:

- Creation of –new” wetland - Rules, Sub-part 11;
- Addition of –public value” Rules, Sub-part 6;
- –Public value” restoration from invasive species to permanent native, non-invasive species - Rules, Sub-part 8; and
- Incorporation of –water quality treatment ponds” under the criteria contained in Sub-part 10(A* and B), with nature of –credit” determined by LRRWMO.

**The City of Ramsey has adopted the LRRWMO stormwater management plan by reference for this portion of the City, thus qualifying the City for eligibility under this element.*

As Table 12.2 shows, a total of 6.94 acres of wetland will be impacted and require replacement. A central feature of the RTC is a greenway corridor running though the central portion of the site. A system of stormwater ponds, infiltration swales and meandering channels will link flows entering the site from the northwest with flows generated on-site. This –waterway” will continue south from the RTC to the Mississippi River. Within the context of this waterway system, on-site wetland replacement will be provided though a combination of new wetlands, upland buffers and water quality improvement ponds designed to improve functions and values to downstream wetlands. The location of proposed on-site wetland replacement is shown in Figures 12.3 and 12.4. Table 12.3 summarizes the acreage and type of wetland replacement for each location. A general description for each wetland replacement site follows.

Table 12.3 Summary of Proposed Wetland Mitigation

| Wetland Type Created | Wetland Replacement by Location (Drainage Area) | | | | | | | | | Totals (acres) |
|---|---|---|---|---|---|---|---|---|---|---|
| | **6** | **7** | **8** | **10** | **18** | **19** | **24** | **26a** | **26b** | |
| Type 1 | | | 1.35 | | | 1.30 | 1.80 | | 1.90 | 6.35 |
| Type 2 | | | | | | | 0.45 | | | 0.45 |
| Type 3 | | | | | | | 0.45 | | | 0.45 |
| Type 4 | | | | | | | | | | |
| **Subtotal** | | | 1.35 | | | 1.30 | 2.70 | | 1.90 | 7.25 |
| | | | | | | | | | | |
| PVC* (Stormwater) | | 2.30 | | | 3.50 | | | 3.40 | | 9.20 |
| PVC* (Buffers) | 0.81 | | 1.35 | | | 1.30 | | | 1.90 | 5.36 |
| PVC* (Restoration) | 0.77 | | | 3.79 | | | | | | 4.56 |
| **Subtotal** | 1.58 | 2.30 | 1.35 | 3.79 | 3.50 | 1.30 | | 3.40 | 1.90 | 19.12 |
| | | | | | | | | | | |
| | | | | | | | | | **Grand Total** | **26.37** |

***PVC – Public Value Credits***

*Drainage Area 6* includes three existing wetlands (Wetland B, C and E). Wetland B is a created wetland that includes a narrow buffer within a conservation easement. The existing drainageway will be left intact, while 0.81 acres of the cropped wetland will be restored to a Type 1, wet prairie wetland. A 0.77-acre riparian buffer will be incorporated along the wetland transition zone in this area.

*Drainage Area 7* will include a 2.30-acre stormwater detention pond. This pond will include a shallow bench that will support a fringe of emergent vegetation. Since this pond will provide pretreatment of stormwater that will benefit the wetland immediately downstream of it (within Drainage Area 8), it is proposed for public value wetland credits.

*Drainage Area 8* includes 1.35 acres of wetland and 1.35 acres of PVC buffer with a meandering channel flowing though it. Portions of the basin will be designed to establish Type 1, wet meadow/wet prairie wetland hydrology. The basin will be established with respect to groundwater levels and a low weir will be installed in front of the outlet such that infiltration will be maintained, but water will be retained at a frequency to facilitate saturation of soils. Finer soils could be mixed in to promote Type 1 vegetation.

Within *Drainage Area 10*, and along the north boundary of the RTC site, is a 3.79 acre wetland, where 2.23 acres of this wetland is within the RTC site and is denoted as ―Wetland D”. This wetland is a low quality reed canary grass monotype with a few small areas of mixed emergent marsh vegetation. A total of 3.79 acres of wetland restoration and buffer PVC is proposed for this wetland. The primary objective of this restoration would be to remove the non-native reed canary grass and reestablish a diverse, wetland community of wet meadow and mixed emergent marsh. Since portions of this 3.79-acre wetland occur on private property, landowner cooperation would be necessary to successfully restore this wetland. The 3.79 acres of proposed restoration includes both wetland restoration and establishment of buffers.

*Drainage Area 18* will include a 3.5-acre stormwater pond that will function much the same as the stormwater pond proposed for Drainage Area 7. The concept design described for Area 7 generally applies to Area 18.

The wetland system in *Drainage Area 19* will function in a way similar to Drainage Area 8; that is, it will include a narrow, meandering, perennial stream with a wet meadow/wet prairie fringe. The design concept described for Drainage Area 8 describes this wetland. A total of 1.3 acres of wetland and 1.3 acres of buffer are proposed for Drainage Area 19.

*Drainage Area 24:* This drainage area encompasses a linear area between the Railroad ROW and the RTC. This entire strip of land encompasses some 10.8-acres of land. A total of 2.7-acres, or 1/4 of Area 24, is proposed as new wetland credit. A central, meandering drainage-way of Type 3 wetland is proposed. The edges of this wetland will be bordered with Type 1 and 2 wetland meadow.

*Drainage Area 26:* Development of this combined wetland/infiltration system is conditioned on approval by Anoka County. This system would receive flows from Drainage Area 25 and would include a wetland treatment/stormwater pond (26a). From this initial pond, flows would outlet into an infiltration pond/wetland system (26b). A landscape theme that incorporates a mixture of dry prairie, oak savanna, and wet prairie with an ephemeral water-way could serve as the cornerstone for this area and provide a valuable link between RTC and Mississippi West Regional Park.

*Off-Site Wetland Mitigation*
Two additional areas have been identified for off-site wetland mitigation in the event on-site mitigation is not feasible. These sites are illustrated in Figure 12.5.

Site #1 would be within the Mississippi Regional Park when development of the park proceeds. Although a specific location cannot be identified at this time, the City, WMO and County would work together to select and develop a site that would hold the best potential for successful wetland establishment. Figure 12.6 illustrates the Anoka County Park Department's concept for how the Park will be designed. Several locations could be possible sites for incorporation of ―new" wetland. To accomplish this action in the future, RTC LLC would need to escrow an amount of funds sufficient to construct the additional wetland acreage not provided for on-site.

Site #2 is located along the south - southeast side of Lake Itasca on land already owned by the City of Ramsey. This area currently contains some excellent quality shrub swamp, wet prairie and emergent marsh along the shores of Lake Itasca. A suitable site could be located where wetland does not currently exist, but where adequate hydrology is available. There are also several areas of reed canary-dominated wetland that could be improved for public value credit though re-establishment of native wetland communities. Any wetland improvements in this area could be designed to also improve Blanding's turtle habitat.

The following are proposed to mitigate impacts associated with the stormwater outfall to the Mississippi River:

*Reduce Frequency of Stormwater Discharge, Lower Magnitude of Peak Flow Rates:* The RTC project incorporates a variety of strategies to lower increases in stormwater rate and volume. While all stormwater conveyance features are designed to accommodate the 100-year runoff event without taking infiltration into consideration, on-site retention and infiltration can be incorporated at multiple scales into the RTC during the detailed design phase for smaller storm retention. Peak flow rates for the 100-year, 24-hour runoff and 100-year, 10-day snowmelt events are 25.1 cfs and 25.3 cfs respectively.

*Oversize Culvert and Reduced Slope at Outfall:* The last section of culvert will be enlarged from 21-inches to 36-inches and include an apron and rip-rap to lower velocities and dissipate the energy at the discharge point. This will minimize the potential for scour and erosion.

*Directional Boring to Install Culvert:* If possible, the culvert will be placed within the river bank by directional boring rather than an open cut. This will reduce the need to remove shoreline vegetation and will minimize the area of disturbance. Erosion control measures will be implemented where soil is disturbed. All disturbed areas will be replanted to native trees, shrubs, grasses and forbs and if appropriate, a temporary cover crop will be established.

## 13. Water Use

*Will the project involve installation or abandonment of any water wells, connection to or changes in any public water supply or appropriation of any ground or surface water (including dewatering)?  _**X**_Yes   __No*

*If yes, as applicable, give location and purpose of any new wells; public supply affected, changes to be made, and water quantities to be used; the source, duration, quantity and purpose of any appropriations; and unique well numbers and DNR appropriation permit numbers, if known. Identify any existing and new wells on the site map. If there are no wells known on site, explain methodology used to determine.*

*If the area requires new water supply wells, specific information about that appropriation and its potential impacts on groundwater levels should be given; if groundwater levels would be affected, any impacts resulting on other resources should be addressed.*

*Background*

Ramsey residents, businesses and others receive their water from one of two sources; the City of Ramsey municipal water system or privately owned wells.  Those with private wells are mainly located in the Rural Preserve, Central Rural Reserve, Rural Developing and un-served areas of within the Urban Growth Boundary.  Those receiving water from the municipal water system are generally located in the Existing MUSA area (Figure 13.1).

Future municipal water users would be those new developments occurring within the existing MUSA and those areas within the Urban Growth Boundary as designated in the *2001 Ramsey Comprehensive Plan,* as amended in 2002 *(Plan)*.  Extension of municipal water service into areas outside of the Urban Growth Area may be necessary at a future date due to environmental or public health concerns.  The *Plan*, however, states that there are no known concerns at this time and, therefore, there is no known timeline for if or when service may be extended.

*Population Projections*

The *1999 City of Ramsey Water Study* prepared by Bolton and Menk, Inc., estimated population growth and water service categories as shown in Table 13.1.  This report has served as the primary planning document for the City's municipal water system and was incorporated by reference into the City's *Comprehensive Plan.*

Table 13.1 Population Projections and Water Service Category

| Year | Total Population | Rural Population (Private Wells) | Urban Population | Municipal Water Service Population |
|---|---|---|---|---|
| 2000 | 19,630 | 8,768 | 10,862 | 8,412 |
| 2005 | 21,748 | 9,403 | 12,345 | 12,345 |
| 2010 | 23,865 | 10,037 | 13,828 | 13,828 |
| 2015 | 26,873 | 10,939 | 15,934 | 15,934 |
| 2020 | 29,880 | 11,840 | 18,040 | 18,040 |

These numbers only represent residential populations and do not include water used by businesses for manufacturing, customers, employees, etc. In addition, growth projections for the City were slightly increased in the Comp Plan. Table 13.2 outlines this information. The last column of this table estimates the number of residents and employees that will be served by the municipal water system based on the ratio of rural to urban residents shown in Table 13.1 above.

Table 13.2 *2001 Comprehensive Plan* Population Projections by City of Ramsey

| Year | Population | Number of Households | Number of Employees | Population Served by Municipal System |
|---|---|---|---|---|
| 1990 | 12,408 | 3,620 | 1,941 | --- |
| 2000 | 19,630 | 5,950 | 2,500 | 11,000 |
| 2010 | 25,050 | 8,350 | 7,000 | 22,000 |
| 2020 | 32,250 | 10,750 | 9,000 | 28,000 |

*Existing Water System Description*

Water Supply. The City currently operates five municipal wells in two well fields (Figure 13.2) and anticipates drilling an additional well in the near future. Approved wellhead protection plans for both well fields are on file with the Minnesota Department of Health (MDH).

All five wells have been developed in the Franconia-Ironton-Galesville (FIG) aquifer. A more complete description of the subsurface stratigraphy and geologic morphology is provided in Item 19. Figure 19.3 graphically displays the well drilling logs for the three wells on and adjacent to the RTC site.

Table 13.3 summarizes the capacity of each well and its permitted appropriation.

Table 13.3: Well Capacities and Permitted Appropriations

| Well | DNR Permit Number | Unique Well Number | Permitted Flow (gpm) | Permitted Withdraw-al (MGY) | Pump Capacity (gpm) | Maximum Annual Capacity (MGY)(1) |
|---|---|---|---|---|---|---|
| No. 1 | 856005-1 | 161441 | 4,900 | | 970 | 424.860 |
| No. 2 | 856005-2 | 416183 | 4,900 | | 220 | 96.360 |
| No. 3 | 856005-3 | 580303 | 4,900 | | 1,450 | 635.100 |
| No. 4 | 856005-4 | 580313 | 4,900 | | 855 | 374.490 |
| No. 5 | 856005-5 | 593672 | 4,900 | | 900 | 394.200 |
| Total | | | | 500(2) | 4,395 | 1,925.010 |

(1) Assumes 20-hour pumping day for 365-days and does not allow for recharge or resting of the aquifer.
(2) Current DNR Permit allows a combined annual appropriation of 500 MGY.

Water Storage. Storage and distribution pressure for the municipal water system is provided by two elevated storage tanks with capacities of 0.5 and 1.5 million gallons respectively. The *1999 Water System Study* demonstrated the need for the construction of additional elevated storage to meet future demands on the water system. This recommendation was based on an analysis of existing and projected future flows and included factors such as fire flow capacity, emergency storage, daily peak use, and water supply and pumping capacity.

Table 13.4 lists the existing water storage facilities as well as those projected in the *1999 Water System Study* for future construction. The location of these facilities is indicated in Figure 13.3.

**Table 13.4: Existing and Future Water Storage Facilities**

| Description | Usable Storage Volume (gal) | Year Constructed | High Water Elevation |
|---|---|---|---|
| Reservoir No. 1 | 500,000 | 1989 | 1036 |
| Reservoir No. 2 | 1,500,000 | 2000 | ±1035 |
| Reservoir No. 3 | 1,000,000 | Projected 2009 | N/A |

Water Treatment. The City does not currently operate a water treatment plant. The current water supply does not violate any of the Primary Drinking Water Standards provided for in the Safe Drinking Water Act. Therefore, water treatment would be required only to treat for secondary contaminants and aesthetic purposes. Because of this, the existing City Capital Improvement Program (CIP) projects constructing a water treatment plant within approximately five years.

Table 13.5 is a summary of average water quality data for the system. Variations in quality may occur periodically due to minor differences in concentrations of each contaminant and depending on which well or combination of wells in operation. Planning for water treatment will occur within the design of the RTC site. Funding for a water treatment facility needs to be identified concurrent with approval for the RTC. This facility should be on line consistent with 60% of the RTC site or completion of wells #6 and #7.

Table 13.5: Water System Quality Data

| **Parameter** | **Average Level of Water Quality Parameter(1)** | **Primary Drinking Water Standard** | **Secondary Drinking Water Standard** |
|---|---|---|---|
| Langelier Index (standard unit) | 0.43 | | |
| Total Iron (mg/l as Fe) | 0.87 | | 0.3 |
| Manganese (mg/l as Mn) | 0.21 | | 0.05 |
| Calcium (mg/l as Ca) | 58 | | |
| Calcium Hardness (mg/l as $CaCO_3$) | 145 | | |
| Magnesium (mg/l as $CaCO_3$) | 12 | | |
| Magnesium Hardness (mg/l as $CaCO_3$) | 50 | | |
| Total Hardness (mg/l as $CaCO_3$) | 195 | | |
| Sodium (mg/l as Na) | 8 | | |
| Arsenic (mg/l as As) | 0.006 | 0.010 | |
| Chloride (mg/l as Cl) | 15 | | 250 |
| Sulfate (mg/l as $SO_4$) | 4.83 | 400 | 250 |
| Total Alkalinity (mg/l as $CaCO_3$) | 221 | | |
| pH (Standard Unit) | 7.9 | | 6.5 – 8.5 |
| Total Dissolved Solids (mg/l) | 210 | | 500 |

(1) Based on data collected on 4/6/99 and extrapolated from the 1999 Water System Study. In addition, each parameter has been normalized based on average annual pumping times and rates for each well.

The City currently adds chlorine, fluoride, and polyphosphate to the raw water at each well-house. Chlorine is added as a protective barrier against harmful pathogens that may enter the water system from the raw well water or through breaks or cross connections in the distribution system. Fluoride is added as a dietary supplement that aids in the prevention of tooth decay. Polyphosphate is added to prevent the precipitation of iron and, to a lesser extent, manganese primarily for aesthetic purposes, such as color, and to prevent the staining of plumbing fixtures and laundry.

*Water Distribution.* The City's water distribution system is comprised of 6-, 8-, 10-, 12- and 16-inch ductile iron pipe. The system includes various necessary appurtenances such as isolation valves, altitude/pressure valves, and fire hydrants. In 1999, the distribution system was analyzed by Bolton and Menk, Inc., using the CYBERNET Hydraulic

Network Model. Results of the model indicated that the system functions well by meeting demand for the existing uses.

Computer modeling and analysis of future expansions to the distribution network, including the RTC development, should be performed at the time of design to ensure there is no impact on the existing users.

*Projected Future Water Demands*

Flow Projections. Development of the RTC site and the remaining areas within the Urban Growth Boundary will result in an increased demand on the existing water system. Projections for the additional demands will be developed in this section in an effort to quantify the potential impacts on the existing water system infrastructure, ground water resources and other related resources.

Projections of future demands from the RTC site will be based on the latest Design Concept Plan (February 15, 2003, as shown in Figure 6.1). Projections for demands from additional growth in areas within the Urban Growth Boundary will be based on information contained in the *2001 Comprehensive Plan*, as amended in 2002.

**Table 13.6: Projected Water Usage for RTC Sub-district Residential Development**

| Development Type | Quantity | Occupants per Unit | Total Occupants | Usage per Occupant(1) (gpd) | Total Usage (gpd) |
|---|---|---|---|---|---|
| Mixed Use Residential | 1012 | 5 | 5,060 | 120 | 607,200 |
| Apartment | 172 | 3 | 516 | 120 | 61,920 |
| Duplex | 62 | 4 | 186 | 120 | 22,320 |
| Townhouse | 1154 | 4 | 4,616 | 120 | 553,920 |
| **Total Residential** | **2,400** | | **10,378** | **120** | **1,245,360** |

(1) Per capita usage based on historic average annual usage for existing Ramsey residents; includes only residential use

Table 13.7: Projected Wastewater Flows in RTC Commercial/Service Development

| **Development Type** | **Acres Used (ac)** | **Usage per Acre[1] (gpd)** | **Total Usage (gpd)** |
|---|---|---|---|
| Commercial (Existing Hwy. 10) | 32.2 | 2,000 | 64,400 |
| Commercial (Service/Convenience) | 11.6 | 2,000 | 23,200 |
| Commercial (Shopping) | 24.4 | 1,600 | 39,040 |
| Mixed Use (Retail/Office) | 30.6 | 2,300 | 70,380 |
| Civic Center | 3.6 | 13,300 | 47,880 |
| Business Enterprise | 35.9 | 1,330 | 47,747 |
| Transit | 4.5 | 1,330 | 5,985 |
| Public/Open Space | 58.2 | 1,500 | 87,300 |
| **Total Developed Area** | **201** | **1,920[2]** | **385,932** |

(1) Projected water usage based on average existing demand per day including irrigation.
(2) Average per acre water usage.

Appendix I shows the water usage and pumping rates for 2002. This information is combined with the above water usage projections for the RTC site plus the projected water use for the undeveloped Urban Growth Area to determine total projected water demand at 2020 and is summarized in Table 13.8. The projected water use for the undeveloped areas, excluding the RTC site, were based on the wastewater flow projections contained in Item 18 and Appendix G (Wastewater Data) and include a premium for irrigation.

Table 13.8: 2020 Urban Growth Area Projected Water Use

| **Area** | **Average Daily Usage[1] (MGD)** | **Average Annual Usage (MGY)** |
|---|---|---|
| RTC Development[2] | 1.631 | 595 |
| Future Northwest Sub-district | 0.160 | 58 |
| Future Southwest Sub-district | 0.839 | 306 |
| Future Rum River District Usage | 0.677 | 247 |
| **Sub-total Future Usage** | **3.307** | **1,207** |
| Existing Service Area Usage | 1.198 | 437 |
| **2020 PROJECTED USAGE** | **4.505** | **1,645** |

(1) Future usage estimated based on projected land use and includes irrigation
(2) Sum of totals from Tables 18.6 and 18.7.

<u>Discussion of Results:</u> Historic records show that overall per capita water usage (including both residential and commercial/industrial) in Ramsey averages between 130 and 150 gpd per capita . The total projected water usage for the RTC development is estimated to be about 1.631 MGD. Dividing this number by the upper usage of 150 gpd yields an equivalent design population for the RTC of approximately 10,900. This

compares extremely well with the projected residential population at the RTC site of 10,378 persons (Table 13.6).

Similarly, the total future projected water usage for 2020 is estimated to be 4.505 MGD which equates to an equivalent population of about 30,000 persons. In comparison, the information contained in Tables 13.1 and 13.2 estimates the 2020 population served by the community water system to be approximately 28,000 persons. The difference between the two of 2,000 equivalent persons is in line with the *2001 Comprehensive Plan* and can be attributed to two factors.

First, the number of new housing units to be built between 2000 and 2020 was estimated in the *Plan* to be 4,800 (3,346 single family and 1,434 multi-family units). Of this amount, we now know that the RTC site will contribute 2,400 housing units alone while using only a small percentage of the land available for development within the Urban Growth area. Secondly, the *Plan* did not consider the higher water usage per acre of developed land using the higher density development model inherent in the RTC design.

The historic peaking factor for water usage is about 2.6. Based on the above, the peak daily flows for 2020 will be about 11.7 MGD. Potential impacts on the FIG or other resources during average and peak demand are discussed in Appendix F. In addition, storage and distribution designs for the RTC and future development should take into account the need to meet these demands.

In short, growth projections and the assumed resulting water usage estimated in the *2001 Comprehensive Plan* seem to be generally in line with the projections of this Item. The difference discussed above, which is based on design and growth information not available during the preparation of the *Comprehensive Plan*, results in an increase in future water usage of about 7% above that anticipated.

<u>Summary of Environmental Impact.</u> To meet the projected future demands, the City will most likely increase appropriations from the Franconia-Ironton-Galesville (FIG) aquifer. At a minimum, two additional wells (#6 and #7) will be required to meet the RTC demand with the need for additional wells as growth continues. Appendix F indicates that at full 2020 build out, there will be a need for as many as 4 or 5 additional wells pumping at rates similar to the existing ones.

Groundwater level data for the FIG that is collected continuously by the City shows that trending has been in an upward direction in the last two years meaning a recharge condition existed during this period (Appendix F). In addition, because the pumps operate intermittently, they allow the aquifer to recover on a daily basis with a maximum residual drawdown level averaging of 5- to 10-feet during peak summer demand. This would mean that the radius of influence for the wells is very, very small. Taken together, that water levels are rising in the FIG and that there is very little drawdown, water level fluctuations in the surficial drift material are not anticipated. In addition, it does not appear that the municipal wells would have any negative influence on private wells developed in the same unit. However, long term monitoring of the surficial aquifer's water level is recommended so that data can be collected to correlate against the long term trending patterns within the FIG.

*Permitting*: The increase in demand will subsequently require an amended DNR water appropriations permit. At that time, the DNR is likely to require the collection of the surficial groundwater data mentioned above. In addition, the DNR may require a pumping test to correlate short term temporal relationships between the two aquifers. The design of additional wells can then be based on this information in an effort to mitigate impacts, assuming any exist.

*Wellhead Protection*: The RTC is located directly within the Wellhead Protection Area (WHPA) and Drinking Water Source Management Area (DWSMA) determined by the Ramsey wellhead protection program. Additional groundwater modeling information is included in Appendix H. Any contaminating material that is spilled on the permeable sands within the site can potentially migrate into the groundwater system. Additionally, some net decrease in recharge is expected as the RTC develops and infiltration decreases. Storm water management practices that encourage the infiltration of treated runoff will be part of the design and is discussed in detail in Tasks 17 and 20.

<u>Mitigation element.</u> Because the RTC site is within a DWSMA, special precautions are needed to protect groundwater resources. To make sure this occurs, any discharge of runoff into an area dedicated to infiltration will be pre-treated through such practices as particulate settling, vegetative filtration, skimming, installation of compact, sub-grade treatment (ex. catch basin inserts, cyclonic separators, filters), and various types of pre-treatment soil filtering systems. These practices will be routinely maintained and inspected to make sure these pre-treatment practices do not provide a pathway for contamination of groundwater. Areas that are potential major sources of contamination ("hot-spots") will be identified during construction and special precautions added. These areas would include any location where pollutant spills are more likely to occur (service stations, public works/police/fire fueling operations, significant chemical storage).

Within WHPAs, the use of conventional underground storage tanks to store anything other than water is restricted. If underground tanks are utilized in these areas they must be double-walled with interstitial sensors and a network of monitoring wells must be installed to assess potential groundwater contamination. In addition, an emergency response plan should be developed for the immediate remediation of any spills or leaky tanks.

When assembling the issues that were to be addressed as part of this AUAR, it was noted by the Anoka Conservation District and by the DNR that there is a possible connection between the increased demand for municipal groundwater and the observed lowering of wetlands in the vicinity of Municipal Wells 3, 4 and 5. Appendix F was prepared to assess the general magnitude of the problem and the solutions required to address the issue. It is now apparent that the wetlands in question experience natural drying during periods of relative low precipitation. The photographic history included as part of the

Wetland Delineation report shows wetlands in the vicinity of the RTC site disappearing during the mid to late 1980's which is prior to the development of the municipal wells. This same phenomenon occurs again in the mid to late 1990's and prior to the installation of Wells 4 and 5. The evaluation also found, as stated earlier, that drawdown levels in the FIG unit are minimal and, therefore, could not be influencing the wetlands. To verify these finding, however, it is recommended that long term monitoring be performed.

There is also some concern that increased pumping in the FIG aquifer could impact private wells that pump from this aquifer. Again, the residual drawdown levels in the FIG average 5- to 10-feet during the peak summer pumping period (Appendix F) and recover fully during the Fall, Winter and Spring. Therefore, the radius of influence of the wells will be very small meaning there could be no impacts to private wells developed in the same unit.

Before additional wells are constructed, additional appropriations will be applied for through the DNR. This will most likely require both short- and long-term testing and monitoring to verify the above findings. Through this process, the City can insure that there continue to be no impacts on groundwater and surface resources due to their appropriations from the FIG.

## 14. Water-Related Land Use Management District

*Does any part of the project involve a shoreland zoning district, a delineated 100-year flood plain, or a state or federally designated wild or scenic river land use district?  __Yes   _**X**_No*

*If yes, identify the district and discuss project compatibility with district land use restrictions.*

*For an AUAR, such districts should be delineated on appropriate maps and the land use restrictions applicable in those districts should be described.  If any variances or deviations from these restrictions within the AUAR area are envisioned, this should be discussed.*

*Resource Protection Zones*
Ramsey Town Center does not lie within a protected floodplain or shoreland zone, nor does it occur within the boundaries of a designated resource protection zone (see Figure 9.2).  However, the site is adjacent to, and will potentially discharge water into the state-designated Mississippi River Critical Area, the federal Mississippi National River and Recreation Area (MNRRA), a state Wild and Scenic River area, and a regional park.  All of these areas overlap in coverage south of Highway 10 adjacent to the Town Center (Figure 14.1).

The City's *2001 Comprehensive Plan* (Chapter XI), as updated in 2002, contains the City's DNR-approved Mississippi River Critical Area Corridor/MNRRA plan.  This chapter of the *Plan* addresses the requirements of the Governor's 1979 Executive Order 79-19, which designated this reach of the Mississippi River as a –critical area" in need of special protection.  The Executive Order lays out the required elements, which the City has met and exceeded.  The *Plan* chapter similarly is consistent with the National Park Service's MNRRA 1994 management plan.

The City's Critical Area Plan (Chapter XI of the 2002 Ramsey updated LCP) closely follows the directions provided by both the National Park Service and the State of Minnesota.  As stated in the *2001 Comprehensive Plan* (page XI-2), –The [Critical Area] plan achieves the required elements of the Critical Area Act (Tier I) and identifies goals, policies and strategies to protect, preserve and enhance the Mississippi River Corridor beyond the required elements of …Tier II."

The City's Critical Area Plan presents the following: an inventory of natural and cultural features; existing and planned land use; key issues discussion; 38 policies on protecting the environment, preserving and celebrating history and culture, and ensuring sensitive development; performance criteria for developments within the Corridor; and six implementation strategies to assure that the City's plans get put in place.

Although none of the project site is within the state-designated Mississippi Wild, Scenic, and Recreation River management area, established in 1976, the project is adjacent to this area and could have some impact upon it as development proceeds. The reach of River covered is classified as ―recreational”, which indicates it is a river that ―…may have adjacent lands which are considerably developed, but that are still capable of being managed so as to further the purposes of ...” the State act. The established State policy is that it is in the interest of present and future generations to preserve and protect the outstanding scenic, recreational, natural, historical, and scientific values of certain Minnesota rivers and their adjacent lands. All state, local, and special governmental units, councils, commissions, boards, districts, agencies, departments, and other authorities shall exercise their powers so as to further the purpose of the Minnesota Wild and Scenic Rivers Act and adopted management plans for the preservation, protection, and management of designated rivers. State Rules pertaining to River management under this program are contained within Chapter 6105.08. The Environmental Protection/Resource Management element of the LCP and its supporting ordinances fulfill these requirements.

The Ramsey Town Center site is also adjacent to the state-designated Mississippi River Critical Area Corridor (Corridor) established in 1976 and the federal Mississippi National River and Recreation Area (MNRRA), a unit of the National Park System, established in 1988. The purposes of designating the Mississippi River as a Critical Area include protecting and preserving a unique and valuable state and regional resource; preventing and mitigating irreversible damage to this resource; preserving and enhancing its natural, aesthetic, cultural, and historical value for public use; protecting and preserving the river as an essential element in the national, state and regional transportation, sewer and water and recreational systems; and protecting and preserving the biological and ecological functions of the corridor.

Under the Critical Area program, Executive Order 79-19 requires that the Standards and Guidelines provided in the Executive Order shall be followed by local units of government when preparing plans and regulations, and followed by State and regional agencies for permit regulation and in developing plans within their jurisdiction affecting lands within the Corridor. Once plans and regulations have been approved by DNR, local units of government shall permit development only in accordance with those adopted plans and regulations and approval. All capital improvement programs or public facilities programs of local units of government, regional agencies, and State agencies which affect lands within the Corridor are required to be consistent with the standards and guidelines in the Critical Area Executive Order 79-19. The City of Ramsey Critical Area Plan has been approved by the DNR as part of the City's LCP.



Summary of Environmental Impact. The RTC site borders management districts, but does not include them. The mitigation element addresses the planning efforts that will be used to assure compatibility.

Mitigation element. The Ramsey *2001 Comprehensive Plan* was amended in 2002 and contains the measures needed to effectively implement resource protection for all of the resource protection zones adjacent to the RTC site.

The City's compliance with each of the applicable Executive Order 79-19 Standards and Guidelines that must be followed is assured through implementation of the *Plan*. Since the regulated area is not on the project site, but could be affected by it, the City will evaluate all phases of construction for impact on the regulated area.

DNR has ascertained that, based on the information provided to them, the applicable Executive Order 79-19 Standards and Guidelines for which compliance is needed appear to include the following items. The Executive Order citation is followed by the section in the Ramsey *2001 Comprehensive Plan* (*CP*) in which the DNR reference is addressed:

- The lands and waters within the Rural Open Space District shall be used and developed to preserve their open, scenic and natural characteristics and ecological and economic functions. [E.O. 79-19 - A. *CP XI.C.1.a*]
- Protect bluffs greater than 18% and provide conditions for the development of bluffs between 12% and 18% slopes.[ E.O. 79-19 - C.1.a.(4) *CP XI.C.2.c*]
- Minimize runoff [E.O. 79-19 - C.1.a.(5) *CP XI.C.2.a*]
- Improve the quality of runoff. [E.O. 79-19 - C.1.a.(5) *CP XI.C.2.a*]
- Minimize site alteration. [E.O. 79-19 - C.1.a.(6) *CP XI.C.1.c*]
- Erosion control. [E.O. 79-19 - C.1.a.(6) *CP XI.C.2.a*]
- Management of vegetation cutting. [E.O. 79-19 - C.1.a.(7) *CP XI.C.2.a*]
- *Control of noise in open space and recreational areas. [E.O. 79-19 - C.1.a.(8)]
- Site plans required for all development for which a permit is required, except single-family residential structures. [E.O. 79-19 - C.2.a. *CP XI.C.2.c*]
  - New development and expansion permitted only after the approval of site plans which adequately assess and minimize adverse effects and maximize beneficial effects.
  - Site plans shall include activities undertaken to ensure consistency with the objectives of the Designation Order and shall include measures which address adverse environmental effects.
  - Site plans shall include standards to ensure that structures, roads, screening, landscaping, construction placement, maintenance, and storm water runoff are compatible with characteristics and use of corridor in that district.
  - Site plans shall contain specific conditions with regard to buffering, landscaping, and revegetation.
- Standards for structure site and location to ensure riverbanks, bluffs, and scenic overlooks remain in their natural state. [E.O. 79-19 - C.2.b. *CP XI.C.2.c*]
- Retention of existing vegetation and landscaping [E.O. 79-19 - C.2.e.(1) *CP XI.C.2.a*]
- Maximization of the creation and maintenance of open space and recreational potential of the Corridor in accordance with the standards. [E.O. 79-19 - C.6 *CP XI.C.2.c*]
- Plans and programs to protect open space areas shall be developed. [E.O. 79-19 - 6. d. *CP XI.C.2.c*]
- Programs to manage undeveloped islands in their natural state. [E.O. 79-19 - 6.e. *CP XI.C.2.c*]

- New or modified utility facilities shall complement the planned land and water uses and shall not stimulate incompatible development. [E.O. 79-19 - C.7.b. *CP XI.C.2.c*]
- Capital improvement programs or public facilities programs shall be consistent with the standards and guidelines in Ex. Ord. Section B. and C. [E.O. 79-19 - C.8. *CP XI.C.2.c*]

*Although Chapter XI of the Ramsey *2001 Comprehensive Plan* contains a thorough set of policies and related actions to protect the natural character of the Critical Area, the Chapter does not contain a specific provision addressing control of noise in this area. The next amendments to the City *Plan* will add a specific provision to address this specific element in Executive Order 79-19.

DNR particularly emphasizes the mandates for protection of slopes and bluffs; minimization of site alteration; retention of existing vegetation; minimization of runoff; erosion control; minimization of adverse effects. Selection from among the many available low-impact stormwater development tools and Best Management Practices, as discussed in Item 17, will occur to achieve both minimization and improvement of runoff. As a best management practice for enhancing ecological function of the Critical Area Corridor, DNR highly encourages the use of native vegetation for the required buffering and landscaping, revegetation of removed vegetated areas, and erosion control (grasses, seeding). DNR is also concerned about any cumulative adverse impacts from this project that accelerate development within the Rural Open Space District in violation of those District's standards, and supports voluntary vegetative buffering of structures outside of the Corridor in order to minimize interference with views of and from the water. Since the project does not directly affect the Critical Area (or MNRRA/WSR), the City will identify those areas potentially under its land use control and apply the appropriate standards from its LCP. The City will also work with Anoka County Parks to implement these standards within MRP land controlled by the County.

## 15. Water Surface Use

*Will the project change the number or type of watercraft on any water body?* __*Yes* _**X**_*No*

*If yes, indicate the current and projected watercraft usage and discuss any potential overcrowding or conflicts with other uses.*

*This item need only be addressed if the AUAR area would include or adjoin recreational water bodies.*

Within the site, there are no water bodies where watercrafts are operated. The nearest recreational water bodies are Lake Itasca to the northwest and the Mississippi River to the south. There is no public water access on Lake Itasca and surface water use is limited to surrounding residents use. The nearest public water access on the Mississippi River is approximately two and a half miles to the northwest in the city of Dayton. According to the Anoka County Parks Department, travel by boat upstream of Anoka is very difficult because of shallow water and numerous sandbars. However, development of Mississippi Regional Park (MRP) may increase watercraft in the area as boaters with small motors or non-motorized boats make their way to the Park. There is not a landing facility proposed in the latest MRP development plan, but casual landing anywhere in the Park can be expected. Also, the availability of parking stalls in the new park will surely add to the ability of canoe and kayak users to more easily access the River. Limited small engine boat use and non-motorized watercraft are not expected to adversely impact the Mississippi River near the MRP.

Summary of Environmental Impact. None are expected.

Mitigation element - Adverse environmental impacts associated with increased small motor and non-motorized boats is not anticipated along the Mississippi River south of the Ramsey Town Center site. In fact, the new Mississippi Regional Park hopes to attract visitors to this portion of the upper River. The use of the park as a formal recreational facility will focus river-related uses to planned areas, and provide resource oversight and supervision of recreational activities.

## 16. Erosion and Sedimentation

*The number of acres to be graded and the number of cubic yards of soil to be moved need not be given; instead a general discussion of the likely earthmoving needs for development of the area should be given, with an emphasis on unusual or problem areas. In discussing mitigation measures, both the standard requirements of the local ordinances and any special measures (ex.WMO) that would be added for AUAR purposes should be included.*

The Ramsey Town Center site is relatively flat and contains very sandy, coarse-grained soils (Figure 12.2). Both of these physical characteristics are advantageous when it comes to erosion and sedimentation. This does not mean, however, that erosion will not occur and that sediment will not move if disturbed. Because the disturbance of over 300 acres of land will present the certainty of erosion, the mitigation plan that follows outlines the measures the City will undertake to minimize its adverse impacts.

Figure 16.1 shows the general areas of borrow and fill that will result when earth-moving activity begins. The general concept that will be followed will be creation of a central low area along the drainage corridor alignment, with land gradually sloping upward to the north and south away from the drainageway. Earth will be moved from the drainageway corridor and placed on the north and south slopes. Some grading will likely also be needed on the southern drainage swale just north of the railroad tracks and around Wetlands B and D (Figure 10.1) as buffer areas are incorporated. Exact numbers on the volume of soil moved will not be available until the detailed design phase.

Care will be taken not to disturb or compact the central drainage corridor that will be used to transmit and store water. Similar efforts will be made to avoid compaction in areas where infiltration best management practices (BMPs) will be used. The soil within any landscaped areas will be loosened after heavy construction traffic has subsided. This will enhance the ability of all landscaped areas, whether formal or native, to infiltrate water.

It is expected that organic topsoil will need to be imported to the site to establish a good vegetative cover. The sandy soils will not support many of the typical landscaping plants and ground cover. Native plants that are inherent to the Anoka Sandplain will be used wherever possible to avoid the need for massive soil importation and extensive irrigation.

Summary of Environmental Impact. The grading and development of over 300 acres of land has the potential to contribute sediment to receiving waters where water could flow. Currently, there are few actual receiving areas where water is present. With the establishment of a central drainage corridor and the possibility of mitigated wetlands and water storage areas, the possibility of water-related impact increases. The following mitigation plan addresses how construction will proceed with adequate erosion BMPs in place.

Mitigation element. Prior to any earth-moving activity on the site, an erosion and sediment control plan will be prepared in accord with the requirements of the City of Ramsey and the LRRWMO. Technical assistance in the preparation of this plan will also be sought from the Anoka Conservation District, the Minnesota Pollution Control Agency and the DNR. The City will be permitted through the Phase II NPDES nonpoint program as a Municipal Separate Storm Sewer System (MS4) operator, and will be subject to all of the provisions of that program, including reducing the discharge of pollutants to the ―maximum extent practicable" (MEP) through construction site runoff control. Any construction on the site will also be permitted through MPCA's NPDES general construction permit process.

Prior to any earth moving in the south east corner of the site, Burlington Northern Santa Fe Railroad should be contacted in regards to arsenic contaminated soils. A more detailed description of contamination and contact information is included in Item 20.

Elements of erosion protection will include: phased construction with minimized periods of bare soil exposure, rapid re-vegetation, slope/grade stabilization, use of mulch and fabric on exposed soils, temporary and permanent (if needed) sediment basins, properly installed and maintained silt fencing, and adoption of a regular maintenance and inspection schedule.

# 17. Water Quality-Stormwater Runoff

> ***17a**. Compare the quantity and quality of site runoff before and after the project. Describe permanent controls to manage or treat runoff. Describe any stormwater pollution prevention plans.*
>
> ***17b.** Identify routes and receiving water bodies for runoff from the site; include major downstream water bodies as well as the immediate receiving waters. Estimate impact runoff on the quality of receiving waters.*
>
> *For an AUAR the following guidance should be followed in addition to that in "EAW Guidelines":*
>
> - *it is expected that an AUAR will have a detailed analysis of stormwater issues*
> - *a map of the proposed stormwater management system and of the water bodies that will receive stormwater should be provided*
> - *the description of the stormwater systems would identify on-site and "regional" detention ponding and also indicate whether the various ponds will be new water bodies or converted existing ponds or wetlands. Where on-site ponds will be used but have not yet been designed, the discussion should indicate the design standards that will be followed.*
> - *if present in or adjoining the AUAR area, the following types of water bodies must be given special analyses*
>     - *lakes: within the TC metro area a nutrient budget analysis must be prepared for any "priority lake" identified by the Metropolitan Council.*

*Background*

*Watershed Setting.* The details of the surface water management system being proposed for the RTC site are best described by joining **Items 17a and b** into a single discussion. Figure 17.1 illustrates the entire watershed within which the RTC site lays. The watershed extends from north of Lake Itasca to the Mississippi River, covering an area of approximately 2,687 acres.

The larger watershed can be sub-divided into a series of 31 sub-watersheds, which were shown in Figure 12.1 in Item 12. Each of these smaller units was characterized for water quantity and quality modeling under existing conditions, and was subsequently modeled for fully developed conditions as proposed under the City's *2001 Comprehensive Plan*, as amended in 2002 (Item 5, Figure 5.4), and the preferred site development (Item 6, Figure 6.1).

*Drainage through the site.* The principal drainage feature currently passing through the site, and evident in Figure 12.1, is a well- to poorly-defined swale that occurs from the northwest corner of the site to the middle of the site, whereupon it disappears. Historically, this swale appears to have been a more significant drainage feature, but limited runoff has diminished its overall hydrologic function and subsequent farming activities have taken advantage of the swale as tillable land. Reference to Figure 10.1, however, shows that Wetlands A and C occur within this swale, while Wetland B lies adjacent to it. The Wetland E, Type 1 acreage also occurs within this historic drainage swale. General concept possibilities for the drainage corridor and how it fits into the current design and the overall site stormwater mitigation plan are contained in Figures 17.2a, -b, and -c. The collection of features that will be incorporated into the new drainage swale includes a channel to convey baseflow, ponds to store water and promote infiltration, created and restored wetlands, and open space areas where excess water can temporarily be stored. The specifics of these features will not be fully known until the design phase proceeds prior to construction, but Figures 17.2a, -b, and -c contain schematics of how these features will generally appear.

The presence of an historic drainage swale on the site presents an excellent opportunity to incorporate the feature into the site drainage system as an amenity. Although the actual drainage swale alignment will change, incorporating the vegetative and hydrologic character of this historic drainageway can provide both functional and recreational value to the feature. As shown in the preferred design in Figure 6.1, the corridor extends beyond the current terminus, reaching into the Mississippi Regional Park, creating a natural drainageway that could extend from Lake Itasca to the Mississippi River.

The introduction of a drainage connection to the northern wetlands (see Figure 6.6) provides two more corridor connections that could establish greenways to connect to northern Ramsey natural areas. The surface water system can be modeled with these changes/additions in mind, and various optional innovative/natural surface water management assumptions can be used to maximize storage, infiltration, and water quality treatment within it.

*Surface water as an Amenity.* Water can be treated as a nuisance that must be moved away quickly, or as an amenity that can enhance the natural features of a site. Ramsey Town Center will use water as an amenity. The large events will be drained to prevent flooding, and smaller events will be stored and infiltrated to the extent possible.

The primary drainage-related consideration for the City is to assure the movement of the 100-year runoff event through the site without damage due to flooding. The proposed stormwater management system accomplishes this. However, with the sandy nature of the soils on site (see Figure 12.2), there is also an opportunity to soak water from smaller events into the ground to retain some of the recharge function that will otherwise be lost with development. This combination of safely routing the 100-year event and trying to reduce overall runoff from the site will form the basis for stormwater management developed in Item 17. Under this approach, provision will be made to route, store and treat the 100-year runoff event safely in a series of storm sewers, drainage swales, floodways and ponds. The system will take maximum advantage of the central drainage swale and its corridor to store water as it meanders through the site. Major storage will occur in lined detention ponds, with open areas also available to detain smaller volumes of water and allow it to soak into the ground after settling and vegetative filtering. The exact character of the corridor and the stormwater management system has not yet been determined, but a range of runoff management effectiveness is discussed in the mitigation section of this Item. The open space value of the corridor will be enhanced with pathways that will parallel the corridor.

Runoff from the areas draining to the central drainage corridor or elsewhere off of the site also could be managed to reduce overall runoff volumes. During the design phase, each major parking area within the Town Center will be evaluated to see whether a system that will pre-treat runoff prior to its introduction into the central drainage system is feasible. Under the ideal scenario, runoff would be routed to the pre-treatment BMP (small-scale detention or filtration) prior to entry into a vegetated flow system that will encourage further filtration and infiltration. Excess flows from these connector drainage features should only occur with substantial precipitation events. Most routinely occurring, small-scale events would soak into the sandy soils. This conveyance system will likely be a connected system of pervious drainage swales, wetlands and vegetated drainageways, but could also include sub-grade settling and filtration treatment trains. The exact character of this system will be determined as part of the final design prior to building construction.

During the detailed design process, the City has the option of incorporating additional volume control features into the drainage system. The specifics of these features can not be defined until the design phase, but they could be used to minimize runoff on a parcel or block scale within the Town Center to hold down the amount of water that will eventually reach the surface water drainage system. Impervious area reduction BMPs that will be used to do this are numerous and will be pursued at the proper design stage. These alternative design features are not intended to replace standard engineering practices of assuring the movement of large storm-related water volumes, but rather supplement the drainage system by reducing overall runoff volumes and peaks.

In addition to the flow reduction benefits, there are water quality benefits. Pre-treating runoff from potentially high loading areas, such as parking lots and roadways, reduces the amount of pollution moving to the regional collection system. Routing pre-settled runoff through wetlands and vegetated swales furthers treatment through vegetative filtration. It is anticipated that these two BMP suites (pre-settling and filtration) will properly prepare water for infiltration into the soil, where additional physical and biological treatment will cleanse the water on its way toward the regional groundwater system. Using the natural cleansing ability of settling areas, vegetative and soil filtration, microbes in the soil and vegetative uptake of nutrients will make the RTC site compatible with the needs of a wellhead protection area. Additional discussion occurs in the groundwater protection section of Item 13 and a recommendation in the Mitigation Plan (Item 33) is made to assure that an ordinance is adopted to assure that incompatible land uses are not allowed within the DWSMA.

*Surface Water Modeling*

*Development of a flow model (XP-SWMM).* To adequately predict the impact that this site will have on water resources, a tool is needed to incorporate development and infrastructure assumptions. The model used by EOR for this exercise is the XP-SWMM model (XP Software, Inc.). This model is used to contrast existing conditions with proposed changes associated with development within a watershed. The model looks at the change in land use and land cover, and relates the change to runoff behavior. Runoff predictions can be made for variable frequency events, and routed through the proposed drainage system. The model output and routing can then be used to determine areas where flooding or high water will occur, and then can be used to design a system of stormwater management facilities, which could include detention storage, diversion, infiltration or any number of associated BMPs.

*Existing Conditions.* The first phase of the quantity and quality modeling involved defining the water behavior as it exists currently. The physical characteristics of each sub-watershed noted in Figure 12.1 form the basis for determining the amount of water that will run off of it during specified climatic events, specifically rainfall and snowmelt events of certain statistical frequency.

The results of the existing conditions quantity analysis using the XP-SWMM model are displayed in Table 17.1 by sub-watershed for the 100-year frequency, 24-hour rainfall event and 10-day snowmelt. This represents the peak flow and volume discharges that would be expected for an event that would occur with a frequency of once every one-hundred years, or 1% in any given year. Volume discharges are based on a 5-day runoff simulation for the 24-hour rainfall event and a 30-day runoff simulation for the 10-day snowmelt event.

Of note in Table 17.1 is the small amount of flow leaving this site at the Highway 10 culvert (subwatershed 30). During a 100-year event, a peak flow of only 28 cubic feet per second (cfs) leaves the AUAR area, reflective of the sandy nature of the watershed and the low intensity agricultural and low density land use. Flow to the Mississippi River from the southeast corner of the site does not occur, but rather soaks into the sandy soils as it flows in a small ditch to the southeast. Because of this reason, the base level for water quantity and quality eventually reaching the Mississippi River is zero.

Table 17.1. XP-SWMM model results for existing conditions

| subwatershed | 100-year 24-hour rainfall (5.9 inches precipitation) | | 100-year 10-day snowmelt (7.2 inches runoff) | |
|---|---|---|---|---|
| | peak flow discharge (cfs) | volume discharge (ac-ft) | peak flow discharge (cfs) | volume discharge (ac-ft) |
| 1 | 0.1 | 0.9 | 1.6 | 22.8 |
| 2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 24.9 | 14.5 | 38.7 | 55.7 |
| 4 | 17.7 | 64.0 | 21.2 | 247.6 |
| 5 | 18.3 | 67.3 | 22.2 | 259.4 |
| 6 | 0.4 | -2.6 | 2.9 | 1.3 |
| 7 | 22.2 | 64.7 | 42.1 | 279.0 |
| 8 | 10.8 | 30.1 | 31.9 | 159.3 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 |
| 10 | 0.0 | 0.0 | 1.4 | 6.1 |
| 11 | 0.0 | 0.0 | 1.0 | 8.2 |
| 12 | 4.4 | 0.9 | 3.0 | 12.4 |
| 13 | 0.0 | 0.0 | 1.3 | 11.9 |
| 14 | 2.0 | 10.7 | 9.0 | 28.1 |
| 15 | 0.0 | 0.0 | 0.0 | 0.0 |
| 16 | 0.0 | 0.0 | 0.0 | 0.0 |
| 17 | 10.3 | 6.0 | 15.4 | 27.5 |
| 18 | 0.1 | 0.1 | 0.7 | 0.7 |
| 19 | 0.1 | 0.1 | 1.3 | 1.4 |
| 20 | 0.0 | 0.0 | 15.1 | 32.3 |
| 21 | 0.4 | -0.5 | 0.9 | 1.3 |
| 22 | 2.3 | -6.3 | 10.0 | 18.0 |
| 23 | 2.0 | 1.9 | 7.3 | 9.3 |
| 24 | 9.4 | 35.6 | 16.0 | 144.8 |
| 25 | 8.8 | 1.2 | 5.1 | 6.3 |
| 26 | 12.4 | 57.9 | 87.0 | 404.4 |
| 27 | 12.4 | 58.7 | 84.1 | 408.5 |
| 28 | 0.0 | 0.0 | 1.6 | -2.7 |
| 29 | 12.4 | 53.8 | 39.2 | 402.9 |
| 30 | 12.4 | 54.9 | 28.3 | 334.7 |
| 31 | 3.4 | 0.5 | 10.4 | 70.8 |

*Discharge from AUAR area at Hwy 10 culvert

Note: Negative volume discharge results from backwater into subwatershed from downstream subwatershed.

*Runoff Under Developed Conditions.* As development proceeds on the 300+ acres that are part of the RTC, runoff will markedly increase. Conversion of sandy open space and agricultural land to commercial and residential uses invariably leads to increased runoff from paved surfaces associated with that development. The translation of the preferred design in Figure 6.1 to a developed schematic for runoff routing was shown in Figure 6.6 as part of the site description. The essential elements of the drainage system proposed for the site are as follows:

- It incorporates a 100-year design event with no infiltration considered, thus generating the –worst case” scenario upon which design can proceed.

- It routes water locally into the central drainage corridor, using a system of smaller ponds, followed by an area of flood storage and infiltration.

- It uses existing detention storage and develops increased storage for the highly impermeable retail center on City property between the railroad tracks and TH10.

- It proposes a connection of the site to the Mississippi River via the County-owned swath of land. This piece of land would contain a detention facility on the upstream side to add storage, followed by an infiltration zone, then a stabilized channel (piped or series of landscaped drop-structures) over the bluff to the river. Of note here is the additional need of this outflow as an outlet for any future TH10 upgrade. Although the development of this corridor for the passage of water has not been approved yet by the County, discussions are under way. This corridor presents the best option for out-letting this closed basin for the RTC site and for future TH10 work. If reaching the River through this option is not approved, another option will need to be pursued, most likely to the southeast along TH10. However, outflow in that direction is also closed and prevented from out-letting to the River, so additional study would be needed to identify an ultimate connection.

- It incorporates infiltration throughout the RTC site as an <u>added benefit</u> rather than as a design component for runoff management. The LRRWMO will not allow infiltration in design of the 100-year event. Rather, whatever other soaking-in that can be achieved in the central corridor will supplement water management. Infiltration can be used to cut peaks and volume, reduce major parts of small-scale events, maintain recharge and treat water quality. Each infiltration feature will need to be designed with an overflow/outlet to assure that water will not remain a permanent feature.

- It develops on-site detention in the central corridor on the western-most of the two sets of available areas; that is, parcel #s 49 and 54. The eastern-most cells (#s 51 and 56) will then be areas with a meandering (baseflow) stream that will rise during runoff events and spill over into a floodplain/infiltration zone, where water can soak into native vegetation, grading upward to a more landscaped, green mowed grass up near trails by the road. If additional storage is needed, these cells could be changed to contain ponds of the needed size.

Following the development of a drainage system, detailed modeling was done for the individual blocks within the RTC site, and combined with the model output for the areas draining into the site from the north and northwest. All of this drainage was then routed through the site, into the stormwater handling facilities south of the site, and through the proposed drainage corridor to the Mississippi River.

Two modeling scenarios were run to bracket a range of flow under maximum and minimum conditions. The first run of the XP-SWMM quantity modeling developed traditional runoff estimates for the 100-year design event with no infiltration occurring on site. This ―maximum runoff condition” is contained in Table 17.2.

In the second scenario, a factor was incorporated into the model on a block-by-block basis to account for some infiltration under small-scale events, reflective of the sandy soils inherent to the site. Infiltration is not a design element for the 100-year event, but rather used to estimate volume and rate reductions during frequently occurring events. Infiltration features will be considered during the design phase, but are not proposed as part of this evaluation. However, to demonstrate the effect of infiltration on the 100-year event, Table 17.3 contains the results of the ―minimum runoff condition”.

Table 17.2. XP-SWMM model results for developed conditions (―maximum runoff condition”).

| | 100-year 24-hour rainfall (5.9 inches precipitation) | | 100-year 10-day snowmelt (7.2 inches runoff) | |
|---|---|---|---|---|
| subwatershed | peak flow discharge (cfs) | volume discharge (ac-ft) | peak flow discharge (cfs) | volume discharge (ac-ft) |
| 1 | 0.1 | 0.8 | 2.7 | 32.3 |
| 2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 24.6 | 14.5 | 45.5 | 66.4 |
| 4 | 9.4 | 45.6 | 14.8 | 284.5 |
| 5 | 9.6 | 52.2 | 16.3 | 302.9 |
| 6 | 11.4 | 47.5 | 16.1 | 301.3 |
| 7 | 23.4 | 58.2 | 22.8 | 329.3 |
| 8 | 24.3 | 74.1 | 30.5 | 371.8 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 |
| 10 | 0.0 | 0.0 | 0.0 | 0.0 |
| 11 | 31.5 | 9.1 | 17.5 | 34.5 |
| 12 | 26.7 | 11.4 | 14.4 | 38.3 |
| 13 | 20.7 | 74.0 | 22.6 | 373.2 |
| 14 | 2.0 | 10.8 | 25.1 | 32.4 |
| 15 | 0.0 | 0.0 | 0.0 | 0.0 |
| 16 | 0.0 | 0.0 | 0.0 | 0.0 |
| 17 | 12.0 | 5.6 | 17.4 | 28.3 |
| 18 | 29.4 | 14.4 | 16.6 | 23.3 |
| 19 | 44.9 | 30.2 | 34.8 | 70.0 |
| 20 | 72.8 | 38.4 | 36.3 | 83.5 |
| 21 | 15.1 | 9.1 | 7.7 | 13.5 |
| 22 | 22.8 | 6.1 | 7.3 | 9.3 |
| 23 | 65.3 | 85.3 | 32.8 | 387.7 |
| 24 | 132.6 | 155.1 | 87.8 | 516.4 |
| 25 | 110.0 | 156.0 | 74.5 | 524.1 |
| 26 WQ Pond | 88.7 | 155.2 | 46.3 | 524.0 |
| 26 Inf Basin | 25.1 | 150.3 | 25.3 | 520.5 |
| 27 | 5.7 | 1.1 | 1.7 | 2.4 |
| 28 | 0.0 | 0.0 | 0.0 | 0.0 |
| 29 | 0.0 | 0.0 | 0.1 | 0.3 |
| 30 | 12.4 | 1.3 | 2.0 | 2.7 |
| 31 | 3.4 | 0.4 | 0.5 | 0.7 |

*Discharge to Mississippi River (26 Inf Basin)

Table 17.3. XP-SWMM model results for developed conditions with some infiltration considered (―minimum run off condition”).

| | 100-year 24-hour rainfall (5.9 inches precipitation) | | 100-year 10-day snowmelt (7.2 inches runoff) | |
|---|---|---|---|---|
| **subwatershed** | **Peak flow discharge (cfs)** | **volume discharge (ac-ft)** | **peak flow discharge (cfs)** | **volume discharge (ac-ft)** |
| 1 | 0.1 | 0.8 | 2.7 | 32.3 |
| 2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 24.6 | 14.5 | 45.5 | 66.4 |
| 4 | 9.9 | 45.7 | 15.7 | 284.5 |
| 5 | 10.3 | 52.2 | 17.5 | 303.0 |
| 6 | 11.8 | 47.6 | 16.9 | 302.4 |
| 7 | 19.8 | 56.4 | 18.8 | 325.4 |
| 8 | 19.3 | 50.0 | 20.4 | 284.9 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 |
| 10 | 0.0 | 0.0 | 4.9 | 12.5 |
| 11 | 25.2 | 9.3 | 12.5 | 30.6 |
| 12 | 28.4 | 11.5 | 13.0 | 34.5 |
| 13 | 20.3 | 51.4 | 20.5 | 287.5 |
| 14 | 2.0 | 10.8 | 24.7 | 31.8 |
| 15 | 0.0 | 0.0 | 0.0 | 0.0 |
| 16 | 0.0 | 0.0 | 0.0 | 0.0 |
| 17 | 12.0 | 5.6 | 17.4 | 28.3 |
| 18 | 29.4 | 16.6 | 16.1 | 25.3 |
| 19 | 34.4 | 24.1 | 26.7 | 47.6 |
| 20 | 41.9 | 32.2 | 33.5 | 61.1 |
| 21 | 17.3 | 9.2 | 7.7 | 13.5 |
| 22 | 37.2 | 6.4 | 7.3 | 9.3 |
| 23 | 64.7 | 61.4 | 31.5 | 302.0 |
| 24 | 131.8 | 125.6 | 86.1 | 408.0 |
| 25 | 109.4 | 126.0 | 78.4 | 413.9 |
| 26 WQ Pond | 89.1 | 123.3 | 54.2 | 409.7 |
| 26 Inf Basin | 24.7 | 92.1 | 24.8 | 356.2 |
| 27 | 5.7 | 1.1 | 1.7 | 2.4 |
| 28 | 0.0 | 0.0 | 0.0 | 0.0 |
| 29 | 0.0 | 0.0 | 0.1 | 0.3 |
| 30 | 12.4 | 1.3 | 2.0 | 2.7 |
| 31 | 3.4 | 0.4 | 0.5 | 0.7 |

*Discharge to Mississippi River

Table 17.4 shows a comparison of discharge from the site for the existing and proposed developed scenarios for the 100-year events. For existing conditions, a maximum peak flow of 28.3 cfs under the Highway 10 culvert occurs during the 100-year, 10-day snowmelt event. Peak flow discharge for proposed development conditions is slightly less (25.3 cfs) than existing conditions, excluding infiltration and assuming that no bio-retention facilities are incorporated into the individual blocks. The existing peak flow rate (12.4 cfs) is exceeded for the 100-year, 24-hour rainfall event under proposed developed conditions (25.1 cfs), but has been significantly reduced from the peak rate of 132.6 cfs at the culvert crossing the RR tracks. Since infiltration is excluded, the numbers presented under proposed conditions are conservative. Slight reductions in peak flow rate discharge at the outlet and significant reductions in volume discharge could be achieved with the incorporation of properly designed and maintained infiltration basins. Volume discharge reductions of 30 to 40 percent could be achieved assuming a moderate rate of infiltration during the 100-year, 24-hour rainfall event and some infiltration during the last 15 days of the 30-day runoff simulation of the 100-year snowmelt event.

Table 17.4. Comparison of peak flows and volumes discharged from site for 100-year events

| Model | 100-year 24-hour rainfall (5.9 inches precipitation) | | 100-year 10-day snowmelt (7.2 inches runoff) | |
|---|---|---|---|---|
| | Peak flow discharge (cfs) | Volume discharge (ac-ft) | Peak flow discharge (cfs) | Volume discharge (ac-ft) |
| Existing conditions | 12.4 | 54.9 | 28.3 | 334.7 |
| Proposed | 25.1 | 150.3 | 25.3 | 520.5 |
| Proposed w/ some infiltration occurring | 24.7 | 92.1 | 24.8 | 356.2 |

The primary benefit of incorporating infiltration BMPs into the site is achieved during small storm events. Table 17.5 compares site discharge for the 1-year and 10-year, 24-hour rainfall events considering site design that first excludes infiltration in the basins and then considers infiltration in the basins.

For existing conditions, a peak flow of 2.3 cfs discharge at the Highway 10 culvert for the 1-year, 24-hour event is due to local drainage south of the railroad tracks only, as there is no flow leaving the site at the railroad tracks. As discussed earlier, the flow discharging from Highway 10 is small and does not reach the Mississippi River. For proposed development conditions excluding infiltration in the basins, peak discharge into the Mississippi River would be 14.4 cfs. By incorporating infiltration basins into the site, peak flow is reduced by 50 percent (7.8 cfs) and volume discharge is also significantly reduced.. The 10-year, 24-hour rainfall event results in a slight reduction in peak flow, but significant reduction in volume (50 percent) by incorporating the infiltration BMPs.

Table 17.5. Comparison of peak flows and volumes discharged from site for 1-year and 10-year events

| Model | 1-year 24-hour rainfall (2.3 inches precipitation) | | 10-year 24-hour rainfall (4.1 inches precipitation) | |
|---|---|---|---|---|
| | Peak flow (cfs) | Volume (ac-ft) | Peak flow (cfs) | Volume (ac-ft) |
| Existing conditions | 2.3 | 0.3 | 7.1 | 0.7 |
| Proposed | 14.4 | 14.4 | 23.1 | 65.0 |
| Proposed w/ infiltration occurring | 7.8 | 4.0 | 22.6 | 35.4 |

Smaller, more frequent rainfall events are critical for water quality. Achievement of long-term year-round water quality benefits requires the ability to retain and treat smaller storm events. To meet LRRWMO water quality requirements based on NURP design criteria, the final design should provide for a dead storage volume of at least 38 ac-ft, which is the volume required to accommodate the runoff volume from a 2.5-inch rainfall event (excluding infiltration in basins).

*Water Quality Modeling*

*Water Quality Under Developed Conditions.* As shown in a previous section, the amount of water leaving the site under current conditions is minimal. Consequently, the amount of pollution associated with the runoff is equally minimal. However, this all changes once development occurs. An increase in nonpoint pollution from this site will occur from many new sources, including some or all of the following:

- Automobile, truck and bus traffic (oil, exhaust, vehicle decomposition);
- Lawn and landscaping chemicals (fertilizer and pesticide);
- Litter;
- Vegetative debris;
- Pet waste;
- Fueling spillage from the convenience stations;
- Increased sanding and salting; and
- New construction (erosion, debris).

The pollutant removal efficiencies of the proposed stormwater management practices were assessed using the P8 Urban Catchment Model (*Program for Predicting Polluting Particle Passage through Pits, Puddles and Ponds*, developed by William Walker). This approach allowed for the evaluation of different runoff scenarios, as well as the prediction of pollutant loads passing through the proposed development and eventually into the Mississippi River. Model results presented are for a complete year with a long term average precipitation depth (23.85 inches). This scenario is different than those presented in the water quantity modeling results, where specific storm events were considered.

Water quality was modeled for several pollutants for two runoff scenarios. Both scenarios consider the likely treatment that runoff would receive in stormwater BMPs located along the route that the water would follow. For example, the runoff routed into a properly designed detention pond would lose about 75% of the total suspended solids it carries. This water can then be routed downstream, where it might encounter another detention pond or infiltration system where another increment is removed.

In the first scenario, runoff is stored only in the detention ponds and infiltration basins within the central drainage corridor. In the second scenario, extra storage that would exist elsewhere on the site in small ponds is considered. In this case, runoff is stored, but does not infiltrate into the groundwater.

The exact nature of the primary solids removal BMPs located at the storm sewer inflows to various drainageways has not yet been determined. These could be a mix of forebays created from earthen material, catch basin inlet filters, all the way to sub-grade treatment train systems.

Table 17.6 presents the results of water quality modeling for total phosphorus (TP). TP was chosen to present the quality results because it is one of the more difficult pollutants to remove. That is, if effective removal of TP occurs, the other pollutants will have equal or better removals. The table shows that with storage and treatment in the central drainage corridor facilities, the total phosphorus load leaving the RTC site (out of subwatersheds 26 and 31) is approximately 20 lbs/year. This figure is cut in half when additional site storage is considered. In terms of a per unit area loading rate, the first scenario yields 0.053 lbs TP/acre-year; that figure is approximately halved with the addition of extra storage. These areal loading rates are reflective of the numerous detention ponds and the natural infiltration occurring throughout the RTC site.

Table 17.6. Average Annual Total Phosphorus in runoff leaving RTC site

| | With storage in the central corridor | With additional on-site storage |
|---|---|---|
| lbs TP/yr | 19.6 | 10.3 |
| lbs TP/ac-yr | 0.053 | 0.028 |

The modeled phosphorus removals are contained in Table 17.7. These results are presented to show the reductions that the water quality treatment system used on the RTC site can achieve.

Table 17.7. Total phosphorus load (lbs/yr) entering and exiting several of the major proposed detention basins and infiltration basins.

| BMP and Sub-watershed (see Figure 12.1) | | lbs TP/yr | |
|---|---|---|---|
| | | With central corridor facilities only | With additional on-site storage |
| Detention basin in sub-watershed 7 | In | 27.3 | 15.6 |
| | Out | 10.2 | 4.3 |
| Infiltration basin in sub-watershed 8 | In | 31.5 | 16.0 |
| | Out | 0 | 0 |
| Detention basin in sub-watershed 18 | In | 35.2 | 20.4 |
| | Out | 9.5 | 3.7 |
| Infiltration basin in sub-watershed 19 | In | 32.1 | 16.9 |
| | Out | 0 | 0 |
| | | | |
| Detention basin in sub-watershed 25 | In | 64.6 | 34.6 |
| | Out | 38.4 | 20.2 |
| Detention basin in sub-watershed 26 (south of TH10) | In | 38.4 | 20.2 |
| | Out | 24.0 | 12.6 |
| Infiltration basin in sub-watershed 26 (south of TH10) | In | 24.0 | 12.6 |
| | Out | 18.9 | 9.5 |



Summary of Environmental Impact. The incorporation of a stormwater management system into the RTC site as it develops raises the need for proper collection, routing and storage of runoff. The standard routing of the 100-year frequency event without consideration of any infiltration, in accordance with LRRWMO regulations, yields a volume of 113 ac-ft that must be accounted for in on-site or near-site storage. When infiltration is considered, the volume can be reduced to 105 ac-ft. For events with a return frequency less than 100-years, infiltration can be designed to reduce volume substantially and provide continued recharge to a certain degree.

Mitigation element. The conversion of agricultural land to urban land ultimately increases the amount and rate of runoff leaving the land. Minimizing the impact of that increased runoff is the objective of this mitigation plan.

It must be stressed that this portion of Ramsey does not have a natural outlet to the Mississippi River. The preliminary drainage system described within this AUAR assumes an outlet that takes advantage of publicly-owned, County land that extends from Highway 10 to the Mississippi River south of the RTC site. Preliminary discussions with the County on the use of this land have occurred, but resolution has not been agreed upon. Advantages of using this land extend beyond the RTC site, to the entire sub-watershed, including the eventual upgrade of Highway 10, which will also need a River outlet. If permission cannot be obtained from the County to use its land, an outlet option will need to be pursued to the southeast, along Highway 10. The small amount of water that now leaves the site, runs southeast along the highway, but infiltrates within a short distance.

*Mitigation Approach*

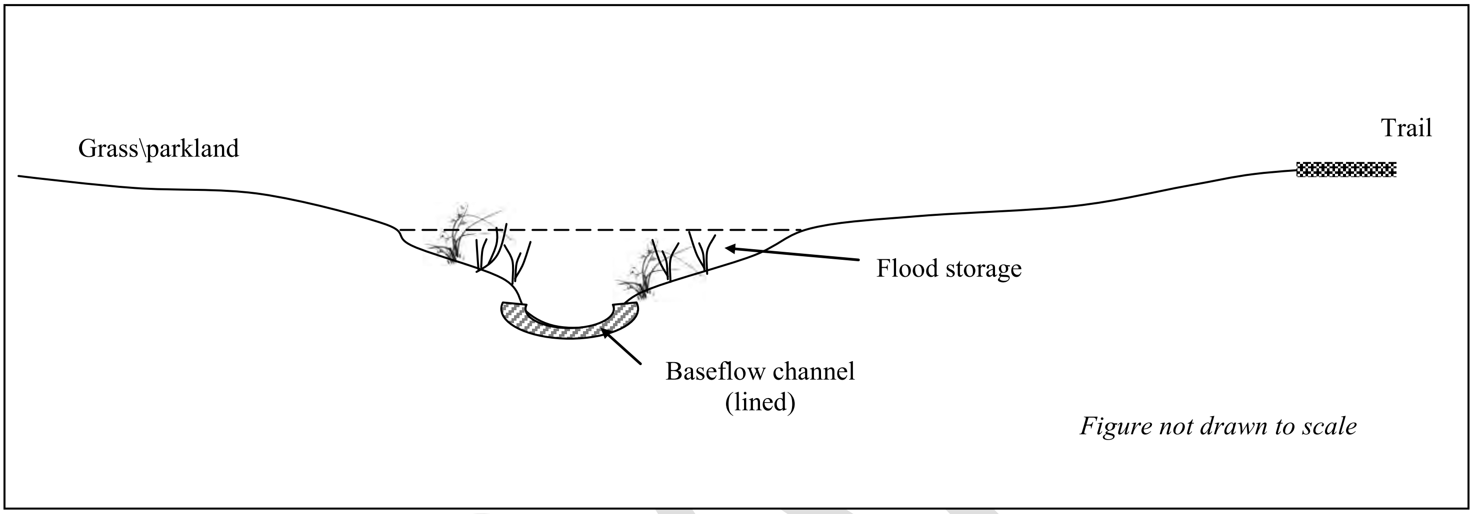
The quantity and quality approach laid-out earlier in this section describes an approach driven by the need to comply with runoff control rules of the LRRWMO and water quality requirements that are described in the next section. The runoff management system proposed in Figure 17.2 is done in a preliminary sense to allow the City and the developer to proceed with some knowledge of what design specifics will be needed. The City will assure that the developer(s) will design and build the final drainage and runoff management system within this overall framework, in compliance with the mandates of the LRRWMO.

*Implementation of BMPs in Preliminary Design*

A system of BMPs can be initially proposed to meet the needs identified in the Item 12 and 17 discussions. The first aspect of this design is the handling of the large-scale (100-year) event. Figures 17.2 (a-c) illustrate the major management practice features that are proposed to store and treat runoff in the central drainage corridor. This system is designed to provide volume/peak reduction storage for the runoff, as well as water quality treatment. This approach starts with large detention storage in ponds located on-site in sub-watersheds 7 and 8, followed by similarly sized detention in ponds located in subwatersheds 25 and 26 south of the active development site. This storage is supplemented with additional smaller-scale storage in sub-watersheds 5, 11, 13, 21 and 22. Tables 17.1-17.5 describe the water quantity reductions in these ponds, and Tables 17.6 and 17.7 describe the water quality improvements for TP.

The ponding system provides both permanent pool storage for water quality treatment and temporary flood storage above the permanent pool. The ponds in the central drainage corridor are supplemented by two areas for additional storage of pre-treated runoff. These two areas in sub-watersheds 8 and 19 will allow for water levels to raise and take advantage of storage available. This water will be slowly drained by a controlled outlet, but infiltration will also occur. Figure 17.3 is a schematic cross-section of this approach. Keeping these areas dry except during high flows allows for their use as open space, recreation areas for essentially all of the year, with the exception of that time when they are needed to absorb flow. They then serve to dampen peaks, reduce volume and enhance recharge.  A similar feature is also proposed for sub-watershed 26. This would be the last BMP in the chain of BMPs installed throughout the site and south of it before flows reaches the Mississippi River.  Table 17.7 showed the dramatic water quality improvement that this system could provide.  Such an approach is mandated by the Phase II discharge requirements (next section) and the MNRRA/Critical Area guidelines (Item 27).

Figure 17.3  Schematic of Flood Storage/Infiltration Portion of Central Corridor.




The runoff calculations in this section included determination of the 100-year event runoff and a condition supplemented by additional on-site storage.  Figures 17.2 (a-c) showed the preliminary concept for the central drainage corridor.  These figures illustrate the ponding system concept for storage during the large-scale event.  Reference to Figure 6.6, however, shows that many additional smaller ponds exist on the site.  Use of these ponds and consideration of the infiltration that naturally occurs through the sandy soils inherent to the site, yield a net reduction in flow leaving the site.  Even further reduction can be made during the design and construction phases with the incorporation of additional BMPs.  These features can also be used to filter inflow to the shallow groundwater system and replace some of the recharge lost to increased urbanization.  The City can expect that volumes will be reduced if these features are incorporated in block design runoff routing.  The largest benefit would likely accrue from installation associated with large parking lot surfaces.  Further reductions can be explored during the detailed design phase.

The final BMP element proposed for runoff control is the use of solids removal pre-treatment at storm sewer outfalls.  These installations can be any of a wide variety of forebays or installed sumps/filters that remove particulates from stormwater prior to discharge into any of the drainageways throughout the site.  These will also reduce overall pollutant removal and will be a major part of the city's Phase II list of available BMPs.

As part of the design process for BMPs, replacement of non-native vegetation with native vegetation will occur whenever practicable and desirable.

*Phase II National Pollutant Discharge Elimination System (NPDES) permit*

The City of Ramsey has submitted its draft application for a Phase II National Pollutant Discharge Elimination System (NPDES) permit. The unsigned permit was submitted on March 10, 2003 under the MPCA requirements for the program of the U.S. Environmental Protection Agency (EPA). MPCA extended the timeline for receipt of an officially signed permit so that the City could authorize signature through a City Council action. The new deadline for receipt of a signed application is May 9, 2003. After that, the City will need to adopt a Storm Water Pollution Prevention Program (SWPPP). Since the City owns and operates a municipal drainage system, it is subject to the provisions of the Municipal Separate Storm Sewer System (MS4) provisions of the law. Construction activities within the City, and specifically on the Ramsey Town Center site, are also subject to the Phase II General Storm Water Permit for Construction Activity.

The MS4 program requires the City to develop and implement a Storm Water Pollution Prevention Program (SWPPP) that includes six minimum control measures:

- Public education and outreach;
- Public participation and involvement;
- Illicit discharge, detection and elimination;
- Construction site runoff control;
- Post-construction site runoff control; and
- Pollution prevention/good housekeeping.

The City must identify best management practices (BMPs) and measurable goals associated with each minimum control measure noted above. The City will be given five-years to develop an effective program after the permit is issued. This period of time coincides with the phased development of the Ramsey Town Center site, which must then include the provisions of the City SWPPP. The City will assure that the provisions of its Program are properly implemented within the Center as development proceeds.

Construction within the City of Ramsey is also subject to the provisions of the NPDES Phase II General Storm Water Permit for Construction Activity. This provision is in addition to the construction control measure required under the MS4 permit. Revisions to the current permit will be implemented by the State in September 2003. Under the proposed State Construction permit, any construction meeting the following criteria will be expected to obtain a permit from the MPCA:

- Any construction activity that results in the disturbance of one acre or more;
- Any construction activity less than one acre, but part of a “larger common plan for development or sale” that is larger than one acre (This would apply to any sub-area construction on the Ramsey Town Center site that is less than one acre because the overall site meets the above criteria.); and

- Any construction activities that MPCA determines will potentially contribute to a violation of a water quality standard or for significant contribution of pollutants to a water resource.

Clearly, any construction on the Ramsey Town Center of any size will be subject to the provision of the Phase II construction permit, especially since the City's MS4 permit requires it to implement control measures addressing construction site runoff control. The SWPPP required for the general construction activity Permit must address the potential for discharge of sediment and/or other potential pollutants from the site, and must include the following elements:

- Temporary erosion prevention and sediment control BMPs;
- Permanent erosion prevention and sediment control BMPs;
- A permanent storm water management system; and
- Pollution prevention management measures.

These elements must be incorporated into the final plans and specifications before applying for permit coverage. Special provisions are made within the General Permit language for discharges to Outstanding Resource Value Waters (ORVW), which includes the Mississippi River through the City of Ramsey, discharges to wetlands and discharges to scenic or recreational river segments, which include the Ramsey reach of the Mississippi River. Within these areas, additional protective BMPs are required. Since the ultimate discharge from Ramsey Town Center is the Mississippi River, these provisions will apply to the construction permits issued for the site. The Item 17 assessment of discharge found that discharge of any storm water from the Town Center downstream to the River will occur under wet conditions. The only feasible and economic alternative for surface water discharge from the site is to the River. Every effort will be made to retain and, if possible, infiltrate normal events on the Town Center site. Excess volumes of surface water runoff will be pre-treated before allowed to drain from the Center or its nearby/adjacent runoff treatment system.

Because the Ramsey Town Center will not have any heavy industrial uses, it is not expected that the provisions of the Phase II NPDES program dealing with Industrial Activity will apply. However, if development conditions change before the site is finally built-out, and heavier industry is allowed on the site, these provisions could apply. Although there is no intent for heavy industry to occur in the Center, the City will monitor the permit requirements relative to land uses under which the permit conditions apply, and implement a control program if ever needed.

*Relationship to Mississippi River TMDL*

One water quality element of note in the mitigation plan is the need to reduce the negative impact of a discharge to an ―impaired water” under the Total Maximum Daily Load (TMDL) program. The Mississippi River through the City of Ramsey has been listed on the MPCA recommended ―303d” list as impaired relative to fecal coliform, PCB and mercury. The PCB and mercury programs are regional in scale and are the subject of regional MPCA and USEPA remediation programs. The discharge of storm water high in fecal coliform, however, is something that the City will need to address. The implementation of nonpoint source pollution control BMPs does not necessarily assure the reduction of fecal coliform. The process for setting a TMDL includes the initiation of a formal study that results in recommendations for control of the pollutant causing the impairment. MPCA has not yet begun this study for the impaired Mississippi River reach; however, once this study begins (currently scheduled for 2004-2006), the City will cooperate to the best of its ability with the MPCA to reduce the input of fecal coliform to the River.

## 18. Water Quality-Wastewater

***18a.*** *Describe sources, composition and quantities of all sanitary, municipal and industrial wastewater produced or treated at the site.*

***18b****. Describe waste treatment methods or pollution prevention efforts and give estimates of composition after treatment. Identify receiving waters, including major downstream water bodies, and estimate the discharge impact on the quality of receiving waters. If the project involves on-site sewage systems, discuss the suitability of site conditions for such systems.*

***18c.*** *If wastes will be discharged into a publicly owned treatment facility, identify the facility, describe any pretreatment provisions and discuss the facility's ability to handle the volume and composition of wastes, identifying any improvements necessary.*

***18d.*** *Does not apply.*

*Observe the following points of guidance in an AUAR:*

- *only domestic wastewater would be coming from industrial uses that are excluded from review through an AUAR process;*
- *wastewater flows should be estimated by land use sub-areas of the AUAR area; the basis of flow estimates should be explained;*
- *the major sewer system features should be shown on a map and the expected flows should be identified;*
- *if not explained under Item 6, the expected staging of the sewer system construction should be described; and*
- *the relationship of the sewer system extension to the RGU's comprehensive sewer plan and (for metro area AUARs) to Metropolitan Council regional systems plans, including MUSA expansions, should be discussed.*

### 18a. General - Source, composition and quantity

In Minnesota communities, the management of wastewater is a health-related necessity. Providing adequate wastewater management services to residents and businesses in a community results in several additional benefits, including protection of the environment, enhanced economic development, and beneficial reuse of bio-solids and nutrients.

Policies within the City's *2001 Comprehensive Plan*, as amended in 2002 (*Comp Plan*), indicate that the City will:

- Extend municipal sewer services to areas within the existing and future Metropolitan Urban Services Area (MUSA) as shown on Figure 5.4 and consistent with the provisions and process outlined by the City.

- Extend municipal sewer services to rural areas *only if*:
    - A pollution problem exists due to failing or leaking septic systems;
    - The only cost effective solution to the problem is connection to municipal sewer or a central sewer system;
    - Capacity exists in the metropolitan treatment system to provide service to the rural area in question; and
    - A fair and equitable financing tool is in place to recover the costs of building the sewer expansion facilities, so that existing rural residents who remain on functioning private septic systems are not required to pay assessments.

- Develop an equitable and fair financial framework for building and maintaining the existing and future municipal sewer system.

- Provide for the efficient and timely extension of municipal sewer services in accordance with the development staging plan as depicted in the future land use plan.

- Oversize sewer pipes so that in the event private septic systems fail the municipal sewer system is properly sized to handle additional capacity.

- Annually monitor sewer flowage into the two metropolitan interceptors in order to identify infiltration and inflow (I&I) problems, which can cost-effectively be repaired.

- Work with the Metropolitan Council Environmental Services division to identify any points of major I&I into the system and devise a plan to minimize future I&I.

- Emphasize prevention and education to protect against ground water pollution related to on-site sewage disposal systems.

- Ensure existing on-site sewage disposal systems in the City are consistently maintained and monitored as required under Minnesota Rules Section 7080.



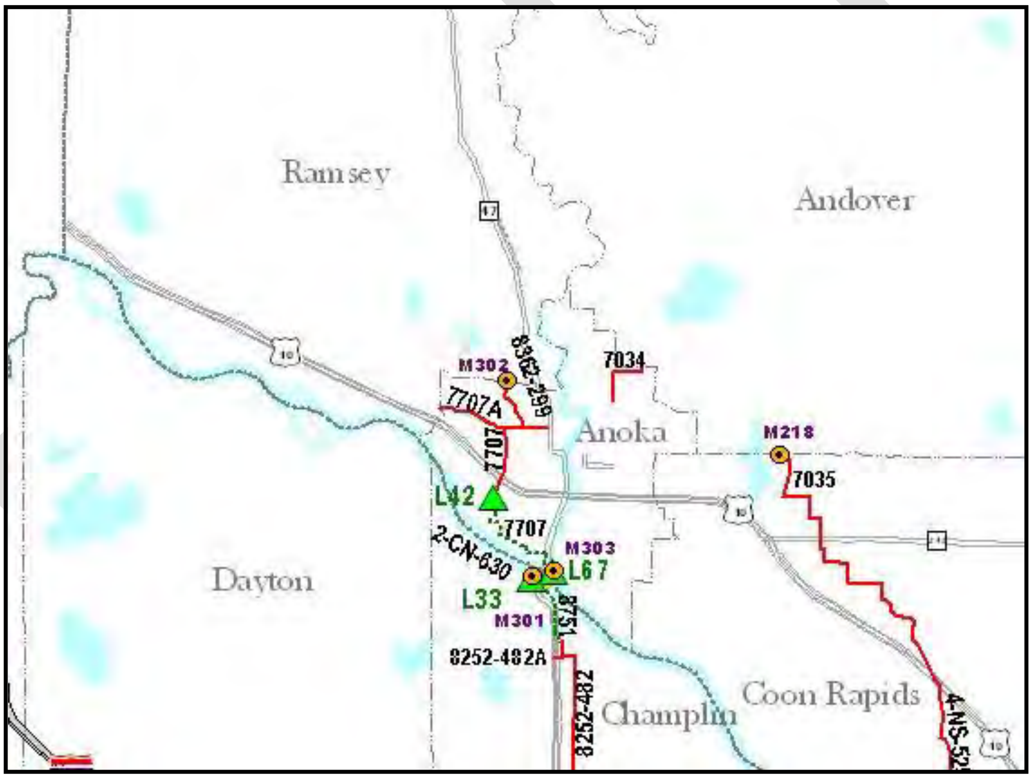
Based on the *Comp Plan,* the availability of wastewater management services within the City can be divided into three distinct service categories as follows:

- Existing Urban (MUSA) Area: Residents and businesses within this area are currently served by the MCES's regional interceptor. Wastewater is transported via this interceptor to the MCES Metro Wastewater Treatment Plant in St. Paul (Figure 18.1 and 18.2).

- Urban Growth Area: These are areas designated by the City of Ramsey in its *Comp Plan*, as being within the Urban Growth Boundary. Wastewater services for future development in this area will be provided by an extension of the City's wastewater collection system for transport to the MCES regional interceptor (Figure 18.1 and 18.2). Existing residences and businesses currently within this area are serviced by individual septic systems.

- Central Rural Reserve and Rural Developing: Residents and businesses in these areas use primarily individual septic systems for wastewater management and individual wells for potable water (Figure 18.2). Although extension of MUSA service to these areas is not currently planned, design of the existing and future sewer mains must take into account any potential future need. Therefore, for purposes of the AUAR, projected flows are calculated for those areas within the Sewer Service Boundary shown in the *1991 Comprehensive Sanitary Sewer Plan* (Sewer Plan). Generally, these areas are designated Rural Developing in the *Comp Plan* and are located north of the Urban Growth Boundary and south of Trott Brook.

**Figure 18.1: MCES Wastewater Facilities Serving Ramsey**



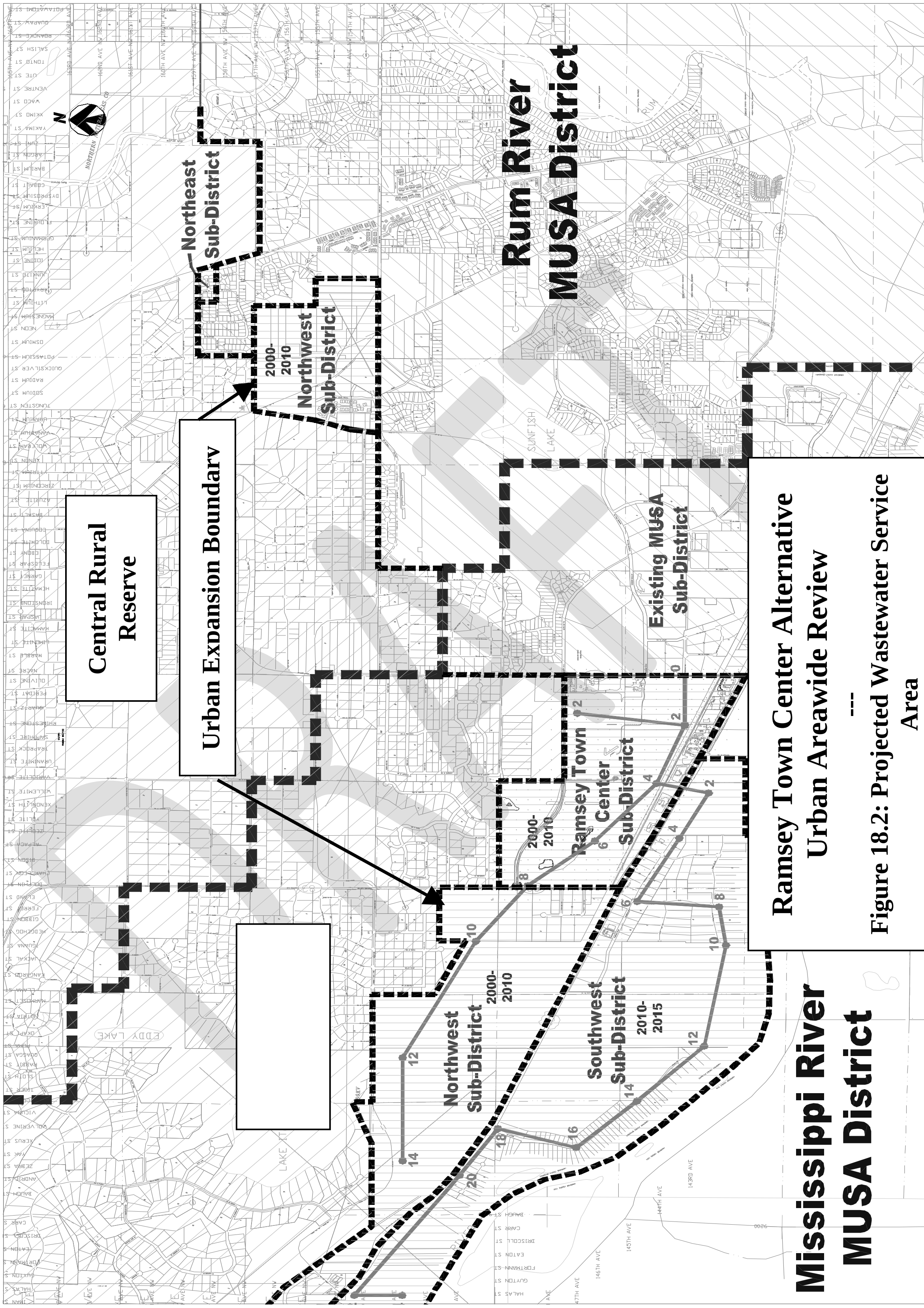



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Figure 18.2: Projected Wastewater Service Area

**Table 18.1: Projected Wastewater Composition and Loadings**

| Contaminant | Concentration (mg/l) | Total Annual Mass Loading(1) (tons) |
|---|---|---|
| Total Dissolved Solids | 500 | 4,871 |
| Total Suspended Solids | 220 | 2,143 |
| Biochemical Oxygen Demand - 5-Day ($BOD_5$) | 250 | 2,435 |
| Chemical Oxygen Demand (COD) | 500 | 4,870 |
| Nitrogen (Total as N) | 50 | 487 |
| Phosphorous (Total as P) | 10(2) | 97 |

(1) Based on a projected annual flow of 2,336 MGY.
(2) Phosphorous levels are somewhat elevated to compensate for disposal and restaurant wastes.

Wastewater from the RTC development is considered domestic as no industrial waste is proposed. Table 18.1 lists the projected composition of the wastewater and the projected concentration of common contaminants. The above projected loadings fall within the range of “average” wastewater strengths. Because of this, it appears that the MCES Metro Wastewater Treatment Plant will be able to handle the projected waste composition and loadings from the RTC Development.

**18b. Description of Existing Wastewater Management Systems**

*Local Collection System Capacity* – Within each of the Districts, wastewater is collected and transported to the main interceptors primarily by gravity sewer. When necessary, pumping stations and force-mains are used to overcome elevation changes. Inflow and infiltration into the sanitary sewer is expected to be minimal due to the relatively new age of the system.

The City’s *Comp Plan* documented MCES Projected Wastewater flows for the City of Ramsey to be between 542 and 668 MGY or a maximum of 1.8 MGD. The *Sewer Plan* indicated that at full build out, 2.8 MGD of flow would be generated by a sewered population of 27,200 persons and a sewered employment of 7,000 employees. It appears that the existing sewer collection system has been designed to accommodate the larger flow of 2.8 MGD.

*Regional Interceptor Capacity* – Availability of capacity in the regional interceptor system depends on several factors but is generally based on Met Council design and growth projections for developing communities. The *Comp Plan* indicates that Met Council projections of wastewater flows for the City of Ramsey in 2020 were between 1.5 and 1.8 MGD. The *Sewer Plan* states that the two regional interceptors serving Ramsey were design to handle a combined average daily flow of 7.87 MGD. However, the regional facilities downstream of the interceptors are not. The *Sewer Plan* also states that approximately 30% (2.8 MGD) of the capacity at the Anoka lift station is reserved for Ramsey. In either case, the *Comp Plan* states that “If and when growth or sewer demand exceeds the current regional facility sizing, those facilities will require upgrading”.

For purposes of this AUAR, it is assumed that the available capacity in the MCES Regional System is at a minimum 2.8 MGD and could be as high as 3.8 MGD without requiring significant upgrades. This 3.8 MGD figure is based on a telephone conversation held in February of 2003 in which MCES Officials indicated that additional capacity may be available due to slower than anticipated growth and development in other cities. Therefore, it is recommended that the City contact MCES to formalize a new agreement on existing and future available capacity. Future decisions on growth, and the need for infrastructure improvements, can then be planned and executed as necessary.

*Existing Urban Flows* – Within the existing Urban Wastewater Service Area (Table 18.2), approximately 1,500 residential households and 250 acres of commercial, industrial and institutional development are served by the MCES regional interceptor. The entire Urban Service Area is divided into two service districts that connect to separate regional interceptors: the Mississippi River District and the Rum River District (Figure 18.2). These Districts are divided somewhat along the watershed divide for the two rivers.

Table 18.2: Existing MUSA (Category 1) Flows by District

| Description | Average Daily Flow (MGD) | Peak Hourly Flow (MGD) | Average Annual Flow (MGY) | Average Daily Flow Capacity (MGD) | Peak Hourly Flow Capacity (MGD) |
|---|---|---|---|---|---|
| Mississippi River MUSA District | 0.161[(1)] | 0.475 | 59 | - | 10 |
| Rum River MUSA District | 0.390[(2)] | 1.120 | 143 | - | 8 |
| **TOTAL** | **0.551** | **1.595** | **202** | **2.8 to 3.8** | **18** |

(1) Based on 2002 monthly flow records provided by MCES. (2001 Comp Plan estimated at 0.199 MGD)
(2) Based on 2002 average quarterly flow monitoring records provided by MCES. (2001 Comp Plan estimated at 0.406 MGD)
(3) Peak hourly flows were calculated using average design value formulas.

The two regional interceptors serving the City have a combined peak capacity of 18.0 MGD. The Rum River MUSA District, which is served by a 30-inch diameter interceptor, has a maximum design capacity of about 8 million gallons per day (MGD). The Mississippi River MUSA District, which is served by a 30-inch diameter interceptor, has a maximum peak design capacity of about 8 MGD. As stated earlier, it is assumed that 2.8 to 3.8 MGD of average daily flow capacity is available in the regional system. Therefore, it appears that approximately 1.2 to 2.2 MGD of average daily capacity is currently available, without upgrades to regional facilities, for future development in Ramsey.

The capacity of the MCES interceptors appears to be adequate for the existing average daily and peak hourly wastewater flows from each District. In addition, the combined average daily flow of 0.551 MGD does not exceed the MCES limit of 2.8 to 3.8 MGD.

The reserve capacity for future growth with the Ramsey MUSA, therefore, appears to be about 2.2 to 3.2 MGD.

*Rural Wastewater Management* – In areas outside of the existing MUSA, a total of 3,750 households are served by private on-site septic systems and drain fields. Of these, 3,260 are systems that are outside of the current Urban Growth Boundary. The remaining 490, which are located within the Urban Growth Boundary, are earmarked in the *Comp Plan* to be connected to the MUSA system during phased expansion through about 2015. Approximately half of the 3,750 onsite systems where constructed before 1974 and have not been replaced or upgraded since. The remaining systems are new or have been upgraded since 1974 due to failures or real estate sales. There has been no known or reported groundwater quality issues related to failing septic systems. The City has passed an ISTS ordinance.

*Future Wastewater Management.* As stated earlier, the City's wastewater collection system is divided into two Districts that generally follow a watershed boundary: the Rum River MUSA District and the Mississippi River MUSA District. The City's 2001 Comprehensive Plan identified areas within the City limits that would receive MUSA wastewater service under future planned expansions through 2015. These areas are all within the Urban Growth Boundary.

In the Rum River MUSA District Urban Growth Area, future expansion is planned to serve two small areas to the north of $163^{rd}$ Ave. (Figure 18.2). In the Mississippi River MUSA District Urban Growth Area, future expansions are planned for a fairly large area to the west of Ramsey Blvd., and to the north and south of U.S. Hwy. 10, also shown in Figure 18.2.

The RTC Site is located within the Mississippi River MUSA District. It was identified in the City's *2001 Comprehensive Plan*, as amended in 2002, for expansion of the centralized wastewater system between 2000 and 2010. In addition to the RTC Site, the plan identified other Urban Growth Areas to the west of the RTC Site with sewer extension occurring between 2000 and 2015.

*(Note: The selection of sub-districts is solely for convenience in determining current and future design flows and was not intended to correlate with any development timelines..)*

Methodology: Existing and projected future flows for each District need to be determined in order to consider potential future impacts from the RTC Development. In general, the methodology follows that used in the City's *2001 Comprehensive Plan,* as amended in 2002, and estimates future flows for all areas within the Sewer Service Boundary developed in the *Sewer Plan* (Generally all areas south of Trott Brook).

Flows for the areas currently served by the MUSA will be based on the 2001 MCES reported flows as shown in Table 18.2. Flows for the future Urban Growth Areas are based on projected land use and generally follow the procedures developed in the City's *2001 Comprehensive Sewer Plan*, as amended in 2002 (A summary of the projected flows is included as Appendix G). For the RTC Site, future flows were estimated based on projected occupancy and development types presented in the latest RTC preferred design shown in Figure 6.1.

*Mississippi River MUSA District* – To determine future wastewater flows, the Mississippi River MUSA District Urban Growth Area was divided into five sub-districts: the existing MUSA Sub-district, the Rural Sub-district, the RTC Sub-district, the Northwest Sub-district and the Southwest Sub-district (Figure 18.2).

Table 18.3: Projected Wastewater Flows for RTC Sub-district Residential Development

| Development Type | Quantity | Occupants per Unit | Total Occupants | Flow per Occupant (gpd) | Total Flow (gpd) |
|---|---|---|---|---|---|
| Mixed Use Residential | 1012 | 5 | 5,060 | 75 | 379.500 |
| Apartment | 172 | 3 | 516 | 75 | 38,700 |
| Duplex | 62 | 4 | 186 | 75 | 13,950 |
| Townhouse | 1154 | 4 | 4,616 | 75 | 346,200 |
| **Total Residential** | **2,400** | | **10,378** | **75** | **778,350** |

Table 18.4: Projected Wastewater Flows For RTC Commercial/Service Development

| Development Type | Acres Used (ac) | Flow per Acre (gpd) | Total Flow (gpd) |
|---|---|---|---|
| Commercial (Existing Hwy. 10) | 32.2 | 1,500 | 48,300 |
| Commercial (Service/Convenience) | 11.6 | 1,500 | 17,400 |
| Commercial (Shopping) | 24.4 | 1,200 | 29,280 |
| Mixed Use (Retail/Office) | 30.6 | 1,700 | 52,020 |
| Civic Center | 3.6 | 10,000 | 36,000 |
| Business Enterprise | 35.9 | 1,000 | 35,900 |
| Transit | 4.5 | 1,000 | 4,500 |
| Public/Open Space | 58.2 | 100 | 5,820 |
| **Total Developed Area** | **201** | | **229,220** |

Table 18.5: Mississippi River District Projected Future Wastewater Flows by Sub-district

| Sub-district | Existing Average Daily Flow (MGD) | Existing Peak Hourly Flow (MGD) | Future Average Daily Flow (MGD) | Future Peak Hourly Flow (MGD) |
|---|---|---|---|---|
| RTC Sub-district | 0 | 0 | 1.010 | 3.100 |
| Northwest Sub-district | 0 | 0 | 0.472 | 1.342 |
| Southwest Sub-district | 0 | 0 | 0.599 | 1.677 |
| Rural Developing(1) | 0 | 0 | 1.427 | 3.602 |
| **Sub-total** | **-** | **-** | **3.508** | **6.422** |
| Existing MUSA | 0.161 | 0.475 | 0.161 | 0.475 |
| **TOTAL** | **0.161** | **0.475** | **3.669** | **6.520** |

(1) From 1991 Comprehensive Sanitary Sewer Plan.

The combined future wastewater average and peak daily flows for the Mississippi River MUSA District are 3.669 MGD and 6.520 MGD, respectively (Table 18.5). These flows are well within the range for the design of the local regional interceptor which has a peak daily capacity of 10 MGD. However, it does appear that improvements to downstream MUSA infrastructure, such as the Anoka lift station, may be required at some future date.

In addition, there is a 27-inch sewer main that terminates at a manhole on the eastern edge of the RTC development at the corner of Ramsey Boulevard and 143rd Avenue. Assuming the minimum allowable design slope of 0.07%, the maximum instantaneous flow that can be handled by this line is 8.216 MGD. Therefore, it appears that the existing 27-inch main is sized to handle wastewater flows from the RTC development and future growth from the Urban Growth and Rural Developing Areas.

*Note: The 27-inch main mentioned above runs for two blocks before tying into a 30-inch main. Because of this, and the uncertainty of future flows and pipe slopes, it is recommended that a 30-inch sewer main be installed throughout the entire RTC development and, if required, only two blocks of 27-inch main will need replacing in the future.*

*Rum River MUSA District* – To determine the future wastewater flows, the Rum River MUSA Sub-District has been divided into four sub-districts: the Existing MUSA Sub-district, the Rural Sub-district, the Northwest MUSA Sub-districts and the Northeast MUSA Sub-district (Figure 18.2). Table 18.6 shows the current and future flows for the Rum River District.

Table 18.6: Rum River District Projected Future Wastewater Flows by Sub-district

| **Sub-district** | **Existing Average Daily Flow (gpd)** | **Existing Peak Hourly Flow (gpd)** | **Future Average Daily Flow (MGD)** | **Future Peak Hourly Flow (MGD)** |
|---|---|---|---|---|
| Northwest MUSA Sub-district | 0 | 0 | 0.097 | 0.287 |
| Northeast MUSA Sub-district | 0 | 0 | 0.021 | 0.063 |
| Rural Sub-district | 0 | 0 | 2.221 | 5.775 |
| **Sub-total** | **-** | **-** | **2.339** | **6.081** |
| Existing MUSA | 0.390 | 1.119 | 0.390 | 1.119 |
| **TOTAL** | **0.390** | **1.119** | **2.729** | **5.704** |

The combined projected average daily flow for the Rum River District is 2.729 MGD with peak flows reaching 5.704 MGD. Therefore, there appears to be sufficient capacity in the MUSA regional interceptor which is designed for a peak flow of 8 MGD. Again, it is recommended that the City reevaluates their MCES allocation of the interceptor capacity prior to performing an update of their Comprehensive Sewer Plan.

*Combined City of Ramsey Flows.* Table 18.7 below shows the total future average daily wastewater flow for the entire City to be 6.4 MGD with a peak hourly flow of 12.2 MGD. It should be noted that these flows assume the maximum possible density at final build-out and, therefore, represent the most conservative scenario. As a result, it appears that the existing interceptors are large enough to carry the projected future average daily flows, as well as the projected future peak hourly flows. However, it appears that the future average daily wastewater flow is above the MCES allocated flow of 2.8 MGD as well as the higher allocation of 3.8 MGD. Discussions with MCES on allocated capacity should begin.

Table 18.7: Projected Wastewater Flows for 2020

| **Sub-district** | **Future Average Daily Flow (MGD)** | **Future Peak Hourly Flow (MGD)** | **Average Annual Flow** |
|---|---|---|---|
| Mississippi River MUSA District | 3.7 | 6.5 | 1,350 |
| Rum River MUSA District | 2.7 | 5.7 | 985.5 |
| **TOTAL** | **6.4** | **12.2** | **2,336** |

Summary of Environmental Impact. The provision of sanitary sewage collection and transport to a treatment facility is a normal urban service provided by a community as its urban area develops. There is no adverse environmental impact expected as long as the plan for provision of this service is followed according to the City's *2001 Comprehensive Plan*, as amended in 2002 and coordinated with MCES.

Mitigation element - Both the wastewater flows and the projected loadings from the RTC development can be effectively transported and treated by the MCES system. In addition, future development and resulting flows are within the range of those estimated in the City's *2001 Comprehensive Plan,* as amended in 2002. Therefore, it does not appear that there is any cause for specific remediation actions. A 30-inch sewer main is recommended to serve the RTC.

As noted earlier, it will be necessary for the City to update its *Comprehensive Sewer Plan,* following discussion with MCES on increased allocated capacity. In addition, it will be important to measure and test the wastewater flows from the new development on a periodic basis. This will allow the City and MCES officials to monitor the characteristics of the wastewater generated by the development over time and to address any future unforeseen changes.

# 19. Geologic Hazards and Soil Conditions

***19a.*** *Approximate depth (in feet) to ground water:* **4 minimum, 10 average**
*Approximate depth (in feet) to bedrock:* **120 minimum, 160 average**

*Describe any of the following geologic site hazards to groundwater and also identify them on the site map: sinkholes, shallow limestone formations or karst conditions. Describe measure to avoid or minimize environmental problems due to any of these hazards*

***19b****. Describe the soils on the site, giving NRCS (SCS) classifications, if known. Discuss soil granularity and potential for groundwater contamination from wastes or chemicals spread or spilled onto the soils. Discuss any mitigation measures to prevent such contamination.*

*For an AUAR, a map should also be included to show any groundwater hazards identified. A standard soils map for the area should be included.*

**19a.** The regional water table is four feet from the surface in low areas of the site, but average depth to groundwater is ten feet (Figure 19.1). The easily accessible water table provides a readily available source of groundwater. Bedrock units below surficial materials provide additional groundwater sources. The City of Ramsey drinking water is currently supplied by five wells. Three of these well are in, and adjacent to, the Town Center and pump water from the Franconia-Ironton-Galesville (FIG) aquifer. Details of this system are provided in Item 13. Groundwater flows at low gradients to the south-southeast towards the Mississippi River in the FIG aquifer.

Surficial sediments consist of Quaternary glacial outwash composed primarily of sand and gravel (Figure 19.2). The majority of the site lies within the Langdon Terrace. The northeast edge of the site consists of the Richfield Terrace. Both Terraces are deposits of the historic Mississippi River and consist of sand layers of varying thickness overlaying till or bedrock. Boulder lags and scarps are typically found at the contact between the two Terraces. Clay layers of varying thickness are found at typical depths of 50 feet. Thickness varies and the layers do not appear to be continuous. These clay layers inhibit the downward flow of groundwater to lower bedrock units. The clay is typically mixed with sand or gravel, or has pockets of sand and gravel. Silt, clay, and hydric soils can be found at or near the surface in some areas. These materials are hydraulic barriers retaining surface water where surface water features are not reflections of groundwater.

Beneath the Town Center, minimum depth to bedrock is 120 feet and average depth is approximately 160 feet (Figure 19.3). The uppermost bedrock unit below the Town Center is the Franconia Formation (Figure 19.3). The Upper Franconia is fine- to coarse-grained dolomite cemented sandstone with thin beds of shale. The Lower Franconia units are glauconitic and feldspathic well-cemented sandstone inter-bedded with thin shale layers. The two are separated by a thicker shale bed, which is far less able to transmit water, further slowing the downward flow of water to deeper aquifers. Below the

Franconia is the Ironton-Galesville Formation. The Ironton and Galesville formations are medium to very coarse-grained sandstones interlaid with thin beds of shale. The formations are separated from the water at the surface by clay layers in glacial material and by the thick shale bed in the Franconia Formation. These units of shale and clay act as ―aquitards”, meaning they have low permeability and slowly transmit water, or retard the flow of water to lower bedrock units.

The Minnesota Geological Survey (MGS) is currently reviewing the bedrock geology of this region. A final map from this study will be available in fall 2003. The study identifies the possibility of shallow bedrock valleys where the St. Lawrence formation is absent throughout Anoka County. These shallow valleys can be difficult to identify, as the St. Lawrence is often misinterpreted as Upper Franconia. It is typically present as a cap on high bedrock areas. Well logs from the project site (Figure 19.3) indicate that the St. Lawrence does not exist below the Town Center, but because of common misinterpretations, a thin layer may be present.

Through the course of the MGS study, a bedrock valley was identified two miles north of the Town Center site (Figure 19.4). The valley cuts down through all upper bedrock units into the Ironton-Galesville Formation. Bedrock valleys bring quaternary sediments in direct contact with deep bedrock formations. This interaction may result in the quaternary aquifer recharging bedrock aquifers without the typical aquitards that protect these aquifers from surface pollutants.

**19b.** Soils within the Town Center are highly permeable sand and gravel in the upper 50 feet. These are the soils through which RTC stormwater infiltrates (Figure 12.2). Soil borings on-site indicate the first foot of soil is silt and sand, followed by poorly graded fine to medium-grained sand with traces of gravel. The Natural Resources Conservation Service (NRCS) classifies the soils on site as Hubbard series, Duelm, and Isanti. The Hubbard soils classified on site are coarse sand with slopes that range from 0-12 percent. The Duelm is a loamy coarse sand and the Isanti is a sandy loam. The Isanti is a hydric soil.

All soils on site have a permeability that ranges from six-to-twenty inches per hour. The high permeability of the soils increases the potential for shallow groundwater contamination. To reduce this risk, pretreatment of stormwater runoff prior to infiltration and community education programs on household chemical and fertilizer use can be implemented.

City wells were tested for tritium as part of the wellhead protection area (WHPA) and drinking water supply management area (DWSMA) delineation for the City of Ramsey. Tritium is a form of hydrogen and can act as an indicator of groundwater age, but does not pose a health risk. Atmospheric tritium levels increased during the 1950's due to testing of atomic bombs. Therefore, tritium levels are used to indicate whether groundwater entered the ground before or after 1950. Public water supply wells with high levels of tritium are classified as ―vulnerable” to surface processes because of the relatively recent (post-1950) interaction with the surface. Tritium levels in the three city wells around the Town Center are high. The high levels may be caused by the rapid rate of infiltration through the highly permeable sand and gravel materials of the Anoka Sand Plain, or by the interaction of the quaternary and bedrock aquifers in the bedrock valley to the north of the site.

Water quality tests of Ramsey public water supply wells including tests for nitrates, pesticides, volatile organic compounds, and arsenic were found to meet all of the Safe Drinking Water Act drinking water limits. Manganese and iron are present and may produce staining and metallic tasting water, but do not pose a health risk. Clay layers in the glacial material and shale layers in the Franconia Formation slow or impede the course of potential surface pollutants towards the lower bedrock formations and therefore help to maintain the quality of the Ramsey water supply.

<u>Summary of Environmental Impact</u>. There were no geologic hazards within the Town Center site. A bedrock valley was identified by the MGS approximately a mile and a half north of the Town Center. Due to the high permeability of the Anoka Sand Plain, the surficial aquifer is susceptible to contamination from surface activities. This contamination could potentially reach the water supply. The following mitigation plan details means to minimize the risk of contamination.

<u>Mitigation element</u>. The high permeability of the soils at the Town Center are ideal for the implementation of infiltration practices that will manage stormwater runoff, provide flood control and recharge the water table aquifer. However, the high permeability also increases the risk for potential contamination of groundwater resources. In order to mitigate this risk, best management practices (BMPs) and community education programs will be implemented.

Extensive use of herbicides, pesticides, and fertilizers on residential and public lawns, and agricultural fields is discouraged in the City of Ramsey, as stated in the City's *2001 Comprehensive Plan*. Implementing community education and awareness programs to discourage the above stated activities, as well as to inform on household and business chemical usage and hazardous waste storage and disposal will help reduce the potential for groundwater contamination by these types of substances. The appropriate use of native vegetation will also reduce the need for herbicides, pesticides and fertilizer throughout the Town Center.

Infiltration of stormwater under carefully managed conditions is essential for recharging groundwater. Infiltration through soil also removes nutrients and other potential pollutants from surface water, pretreating and maintaining the quality of the water. Potential groundwater contaminants from stormwater runoff associated with land uses similar to the proposed Town Center land uses include nitrates, pesticides, organic compounds, and heavy metals. The potential for contamination from these substances is greatly reduced when stormwater runoff is pre-treated prior to infiltration and BMPs are implemented. Pretreatment methods vary, but include the use of permeable materials to promote infiltration and pollutant removal by soil, vegetation to filter surface water, settling to remove solids and pollutants associated with them, and preventative measures such as limiting the storage of chemicals and homeowner education on chemical use. Several manuals for design, installation and maintenance of BMPs are available to guide the City. Citizen and staff education will also help implement protective practices.

The use of these types of practices increases wildlife habitat and public green space while reducing the risk of groundwater contamination. Several manuals are available to guide actual installation, use and operation/maintenance of chosen BMPs.

## 20. Solid Wastes; Hazardous Wastes; Storage Tanks

> ***20a***.*Describe types, amounts and compositions of solid or hazardous wastes, including solid animal manure, sludge and ash, produced during construction and operation. Identify method and location or disposal. For projects generating municipal solid waste, indicate if there is a source separation plan; describe how the project will be modified for recycling. The total quantity of municipal solid waste generated and information about any recycling or source separation programs of the RGU need to be included. If hazardous waste is generated, indicate if there is a hazardous waste minimization plan and routine hazardous waste reduction assessments.*
>
> ***20b***. *Not applicable to an AUAR.*
>
> ***20c***. *Indicate the number, location, size and use of any above or below ground tanks to store petroleum products or other materials, except water. Describe any emergency response containment plans. Potential locations of storage tanks associated with commercial uses in the AUAR should be identified (for example, gasoline tanks at service stations).*

**20a.** Information on solid waste generation expected from the RTC site was obtained from Ace Solid Waste Inc. (Rick Nelson, 763-427-3110). The analysis used the preferred design shown in Figure 6.1 and the extensive local experience of Ace Solid Waste Inc. to calculate the most likely amount of solid waste that will be generated by the Town Center. The completed analysis is shown in Table 20.1.

Table 20.1 Solid Waste Analysis

| Use Type | Solid Waste (tons/month) |
|---|---|
| Business/Medical Office | 21.33 |
| Commercial | 12.11 |
| Mixed-Use | 86.93 |
| Residential | 123.65 |
| Retail | 26.99 |

**20b**. Not applicable to an AUAR.

**20c**. There are no underground storage tanks at the Town Center Site at this time, nor were there any identified to have been present historically. A Phase I investigation conducted by Delta Environmental Consultants, Inc. in 2002 identified two sites within one-half mile of the project area that were of regulatory environmental concern (Figure

19.4). Both sites were part of the Minnesota Pollution Control Agency's (MPCA) Leaking Underground Storage Tank (LUST) Cleanup Program. Brook's Food Store (LUST #7470) at 14550 Armstrong Boulevard Northwest was added to the LUST database in 1994 due to a release of unleaded gasoline. Custom Coaches (LUST #1042) at 6845 Highway 10 North was added to the LUST database in 1989 after a release of gasoline. Both sites were closed as of 1997.

Within the project area, there is an active site in the MPCA's Voluntary Investigation and Cleanup (VIC) program (Figure 19.4). The site is located on the corner of Ramsey Boulevard and Highway 10, and is identified as VP8480. In July 1963, a railcar accident resulted in the release of powdered lead arsenate. There was also a report of several barrels, possibly containing lead arsenate, being buried at this same location at a later, unspecified, date and then removed. An electromagnetic induction survey indicated three disturbed areas in the subsurface that could be burial locations. Burlington Northern Santa Fe (BNSF) has no record of the burial of any items. From soil boring investigations, the extent of arsenic contamination is 350 feet long and 40 feet wide (Figure 19.4).

The Minnesota Department of Health (MDH) and the United States Environmental Protection Agency (USEPA) determined the maximum contaminant level (MCL) for arsenic in drinking water to be 50 parts per billion (ppb). In the 1990's the limit was reviewed and changed to 10 ppb. The new regulation does not go into affect until 2006. Groundwater samples were collected from monitoring wells at the spill site and from several residential wells near the spill. Soil samples were taken at varying depths from soil borings at the spill site. Of forty-two soil samples taken from 1998-2000, eight were over current MCL for arsenic. Groundwater samples were taken from six monitoring wells in 2000, and all six were over the current limit. In 2001, only one of these wells was over the MCL. Sample collection methods in 2001 differed from those used in 2000. The only arsenic level that exceeded the present MCL in a sampled residential well was to the north of this site. Because groundwater flow is to the south, the BNSF site is not thought to be the source of arsenic in that well.

A supplementary Phase II investigation has been completed for this site and is under review by the MPCA.

BNSF indicated its intent to remove the contaminated soils prior to the construction of the Burger King restaurant, parking lot, and stormwater detention pond. BNSF currently has plans to remove the contaminated soils in the summer of 2003. BNSF and the MPCA should be notified prior to any earth moving activities. The project representative for the MPCA is Karen Kromar, who can be contacted at (651) 297-3080. The BNSF representative is Mike Woolridge, who can be contacted at (763) 782-3483. Thomas Dahl, of Retec, performs environmental testing for BNSF at this site and can be contacted at (651) 222-0841.

BNSF hauls hazardous materials along the tracks that adjoin RTC. There has been only one known derailment of hazardous materials on the site over the past 40 years, as discussed above. The transportation of hazardous materials is regulated at the federal, state and local level. Hazardous materials hauled through this area are reported to the Anoka County Emergency Management Department and are required to be properly placarded, stored and transported according to all applicable regulations. The City of Ramsey Police and Fire Departments are fully trained and prepared for potential derailments. Further information on City preparedness plans can be obtained from Fire Chief Dean Kapler at (763) 427-3764.

The Phase I Environmental Assessment performed in June 2002 by Delta Environmental Consultants Inc., concluded, based on site inspection, that hazardous substances and petroleum products were used and stored on an abandoned farmstead along Ramsey Boulevard Northwest within the Town Center site (Figure 19.4). Due to the unsecured nature of these substances, the potential for release or improper disposal exists. Materials identified at the farmstead included cement cans, motor oil containers, an open bucket of motor oil, rust retardant, bonding adhesive, car batteries, antifreeze, air conditioners, refrigerators, and several abandoned vehicles. Tests of ceiling tiles, floor tiles, insulation, and siding from the abandoned farmstead buildings were negative for asbestos. If this site is found to have contaminated soils or groundwater, appropriate remediation will be needed.

In order to safeguard and sustain the public water supply, ―wellhead protection areas” (WHPAs) and ―drinking water supply management areas” (DWSMAs) are delineated around public water supply wells (Figure 20.1). The Ramsey *Wellhead Protection Plan* was developed in cooperation with Anoka County Environmental Services as part of a ten-city program to delineate WHPAs and identify potential contaminant sources by parcel number. The WHPA is the recharge area for the public water supply. Parameters used to determine recharge area include a ten-year travel time, aquifer transmissivity, pumping volume, flow direction, flow boundaries, and geologic setting. The DWSMA is the geographic area including and adjacent to the WHPA extended to public roads and/or property lines.

WHPA and DWSMA designations restrict or specially manage land uses that could degrade the quantity and quality of the public water supply. The most controlled land use in the WHPA is the use of underground storage tanks to store petroleum and any other potentially harmful substance. Underground tanks are allowed in the WHPA if the tanks are double-walled and groundwater around the tank is monitored for contamination from a possible leak in the tank. However, the use of underground tanks in these areas is strongly discouraged. In the case that a leak occurred, alternative water sources, such as the emergency connection with the city of Anoka, would potentially have to be used. Ramsey city wells would be particularly susceptible to an up gradient leak. In the event of a water supply emergency, the City would respond using its normal police and fire emergency response plan until a specific emergency response plan can be developed as part of an updated water supply plan.

<u>Summary of Environmental Impact</u>. There is an active MPCA VIC site in the southeast corner of the site as result a release of lead arsenate. The soils and groundwater in that

area were contaminated with arsenic. BNSF is working with current landowners and the MPCA to remove the contaminated soils during the summer of 2003. Additionally, improperly handled and stored hazardous materials on an abandoned farmstead may pose an environmental impact. Finally, the Town Center site includes the WHPAs and DWSMAs for the city of Ramsey west well field. The following mitigation plan discusses how to minimize the impact to the drinking water supply within the regulated areas, as well as how to minimize further impact by the farmstead and VIC sites.

Mitigation element. To decrease the amount of solid waste generated within the City, Ramsey maintains the following policies as stated in its *2001 Comprehensive Plan* -

- Work with the Anoka County Integrated Waste Management Department to develop and implement programs that contribute to waste reduction, resource recovery, recycling and limited landfilling;
- Continue to support curbside recycling of reusable waste materials through educational events, promotional events, and volunteer efforts;
- Research grants and funding programs through federal, state, and local organizations that support the ―Three R's" (reduce, reuse, and recycle); and
- Continue to pursue and support research efforts in innovative techniques that enhance the environment, provide alternative means of energy, and reduce the waste stream.

The implementation of these policies will help to reduce the quantities of solid waste produced at the Town Center.

The contaminated soils at the BNSF VIC site must be removed as soon as possible under the plan for the summer of 2003. Removal could potentially occur during construction of the multi-modal facility, Highway 10 improvements, or Town Center construction. BNSF and the MPCA should be contacted in regards to any earth moving activity in the vicinity of the spill site. The project representative for the MPCA is Karen Kromar, who can be contacted at (651) 297-3080. The BNSF representative is Mike Woolridge, who can be contacted at (763) 782-3483. The contamination of groundwater may restrict the installation of additional water supply wells near Ramsey Boulevard and Highway 10.

Further investigation may be needed in order to determine the extent, if any, of contamination at the abandoned farmstead. If there is soil or groundwater contamination due to the improper handling and storage of chemicals and hazardous substances at this site, appropriate removal and remediation of the contaminated areas may be required. State and county fiscal aid programs exist for the cleanup and investigation of these types of sites. The MPCA Site Assessment Unit has fiscal aid available for Phase I and Phase II investigations; contact Tom Whear at 651-296-7349 for additional information. The United States Environmental Protection Agency also currently has funding for cleanup and investigation. For additional information regarding cleanup and investigation programs, the Minnesota Brownfields Resource Guide is available at http://www.pca.state.mn.us/publications/reports/brg-0901.pdf.

Within the WHPA, underground storage tanks and infiltration are not recommended. Should contamination occur due to these or any other practice, alternative water supply sources may be required. Currently the city water towers store an extra amount of water equivalent to meet the supply need for one day. There is also an emergency connection with the City of Anoka for additional water needs. A contingency plan should be developed as part of the next water supply plan update to deal with contamination. According to the EPA, a contingency plan should include the following:

- Basic water supply information
- List of potential contamination sources and location
- Mapped WHPA
- Firefighting plan for toxic chemical storage locations
- Surface spill emergency response plan
- Alternative short term water supply
- Alternative long term water supply

These could be coordinated with existing city plans, data, and management procedures, many of which are detailed in the city's Water Supply Plan, WHP Plan, *2001 Comprehensive Plan*, and this document. A contingency plan is also required by the State as part of the city's water supply plan (M.S., Section 103G.291, subd.3). Guidelines provided by the DNR and Metropolitan Council for the content of this water supply plan element indicate the need for the following components:

- emergency telephone contact list
- current water sources and service area description
- procedure for augmenting supplies
- demand reduction procedures
- procedures for water allocation
- establishment of triggers for implementing plan components
- enforcement
- water supply protection

As part of its next revision, the City of Ramsey will amend its *1999 Water Supply Plan* to include an emergency response element. The amendment will include all of the above components. This will occur prior to applying for a DNR appropriation permit amendment, which would likely trigger the DNR request for emergency plan completion, as well.

Use of underground storage tanks within the WHPA should be discouraged. If underground storage tanks are used to store anything other than water within the WHPA, the tanks must be double-walled and the groundwater around the tank must be appropriately monitored for contamination. The development of a contingency plan as discussed previously should address the management and procedures that would be implemented in the case of a leaky tank.

Infiltration practices within the WHPAs will be carefully controlled to prevent any water that has not been pre-treated from entering. Rain barrels, grading, and other on-lot best management practices should be utilized in these areas as long as the infiltration of street, parking lot, or industrial runoff does not occur within the WHPA. Implementation of community education programs for residential and business contaminant sources, such as fertilizers and hazardous household products, will reduce the risk of groundwater contamination from these sources.

The installation of monitoring wells throughout the WHPA would be appropriate to protect the water quality of the upper aquifer. Should contamination occur, a network of monitoring wells would help to quickly identify the contaminant source and aid in the quick remediation and possibly reduce the extent of contamination. A monitoring well network would also help to understand the relationship between the pumping in the Franconia-Ironton-Galesville aquifer and the upper aquifer. The extent of any further monitoring will be determined during wellhead protection plan development and State water appropriation permitting.

## 21. Traffic

*For most AUAR reviews, a relatively detailed traffic analysis will be needed, especially if there is to be much commercial development in the AUAR area or if there are major congested roadways in the vicinity. The results of the traffic analysis must be used in the response to Item 22 and to the noise aspect of Item 24. Instead of responding to the information called for in the EAW Guidelines for Item 21, the following information should be provided:*

- *Description and map of existing and proposed roadway system (including state, regional and local roads to be affected by the development of the AUAR area. This information will include existing and proposed roadway capacities and existing and projected background traffic volumes.*
- *Trip generation data for each major development scenario broken down by land use zones and/or other relevant subdivisions in the area. The projected distributions onto the roadway system must be included.*
- *Analysis of impacts of the traffic generated by the AUAR area on the roadway system, including: a comparison of peak period total flows to capacities and analysis of Levels of Service and delay times at critical points (if any).*
- *A discussion of structural and non-structural improvements and traffic management measures that are proposed to mitigate problems.*

*NOTE: in the above analyses, the geographical scope must extend outward as far as the traffic to be generated would have a significant effect on the roadway system and traffic measurements, and projections should include peak days and peak hours, or other appropriate measures related to identifying congestion problems, as well as ADTs.*

Appendix B contains a complete traffic analysis compiled by Meyer, Mohaddes Associates, Inc. for this AUAR. The report entitled *Ramsey Town Center Traffic Analysis* was completed in March 2003 and is contained in its entirety in the Appendix.

*Classification Summary*

The project site is served by a network of principal and minor arterial roadways and local streets as shown in Figure 21.1. Highway 10/169 near the study area is a four-lane divided US Highway that is classified as a Principal Arterial. Ramsey Boulevard (CR 56) and Industry Avenue (CR 116) near the study site are two-lane County Roads that are classified as B-Minor Arterials. Armstrong Boulevard (CSAH 83) and Sunfish Lake Boulevard (CSAH 57) near the study area are two-lane County State Aid Highways that are functionally classified as Collectors. Sunwood Drive, a two-lane local street that extends in an east-west direction and connects Ramsey Boulevard to Industry Avenue and Sunfish Lake Boulevard, is identified in the City of Ramsey *2001Comprehensive Plan* as a future Collector. Anoka County is in the process of requesting a functional class change for Industry Avenue and Armstrong Boulevard to upgrade their designations to A-Minor Arterial.

*Traffic Volumes*

Average daily traffic volumes on streets and highways in the study area vary widely with TH 10 carrying about 42,000 vehicles per day (vpd) east of Ramsey Boulevard and 31,000 west of Armstrong Boulevard. By contrast, volumes on the other roadways in the study area range from about 5,000 to 8,000 vpd, with the exception of Industry Avenue between Ramsey and Armstrong Boulevards, which carries about 2,400 vpd.

*Planned Improvements*

The intersection of TH 10 and Ramsey Boulevard is currently a T-intersection. The city has approved the construction of the south leg at this intersection by a private developer. However, after discussions with the Anoka County staff, the proposal to construct this leg is on hold as a result of budget considerations and other factors. Signal operations improvements at the intersection of Sunfish Lake Boulevard and TH 10 to address existing congestion have been identified, but are deferred because of current state budget considerations.

No other roadway projects are currently programmed for the study area, but several regional studies are in process or recently completed that affect the study area. The TH 10 IRC Study/Corridor Management Plan[2] is a regional roadway planning analysis for Mn/DOT that evaluated future needs on TH 10 through Anoka County. While the study findings have been adopted, the improvements suggested in the study have not yet been incorporated into the State Transportation Improvement Plan, nor are they yet in the Metro Division *Transportation Systems Plan*. Updates of these planning documents are expected to address the recommendations from the TH 10 study. The TH 10 study estimates that traffic volumes on TH 10 will grow between 40 and 50 percent by the year 2025 to over 50,000 vpd in the study area. The report notes that to accommodate this level of volume, even if the Northstar Commuter Rail service and a new Mississippi River crossing are implemented, will require TH 10 to become a six-lane freeway through Ramsey by 2025 with interchanges at Sunfish Lake and Ramsey Boulevards.

In the interim by 2010, the report suggests that TH 10 in the study area be expanded to a six-lane expressway with improved intersections. In the near terms by 2005, the study suggests that signal timing optimization and improvements to Ramsey, Armstrong, and Sunfish Lake Boulevards are necessary. The report notes that one ~~"~~concern with constructing a 6-lane expressway as an interim strategy to constructing a freeway is the roadway alignment. As an expressway, it is preferable to have TH 10 as far away as possible from the parallel railroad in order to allow for vehicle stacking at the intersections. As a freeway, it would be preferable to have the roadway alignment as close to the railroad as possible so that interchanges can provide grade separation over both the highway and the railroad. ”[3] The study also notes that environmental documentation for the proposed improvements has not started and that an EIS will likely be required for the expansion of the roadway.



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[2] H. R. Green Co., *TH 10 IRC Study Corridor Management Plan*, Mn/DOT, January 2002
[3] *ibid.* Page 6-24.

The draft Scoping Document for the Northwest Metro Corridor and River Crossing Study[4] has been completed by Mn/DOT and the final is expected to be published in May 2003. This document explored a reasonable range of alternatives for a new Mississippi River crossing and for the highway and network elements needed to connect the crossing to the existing regional roadway system. The new crossing would be located west of the TH 169 crossing in Anoka and east of the TH 101 crossing in Elk River. The Scoping Document has established the purpose and need for the study and the Draft Scoping Decision has identified a corridor for the crossing.

It is anticipated that the northern terminus of the crossing will likely be west of Armstrong Boulevard and will likely connect to an extension of Industry Avenue. The next step for the crossing would be to start preparation of an EIS, but this work has not been initiated because of the current state budget status and issues with the City of Dayton about alignments south of the river. It is unlikely that interchanges with TH 10 would be allowed at both Armstrong and the river crossing, but might be possible and would depend on the distance separating the interchanges and the function of each in the roadway system. Detailed planning for the section of TH 10 adjacent to the project site would be part of an EIS for the river crossing, if/when it is initiated.

Traffic volumes on Armstrong Boulevard and Industry Avenue would be directly affected by the proposed river crossing if the new roadway terminates in an extension of Industry Avenue. The portion of Armstrong Boulevard south of Industry Avenue, currently a direct connection to and across TH 10 would become a local-serving street, while north of Industry Avenue, its regional role serving traffic north and west would be expanded since it would directly connect to the new river crossing. Similarly Industry Avenue would be expected to see an increase in regional traffic. Anoka County's proposal to change the functional class on these roadways to Principal Arterial is in anticipation of this increased regional role.

The project site is located west of the portion of Anoka County served by fixed route transit service and is currently served only by Anoka County Traveler demand responsive service. The North Star commuter coach operated by Mn/DOT, which currently provides peak period, peak direction, express service between Elk River, Coon Rapids and Minneapolis, is expected to serve a park and ride at the project site in the future. The Northstar service is a demonstration project that is operating motor coaches along the proposed route for the Northstar commuter rail service and is currently carrying between 500 and 600 passenger trips per day[5].

A Final Environmental Impact Statement[6] has been completed for the Northstar Corridor. The preferred alternative for the corridor is a commuter rail service that would operate on the freight railroad tracks that are adjacent to the site. In the FEIS, the Ramsey station location was dropped in favor of the Anoka station location for the preferred alternative. However, the Ramsey station location is listed in the EIS as a candidate for expansion once service has commenced.

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[4] *Northwest Metro Corridor and River Crossing Study,* Mn/DOT, Draft, April 2002
[5] *Rider Report*, *Northstar Commuter Coach*, Mn/DOT, October 2002
[6] BRW, Inc., *Northstar Corridor FEIS*, Mn/DOT, March 2002

Accordingly, this traffic analysis assumes that a rail station is active on the site in the future and that 450 riders per day would use the Ramsey stop[7].

*Traffic Analysis Report Summary*

A detailed Traffic Analysis has been prepared to fully investigate the effects of the proposed project on the local and regional roadway systems. This report has been included in its entirety in Appendix B.

Two sets of future conditions, Future Base and Future with Project, were analyzed. The Future Base represents growth in traffic from non-project sources at the year of project buildout, which was assumed to be the year 2007. A growth factor was used to account for the regional growth in traffic in the area irrespective of the proposed development. This growth factor was calculated to be two percent per year on the basis of forecasts for 2025 from the Metropolitan Council. This level of growth is consistent with the volume projections in the TH 10 IRC Study.[8]
The Future Base also includes the effects of other approved development projects in the vicinity of the project site that anticipate being constructed and occupied within the 2007 time line. The following two projects were identified as having a qualifying development time line:

- The Rivenwick 3rd Subdivision residential development, which is located south of TH 10 at Ramsey Boulevard, would have 112 townhouses and would add a fourth leg to the intersection of Ramsey Boulevard and TH 10.
- The Bright Keys residential development, located across Industry Boulevard from the project site near Ramsey Boulevard, would have 284 townhouse units.

Traffic for the Rivenwick 3rd Subdivision, as reported in that project's traffic study[9], was added into the Future Base. Traffic for the Bright Keys development was generated using standard trip generation rates and assigned to the study area street system using the data developed for the project traffic forecasts (see below).

The Future with Project conditions were developed by adding the project trip generation to the Future Base volumes. Trip generation for the proposed development was estimated using the rates from the 6$^{th}$ edition of the Institute of Transportation Engineers' (ITE) *Trip Generation Manual*. Some trips generated by a mixed-use development of the project type will move between uses within the development site and not reach intersections external to the site and should be excluded from traffic assignment at those locations. This internal trip making is attributed to the interaction between various land uses in a development. Additionally, some trips will take alternate forms of transport, which can be bicycling, walking, and use of transit. The presence of sidewalks, street network density and proximity to transit facilities affect the amount

[7] Ridership estimate is from the supplemental analysis commissioned by the City of Ramsey and presented to the Northstar Corridor Development Authority in support of a Ramsey station (HKGI/SRF, April 4, 2000).
[8] Table 3.4-5 of the TH 10 study reports growth rates of 1.66 and 1.96 percent per year for TH 10 with and without the Northstar Commuter Rail respectively.
[9] SRF, Inc., Traffic *Study for Rivenwick 3rd Subdivision Residential Development in the City of Ramsey*, October 2002.

of trip making by non-auto modes. Because of the limited nature of transit service to the site, no reductions have been made for alternate mode use.

Rather, a single factor was used to calculate the percentage of trips that would remain internal to the proposed redevelopment. This factor considers the diversity of uses within the project and their potential to create linked trips among the project land uses. This factor is based on ITE data for mixed-use developments and is a function of the size and mix of land uses. For the proposed project, the diversity factor indicates that approximately nine percent of AM peak trips and about 16 percent of PM peak trips would be internal.

No adjustments for pass-by or diverted traffic[10] within the site were made, although some of the uses would warrant incorporation of such reductions. Accordingly, the amount of linked trips is conservatively low in relation to the scale and mix of land uses.

Table 21.1 shows the trip generation rates for the proposed redevelopment scenario estimated using the ITE rates for both the AM and PM peak hours. Northstar riders who would park and ride from the site (assumed to be 150 peak hour trips) were included in the analysis, but were added directly to the intersection traffic assignment and are not shown in the trip generation numbers in Table 21.1. Since the existing site is largely vacant and not generating any traffic, no adjustments were made to subtract existing trips from the project site.

**Table 21.1: Project Trip Generation**

| | | **AM PEAK HOUR** | | | **PM PEAK HOUR** | | |
|---|---|---|---|---|---|---|---|
| | **Daily** | **Total** | **In** | **Out** | **Total** | **In** | **Out** |
| Total New Trips | 51,200 | 2,920 | 1,700 | 1,220 | 5,210 | 2,480 | 2,730 |

Future direction of approach trip distribution for the site-generated trips was estimated using forecast data for zones in the project area from the Metropolitan Council's regional travel demand forecasting model and used to assign trips to turning movements at the study area intersections. The regional forecasts used for this analysis did not include the new Mississippi River crossing. Accordingly, traffic distribution is highly biased with about 43 percent of the trips being made to and from the south and east along TH 10 (this also includes traffic destined south on TH 169). It should be noted that with the new Mississippi River crossing, approximately one-third to one-half of the project trips on TH 10 to the south and east would redistribute to the new crossing.[11]

AM and PM peak hour capacity analyses were conducted for all the study area intersections using Synchro software that estimates delay at intersections on the basis of *Highway Capacity Manual*[12] procedures. Since many of the intersections included in the analysis are currently stop controlled, it is important to distinguish that while signalized and all-way stop controlled

[10] Pass-by and diverted trips are opportunity trips that are already on the street system and divert to a new land use. As such, these trips are included in the counted traffic volumes (other than at site access points) and are double-counted in the trip generation rates for some retail uses.
[11] See *Ramsey Smart Growth Twin Cities Opportunity Site* (Calthorpe Associates, 2003)
[12] Highway Capacity Manual, Special Report 209, Transportation Research Board, Washington D.C.

intersections are analyzed for total intersection delay, two-way stop controlled intersections are analyzed only for minor approach delay. Level of Service D is a generally acceptable standard for planning and design of urban transportation facilities. At Level of Service E, poor intersection operations occur as traffic volume approach capacity and LOS F represents extremely congested conditions.

Table 21.2 shows the results of the capacity analyses at the study area intersections for existing conditions and for both Future scenarios.

**Table 21.2: Level of Service Comparison**

| Intersection | Traffic Control at Intersection | Existing[a] | | Future Base[a] | | Future w Project[a] | | Mitigated[a,b] | |
|---|---|---|---|---|---|---|---|---|---|
| | | AM Peak | PM Peak | AM Peak | PM Peak | AM Peak | PM Peak | AM Peak | PM Peak |
| Armstrong Blvd at TH 10 | Signalized | B | A | B | B | F | F | C | C |
| Ramsey Blvd at TH 10 | Signalized | B | A | C | B | F | F | C | D |
| Sunfish Lake Blvd at TH 10 | Signalized | C | F | D | F | F | F | C | E |
| Armstrong Blvd at Industry Ave | One way Stop | (B) | (B) | (B) | (B) | (C) | (E) | A[c] | A[c] |
| Ramsey Blvd at Industry Ave | All-way Stop | B | B | C | B | F | F | C[c] | C[c] |
| Industry Ave at Sunfish Lake Blvd | All-way Stop | B | C | C | C | D | F | A[c] | B[c] |
| Ramsey Blvd at Sunwood Drive | One way Stop | (B) | (B) | (B) | (B) | (F) | (F) | C[c] | C[c] |
| Sunwood Drive at Industry Ave | One way Stop | (B) | (B) | (B) | (B) | (C) | (F) | B[c] | B[c] |
| Sunwood Drive at Armstrong Blvd | One way Stop | | | | | (F) | (F) | A[c] | B[c] |
| NS2 Street at Industry Ave | One way Stop | | | | | (B) | (C) | (B) | (C) |
| NS3 Street at Industry Ave | One way Stop | | | | | (C) | (F) | A[c] | A[c] |
| NS5 Street at Industry Ave | One way Stop | | | | | (B) | (C) | (B) | (B) |
| EW1 Parkway at Ramsey Blvd | One way Stop | | | | | (F) | (F) | (B) | (B) |
| EW1 Parkway at Armstrong Blvd | One way Stop | | | | | (B) | (F) | (A) | (B) |

Notes:
(a) Values in parentheses indicate Minor Approach LOS only
(b) Mitigated conditions include lane adjustments and lane additions at intersections as noted in the text.
(c) Intersection is signalized in the mitigated condition

Under existing conditions, the intersection of TH 10 and Sunfish Lake Boulevard is operating in substandard conditions (worse than LOS D) in the PM peak hour. The other intersections are operating in good conditions in both peak hours. However, the analysis of conditions at TH 10 and Ramsey and Armstrong Boulevards indicates that conditions are unstable, particularly in the PM peak hour when the Ramsey and Armstrong approaches are at LOS F and E respectively. Left turns from TH 10 are also at LOS F and E respectively at these intersections. Under these conditions, moderate increases in volumes on either Ramsey or Armstrong Boulevard or left turning from TH 10 would cause conditions to deteriorate similar to what is currently experienced at Sunfish Lake Boulevard and the intersections could quickly move into LOS E and F.

The Future Base conditions show that addition of the background growth in traffic will cause the intersection of TH 10 and Sunfish Lake Boulevard to deteriorate to LOS D during the AM peak period. The other intersections in the study area remain in acceptable conditions. Unstable conditions continue to be present at the intersections of TH 10 and Ramsey and Armstrong Boulevards.

Project traffic would cause the intersections on TH 10 to deteriorate to LOS F and would cause the stop-controlled intersection on Industry Avenue, Ramsey Boulevard, and Armstrong Boulevard to move into LOS E and F conditions during one or both peak periods.

New intersections created by the project with Industry Avenue (see Figure 21.2) would operate in acceptable conditions with the exception of the central north-south street (NS3) at Industry Avenue during the PM peak period. The two new intersections of the east-west parkway (EW1) with Ramsey and Armstrong Boulevards would operate in unacceptable conditions during at least one peak period.

Within the project site, the extension of Sunwood Drive would be the primary east-west connector street in the project site and is estimated to carry 10,000 to 13,000 vehicles per day (vpd) west of NS6 Street. Volumes on Sunwood west of Ramsey would be about 18,000 vpd as shown in Figure 21.2. West of NS6 Street, the volume on Sunwood Drive would be adequately handled by a two-lane cross section (one lane in each direction). However, left-turn lanes would be needed at cross streets. Between NS6 Street and Ramsey Boulevard, four lanes would be needed to accommodate the projected volumes. Two-way or all-way stop control at the intersections of Sunwood Drive internal to the site would provide LOS C or better conditions for the level of traffic projected at those locations, although the intersections with NS~~1~~6 and/or NS~~2~~5 Streets may require signalization for acceptable PM peak hour operations.

The EW1 parkway would carry about 3,600 vpd on the western end of the project and between 5,000 and 9,000 vpd on the eastern end. The proposed one-lane parkway cross section would be adequate for the segments of the EW1 parkway.

The other east-west streets internal to the project, because of their discontinuous nature would carry less volume than either Sunwood Drive or the EW1 Parkway and would generally be under 4,000 vehicles per day (and some would be in the under 1,000 range). Two-lane cross sections and stop (or yield control on the lower volume ones) would be appropriate.

The north-south streets internal to the project would carry slightly higher volumes, particularly the three streets that would have full access intersections with Industry Avenue. Those streets would have between 2,100 and 5,700 vehicles per day. The other north-south streets inside the project would be expected to have less than 2,000 vehicles per day, with the exception of the NS~~1~~6 Street that serves the employment cluster in the southeast corner of the site, which would have upwards of 4,000 vpd. Two-lane cross sections and stop (or yield control on the lower volume ones) would be appropriate although signals may be required at the NS6 and/or NS5Streets intersections with Sunwood Drive.

Summary of Environmental Impact. Direct environmental impacts due to the traffic analysis are addressed in Items 22 and 24, which address vehicle related air emissions, and dust, odors, and noise, respectively.

Mitigation element. Analysis of the intersection operations indicates that lane additions and installation of intersection channelization and traffic signals would be adequate to mitigate the project impacts at the intersections in the study area. The following roadway widenings are suggested:

- Ramsey Boulevard—widen to five lane cross section south of Industry Avenue to provide two through lanes in each direction and a left turn lane/center median
- Industry Avenue—widen to five lane cross section west of Ramsey Boulevard to provide two through lanes in each direction and a left turn lane/center median

The existing cross sections on Armstrong Boulevard north of the railroad, Sunwood Drive and Industry Avenue east of Ramsey, and Sunfish Lake Boulevard north of the railroad would be adequate to meet the future demand.

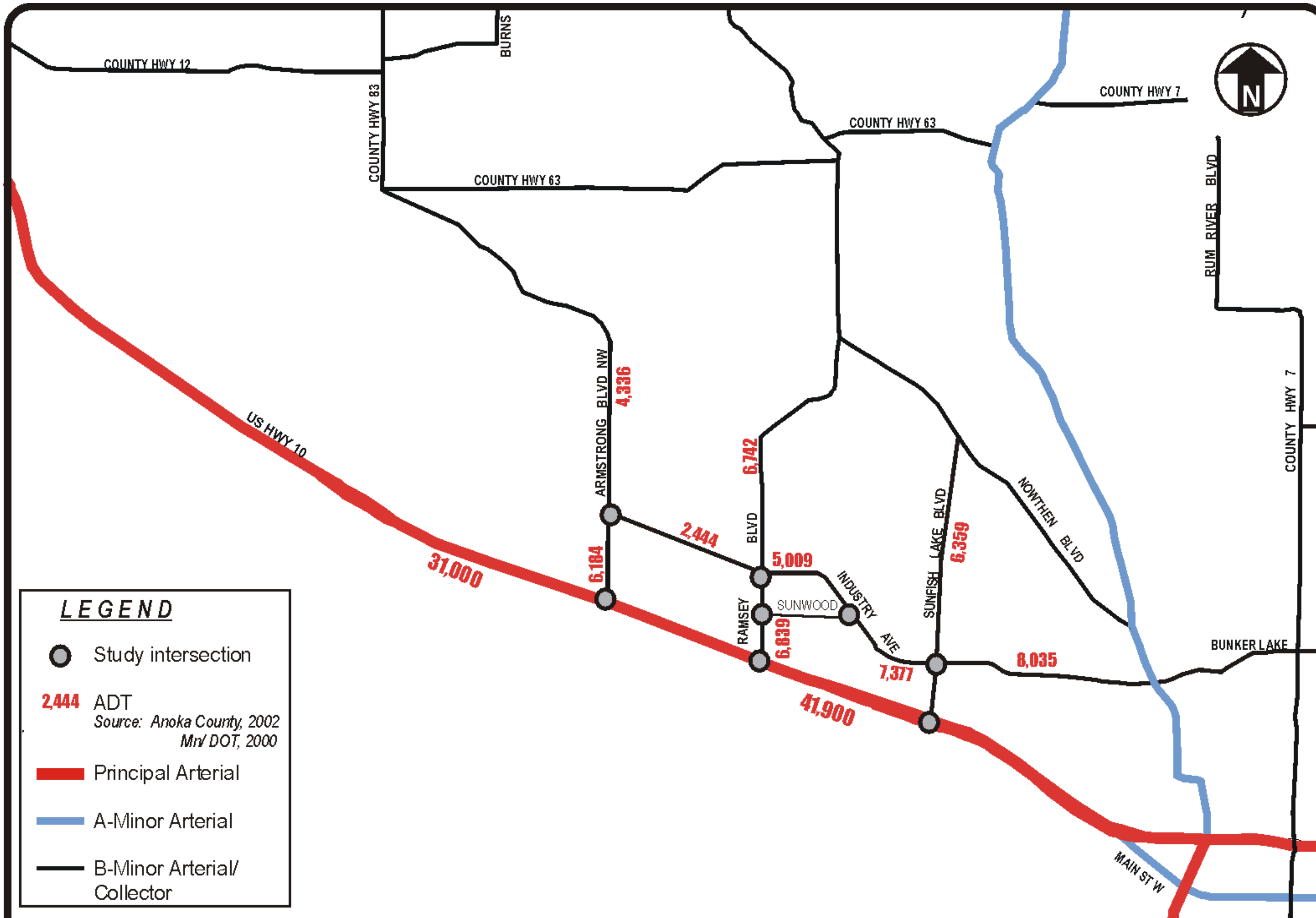
Turn lanes and lane adjustments would be needed at the following intersections:

- TH 10 at Armstrong Boulevard—add an eastbound and a westbound through lane on the intersection approaches; add an eastbound and a southbound left turn lane and a southbound right turn lane.
- TH 10 at Ramsey Boulevard—add an eastbound and a westbound through lane on the intersection approaches; add an eastbound and a southbound left turn lane and a westbound right turn lane. A southbound through lane and a northbound left turn lane and northbound through/right lane would need to be added to serve the Rivenwick 3rd Subdivision traffic independent of the project traffic.
- TH 10 at Sunfish Lake Boulevard—add an eastbound and a westbound through lane on the intersection approaches; convert the southbound approach from a through/left turn lane and a right turn lane to through/right turn lane and two left turn lanes (this adds one lane to the approach).
- Industry Avenue at Ramsey Boulevard—add a southbound right turn lane; eastbound and northbound approaches would be widened by the above recommendations.
- Sunwood Drive at Industry Avenue—modify the shared lanes on the northbound, eastbound and westbound approaches to provide left turn lanes and shared through/right turn lanes

The following stop-controlled intersections would need to be signalized:

- Ramsey Boulevard at Industry Avenue
- Armstrong Boulevard at Industry Avenue
- Industry Avenue at Sunfish Lake Boulevard
- Ramsey Boulevard at Sunwood Drive
- Sunwood Drive at Industry Avenue
- Sunwood Drive at Armstrong Boulevard
- NS3 Street at Industry Avenue

The left turn volumes from the EW1 parkway onto both Armstrong and Ramsey Boulevard cannot be accommodated at an acceptable LOS under stop control and require signalization to achieve acceptable operations. However, the close spacing between the intersections of the EW1 parkway and the intersections of Armstrong and Ramsey Boulevard with Industry Avenue limits the potential for the two parkway intersections to be signalized. Accordingly the parkway intersections should be channelized to provide right-in/right-out and left-in access (¾ access). Left out from the parkway would be prohibited and would redistribute to the north-south streets and to Industry Avenue (these volumes have been included in the mitigated calculations for the other intersections).

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Ramsey Town Center AUAR

**Roadway Network**

FIGURE
21.1

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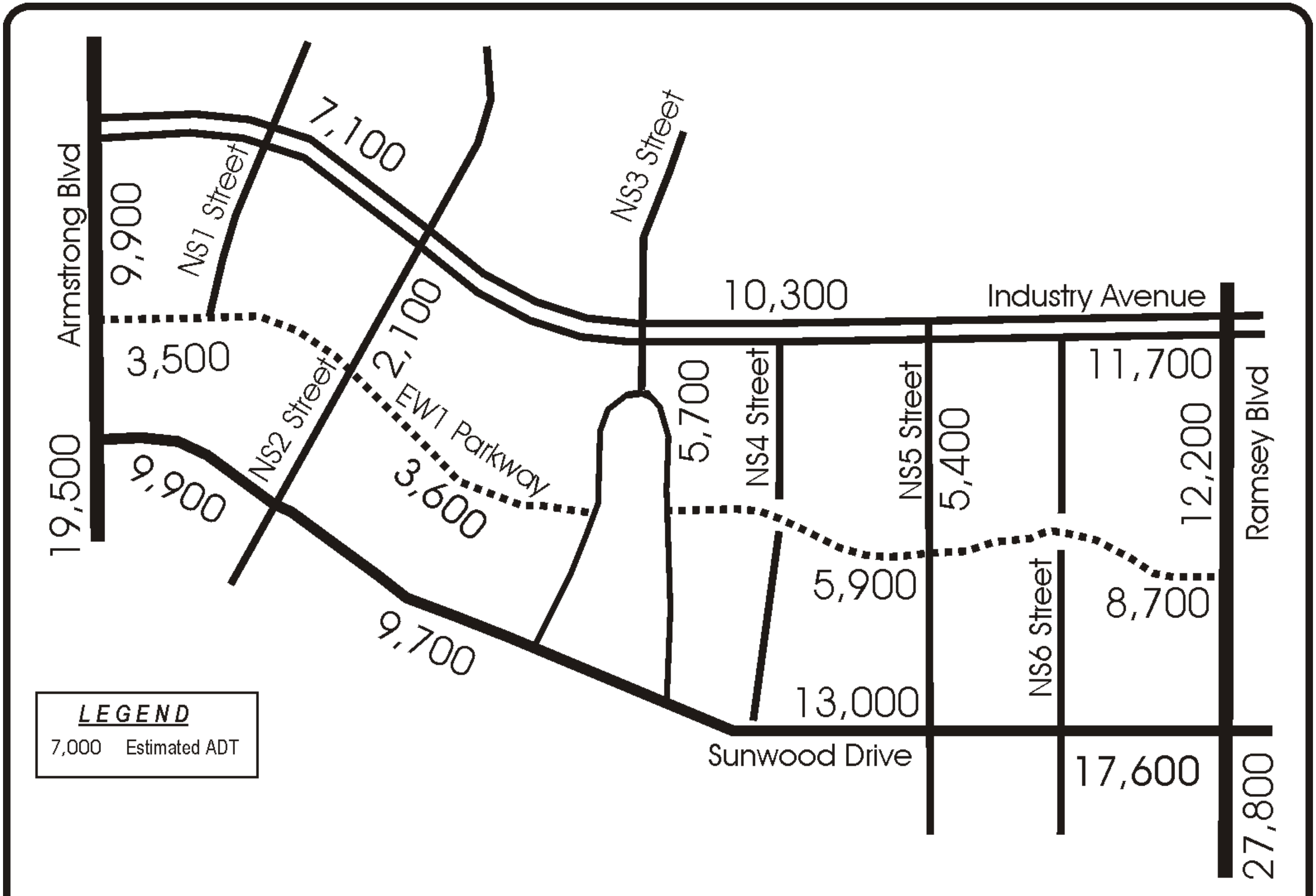


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Ramsey Town Center AUAR

**Estimated Daily Traffic Volumes**

FIGURE
**21.2**

C:\MMA\RAMSEY AUAR\Graphics\Figure 10-Project ADT.CDR

## 22. Vehicle Related Air Emissions

*Estimate the effect of the project's traffic generation on air quality, including carbon monoxide levels. Discuss the effect of traffic improvements or other mitigation measures on air quality impacts. Note: If the project involves 500 or more parking spaces, consult EAW Guidelines about whether a detailed air quality analysis is needed.*

*Mitigation proposed to eliminate any potential problems may be presented under Item 21 and merely reference here. The MPCA staff should be consulted regarding possible ISP requirements for certain proposed developments; although the RGU may not want to assume responsibility for applying for an ISP for specific developments, it may be desirable to coordinate the AUAR and ISP analyses closely.*

Motorized vehicles emit airborne pollutants that affect air quality. Changes in traffic volumes, travel patterns and roadway locations affect the level and dispersion of vehicle emissions. The proposed Ramsey Town Center Development will impact the traffic flow along the Highway 10 corridor and within the development site as discussed in Item 21. The purpose of this air quality analysis is to estimate the future air quality conditions along the Highway 10 corridor with the implementation of the Ramsey Town Center Development. Based on the future air conditions, the AUAR will identify potential effects on regional and local air quality, address conformity with national and state air quality standards, and determine if any mitigation measures are necessary.

*Regulatory Requirements*

National and state ambient air quality standards identify pollutant concentrations that are not to be exceeded over specified periods of time. Table 22.1 shows the National and State Ambient Air Quality Standards (NAAQs) for carbon monoxide (CO), the major airborne pollutant of interest. Primary ambient air quality standards are defined for the protection and preservation of public health. Secondary standards are intended to protect the environment and properties from damage. Compliance is required for both primary and secondary standards.

Under federal regulations, areas that violate primary ambient air quality standards are designated as –non-attainment areas”. The Twin Cities Metropolitan Area was previously designated as a CO non-attainment area as a result of violations of the NAAQs. In 1999 the Environmental Protection Agency (EPA) reclassified Minneapolis/St. Paul as an attainment area for CO. The attainment status is contingent upon the implementation of measures to assure that CO concentrations remain below standards. Therefore, carbon monoxide is the traffic-related pollutant of most concern in the Twin Cities Metropolitan Area. The State of Minnesota has established the standards listed in Table 22.1. It should be noted that the state one-hour carbon monoxide standard of 30 ppm is more stringent than the national standard of 35 ppm.

Table 22.1: National and State Ambient Air Quality Standards

| Pollutant | Averaging Period | National Standards | | MN State Standards | |
|---|---|---|---|---|---|
| | | Primary | Secondary | Primary | Secondary |
| **Carbon Monoxide (CO)** | 8-hour | 9 ppm (10 mg/m$^3$) | 9 ppm (10 mg/m$^3$) | 9 ppm (10 mg/m$^3$) | 9 ppm (10 mg/m$^3$) |
| | 1-hour | 35 ppm (40 mg/m$^3$) | 35 ppm (40 mg/m$^3$) | 30 ppm (35 mg/m$^3$) | 30 ppm (35 mg/m$^3$) |

*Carbon Monoxide Modeling Methodology*

The methodology for identifying potential local air quality impacts follows the EPA-recommended procedure for carbon monoxide micro-scale impact analysis. The general evaluation procedure, outlined in the Guideline for Modeling Carbon Monoxide for Roadway Intersections (EPA 1992), includes a multiple intersection screening process followed by micro-scale CO analysis with the CAL3QHC line-source dispersion model.

Screening Process. The intersection screening process includes the following steps:

1. Identify the signalized intersections in the project vicinity that will be impacted by the project alternatives.
2. Determine the average delay and Level of Service (LOS) for those intersections.
3. Determine total intersection delay as the product of average delay and total intersection approach volume.
4. Rank the intersections according to total delay and select the intersections with the highest total vehicle delay for analysis.

Carbon monoxide concentrations are generally highest at intersections with poor levels of service and consequently, more idling vehicles. Typically intersections with levels of service of D, E, and F (worst levels) are analyzed. As described in Item 21, all of the major intersections within the project area were analyzed to determine both present and forecasted levels of service. Peak hour traffic volumes used for this analysis assumed that the Ramsey Town Center would reach full built-out potential by 2007.

Based on consultation with the Minnesota Pollution Control Agency (MPCA), it was agreed that carbon monoxide analysis would be performed at intersections that were projected to operate at level of service D or worse for year 2008 (one year after the anticipated Ramsey Town Center completion). The traffic study identified that the three intersections of prime concern are all located along the Highway 10 corridor. The locations of these intersections in relationship to the project site are shown on Figure 22.1 and include the following:

- Highway 10 and Armstrong Boulevard
- Highway 10 and Ramsey Boulevard

- Highway 10 and Sunfish Lake Boulevard.

**CAL3QHC Model.** In accordance with the EPA procedure for carbon monoxide analysis, the CAL3QHC dispersion model was used to forecast the air quality along the Highway 10 corridor. Required input for this model includes meteorological characteristics, traffic characteristics, intersection geometries, and emission rates.

Meteorological Characteristics. The meteorological characteristics used in the model are summarized in Table 22.2. The inputs listed are consistent with EPA and MPCA recommendations.

Table 22.2 CAL3QHC Meteorological Characteristics

| Characteristic | Model Input |
|---|---|
| Analysis Year | 2002 (existing) 2008 (future) |
| Wind Speed | 1 m/s |
| Wind Direction | Tested 360 degrees at 10º increments |
| Atmospheric Stability Class | D |
| Mixing Height | 1000 cm |
| Surface Roughness | 321 cm |
| Averaging Time | 60 min |
| Settling Velocity | 0 cm/s |
| Deposition Velocity | 0 cm/s |
| 8-Hour Persistence Factor | 0.7 |

Traffic Characteristics. Traffic characteristics were based on the existing traffic conditions in 2002 and the modeled levels of 2007 (including traffic generated by the proposed project). Traffic volumes, saturation levels, lane configurations, signal type, signal cycle length, red time length and clearance lost time were taken from the traffic analysis conducted for the project. The heaviest traffic volumes were projected to occur during the evening; therefore the CO concentrations using p.m. peak traffic data were modeled as a worst-case scenario.

Intersection Geometries. Intersection geometries were based on existing roadway dimensions from maps and aerial photographs. The proposed roadway improvements discussed in Item 21 were not incorporated into the intersection geometries in order to model a worst-case (most idling traffic) scenario.

**Emission Rates.** EPA model Mobile 5b was used to calculate carbon monoxide emission rates. There are two types of emission rates needed for the CAL3QHC CO dispersion model, and include a running emission rate and an idling emission rate. The running emission rate was generated directly by the Mobile 5b model assuming an average free flow speed of 35-mph on all roadways and links. The idling emission rate was calculated by converting a 2.5-mph Mobile 5b running emission rate from grams per mile to grams per hour. The parameters and assumptions used in the Mobile 5b analysis are summarized in Table 22.3.

*Table 22.3 Mobile 5b Model Inputs*

| **Parameter** | *Model Inputs* |
|---|---|
| Analysis Year | 2002 (existing) 2008 (future) |
| Free Flow Speed | 35-mph for all roadways |
| Idling Factor Speed | 2.5-mph for all roadways |
| Cold Start Percentages | 20.6 % for all traffic |
| Hot Start Percentage | 27.3 % for all traffic |
| Traffic Mix | MN Car Registration Distribution |
| Temperature | January, 20ºF |
| Inspection/Maintenance Program | No |
| Oxygenated Fuel | Yes |
| Average Fuel Volatility | 9.0 psi |

*Background Carbon Monoxide Concentrations*

Background carbon monoxide concentrations are needed as a baseline to accurately predict future CO concentrations that incorporate modeled vehicle related emissions. These background concentrations are added to the model generated vehicle CO emissions to determine compliance with national and state air quality standards.

The background (2002) carbon monoxide concentrations for the three intersections analyzed were derived from the MPCA-monitored CO site at 6000 West Moore Lake Road in Fridley, MN. Figure 22.2 shows the location of this site. In discussions with the MPCA it was agreed that this site had background characteristics similar to the intersections being modeled and would be a conservative representation of background CO concentrations.

Carbon monoxide emissions are monitored daily at the Fridley site by the MPCA. In 2002, the maximum one-hour and eight-hour CO concentrations were 2.1 ppm and 1.4 ppm respectively. In order to obtain the background concentration for 2008 (modeled year), these 2002 concentrations were adjusted for increases in regional traffic volume and reductions in vehicle emission rates.

Average CO emission rates in the region are expected to decrease due to improved emission controls, turnover in vehicle fleet and cleaner burning fuel sources. Because over 50 percent of the overall carbon monoxide concentrations in the metropolitan area are due to vehicle related emissions, the reduction in vehicle emission rates will tend to decrease the overall background CO concentrations. The Mobile 5b model takes these factors into account when generating emission rates. Average CO emission rates for 2002 and 2008 were generated using Mobile 5b. The ratio of the 2008 rate to the 2002 rate was used to decrease background CO concentrations by a factor of 0.91.

Background traffic volume will increase from 2002 to 2008. This increase will in turn increase vehicle CO emission, which increases overall background CO concentrations. The ratio of the future regional traffic volume (2008) to the existing regional traffic volume (2002) was used to increase the background CO concentration by a factor of 1.34. These emission and traffic volume adjustment factors are summarized in Table 22.4.

Table 22.4: Calculation of CO Background Concentrations

| | 2008 | |
|---|---|---|
| *Factor* | **1-Hour** | **8-Hour** |
| Maximum 2002 Monitored Concentration (ppm) | 2.1 | 1.4 |
| Background Traffic Volume Adjustment Factor | 1.34 | 1.34 |
| Emission Adjustment Factor | 0.91 | 0.91 |
| Worst Case Background Concentration (ppm) | 2.56 | 1.71 |
| **State Standard (ppm)** | **30** | **9** |
| **Federal Standard (ppm)** | **35** | **9** |

*Modeling Results*

The carbon monoxide modeling analysis was based on forecasted traffic volumes and signal timing under predicted 2008 P.M. peak traffic conditions. Locations of likely outdoor human activity next to the analyzed intersections were selected for air quality receptors. Receptor locations were sited within a 1,000-foot radius of the analyzed intersections and are depicted in Figure 22.3.

The siting of carbon monoxide receptors was based on the likelihood of human outdoor activity occurring in excess of one hour. This is consistent with the MPCA's method of quantifying adverse air quality impacts based on hours of exposure. Locations chosen include gas station parking lots, entrances to offices and buildings, parks, and open space. Existing commercial buildings and retail stores along Highway 10 are located in close proximity to the road. Therefore, receptors were placed on all four corners of the intersections as depicted in Figure 22.3. These receptors represent the locations of the greatest potential exposure to vehicle CO emissions. A total of twenty receptor locations were selected.

The results of the air quality analysis are presented in Tables 22.5 and 22.6. Table 22.5 lists the 2008 P.M. peak one-hour CO concentrations which were derived directly from the CAL3QHC dispersion model. The 2008 background concentrations were added to the model results to yield a total one-hour CO concentration in ppm for each receptor. The wind angle for the highest CO concentration is also included in the table. The highest one-hour CO concentration modeled was 11.4 ppm at Receptor 15 at the intersection of Highway 10 and Sunfish Lake Boulevard. This is below the state and national air quality standards of 30 ppm and 35 ppm respectively.

Table 22.6 lists the 2008P.M. peak eight-hour CO concentrations. These concentrations were derived from the one-hour CO concentration results listed in Table 22.5. The CAL3QHC dispersion model predicts one-hour CO concentrations only. These one-hour concentrations are adjusted using a persistence factor. EPA recommends an eight-hour persistence factor for urban areas of 0.7. The factor takes into account the fluctuations of wind directions, temperatures, and traffic volumes that are likely to occur over eight hours. The highest eight-hour CO concentration calculated was 7.9 ppm at Receptor 15 at the intersection of Highway 10 and Sunfish Lake Boulevard. This is below both the state and national air quality standards of 9 ppm.

Table 22.5: 2008 P.M. Peak Carbon Monoxide Modeling Results – 1 Hour

| | **1-Hour Average (ppm)** | | | |
|---|---|---|---|---|
| | Modeled | Background | Total Concentration | Wind Angle |
| Highway 10 & Armstrong Blvd. | | | | |
| Receptor 1 | 6.8 | 2.6 | 9.4 | 100 |
| Receptor 2 | 6.1 | 2.6 | 8.7 | 120 |
| Receptor 3 | 7.6 | 2.6 | 10.2 | 10 |
| Receptor 4 | 6.6 | 2.6 | 9.2 | 350 |
| Receptor 5 | 2.6 | 2.6 | 5.2 | 260 |
| Receptor 6 | 2.6 | 2.6 | 5.2 | 210 |
| Receptor 7 | 2.1 | 2.6 | 4.7 | 230 |
| Receptor 8 | 3.9 | 2.6 | 6.5 | 160 |
| Highway 10 & Ramsey Blvd. | | | | |
| Receptor 9 | 6.5 | 2.6 | 9.1 | 100 |
| Receptor 10 | 5.8 | 2.6 | 8.4 | 260 |
| Receptor 11 | 8.0 | 2.6 | 10.6 | 10 |
| Receptor 12 | 6.3 | 2.6 | 8.9 | 350 |
| Receptor 13 | 2.4 | 2.6 | 5.0 | 150 |
| Receptor 14 | 3.2 | 2.6 | 5.8 | 250 |
| Highway 10 & Sunfish Lake Blvd | | | | |
| Receptor 15 | 8.8 | 2.6 | 11.4 | 100 |
| Receptor 16 | 7.6 | 2.6 | 10.2 | 110 |
| Receptor 17 | 7.2 | 2.6 | 9.8 | 10 |
| Receptor 18 | 6.1 | 2.6 | 8.7 | 350 |
| Receptor 19 | 3.3 | 2.6 | 5.8 | 120 |
| Receptor 20 | 3.5 | 2.6 | 6.1 | 240 |
| **State Standard** | **30.0** | | | |
| **Federal Standard** | **35.0** | | | |

Table 22.6: 2008 P.M. Peak Carbon Monoxide Modeling Results – 8 Hour

| | **8-Hour Average (ppm)** | | | |
|---|---|---|---|---|
| | Modeled | Background | Total Concentration | Wind Angle |
| Highway 10 & Armstrong Blvd. | | | | |
| Receptor 1 | 4.8 | 1.7 | 6.5 | 100 |
| Receptor 2 | 4.3 | 1.7 | 6.0 | 120 |
| Receptor 3 | 5.3 | 1.7 | 7.0 | 10 |
| Receptor 4 | 4.6 | 1.7 | 6.3 | 350 |
| Receptor 5 | 1.8 | 1.7 | 3.5 | 260 |
| Receptor 6 | 1.8 | 1.7 | 3.5 | 210 |
| Receptor 7 | 1.5 | 1.7 | 3.2 | 230 |
| Receptor 8 | 2.7 | 1.7 | 4.4 | 160 |
| Highway 10 & Ramsey Blvd. | | | | |
| Receptor 9 | 4.6 | 1.7 | 6.3 | 100 |
| Receptor 10 | 4.1 | 1.7 | 5.8 | 260 |
| Receptor 11 | 5.6 | 1.7 | 7.3 | 10 |
| Receptor 12 | 4.4 | 1.7 | 6.1 | 350 |
| Receptor 13 | 1.7 | 1.7 | 3.4 | 150 |
| Receptor 14 | 2.2 | 1.7 | 3.9 | 250 |
| Highway 10 & Sunfish Lake Blvd | | | | |
| Receptor 15 | 6.2 | 1.7 | 7.9 | 100 |
| Receptor 16 | 5.3 | 1.7 | 7.0 | 110 |
| Receptor 17 | 5.0 | 1.7 | 6.7 | 10 |
| Receptor 18 | 4.3 | 1.7 | 6.0 | 350 |
| Receptor 19 | 2.3 | 1.7 | 4.0 | 120 |
| Receptor 20 | 2.5 | 1.7 | 4.1 | 240 |
| **State Standard** | **9.0** | | | |
| **Federal Standard** | **9.0** | | | |

**Summary of Environmental Impact.** The implementation of the proposed Ramsey Town Center project will increase the amount of vehicle-related carbon monoxide emissions. This increase is due to the increase in traffic volume along the Highway 10 corridor. Peak CO emissions were modeled along Highway 10 for the year 2008 (one year after anticipated build-out) under a worst-case (p.m. traffic, no road improvement) scenario. The CO concentrations modeled were less than the state air quality standards of 30 ppm for one-hour and 9 ppm for eight-hours. The modeled CO concentrations are summarized in Tables 22.5 and 22.6.

**Mitigation Element.** There are no specific air quality mitigation measures proposed for the Ramsey Town Center Development, because implementation of the project does not result in violation of State or National Air Quality Standards.  Carbon monoxide concentrations were modeled along the Highway 10 corridor assuming no road improvements in the project vicinity.  The road improvements discussed in Section 21 would help to reduce carbon monoxide emissions, although they are not required as a result of the air quality analysis.

## 23. Stationary Source Air Emissions

This item is not applicable to an AUAR.

## 24. Dust, Odors, Noise

> *EAW: will the project generate odors, noise or dust during construction and/or operation?* ___ *no* _x_ *yes*
>
> *If yes, describe the source, characteristics, duration, and quantities or intensity, and any proposed measures to mitigate adverse impacts. Also, identify the locations of sensitive receptors and estimate the impacts on them. Discuss potential impacts on human health or quality of life.*
>
> *Dust, odors, and construction noise need not be addressed in an AUAR unless there is some unusual reason to do so. The RGU might want to discuss as part of the mitigation plan, however, any dust control or construction noise ordinances in effect. If the area will include or adjoin major noise sources, a noise analysis is needed to determine if any noise levels in excess of standards would occur and if so, to identify appropriate mitigation measures. With respect to traffic-generated noise, the noise analysis should be based on the traffic analysis of Item 21.*

*Construction-related Odors, Dust and Noise*

The proposed project will not generate any odors during construction. Dust normal to construction will occur as a result of this project and will be minimized through standard control measures such as watering. These dust minimization efforts will be identified in the grading plan submitted to the City prior to construction. After construction is complete, anticipated dust levels will be minimal, as all soil surfaces will have permanent cover (i.e. pavement or lawn).

Construction noise will be limited to daytime hours in accordance with the City of Ramsey ordinances. Construction equipment will be fitted with mufflers, which will be maintained during the construction.

*Traffic-related Noise*

<u>Background/Regulatory Framework</u>
After construction is complete, potential sources of noise from the proposed development will include transit noise and traffic noise. The analysis and impacts related to transit noise adhere to the Federal Transit Administration's *Transit Noise and Vibration Impact Assessment, April 1995* guidelines and are fully addressed in the *Northstar Corridor Project Final Environmental Impact Statement, March 2002.*

Noise is defined as any unwanted sound. Sounds are described as noise if they disturb the person hearing them. Noise levels are measured in a logarithmic unit called a decibel (dB). Humans are more receptive to middle- and high-frequency sounds than they are to low-frequency sounds, so a weighted unit is used to reflect human perception more closely. For the purpose of this study, sounds are measured using this adjusted scale, called dBA. All references to decibels in the discussion of traffic noise impacts refer to this scale. According to the MPCA publication –An Introduction to Sound Basics", a sound increase of 3 dBA in an outdoor setting results in a barely perceptible increase in noise, whereas a 5 dBA increase is clearly audible. An increase of 10 dBA is perceived twice as loud as the original sound.

Under Minnesota Statute 116.07, Subdivisions 2 and 4, the Minnesota Pollution Control Agency has developed Noise Pollution Control Rules (Minnesota Rules Chapter 7010.0001 – 7010.008). The noise criteria used in a noise analysis depends on whether the land use is designated as Noise Area Category (NAC) 1, 2, or 3. NAC Category 1 land use includes parks, single-family and multi-family residences, libraries, hospitals, and other areas where nighttime sensitivity to noise is high. NAC Category 2 standards are applied to commercial areas, hotels, and residences which have adequate acoustic insulation, year-round climate control, and no accommodations that are intended for outdoor use. NAC Category 3 includes industrial areas. Table 24.1 details the MPCA noise level standards for each category.

Table 24.1: Minnesota Pollution Control Agency Noise Level Standards

| **MPCA Noise Level Standards** | | | | | |
|---|---|---|---|---|---|
| Classification | Land Use | Daytime Noise Level [dBA] (7a.m. – 10 p.m.) | | Nighttime Noise Level [dBA] (10 p.m. – 7 a.m.) | |
| NAC-1 | Residential | $L_{10}$ of 65 | $L_{50}$ of 60 | $L_{10}$ of 55 | $L_{50}$ of 50 |
| NAC-2 | Commercial | $L_{10}$ of 70 | $L_{50}$ of 65 | $L_{10}$ of 70 | $L_{50}$ of 65 |
| NAC-3 | Industrial | $L_{10}$ of 80 | $L_{50}$ of 75 | $L_{10}$ of 80 | $L_{50}$ of 75 |

Traffic-generated noise can vary considerably over a relatively short period of time. There are two analytical approaches which may be used for reporting traffic-related noise levels, the first of which uses $L_{10}$ and $L_{50}$. For these values, the subscript value refers to the percent of time during a one hour period that the noise level exceeds the specified value. For example, an $L_{10}$ value of 65 dBA during the peak hour indicates that the noise level exceeded 65 dBA 10% of the time, or for 6 minutes during that hour. The second approach, used in this report, uses $L_{eq}$. This value represents the equivalent of a constant sound level which, over a period of time, contains the same average amount of sound energy as the varying level of traffic noise. According to the Federal Highway Administration noise abatement procedures detailed in the Code of Federal Regulations (23 CFR 722), $L_{eq}$ for typical traffic conditions is usually about 3 dBA less than the $L_{10}$ for the same conditions. This rule has been used to create an equivalent table of $L_{eq}$ values based on the MPCA Noise Level Standards and is presented is Table 24.2.

Table 24.2: Equivalent $L_{eq}$ values for MPCA Noise Level Standards

| *Equivalent MPCA Noise Level Standards* | | | |
|---|---|---|---|
| Classification | Land Use | Daytime Noise Level [dBA] (7a.m. – 10 p.m.) | Nighttime Noise Level [dBA] (10 p.m. – 7 a.m.) |
| NAC-1 | Residential | $L_{eq}$ of 62 | $L_{eq}$ of 52 |
| NAC-2 | Commercial | $L_{eq}$ of 67 | $L_{eq}$ of 67 |
| NAC-3 | Industrial | $L_{eq}$ of 77 | $L_{eq}$ of 77 |



Noise Level Monitoring

Background noise level monitoring is performed during a noise study to measure existing noise levels. These levels are often used as a baseline against which modeling scenarios can be compared. They are also used to validate computer-generated results. Monitoring at receptor ―M3” was performed as part of the *Northstar Corridor Project Final Environmental Impact Statement, March 2002*. Receptor ―M3” is located on the northwest corner of the intersection of Highway 10 and Ramsey Boulevard (shown in Figure 24.1) and was used in this report as the background noise level monitoring location for the site.

Table 24.3: Monitored Existing Noise Levels for Receptor M3

| **Monitoring Site** | **$L_{eq}$ [dBA]** | **Primary Noise Sources** |
|---|---|---|
| M3 | 62 | Airplanes/Cars |

Source: Northstar Corridor Project Final Environmental Impact Statement, March 2002

Noise Modeling Methodology

A noise analysis was conducted to assess the extent to which the proposed project will affect future noise levels. The analysis was performed using Traffic Noise Model v. 2.1 (TNM). The noise model uses traffic volumes, vehicle type mix, vehicle speed, receptor locations, and road alignment to calculate noise levels. TNM is approved by the Federal Highway Administration for modeling traffic noise.

For the purpose of this study, 58 noise receptors were chosen to represent each of the 58 proposed blocks of land presented in Figure 24.2. Each block was assigned a land use according to the Ramsey Town Center Preferred Design Schematic shown in Figure 6.1 located in Item 6. Residential and public space areas (shown in brown and green) were classified as NAC-1 noise receivers. All other parcels fall under the NAC-2 commercial classification previously discussed. An additional noise receptor was placed at the northwest corner of the intersection of Highway 10 and Ramsey Boulevard to compare modeled results with the existing noise level at monitoring site ―M3”.

Modeling for receptor ―M3” was performed using the current traffic volumes for the AUAR project area. Speed limits and vehicle mix were taken from the traffic analysis of Item 21. The modeled results differ somewhat from the measured noise levels but are within a reasonable margin of error, keeping in mind that an increase of 3 dBA is barely perceptible to the human ear. The remainder of this section discusses the future traffic noise impacts based on computer-generated modeling results.

Table 24.4: Existing and Modeled Noise Levels for Receptor M3

| | **Modeled Noise Level Receptor M3 [dBA]** | **Existing Noise Level Receptor M3 [dBA]** |
|---|---|---|
| Day | $\mathbf{L_{eq}}$ = 65.9 | $\mathbf{L_{eq}}$ = 62.0 |
| Night | $\mathbf{L_{eq}}$ = 64.0 | |

<u>Noise Modeling Results</u>
The noise analysis was conducted for the existing year 2002 and for one year after the AUAR development scenario, year 2008. Traffic conditions for both morning and afternoon peak traffic hours were analyzed. The year 2008 analysis includes the impact of the AUAR development traffic as well as the increased background traffic on local and regional roadways over the six-year period. Existing speed limits were assumed, and the remaining data necessary for analysis was taken from the traffic analysis of Section 21.

Traffic noise modeling results for 2008 are presented in Tables 24.5 and 24.6. Both daytime and nighttime $L_{eq}$ values are shown. The analysis shows that during daytime hours, for both existing and future traffic scenarios, there are no receptors that exceed state standards. Three receptors (Blocks 36, 37, and 38) currently exceed the state nighttime NAC-1 standard of 52 dBA. These receptors will continue to exceed the state nighttime NAC-1 standard in 2008, along with one additional receptor, Block 28. These four blocks are all located along the south side of Industry Avenue.

Table 24.5: Daytime and Nighttime Peak Hour Noise Assessment Results (Modeled)
For NAC-1 Noise Receivers

| **Receptor** | **Modeled 2002 Daytime $L_{eq}$ [dBA]** | **Modeled 2008 Daytime $L_{eq}$ [dBA]** | **Modeled 2002 Nighttime $L_{eq}$ [dBA]** | **Modeled 2008 Nighttime $L_{eq}$ [dBA]** | **Potential Noise Impact** |
|---|---|---|---|---|---|
| Block 27 | 47.9 | 51.1 | 46.7 | 49.8 | None |
| **Block 28** | 52.0 | 57.1 | 51.4 | **55.7** | Impact |
| Block 31 | 47.5 | 51.5 | 46.5 | 50.3 | None |
| Block 32 | 47.0 | 51.0 | 45.8 | 49.8 | None |
| Block 33 | 49.4 | 53.4 | 48.3 | 52.3 | None |
| **Block 36** | 55.8 | 61.1 | **55.2** | **59.7** | Impact |
| **Block 37** | 56.0 | 61.4 | **55.4** | **59.9** | Impact |
| **Block 38** | 56.2 | 61.7 | **55.7** | **60.3** | Impact |
| Block 39 | 48.4 | 52.3 | 47.5 | 50.9 | None |
| Block 40 | 46.5 | 50.1 | 45.5 | 48.7 | None |
| Block 41 | 48.2 | 52.0 | 47.3 | 50.5 | None |
| Block 43 | 47.6 | 49.3 | 46.4 | 48.2 | None |
| Block 44 | 46.3 | 48.9 | 45.0 | 47.7 | None |
| Block 45 | 45.5 | 48.0 | 44.2 | 46.9 | None |
| Block 46 | 46.7 | 48.4 | 45.3 | 47.3 | None |
| Block 48 | 48.9 | 52.1 | 47.8 | 50.5 | None |
| Block 49 | 50.6 | 52.8 | 49.2 | 51.5 | None |
| Block 50 | 50.9 | 53.1 | 49.4 | 51.7 | None |
| Block 51 | 50.5 | 52.6 | 49.2 | 51.5 | None |
| Block 53 | 50.9 | 56.1 | 49.4 | 54.2 | None |
| Block 54 | 46.6 | 49.9 | 45.2 | 48.7 | None |
| Block 55 | 46.9 | 50.6 | 45.8 | 49.4 | None |
| Block 56 | 47.9 | 52.5 | 46.7 | 51.5 | None |
| Block 57 | 47.2 | 51.9 | 45.9 | 50.8 | None |
| **State Standard** | **62.0** | **62.0** | **52.0** | **52.0** | |

**Bold** noise levels exceed State noise standards.

Table 24.6: Daytime and Nighttime Peak Hour Noise Assessment Results (Modeled) For NAC-2 Noise Receivers

| Receptor | Modeled 2002 Daytime $L_{eq}$ [dBA] | Modeled 2008 Daytime $L_{eq}$ [dBA] | Modeled 2002 Nighttime $L_{eq}$ [dBA] | Modeled 2008 Nighttime $L_{eq}$ [dBA] | Potential Noise Impact |
|---|---|---|---|---|---|
| Block 4 | 53.9 | 55.7 | 52.3 | 54.5 | None |
| Block 5 | 50.5 | 53.3 | 49.0 | 52.2 | None |
| Block 6 | 53.1 | 56.6 | 51.6 | 55.7 | None |
| Block 7 | 52.0 | 57.8 | 50.9 | 57.0 | None |
| Block 8 | 46.9 | 51.4 | 45.5 | 50.2 | None |
| Block 9 | 47.2 | 50.7 | 45.7 | 49.3 | None |
| Block 10 | 48.7 | 53.0 | 47.2 | 51.3 | None |
| Block 11 | 49.2 | 51.7 | 47.6 | 50.4 | None |
| Block 12 | 49.6 | 51.7 | 48.0 | 50.5 | None |
| Block 13 | 51.0 | 55.9 | 49.5 | 54.0 | None |
| Block 14 | 49.1 | 51.6 | 47.6 | 50.2 | None |
| Block 15 | 48.1 | 50.8 | 46.9 | 49.7 | None |
| Block 16 | 51.0 | 54.7 | 49.5 | 53.1 | None |
| Block 17 | 51.9 | 53.5 | 50.4 | 52.4 | None |
| Block 18 | 50.6 | 56.5 | 49.1 | 54.5 | None |
| Block 19 | 50.9 | 53.0 | 49.4 | 51.7 | None |
| Block 20 | 50.4 | 54.8 | 49.0 | 53.1 | None |
| Block 21 | 52.9 | 57.7 | 51.7 | 56.1 | None |
| Block 22 | 57.0 | 60.7 | 55.8 | 58.6 | None |
| Block 23 | 57.3 | 60.0 | 56.2 | 57.5 | None |
| Block 29 | 48.2 | 52.3 | 47.2 | 51.0 | None |
| Block 30 | 47.6 | 51.8 | 46.5 | 50.5 | None |
| Block 34 | 53.4 | 59.5 | 52.4 | 58.8 | None |
| Block 35 | 57.1 | 62.9 | 56.4 | 61.8 | None |
| Block 42 | 52.3 | 55.5 | 51.3 | 53.3 | None |
| Block 47 | 59.0 | 61.6 | 57.8 | 59.0 | None |
| Block 52 | 48.5 | 50.6 | 47.1 | 49.5 | None |
| Block 58 | 59.4 | 65.7 | 58.4 | 65.0 | None |
| **State Standard** | **70.0** | **70.0** | **70.0** | **70.0** | |

Bold noise levels exceed State noise standards.

**Summary of Environmental Impacts.** There are no areas within the proposed Ramsey Town Center development that are projected to exceed the state daytime standards. However, there are four blocks along Industry Avenue (Blocks 28, 36, 37, and 38) that either already or will exceed the state nighttime NAC-1 standard of 52 dBA. The exceedances are less than 10 dBA. While these predicted noise levels are above the state nighttime standard, they are not uncommon in developed residential areas that are adjacent to busy roadways.

**Mitigation Element.** Noise wall mitigation would not be practical along Industry Avenue. Driveways and street intersections would create gaps in the wall, defeating its purpose. It is suggested that the proposed residential units in Blocks 28, 36, 37, and 38 be designed to minimize noise impacts. The noise around the homes and surrounding areas can be reduced by providing climate-controlled units, increasing wall insulation, and providing common areas on the side of the buildings furthest from Industry Avenue.

## 25. Sensitive Resources

*Are any of the following resources on or in proximity to the site?*

***25a.*** *Archeological, historic, and architectural resources.__Yes _**X**_ No*
*For an AUAR, contact with the State Historic Preservation Office is required to determine whether there are areas of potential impacts to these resources. If any exist, an appropriate site survey of high probability areas is needed to address the issue in more detail. The mitigation plan must include mitigation for any impacts identified*

***25b.*** *Prime or unique farmlands.__Yes _**X**_ No*
*The extent of conversion of existing farmlands anticipated in the AUAR should be described. If any farmland will be preserved by special protection programs, this should be discussed.*

***25c.*** *Designated Parks, recreation areas or trails._**X**_Yes __ No*
*If development of the AUAR will interfere or change the use of any existing such resource, this should be described in the AUAR. The RGU may also want to discuss under this item any proposed parks, recreation areas or trails to be developed in conjunction with the development of the AUAR area.*

***25d.*** *Scenic Views and Vistas.__Yes _**X**_ No*
*Any impacts of such resources present in the AUAR should be addressed. This would include both direct physical impacts and impacts on visual quality or integrity.*

**25a.** A request was made to the Minnesota State Historic Preservation Office (SHPO) to provide a list of potential historical or archaeological resources in the project area. In a letter dated December 19, 2002 (Appendix E), SHPO stated that their research of the National and State Registers of Historic places as well as other sources showed that there were no known or suspected historic or archeological resources in the affected area.

**25b.** ―Prime Farmland" is considered rural land with the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and is available for these uses. Prime farmland has the soil quality, growing season, and moisture supply needed to economically produce consistently high yields of crops when treated and managed with modern farming methods.

In general, the Natural Resources Conservation Service (NRCS) indicates that prime farmland soils must: have an adequate and dependable water supply from precipitation or irrigation; have a favorable temperature and growing season; have acceptable levels of acidity or alkalinity, content of salt or sodium, and few or no rocks; be permeable to water and air; are not excessively erodible; not be saturated with water for long periods of time; and, not flood frequently or are protected from flooding.

Agricultural land that is not considered Prime Farmland may be considered “State-wide Important Farmland”. This is land, in addition to prime farmlands, which is of statewide importance for the production of food, feed, fiber, forage, and oilseed crops. Generally, soils of statewide importance include those that are nearly prime and produce high yields of crops in an economic manner when treated and managed according to acceptable farming methods. Some may produce as high a yield as prime farmland soils if conditions are favorable.

Table 25.1 lists the soil map units present on the proposed project site (also see Figure 12.2). Land within the project site was historically agricultural in nature. Commonly grown agricultural crops include corn and soybeans in the Hubbard coarse sand, Duelm loamy sand, Dickman sandy loam and portions of the Isan sandy loam. No agricultural activity occurred in soils designated as Marsh.

As seen in the table, no soils on the property are designated as prime farmland; however, the Dickman sandy loam is considered a State-wide important farmland. The soil unit however, only consists of 0.5% of the total area of the site located in the far southwest corner (Figure 25.1). Project related impacts to prime farmland and State-wide important farmland are therefore considered to be minimal.

Table 25.1 RTC Site Soil Units

| Series No. | Series Name | Prime Farmland Status | Percent Coverage in Project Area |
|---|---|---|---|
| HuA/B/C | Hubbard coarse sand | None | **77%** |
| Dp | Duelm loamy coarse sand | None | 18% |
| DnA | Dickman sandy loam | None* | 0.5% |
| Is | Isanti sandy loam | None | 4% |
| Mc | Marsh | None | 0.5% |

* - Identified as a State-wide Important Farmland, but not Prime Farmland.

The other area of farmland designation that exists is “Green Acres”, which is more of a tax-based program to keep productive farmland in business than an environmental program. The acreage is shown here for information purposes. Figure 25.2 shows all of the Green Acres program acreage on the RTC site.

Figure 25.1. Designation of State-wide Important Farmland

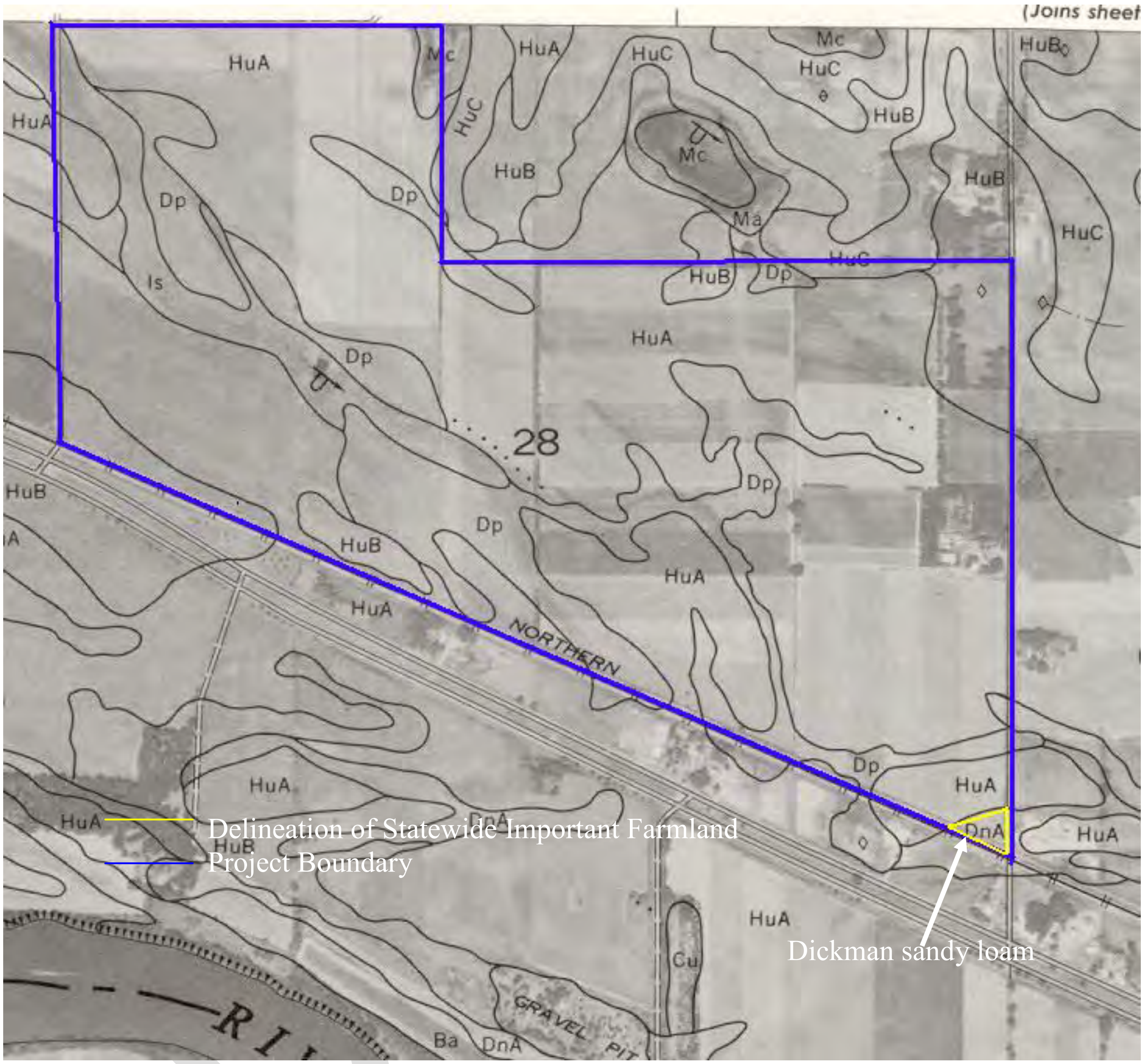
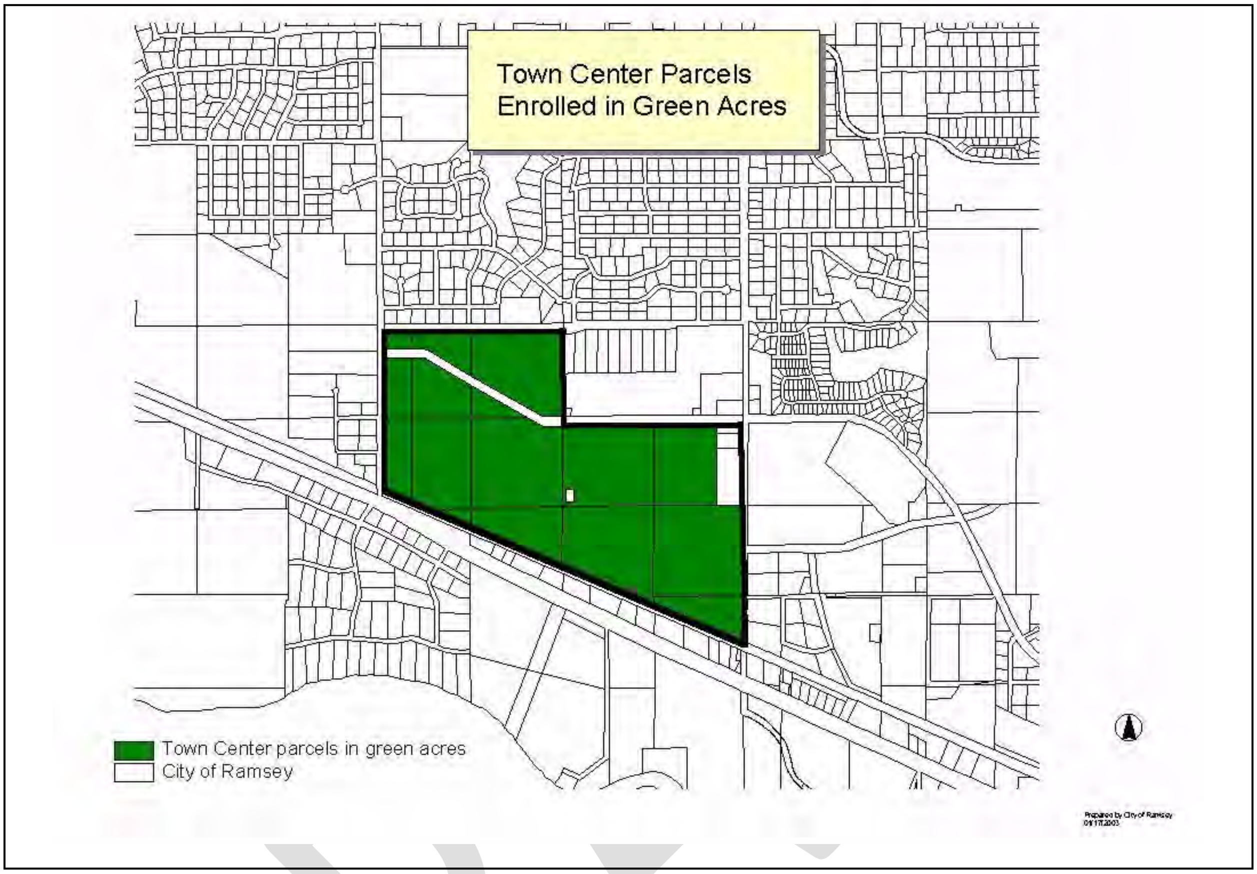


Figure 25.2  Green Acres land within the RTC site.




**25c.** The Ramsey Town Center site is fortunate to fall within an area surrounded by parks and trails.  A unique opportunity exists within the site to incorporate new parks and open space, and to tie together several trail links.  Figures 25.3 and 25.4 show the Anoka County and City of Ramsey parks and trail plans, respectively.  The City of Ramsey plan reflected in the figure is the most recent version.  Because of rapid growth within the City, the park and trails system has been changing often, such that revisions are constantly under way.  The information in Figure 25.4 should be considered current through the Spring of 2003.

Reference to the preferred design in Figure 6.1 shows several parks and open space areas that will be included in the RTC development.  The latest design contains approximately 40 acres of –green/open space” in a series of neighborhood parks, drainage corridors, preserved and restored wetlands, and general open space.  Much of this area, especially in the drainageways, can serve a dual purpose of open space and temporary detention of water.

Among the many issues identified during the stakeholder issues interview was the key role that the RTC site could play in linking open space areas (parks, trails, green space) throughout this portion of Anoka County. Staff from both Anoka County and City of Ramsey Parks Departments stressed the importance of incorporating green space into the site plan and providing for trail connections to the Mississippi Regional Park (MRP) Trail, which is part of the MNRRA regional River trail, and to trails north and northwest of the RTC site.

Figure 25.5 is a concept depiction of a greenway/trail connection that extends from the City trail at Lake Itasca to the Mississippi River. This corridor is also discussed in Item 17 (Figure 17.1) as a surface water flow route for water from the Lake and from the area to the northwest of RTC as it develops.

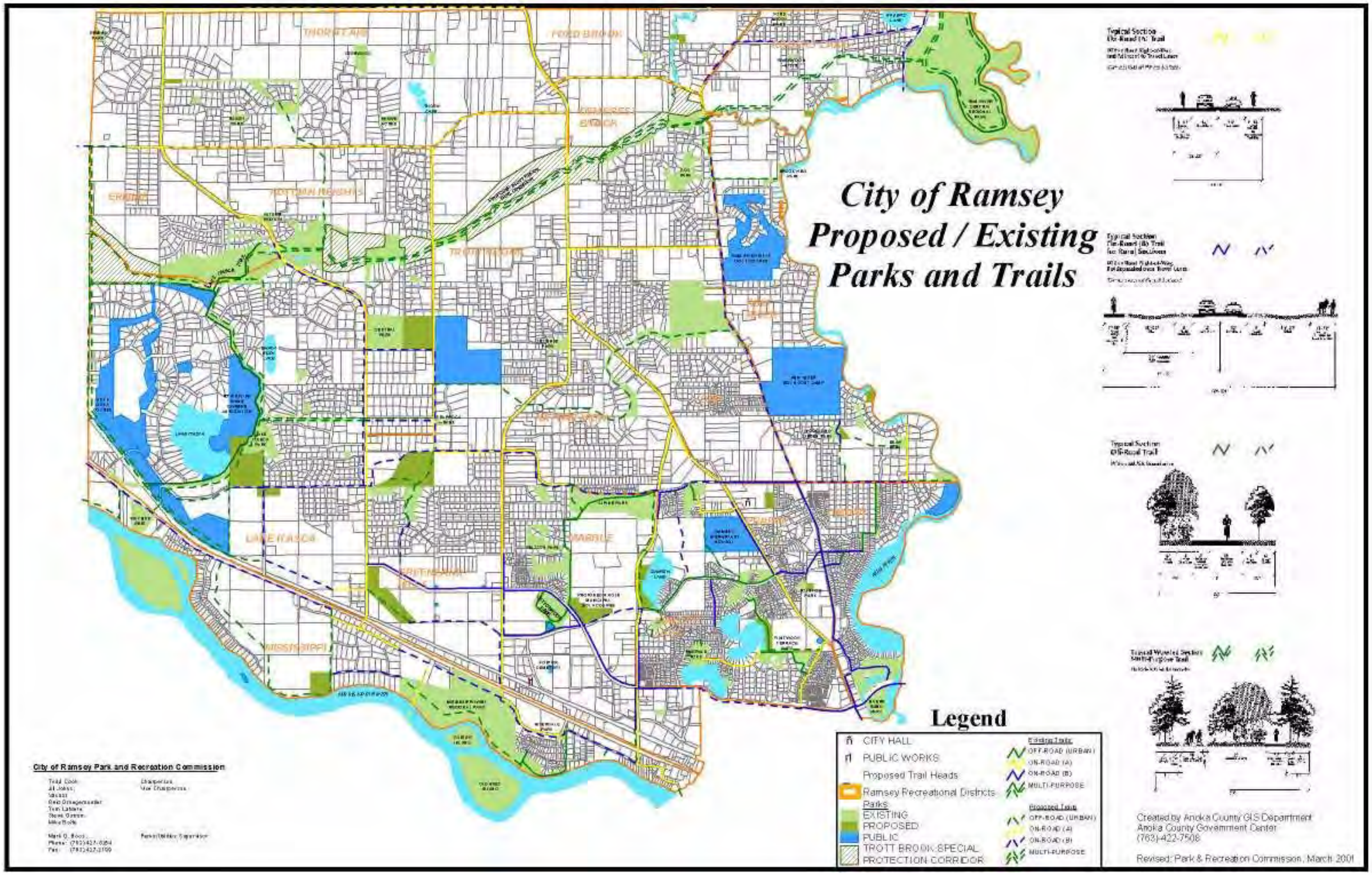
Within the RTC site, as reflected in Figure 6.1, are numerous opportunities to expand open space and trails. The prominent trail feature will be along the central drainage corridor portrayed as green space in the figure. Trails will be present on both sides of the corridor, providing the desired opportunity for linkage with MRP and Lake Itasca. The trail crossings of the BNSF railroad tracks and Highway 10 to the south, and Armstrong Boulevard to the northwest need to be carefully considered during the design phase. Options for crossing the railroad tracks and Highway 10 include numerous locations at-grade, above via elevated crossing or walkway (needed for transit station if Northstar becomes a reality), or sub-grade. The exact nature of this crossing will not be known until many of the design features of the site are coordinated with the agencies involved, including Mn/DOT and BNSF. Anoka Parks prefers a connection south of the site (similar to the Calthorpe location shown in Figure 6.2) rather than along Ramsey Boulevard, but the nature of the crossing could dictate the location, which will be determined during detailed site design. RTC LLC is committed, however, to making the trail connection to MRP an integral part of the RTC when completed.

With proximity to the MRP comes the need for attention to minimize any adverse impact that could result from a new urban center. The development should enhance the park by using the project site as a connection to existing and new open space, and as a source of new users interested in supporting the recreational system. Land use along the trail connection within the site should be compatible with the trail. High intensity commercial use would deter use of the trail leading from the site into the Regional Park.

Anoka Parks has expressed an interest in having the architectural style of the MRP buildings and RTC be compatible. Since the Park development will not proceed for years, the exact style to consider is unknown. RTC LLC will consider the need for visual coordination during the building design phase, and will make its design decisions known to Anoka Parks for its use in future park development.

In 1988, Congress passed Public Law 100-696 establishing the Mississippi National River and Recreation Area (MNRRA) as a unit of the National Park System to preserve, protect, and enhance the nationally significant historical, recreational, scenic, cultural, natural, economic, and scientific resources of the Mississippi River Corridor in the Twin Cities metro area. Item 14 previously addressed the reflection of MNRRA, Critical Area, and Wild and Scenic Rivers language into the City's *Comprehensive Plan*. In 1995, a

Figure 25.4. City of Ramsey Parks and Trails (under revision).



Comprehensive Management Plan (CMP) for the MNRRA was approved by the Secretary of the Interior. The CMP provides a management framework to assist the State of Minnesota and units of local government in the implementation of integrated resource management programs and to ensure orderly public and private development in the area. The CMP incorporates the state Critical Area program and other state land use management programs by reference as the foundation for compliance with the CMP, and encourages voluntary state and local compliance with additional policies to protect and enhance the river corridor. The Mississippi River Critical Area Corridor and MNRRA are geographically identical. In 1991, the Minnesota Legislature designated the federal MNRRA as a state Critical Area by the enactment of Minn. Stat. 116G.15.

**25d.** A complete analysis of visual impacts is contained in Item 26 that follows.

<u>Summary of Environmental Impact.</u> None are expected with regards to archeological, historical or cultural resources.

The RTC site will be converted from over 350 acres of largely agricultural land to urban uses. This change reflects growth by the City of Ramsey in a manner contained within its *2001 Comprehensive Plan,* as amended in 2002.

The addition of new open space, trail connections and park land in an area previously not publicly accessible will be a benefit to the community. The addition of these features will be carefully coordinated with the proper agencies to assure compatibility.

<u>Mitigation element.</u> *Unidentified Resources*. Various circumstances may lead to the discovery of unidentified historic or archeological resources within the project boundaries. When any such new discovery is brought to the attention of the developer or the City, an evaluation of the significance will be conducted and appropriate management measures will be devised in consultation with SHPO.

Discovery does not mean that all work must stop. However, depending on the nature of the cultural resource and the activity's apparent effects on it, the developer and City will make reasonable efforts to avoid or minimize harm to the resource until it has been processed. Following are the procedures that will be followed when a discovery of what appears to be a cultural resource (historic or archaeological artifacts) has been made:

> (a) Contact the supervisor in charge immediately. If human remains are discovered, also refer to the below section, *Unmarked Human Burial Sites*.
>
> (b) The supervisor will contact SHPO immediately (651-296-6126). The supervisor will arrange for the site or the relevant portion of the site to be secured against further disturbance until a professional assessment of the potential finding can be made.

(c) The contractor, lessee or employees will consult with SHPO to safeguard the resource and note its location, depth, etc. for future report, and to determine what type of investigation (if any) or mitigation is appropriate for the circumstances.

*Unmarked Human Burial Sites.* The discovery of human remains is covered under Minnesota Statute, Section 307.08. Human remains deserve respect and should be treated appropriately. The discovery of human remains involves legal as well as archaeological issues. The odds of discovering human remains are low; however, complete records of all Native American, pioneer and settler burial sites are not available. Therefore, discovery of such unidentified sites is typically accidental and will occur at sites where the soil has not been previously excavated to an appropriate depth.

Immediately upon the discovery of buried human remains, the procedures listed below will to be followed:

(a) Stop the excavation, and using appropriate safety precautions, and with a minimum of further disturbance to the remains, verify that it appears to be human remains. Make note of what was found, its location and depth, etc.

(b) Contact the supervisor in charge immediately. The supervisor will contact the Ramsey Police Department immediately if it is suspected that the remains are recent.

(c) If unable to contact a supervisor, or if instructed, call the Ramsey Police Department and report the discovery. If necessary, the developer will cooperate with law enforcement authorities in securing the site.

(d) As soon as possible but within 48 hours, the supervisor shall contact the State Archaeologist and consult with them on how to proceed.

*Disposition* - Ownership/disposition of historic and prehistoric archaeological items, including Native American human remains or grave goods, will be determined by the State Archaeologist, the Native American Council or other appropriate authority.

Because there is no prime farmland on the site, there are no mitigation measures needed to address the change in land use. The very small amount of State-wide Important Farmland in the far southeast corner of the site will be lost from productive agricultural land, but will be replaced by green space uses that preserve the open character of the land.

Although the RTC site is not within the geographic area covered by MNRRA, every effort will be made by RTC LLC to work with Anoka County Parks, Ramsey Parks and the National Park Service to comply with the policies of these agencies and to minimize or avoid any adverse impacts from development of the RTC site.

## 26. Adverse Visual Impacts

*Will the project create adverse visual impacts during construction or operation? Such as glare from intense lights, lights visible in wilderness areas and large visible plumes from cooling towers or exhaust stacks?  _**X**_Yes   __No*

*If yes, explain.  If any non-routine visual impacts would occur from the anticipated development, this should be discussed here along with appropriate mitigation.*

The current visual aesthetic on the site is one of an actively farmed area surrounded by residences to the north, a busy state highway and commercial strip to the immediate south, and commercial strips to the east and west.  Although views from the site will not be impacted, those used to viewing farmland on the site will have a change.

Views during construction will change from the agricultural view currently seen at the site.  Although “adverse” is not a quantitative measure relative to visual impressions, it is anticipated that most would consider an active construction site as less than visually appealing.

Views from the Mississippi River northward are not likely to be directly impacted because of the elevation difference between the River and the site.  The site elevation is between about 860’ and 865’, with a knoll on the north end of the site reaching about 880’.  The Mississippi River through this reach is about 830’ and located below a forested bluff.  Direct viewing of the Ramsey Town Center will not be possible from the River.  However, lights emanating from the site would likely be seen once the site is developed.

<u>Summary of Environmental Impact.</u>  Conversion of agricultural land to urbanized land will have a net change in views that many do not view positively.  Changing this view of “open land” to one of a fully developed urban area, however, is part of the City’s plan for its growth.  The impacts of the conversion, however, can be mitigated, as outlined in the next section.

<u>Mitigation element.</u>  Light emissions from commercial and residential areas cannot be avoided because of safety issues and the need for residences and businesses to see clearly at night.  City Ordinance 9.11.07 describes any lighting used to illuminate an off-street parking area, sign, or other structure, must be arranged so that the light is deflected away from residential districts and public streets.  Bulbs emitting in excess of 3,000 lumens (150 watts) must be arranged so that the light is not visible outside of the property where the light is located.  There are several methodologies of acceptable screening methods for these nuisances that can also be used for transitioning from high- to low-density residential or from residential to commercial areas.  Screening methods typically include a vegetative barrier no less than five feet high or other natural materials.  Applying shields to street and parking lot lamps directs the light to the ground surface where it’s wanted, not into the adjacent neighborhood.  All of these practices should minimize the impact of the light at the River, but will not eliminate it.

The visual impacts of construction on a scale that will occur at RTC over several years will be difficult to mitigate, but several measures to minimize the impact will be followed. The most offensive visual characteristics of construction, and possible mitigating actions are:

- Soil erosion leading to sediment movement off-site - Item 16 spelled-out a mitigation element to control on-site erosion and off-site sedimentation.
- Access streets and roads covered with dirt and gravel/rocks - The erosion and sediment control program will include egress gravel wash pads and will contain a daily sweeping plan for roads affected by construction traffic.
- Swirling dust caused by earth-moving activity on dry soil - A water truck will be available on site to spray areas experiencing dust movement. This will be especially critical on the sandy soils prevalent on site.
- Construction equipment and temporary trailers - Every effort will be made to screen immobile equipment and to park mobile equipment in a visually sheltered location at the end of the working day.
- Exposed soil - One of the essential elements in the erosion and sediment control plan will be rapid stabilization, covering and re-vegetation of exposed soils. Although some exposed soil will be impossible to avoid, every attempt will be made to minimize exposure.

## 27. Compatibility with Plans

*Is the project subject to an adopted local comprehensive plan, land use plan or regulation, or other applicable land use, water, or resource management plan of a local, regional, state or federal agency? _**X**_Yes __No.*

*If yes, describe the plan, discuss its compatibility with the project and explain how any conflicts will be resolved. If no, explain.*

*The AUAR must include a statement of certification from the RGU that its comprehensive plan complies with the requirements set out in (Minnesota Rules) 4410.3610, subpart 1. The AUAR document should address the proposed AUAR area development in the context of the comprehensive plan. If this has not been done as part of the responses to Items 6, 9, 18 21, and others, it must be addressed here; a brief synopsis should be presented here if the material has been presented in detail under other Items. Necessary amendments to comprehensive plan elements to allow for any of the development scenarios should be noted. If there are any management plans of other local, state, or federal agencies applicable to the AUAR area, the document must discuss the compatibility of the plan with the various development scenarios studies, with emphasis on any incompatible elements.*

*City of Ramsey Local Comprehensive Plan.* The basis of implementing a large-scale development as covered by an AUAR is the compatibility of that development with the local unit of government's plan for the future of its community. In the Metropolitan Area, this outlook is described in a local comprehensive plan (LCP) prepared in accordance with Minnesota Statutes, Section 473. Among the requirements of this statute is the inclusion of a land use plan with staged development, housing and surface water management components, a public facilities section that addresses transportation, sanitary sewer, parks and open space, and water supply, and finally, an implementation program that describes the financial and institutional methods to be used to implement the LCP.

Minnesota Rules 4410.3610 references the need for a local unit of government within which an AUAR is being prepared to certify that the three elements referenced above are contained in its LCP. The City of Ramsey has an adopted *2001 Comprehensive Plan* that was most recently amended on February 26, 2002. The following list identifies the specific LCP chapter references meeting the content requirements for AUAR/LCP conformity:

- <u>Chapter V</u> - Land Use (existing land use, future land use, historic preservation, solar access protection)

- <u>Chapter VI</u> - Transportation Element (framework and goals, existing roadways, analysis of roadway system needs, roadway system plan, transit, aviation, railroad lines, bicycle and pedestrian trail system)

- Chapter VII - Housing Plan (existing conditions, senior housing, affordability, the plan for housing)

- Chapter VIII - Sewer Element (existing system, future sanitary sewer services)

- Chapter X - Park, Recreation and Open Space (existing park and creation facilities, the parks and creation plan)

- Chapter XV - Public Facilities (city administration, fire and rescue, police, public works, public schools, public facilities and services plan)

- Chapter XVI - Implementation Strategy (zoning ordinance, subdivision ordinance, septic system management program, capital improvement program, corridor studies, housing program, redevelopment planning, area master planning, part and trail comprehensive planning, GIS development, public services and facilities, central rural reserve area)

- Appendix C - Surface Water Management Policy

- Appendix E - Individual Sewage Treatment System (ISTS - septic tank) Program

- Appendix F - Water Supply Plan

- Appendix G - Capital Improvement Program

Based on the content contained with the February 26, 2002 Ramsey *Comprehensive Plan Update*, the City of Ramsey certifies that the requirements of Minnesota Rules 4410.3610 have been met.

*Preferred site design conformity with Ramsey LCP*. The preferred site design illustrated in Figure 6.1 is consistent with the City of Ramsey LCP, as referenced above and illustrated in Figure 5.4. The key element in establishing conformity is consistency with the future land use expectations of the City. The consistency set the stage for infrastructure support and financing needed to assure smooth development staging. Figure 5.4 illustrates that the Ramsey Town Center site is noted as predominantly “Mixed Use”, with additional increments of “Places to Work”, “Medium Density Residential” and “Low Density Residential”. The corridor between Highway 10 and the BNSF railroad tracks is designated as “Palces to Shop”. The “Mixed Use” category represents a combination of residential, commercial, light industrial, open space and a transit hub. “Places to Work” is defined by the City as areas primarily reserved for office and industrial type development. The plan’s description of mixed use and the other less prominent uses fits perfectly with the preferred design. The existing highway commercial strip on the north side of Highway 10 (Figure 6.1) is subject to change as Mn/DOT’s plans for the highway take shape, but until that happens, there is no anticipated change in its usage, other than possible use of City land for detention of stormwater.

Consistency on a map does not assure that project implementation will fully meet the City’s intent with respect to the provision of service. It is for this reason that the various AUAR Items address infrastructure needs and phasing. The timing within which services will be provided to Ramsey Town Center is spelled-out in Items 12, 13, 17, 18, 21, 25 and 28. However, at this time, there has not been any financial commitment by the City to meet the timing schedule.

Although the entire LCP supports the approach proposed for Ramsey Town Center, some specific elements within the Plan pertain especially to the project. The Guiding Principles within the Vision and Guiding Principles section of the Plan (Chapter II) contain many statements that reflect the –town center” concept of development, with its emphasis on mixed land uses, pedestrian and environmental friendliness, and building a sense of community.

Chapter III of the LCP (Community Background) and Chapter XIV (Community Identity) address the City’s intent to grow in a well thought-out manner and to build a sense of community. The Ramsey Town Center project will provide an opportunity to develop a central focal point for municipal civic activities, as well as working, shopping, establishing a home and finding local entertainment as the City’s population grows from about 19,500 in the year 2000 to well over 30,000 by 2020.

Consistency relative to sense of community cannot be shown with maps and charts, but must be gained through repeated contact with public officials and members of the community. The preferred concept that eventually evolved into Figure 6.1 was derived after many such meetings. The list of forums for discussion included: Metropolitan Council Smart Growth community meetings; presentation and listening sessions with City officials and community leaders; a Town Center Task Force; the January 2003 retail design charette; and day-to-day interaction with City staff.

Consistency is also assured by matching the character of a new Ramsey Town Center with what the City expresses as its needs and desires in the LCP. Following are several such statements from the LCP for which the Town Center design fits:

> *“Landowners are encouraged to preserve and restore areas of significant natural resources such as open prairie or tree canopy as permanent open space by increasing density in areas more conducive to development.” (page V-11)*
>
> *It is an Urban Residential policy of the City to “Encourage environmentally conscious site design and construction methods to assure that development respects the natural environment”, to “Ensure open space that is part of a residential development is preserved as permanent open space…” and to “Ensure projects are consistent with the goals and policies of the Mississippi River*

*Critical Area Plan (MNRRA) and are sensitive to the Rivers natural environment". (pages V-20 and 21)*

*It is a Places to Work policy of the City to "Require developments to adhere to environmentally sensitive design and construction standards", to "Facilitate the clean up and redevelopment of brownfields and underutilized sites…" and to "Require individual sites to be connected to a trail system that links employees with the Town Center, parks and neighborhoods." (page V-25)*

*"The purpose of the Town Center Mixed Use Area is to establish a community hub that integrates places to work, play and live and embraces transit oriented design in anticipation of the potential future commuter rail station." The site will be a "pedestrian friendly environment that supports mass transit" with mixed use development that would support the station with connections to MRP. (pages V-26 and 27)*

*It is a Park and Recreation Plan goal of the City "To preserve continuous open space corridors that protect natural vegetation and water quality, provide wildlife habitat, and preserve the natural identity of Ramsey." (page X-7)*

*"The Ramsey community has acknowledged and embraced the importance of the Mississippi River Corridor, its history, water quality, beauty and recreational opportunities. The future of the corridor through Ramsey consists of a sanctuary where wildlife and nature coexist with people and development." (page XI-3)*

*"All future development should minimize the negative environmental impacts on the region's ecological system ensuring that the built environment is in harmony with the natural environment." (page XIII-1)*

Reference to Figure 5.4 shows the future land use reflected in the LCP. A comparison with the preferred concept plan for Ramsey Town Center (Figure 6.1) clearly illustrates the compatibility between the City's vision for the future and the proposed development. Chapter V of the LCP describes how the City's expectations on how it will develop by 2020. The Chapter is replete with references to the City's intentions. All of this guidance will be used as Ramsey Town Center moves through the various phases of development and comes to the City for the approvals that accompany the development steps. Specific reference is made in Chapter V to a sub-set of Mixed Use called ―Town Center Mixed Use Area". This description addresses the area being proposed for development under this AUAR. The vision laid-out in the description parallels the site concept and sense of community focus proposed for Ramsey Town Center. The entire parcel being considered is within the MUSA (Figure 5.4) and will be served accordingly, as described in the various infrastructure elements of this AUAR, consistent with the 2000-2010 staging plan identified in the LCP (Figure V-3 in the Plan).

Chapter VI also identifies the City's desire to improve its trail system.  The connection of trail linkages from Mississippi Regional Park (MRP) through Ramsey Town Center, connecting to Lake Itasca and other trails north of the Center is an integral part of this City vision.  Completing this vision during development has always been part of the Town Center plan, as evidenced in Figure 6.1.

The water and sanitary sewer service elements of the LCP (Chapters IX and VIII) are discussed within the AUAR in Item s 13 and 18, respectively.  The storm sewer element is discussed in both Items 12 and 17.  All of the infrastructure details are also discussed in Item 28.

Chapter X of the LCP addresses the parks and open space plans for the City.  Figure 6.1 shows that a substantial portion of the proposed Ramsey Town Center will be devoted to open space that can become part of the City's system.  Trail linkages have already been identified, but additionally, linkages within the site will occur among the various neighborhood parks and more regional-scale trails.  The development of MRP will be a major benefit to the City's long-term goal of providing public access to the River.  The connection of Ramsey Town Center trails to the River, as described in the site concept plan, will be a critical step in achieving this goal.  Similarly, the opportunity exists to tie the Center to the Lake Itasca trail via a green corridor trail.  Figure 25.5 illustrates one potential alignment for this trail.  The City has not yet formalized the means by which this trail would be established, but identifying a possible path is part of the process.  The City's Parks and Recreation Committee and City Council will ultimately decide upon the method of incorporating that this trail into development as it occurs northwest of Ramsey Town Center.

The connection and coordinated planning between the City and the state Mississippi River Critical Area and Wild and Scenic River (WSR), and the federal Mississippi National River and Recreation Area (MNRRA) was discussed in Task 14.  The boundaries of these three specially designated areas overlap, as shown in Figure 14.1.  Chapter XI of the City's LCP contains the required elements for implementing Executive Order 79-19 issued by the state for defined Critical Areas in 1979.  This chapter addresses all of the required elements and also ties in the coordination aspects with MNRRA and WSR.  Although none of these protected areas occurs within the boundaries of Ramsey Town Center, the AUAR must address potential impacts that site development could have on them.  Task 14 addressed this impact and the mitigation plan associated with it.   Reference is made in the LCP to the 1994 MNRRA Plan, *Comprehensive Management Plan for the Mississippi National River and Recreation Area* prepared by the Mississippi River Coordinating Commission and the USDI-NPS.  This plan serves as general management plan for MNRRA and is reflected in the City's LCP, which exceeds Tier II requirements of MNRRA.

Chapter XIII of the LCP establishes the City's vision for environmental protection and resource management.  A key feature of the Ramsey Town Center is its integration of natural resource attributes into the concept design.  Chapter XIII identifies the natural features of the City and the manner in which they will be protected and enhanced.

Development of the Center site actually presents an opportunity to restore and incorporate environmental features that have not been a part of the landscape in recent memory. For example, the central green corridor is a remnant drainage feature that has not transmitted water in the memory of City or WMO officials. Connecting drainage from Lake Itasca to the Mississippi River to and through this feature will provide a chance to restore a natural function and the habitat, water quality and aesthetic benefits that accompany it. Similarly, installing runoff management practices that take full advantage of the infiltration character of porous Anoka Sandplain soils assures that surface water continues to recharge the essential drinking water aquifer supplying drinking water to City residents, whether on a municipal or private system.

Finally, the public facilities and implementation requirements of planning are addressed in Chapters XV and XVI of the LCP.

*Management plans of any other government agencies.*
As discussed previously in this AUAR, there are several other plans that potentially cover the Town Center site and its adjacent area.

*Lower Rum River Watershed Management Organization (LRRWMO).* The entire site falls within the jurisdiction of the Lower Rum River Watershed Management Organization (LRRWMO), which is a Joint Powers Agreement among the Cities of Ramsey, Anoka, Andover and Coon Rapids. Aspects of the LRRWMO relationship to this project were addressed in both Item 8 (permits) and Item 14 (related management districts).

The WMO's state approved (BWSR) second generation watershed plan was adopted by the LRRWMO in late 1998. The Ramsey Town Center site occurs within the WMO's West Mississippi District. The WMO plan, however, mapped the portion of the sub-watershed surrounding Lake Itasca as part of the Trott Brook drainage area, which meant that flow would be to the north from the Lake rather than to the south. Because flow emanating from Lake Itasca has not occurred within recent history, there was some uncertainty over the direction of flow, if it were ever to occur. To address this uncertainty, an EOR survey team established elevations around the lake and determined the drainage directions located in Figure 12.1. Determining this flow direction is essential for to the modeling effort to quantify the area contributing to flow that could cross the Ramsey Town Center site.

LRRWMO is also the designated ―Local Governmental Unit" or LGU under the 1991 Wetland Conservation Act. This means that regulatory decisions on wetland impact within the City are made by the WMO. The WMO participated in all of the Technical Evaluation Panel (TEP) meetings related to this site, and is ultimately responsible for any subsequent permit decisions.

*Critical Area, MNRRA, Wild and Scenic River.* The management overlap between the Critical Area component of the City's LCP and the MNRRA plan were addressed in Item 14. This discussion also addressed the Wild and Scenic River coverage. Local governments within the state Critical Area Corridor are required to incorporate the Standards and Guidelines of Executive Order 79-19 into local plans and ordinances for the Corridor. Local units of government shall permit development in the Corridor only in accordance with those adopted, approved plans and regulations. Specific policies within the Ramsey Critical Area Plan address those needs, as referenced earlier (Item 14). In addition to the Executive Order standards (previously listed) that were incorporated and approved in the City of Ramsey Critical Area plan, the following additional policies occur in the City's plan:

- Minimize direct overland runoff and maintain natural watercourses such as ditches, wetlands and floodplains to handle existing storm water runoff and slow the process of surface water infiltration.
- Ensure urban best management practices are strictly adhered to during and after construction projects including the replacement of all vegetative cover which is removed for construction purposes.
- Adopt development controls consistent with NURP standards and the MPCA's Urban Best Management Practices to reduce nonpoint source pollutant loading in storm water runoff.
- Minimize site alterations and protect natural watercourses, bottomland forests, prairies and woodlands as part of the development plan through such means as conservation easements or land preservation techniques.
- Prohibit alterations or disturbances of wetlands, tree canopy, significant habitat areas and natural vegetation areas.
- Ensuring that trail locations minimize any negative affects on the natural resource base.
- Ensure future development emphasizes continuous open space, minimizes utility and infrastructure needs and crossings....
- Ensure adequate views to and from the river are preserved while maintaining appropriate landscaping buffers and vegetative covers.
- Require future utility construction ... to be underground while minimizing disturbance of endangered habitat areas or undisturbed natural vegetation areas.
- Prohibit any unnecessary grading, filling, or any other significant alteration of areas within the Critical Area Corridor.
- Prohibit development on or alteration of slopes exceeding 12% including the riverfront bluff face.



*Anoka County.* Anoka County has a Comprehensive Master Plan for the County that covers all parts of the Critical Area under County jurisdiction in the Plan’s Mississippi River Critical Area Management section. Planning and development of parks within this area by Anoka County Parks reflects the Critical Area goals under the Critical Area Act and Executive Order 79-19. The County’s plan for Parks and Trail Corridors was shown in Figure 25.3. The City of Ramsey is working very closely with Anoka County Parks to develop trail connections paralleling the Mississippi River through MRP and connecting this regional trail to other City and County trails north of the River. The connections to Lake Itasca and Trott Trails would then traverse the Town Center site. Anoka County Parks has also expressed an interest to tie the architecture of the MRP buildings to the architectural themes used in Ramsey Town Center. Finally, Anoka County Highway Department is working with the City and the site developer to assure that all of the road work potentially impacting County highways is acceptable and meets County standards.

*Anoka Conservation District (ACD).* ACD has a greenway corridor plan for wildlife corridors that crosses the Ramsey Town Center watershed and the site itself. Figure 27.1 illustrates the ACD greenway contained within the plan. Currently the plan indicates that an ideal wildlife corridor would go through the Town Center in essentially the same location as the central drainage swale. The location of the corridor is critical here because of the proximity of the Town Center to Mississippi West Regional Park, which is a local hub for wildlife. In a conversation with EOR, ACD staff (Rich Biske, Wildlife Habitat Management Technician) indicated that the drainage swale could be an appropriate wildlife corridor if native vegetation (specifically mentioned big blue stem and forbs) instead of turf grass was planted. He noted that if turf grass is planted in the central drainage swale, a wildlife corridor would need to be created in a less desirable location, possibly in the undeveloped area to the west of the site, as east of the site is already developed. ACD also expressed interest in connecting the trail system and possibly the wildlife corridor to the trails and open space associated with Sunfish Lake to the east.

*Department of Natural Resources (DNR).* DNR implements the State's Critical Area program and has approved the City's Critical Area Plan as part of its local comprehensive plan (see Item 27). DNR also administers the State Wild and Scenic Rivers program. Provisions to coordinate the Critical Area Plan with the Wild and Scenic River and the federal Mississippi National River and Recreation Area (MNRRA) are contained within the City's comprehensive plan.

*Metropolitan Council.* The Metropolitan Council is charged under Minnesota Statutes, Chapter 473 with assuring the orderly and economic development of the seven-county metropolitan area. To implement this responsibility, the Council reviews the local comprehensive plans (LCP) of communities within the region, and has approval authority over aspects of the plan that affect one of the four ―regional systems" - wastewater, transportation, regional parks and airports. Other elements of the LCP that are not related directly to the four regional systems are reviewed for consistency with overall regional plans.

Of specific AUAR concern to the RTC site are the Ramsey LCP regional system elements addressing traffic and wastewater, and the non-system components addressing water supply and stormwater. The Ramsey LCP was adopted in 2001 by the City and approved by the Metropolitan Council. This AUAR reviewed the traffic and wastewater elements of the site development and drew some conclusions in Items 21 and 18, respectively, on system impact. Items 13 and 17 similarly addressed the water supply and stormwater aspects of the development.

*Minnesota Department of Health (MDH).* The MDH is the state agency responsible for assuring that municipal water suppliers meet the requirements of the state and federal

Wellhead Protection Program. The City of Ramsey has joined with several other communities in Anoka County, and the County itself, to develop its wellhead protection plan. This plan was addressed in Item 6.

Summary of Environmental Impact. The proposed RTC site development is consistent with all of the planning documents covering its area.

Mitigation element. At this time, the Ramsey *2001 Comprehensive Plan*, as amended in 2002, fully addresses the development of the RTC site and adequately relates this development to the various other agency plans with which it must comply. However, any change in the project that would lead to deviation in one or more of the plans must be corrected by a plan amendment.

## 28. Impact on Infrastructure and Public Services

*Will new or expanded utilities, roads, other infrastructure or public services be required to serve the project?* _**X**_*Yes* __*No.*

*If yes, describe the new or additional infrastructure or services needed. (Note: any infrastructure that is a connected action with respect to the project must be assessed in the EAW; see EAW Guidelines for details.)*

*For an AUAR, this item should first of all summarize information on physical infrastructure presented under Items such as 6,17, 18, and 21. Other major infrastructure or public services not covered under other items should be discussed as well – this includes major social services such as schools, police, fire, etc. The RGU must be careful to include project-associated infrastructure as an explicit part of the AUAR review if it is to exempt from project-specific review in the future.*

*Social Services.* The project area is served by the Ramsey Police Department. Based on the current standard ratio of 1.3-1.5 licensed officers per 1000 residents, the City of Ramsey should have 26 officers. There are typically 3 police officers on duty at a time from a total of 17 full time police offers, therefore the current ratio is 0.85 licensed officers per 1000 residents. The Police Department, when predicting future needs, considers crime rate, traffic increases, and overall growth. Future personnel, equipment and training needs are based on the general population growth of the City of Ramsey, which would include, but is not specific to the RTC. Future personnel needs are listed in Table 28.1. Through 2015, equipment and training needs are expected to increase proportionately with staffing changes. The Department is investigating the equipment and training required for preparing an officer for a potential terrorist attack anywhere within the city. The RTC is described by the department as the most likely location within the city for such an attack. Currently, the streets adjacent to the RTC are patrolled at least once a day. The RTC development may require more frequent patrols. The preferred design plan for the RTC includes the construction of a new police station, which would establish a permanent police presence on the site.

Table 28.1 Ramsey Police Department Future Personnel Needs

| Year | No. of Police Officers Needed | Additional Personnel Needs |
|---|---|---|
| 2004 | 2 Patrol Officers | 1 Crime Prevention Specialist 1 Technician |
| 2005 | 2 Patrol Officers | 1 Community Service Officer |
| 2006 | 2 Patrol Officers | |
| 2007 | 2 Patrol Officers | 1 Investigator<br>1 Technician |
| 2008 | 2 Patrol Officers | 1 Supervisor |
| 2009 | 2 Patrol Officers | 1 Lieutenant |
| 2010-2015 | 1-2 Patrol Officers per year | 1-2 Technicians |

The Ramsey Fire Department serves the project area and has two full-time fire fighters, thirty one volunteers, two class A rated engines, a tanker engine, a tanker truck, two rescue vehicles, and two grass/brush fire trucks. The Fire Department has two stations with intentions to build a third. The recently built fire station on Armstrong Boulevard is less than a quarter of a mile from the RTC. The current equipment and staff should continue to be adequate after the development of the RTC. The Department does not foresee future needs until the completion of the third station.

The City of Ramsey feels that there is going to be a substantial level of commitment necessary for the Ramsey Towne Center as it relates to the Public Works Department. Due to the operational expectations of this area and impacts on the existing level of service, the City expects that there will be a need for 3 to 4 additional Public Works personnel to meet these increased demands such as: additional street maintenance, additional mowing and park clean-up, snow removal instead of snow plowing, sidewalk maintenance on a higher priority, additional street lighting with aesthetic banners, as well as traffic signals.

The City also expects an increased impact to its equipment needs to perform these additional and unique services such as banner hanging, replacement, and service, storm sewer cleaning at a increased increment and snow removal. This includes an additional sweeper due to the increased regularity of sweeping, sidewalk sweeper to keep the debris and therefore particulates and floatables out of the storm sewer, vacuum truck to keep up with the demands of catch basin cleaning and additional "snow removal" equipment with conveyor to help with removal activities. Since the amount of responsibility for maintenance is unclear at this stage, the above information is the City's estimate of the needs that will accompany this project.

The site should be adequately served by existing library and post office facilities. The preferred design includes a community center and new city hall to better serve the City of Ramsey and RTC residents.

The RTC and the surrounding area are within School District #11, served by nearby Ramsey Elementary School, Sandburg Middle School and Anoka High School, as well as several private schools. From the Anoka-Hennepin School District, new housing construction in the City of Ramsey impacts school enrollment as listed in Table 28.2. Using the data from the school district and the total residential units from the February 28, 2003 RTC concept design, the impact to school enrollment was calculated and is listed in Table 28.3. When residential type was specified as mixed use in the concept plan, the highest impact unit type, ―Single Family Homes”, was assumed in order to determine the highest possible impact scenario. The unit type ―Apartments” in Table 28.3 includes apartments and duplexes. All calculations were rounded up to the nearest whole number. Based on statistics and stated criteria, the impact of the RTC on school enrollment will be 830 school age enrollments and 399 preschool enrollments. Because the development will occur over time, not all enrollments will occur at the same time. Also, if the unspecified residential units are not single family homes, the enrollment impact will be significantly less than assumed here. Additionally, the RTC currently maintains that a school will be built on-site, which could absorb some of the additional enrollments. Finally, according to the Anoka-Hennepin School District, new housing is needed in order to replace the 100 graduating students every year. Therefore, as new housing units are constructed in the RTC over time, new students should be absorbed without significant impacts to school enrollment.

Table 28.2 City of Ramsey's assumptions for new housing impacts on school enrollment

| Unit Type | No. of School Age Children/ No. of Units | No. of Preschool Age Children/ No. of Units |
|---|---|---|
| Townhouses | 1/8 | 1/25 |
| Apartments | 1/25 | 1/16 |
| Single Family Homes | 2/3 | 1/3 |

Table 28.3 Impact scenario of proposed RTC development

| Unit Type | Ramsey Town Center New Units | New School Age Children | New Preschool Age Children |
|---|---|---|---|
| Townhouses | 1154 | 145 | 47 |
| Apartments | 234 | 10 | 15 |
| Mixed Use | 1012 | 675 | 337 |
| Total | 2400 | 830 | 399 |

Summary of Environmental Impact. No adverse impacts to the social service infrastructure are anticipated. Road, sanitary sewer, water supply and stormwater infrastructure are addressed in Items 21, 18, 13 and 17, respectively.

Mitigation element. The major physical infrastructure elements of roads and streets, sanitary sewer, municipal water and storm sewer have all previously been addressed within this AUAR.

An evaluation of the social services needed for the RTC development indicates that the planning done for the City has accounted for the growth related to the RTC. Police, fire, public works, schools, and related City and postal services will all be impacted by the development. Additional equipment to perform City public works services will be needed. No additional mitigation is needed to meet the expected growth.

## 29. Cumulative Impacts

This item does not require a response from an AUAR since the entire AUAR process deal with cumulative impacts from related developments within the AUAR area.

## 30. Other Potential Environmental Impacts

> *If applicable, this item should be answered as requested by the EAW form (if the project may cause any adverse environmental impacts not addressed by items 1 to 28, identify and discuss them here, along with any proposed mitigation).*

There are no additional major adverse environmental impacts beyond those addressed by Items 1-28. There are, however, two minor issues that need to be raised. First, the impacts of the Anoka-Ramsey Landfill on the RTC are presented to alleviate any potential concerns. The landfill is located within one mile of the RTC site in Township 32N, Range 25W, Section 22 (Figure 19.5). The RTC is located southwest of the landfill. Regional groundwater flow throughout this part of Ramsey is to the southeast, indicating that pollutants from the landfill are flowing away from the project area. Additionally, the continued mitigation at the landfill has contained the plume horizontally using twelve barrier wells and eight recovery wells. Finally, sampled residential wells screened in the Franconia aquifer have been negative for all monitored contaminants. This means that the potential for contamination of the water supply from the landfill is minimal because the City of Ramsey wells are screened in an aquifer that has not been contaminated and groundwater flow direction is away from the wells (Anoka/Ramsey Landfill SW-094 2000 Annual Report). Because of the location of the RTC, the minimal threat to the water supply and the successful remediation at the landfill, there should not be any adverse environmental impacts.

Secondly, the RTC will change land use from agricultural to urban. Although this marks an end to agricultural use of the site, Item 27 described the orderly planning process under which this transition occurred. The mitigation elements summarized in Appendix D address how the lost environmental features of the undeveloped agricultural site will be replaced, and in some cases, improved.

## 31. Summary of Issues

*List any impacts and issues identified above that may require further investigation before the project is begun. Discuss any alternatives or mitigative measures that have been or may be considered for these impacts and issues, including those that have been or may be ordered as permit conditions.*

*The RGU may answer this question as asked by the form or instead may choose to provide an Executive Summary to the document that basically covers the same information. Either way, the major emphasis should be on potentially significant impacts, the difference in impacts between major development scenarios, and the proposed mitigation.*

Meetings were held with many agency staff to identify issues related to this project that would be of interest to them. The agencies contacted for input were:

- Anoka Conservation District
- Anoka County - Parks, Public Services, Environmental Health, and Highways
- City of Ramsey
- Lower Rum River Watershed Management Organization
- Metropolitan Council - Comprehensive Planning, Environmental Services
- Minnesota Department of Natural Resources - Waters (Metro Region, Critical Areas Program)
- Minnesota Department of Transportation
- Minnesota Pollution Control Agency- Planning, Permitting
- National Park Service - MNRRA
- U.S. Army Corps of Engineers

Based on the input received, the following issues statements emerged as those in need of attention in the AUAR:

*Surface Water and Wetlands*

- There is a need to maintain the small amount of wetlands on the site, mitigate any losses and focus on maintaining infiltration capability through a surface water management plan; the City would like to incorporate Lake Itasca and the two northern wetlands, and an outlet for the site into the surface water management plan for the site. <u>Issue addressed in Items 8, 11 and 17.</u>

- A Ramsey street and sewer maintenance staff member stated that he could deal with pipes, but things like storm rain gardens and native vegetation he is not used to handling; therefore, the O&M is —different” and would require new training and possibly new equipment. <u>Issue addressed in Item 17.</u>

- A green drainage corridor/trail extending from Lake Itasca through the site to the Mississippi River crosses large tracts of privately held land. Although many are in favor of this, until a development proposal is received by the City, this can only be referenced as a –recommended” corridor. <u>Issue addressed in Item 17</u>

- The impact of the new NPDES Phase II nonpoint source control permit program should be assessed relative to future requirements as the site develops. Water quality impact should be evaluated down to the ultimate receiving water - the Mississippi River - because of its status as a highly valued and protected water throughout this reach. Issue addressed in Items 8 and 17.

- Any wetland alteration must be mitigated according to the Wetland Conservation Act process. Issue addressed in Items 8, 11 and 17.

- The adequate handling and passage of the 100-year flood event must be assured, and all LRRWMO requirements associated with this design must be met in doing so. Issue addressed in Item 17.

- An outlet is needed from this drainage area, since currently the minimal amount of flow leaving the site soaks into the ground along Highway 10 shortly to the southeast of the site. Issue addressed in Item 17.

*Parks and Trails*

- Project needs to provide an opportunity to link a trail system through the site. Issue addressed in Item 25.

- Attention is needed to minimize adverse impact on the Mississippi Regional Park; instead, it should enhance the park by using the project site as a connection to Lake Itasca via greenway and trail. Issue addressed in Item 25.

- In its dealings with Anoka Parks, BNSF has not allowed any elevated pedestrian crossings and has strict rules on tunneling under tracks; the at-grade option presents safety problems. Issue addressed in Items 21.

- Traffic plans for the Ramsey Boulevard/Highway 10 intersection should incorporate Anoka Parks' plan for development of the Mississippi Regional Park because this will be the only vehicle access location (with parking) allowed for the park. Issue addressed in Items 21 and 25.

- Land use along the trail connection within the site should be compatible with the trail. High intensity commercial use would deter use of the trail leading from the site into the Regional Park. Anoka Parks prefers a connection south of the site (similar to the Calthorpe location) rather than along Ramsey Boulevard, but the nature of the crossing could dictate the location. Issue addressed in Items 21 and 25.

*Traffic and Highways*

- The project needs to assess traffic patterns and flow to move cars in and out, and take advantage of site as regional center for transit. The site needs to fit into the regional and state plans for the City. Issue addressed in Item 21.

- The project needs to assess parking needs and traffic impact on, and adjacent to, the site, including traffic along County Roads 22, 64 and 5 that are used to bypass Highway 10, and using Ramsey and Sunfish Boulevards to by-pass Highway 47 through Anoka. Issue addressed in Item 21.

- Anoka County is requesting changes in the functional classification of several route segments on the County Road system near the project. Changes are being requested from collector to arterial status to address changing regional traffic patterns. Issue addressed in Item 21.

- Anoka County has identified traffic issues along Highway 10 that need to be addressed in any highway modifications. Issue addressed in Item 21.

- Transit planning coordination needs to occur among the site developers, the City the County and Mn/DOT. Issue addressed in Item 21.

- Access spacing on Industry Avenue must be negotiated with the County and the AUAR should recognize the changing character of Industry Avenue when it becomes a feeder road for the new River crossing. Issue addressed in Item 21.

- Impacts on air quality related to new traffic levels should be assessed. Issue addressed in Item 22.

- Mn/DOT plans for the Northwest River Crossing will start to take shape with the publication of a scoping study in May 2003. RTC will likely be impacted by the location of the crossing and its relationship to Highway 10 at Armstrong. Meanwhile, short-term improvements will be underway on Ramsey and Sunfish intersections. Issue addressed in Item 21.

- Longer-term improvements for Highway 10 have been studied but not yet added to the Mn/DOT list of projects (STIP). Mn/DOT's area manager for Highway 10 should be included in discussions about the sliver of land between the railroad tracks and Highway 10. Issue addressed in Item 21, and Mn/DOT brought into discussions on land in question.

- The status of the park and ride location, and the grant from Mn/DOT is not yet resolved (late February 2003), but funding could face some difficulty because of the state budget crisis. Details on location are needed by the City to keep the grant process alive. Issue addressed as part of the site design process and should be resolved by the time of AUAR document issuance.

*Drinking Water Protection*

- The project site is within the City's Drinking Water Supply Management Area (DWSMA) under the MDH Wellhead Protection (WHP) Program, and needs to be protected as such. The area has been identified as ―vulnerable” in the WHP plan preparation process because of tritium levels in the bedrock aquifer. Maintaining clean water infiltration is essential. Issue addressed in Items 13,17 and 19.

- The clean-up of all possible contamination on the site must be assured, including the BNSF railroad and the derelict farm. Issue addressed in Items 19 and 20.

- Coordination between infiltration practices and wellhead/groundwater protection is essential and should be a key design factor; that is, pre-filter pollutants prior to infiltration through such means as use of native vegetation swales and small-scale detention near parking lots, minimized pavement, or possible clay sealing of ponds that drain pollutant sources that could degrade groundwater (if any such sources are even allowed in the RTC). Issue addressed in Items 17 and 19.

- An assessment of the potential for the increased demand from the municipal system to impact local wells should be done. Issue addressed in Items 13 and 19.

*Planning*

- The site should be consistent with the local comprehensive plan, including the Critical Area component, and also consistent with MNRRA and ―Wild and Scenic River" status of the River across Highway 10. Issue addressed in Items 8, 11, 14 and 27.

*Natural Resources*

- The existing wetlands should be incorporated into the surface water system as an amenity that adds to the environmental benefits of the site. Any alteration of wetlands must be mitigated according to the WCA process. Issue addressed in Items 11, 12 and 17.

- The few mature trees there are on the site should be preserved. Issue addressed in Item 11.

- The project should relate the natural features of the site to the Regional Park, featuring native vegetation types typical of the Anoka Sandplain. Issue addressed in Item 11.

*Hazardous Material Transport*

- There are many trains per day on the BNSF tracks. Some surely contain hazardous material that could pose a risk if spilled. Issue addressed in Item 20.

## 32. Certification by the RGU

In an AUAR document, no certification by the RGU is required. However, the RGU is legally responsible for the accuracy and completeness of the document, for properly conducting the process associated with it, and for implementing the mitigation elements contained within the plan.

## 33. Mitigation Plan

> *The final AUAR document must include an explicit mitigation plan. At the RGU's option, a draft plan may be included in the draft AUAR document; of course, whether or not there is a separate item for a draft mitigation plan, proposed mitigation must be addressed through the document.*
>
> *It must be understood that the mitigation plan in the final document takes on the nature of a commitment by the RGU to prevent potentially significant impacts from occurring from specific projects. It is more than just a list of ways to reduce impacts- it must include information about how the mitigation will be applied and assurance that it will. Otherwise the AUAR may not be adequate and/or specific projects may lose their exemption from the individual review. The RGU's final action on the AUAR must specifically adopt the mitigation plan; therefore, the plan has a political as well as a technical dimension.*

Mitigation elements have been included with each of the Tasks contained within this AUAR. The various elements have been combined to present a single reviewable element in Appendix D.

The City of Ramsey, in adopting this AUAR document, commits itself to implementing the mitigation elements contained throughout the document. To accomplish this, the City will work with its own programs, as well as those of the State, the County, the developer(s) and any builders they use, and citizens of the City.

## 34. Response to Comments on the Draft AUAR Document

*The final AUAR document must include a section specifically responding to each timely and substantive comment on the draft that indicates the way in which the comment has been addressed. Similar comments may be combined for the purposes of responding.*

Comments will be addressed as they are received after City release of the AUAR draft document for public review.

# RAMSEY TOWN CENTER TRAFFIC ANALYSIS

## Ramsey, MN

**Prepared for**

**Ramsey Town Center, LLC**

**Prepared by**

Meyer, Mohaddes Associates, Inc.
An Iteris Company

**March 24, 2003**

17-J02-0073

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# INTRODUCTION

This report presents the results of a traffic impact analysis of the proposed Ramsey Town Center in Ramsey, MN, which has been conducted in support of an Alternative Urban Areawide Review (AUAR) process for the development site. The proposed development has a varied mix of residential, retail, entertainment, institutional, office and civic uses. Currently, the site is vacant and is being used for agriculture. The site is adjacent to the BNSF Railroad tracks north of Trunk Highway (TH) 10/169 near Ramsey Boulevard. The proposed development site straddles Industry Avenue to the north and is bordered by Ramsey Boulevard to the east, TH 10 to the south, and Armstrong Boulevard to the west.

## Scope

A detailed traffic study was conducted for the proposed development, as per the Environmental Quality Board (EQB) requirements for an AUAR. After discussions with the City of Ramsey (the Responsible Government Unit for the AUAR), the influence area for this traffic study was defined to include the following roadways:

- Industry Avenue, County Road (CR) 116, is the northern boundary for the analysis
- TH 10 is the southern boundary of the analysis area
- Sunfish Lake Boulevard, County State Aid Highway (CSAH) 57, is the eastern boundary
- Armstrong Boulevard (CSAH 83) is the western boundary of the analysis area.

Intersections within this study area were then identified for traffic analysis purposes. The intersections were chosen after careful review and understanding of the proposed development magnitude, and its potential to influence traffic conditions at various nearby intersections. Figure 1 shows the intersections that were analyzed for traffic impacts.

## Approach

EQB requirements dictate that the traffic study conducted for an AUAR include an analysis of the proposed maximum development scenario. The proposed Ramsey Town Center has a development plan with a mix of residential, retail, civic, recreational, office and employment land uses. Appendix A contains a table of uses by block and a land use diagram for the site. This development plan was analyzed as the maximum development scenario.

The traffic study analyzed three scenarios for two peak hour conditions. Analyzed scenarios include the existing, future base, and future with proposed project. These three scenarios were analyzed for the AM and PM peak hours of a typical weekday. The future base scenario is an analysis of the year when full build out of the development is estimated to occur, which was assumed to be the year 2007.

A factor for regional growth was included in the future base scenario. Regional growth is the growth that will occur in the study area, irrespective of the proposed development. The future base scenario also included other approved development projects near the study area that are expected to occur within the same timeframe as the project. This future base scenario was used as a base to delineate the impacts of the proposed development.

The future with proposed project scenario includes the new trips generated by the proposed development. New trips generated by the proposed development were calculated using standard practices, assigned to study area intersections on the basis of the directional approach of trips in the study area, and analyzed for impacts. Mitigation of potential impacts was developed for the future with project conditions.

# EXISTING CONDITIONS

An inventory of the existing conditions in the study area was conducted. Data collection for the traffic study included turning movement volumes at all the study intersections in the year 2002, existing lane geometry at the study intersections, type of intersection traffic control, existing daily volumes on various streets and highways in the study area, and transit facilities in the study area.

## Land Use

Currently the proposed development site is undeveloped land that has been in use for agricultural production. No existing trip generation is associated with the site.

## Street System

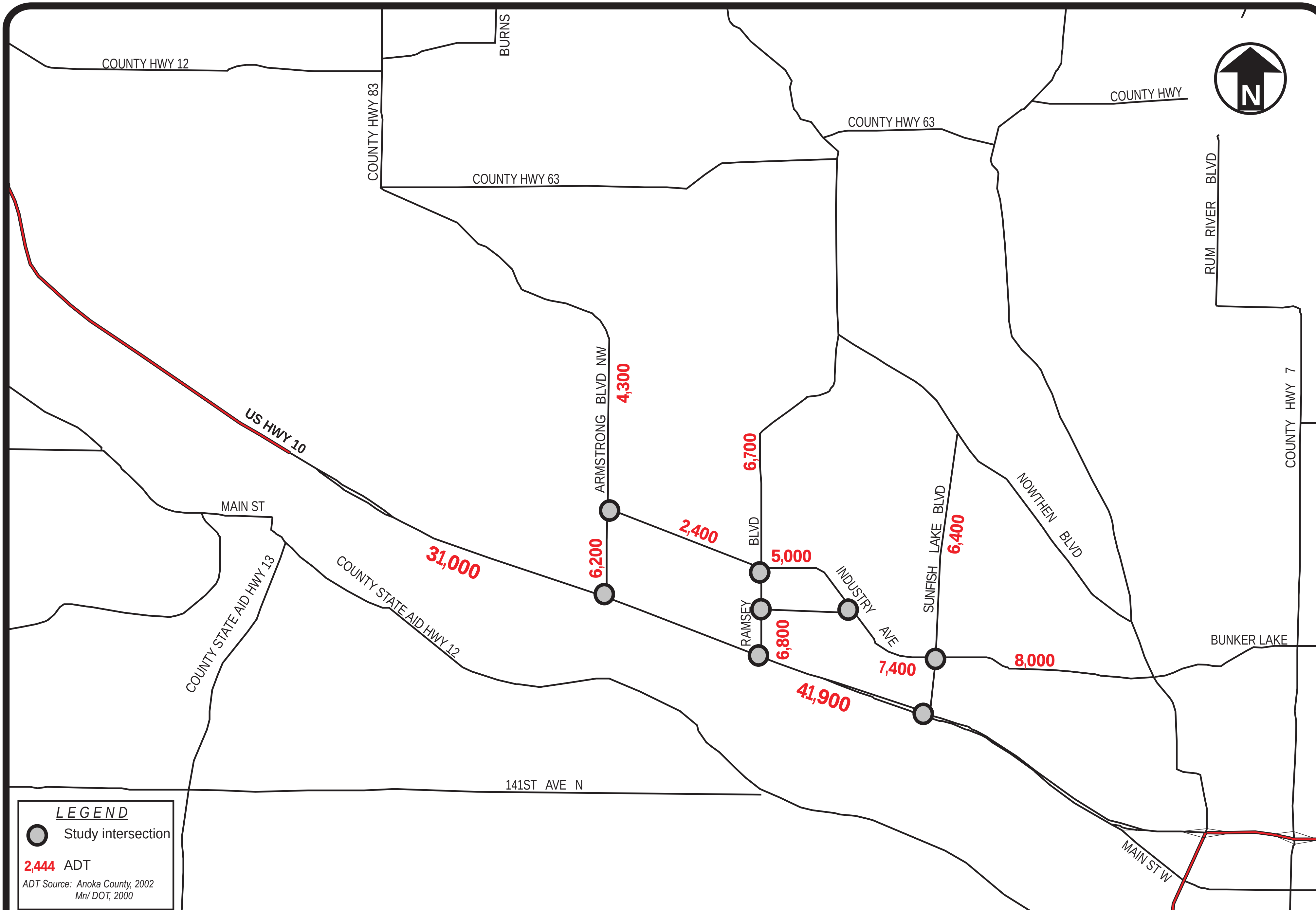
The existing street network and average daily traffic currently on that network is shown in Figure 1. Highway 10/169 near the study area is a US Highway that is classified as a Principal Arterial. Ramsey Boulevard (CR 56) and Industry Avenue (CR 116) near the study site are County Roads that are classified as B-Minor Arterials. Armstrong Boulevard (CSAH 83) and Sunfish Lake Boulevard (CSAH 57) near the study area are County State Aid Highways that are functionally classified as Collectors. Sunwood Drive, a local street that extends in an east-west direction and connects Ramsey Boulevard to Industry Avenue and Sunfish Lake Boulevard, is identified in the City of Ramsey *2001Comprehensive Plan* as a future Collector. Anoka County is in the process of requesting a functional class change for Industry Avenue and Armstrong Boulevard to upgrade their designations to A-Minor Arterial.

Highway 10 at the intersection of Armstrong Boulevard has a four-lane approach in both the eastbound and westbound directions. Two through lanes with an exclusive right turn and left turn lanes exist on TH 10 at this intersection. Armstrong Boulevard at this intersection has two lanes on both the northbound and southbound approaches that consist of an exclusive left turn lane and a shared through and right turn lane.

The intersection of TH 10 and Ramsey Boulevard is a T-intersection with three approach legs as shown. Two through lanes and an exclusive left turn lane exist on the Highway 10 eastbound approach at this intersection. The westbound approach on TH 10 at this intersection has two through lanes, an exclusive left turn, and a right turn lane. Due to the absence of a south leg at this intersection, the westbound exclusive left turn lane on Highway 10 serves only U-turning traffic. The city has approved the construction of the south leg at this intersection by a private developer. However, after discussions with the Anoka County staff, the proposal to construct this leg is on hold due as a result of budget considerations and other factors. Southbound Ramsey Boulevard has an exclusive right turn lane and a left turn lane.

Highway 10 at Sunfish Lake Boulevard is a four-legged intersection with two through lanes and exclusive right turn and left turn lanes on TH 10 in both directions. Sunfish Lake Boulevard at this intersection has two lanes (one shared through and left lane, and an exclusive right turn lane) in both directions. Improvements at this intersection have been identified by Mn/DOT and Anoka County, but have been deferred pending acquisition of funding.

Currently, Industry Avenue near the study site is an east-west street that terminates at Armstrong Boulevard. The intersections of Industry Avenue with Ramsey Boulevard and with Sunfish Lake Boulevard are currently operating as all-way stop controlled (AWSC) intersections. The tee intersection of Industry with Armstrong is a stop-controlled intersection only on the Industry Avenue approach. Traffic on Armstrong Boulevard at this intersection is not controlled.

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Ramsey Town Center AUAR

# Study Intersections

FIGURE 1

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Sunwood Boulevard is currently a two-lane local street that terminates in a tee intersection with Ramsey Boulevard and has four-leg intersections with Industry Avenue and Sunfish Lake Boulevard. All three intersections are under minor approach stop control with stop signs on the Sunwood Drive approaches.

**Volumes**

Volumes at all but two of the study area intersections were counted during December 2002 for both AM and PM peak hours. Volumes at the intersections of TH 10 with Ramsey Boulevard and with Armstrong Boulevard were obtained from Mn/DOT and were counted during mid 2002. Figures 2 and 3 show the existing AM peak hour and PM peak hour volumes respectively at all the study intersections. The volumes shown in these figures were extracted for the single peak hour (AM or PM) from two-hour count data. Operational analysis was performed using these volumes to ascertain the existing operating conditions at the study intersections.

Average daily traffic volumes on streets and highways in the study area vary widely with TH 10 carrying about 42,000 vehicles per day (vpd) east of Ramsey Boulevard and 31,000 west of Armstrong Boulevard. By contrast, volumes on the other roadways in the study area range from about 5,000 to 8,000 vpd, with the exception of Industry Avenue between Ramsey and Armstrong Boulevards, which carries about 2,400 vpd.

**Planned and Programmed Roadway Improvements**

No roadway projects are currently programmed for the study area, but several regional studies are in process or recently completed that affect the study area.

As noted above, improvements to the intersection of Sunfish Lake Boulevard and TH 10 to address existing congestion have been deferred because of current state budget considerations, as have improvements to the intersection at TH 10 and Ramsey Boulevard that would add a south approach to that intersection.

The TH 10 IRC Study/Corridor Management Plan[1] is a regional roadway planning analysis for Mn/DOT that evaluated future needs on TH 10 through Anoka County. While the study findings have been adopted, the improvements suggested in the study have not yet been incorporated into the State Transportation Improvement Plan, nor are they yet in the Metro Division *Transportation Systems Plan*. Updates of these planning documents are expected to address the recommendations from the TH 10 study. That study estimates that traffic volumes on TH 10 will grow between 40 and 50 percent by the year 2025 to over 50,000 vpd in the study area. The report notes that to accommodate this level of volume, even if the Northstar Commuter Rail service and a new Mississippi River crossing are implemented will require TH 10 to become a six-lane freeway through Ramsey by 2025 with interchanges at Sunfish Lake and Ramsey Boulevards.

In the interim by 2010, the report suggests that TH 10 in the study area be expanded to a six-lane expressway with improved intersections. In the near terms by 2005, the study suggests that signal timing optimization and improvements to Ramsey, Armstrong, and Sunfish Lake Boulevards are necessary. The report notes that one "concern with constructing a 6-lane expressway as an interim strategy to constructing a freeway is the roadway alignment. As an expressway, it is preferable to have TH 10 as far away as possible from the parallel railroad in order to allow for vehicle stacking at the intersections. As a freeway, it would be preferable to have the roadway alignment as close to the railroad as possible so that interchanges can provide grade separation over both the highway and the railroad. "[2]

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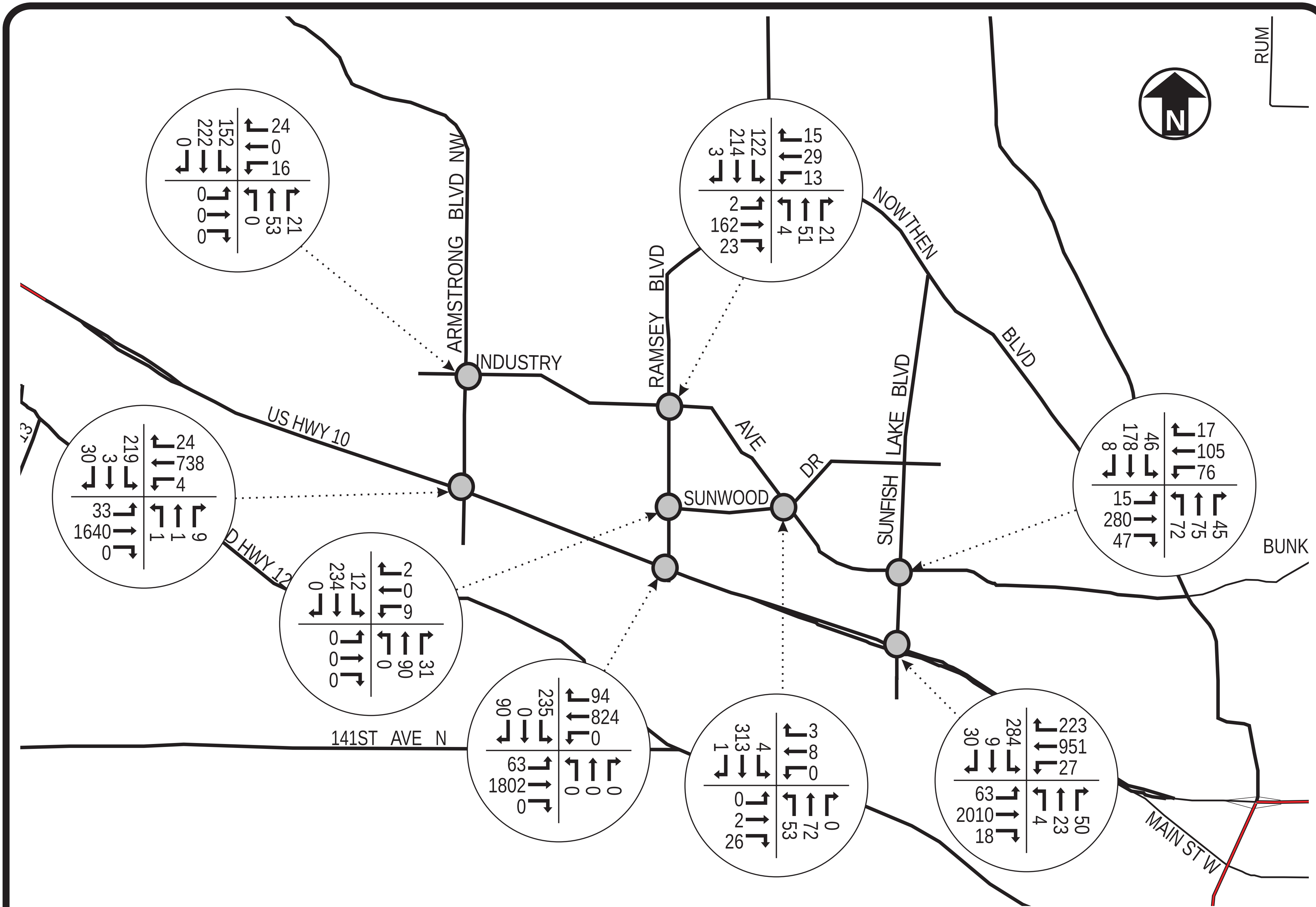
[1] H. R. Green Co., *TH 10 IRC Study Corridor Management Plan*, Mn/DOT, January 2002
[2] *ibid.* Page 6-24.

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# Existing AM Peak Volumes

FIGURE 2

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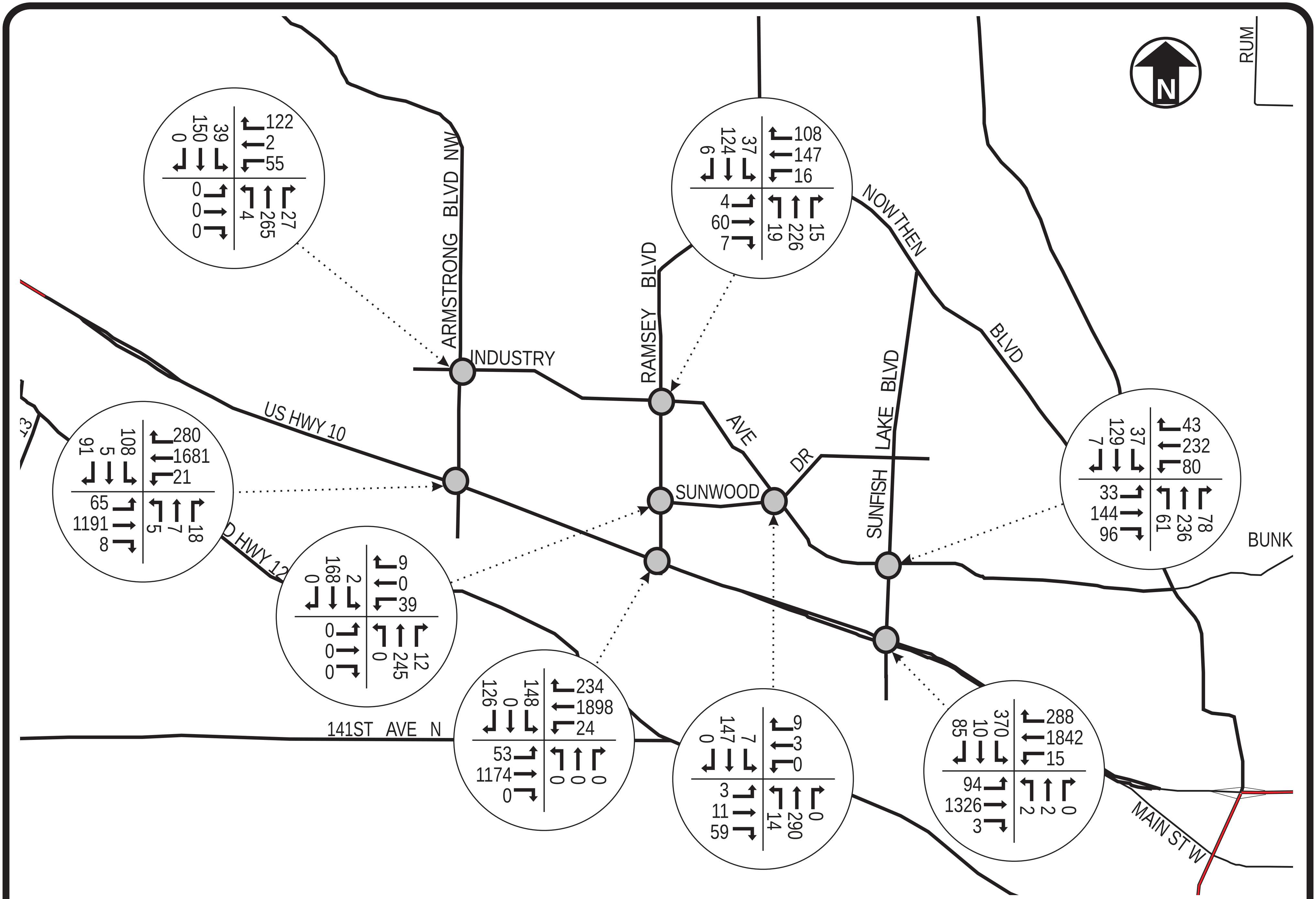


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# Existing PM Peak Volumes

FIGURE 3

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The study also notes that environmental documentation for the proposed improvements has not started and that an EIS will likely be required for the expansion of the roadway.

The draft Scoping Document for the Northwest Metro Corridor and River Crossing Study[3] has been completed by Mn/DOT and the final is expected to be published in May 2003. This document explored a reasonable range of alternatives for a new Mississippi River crossing and for the highway and network elements needed to connect the crossing to the existing regional roadway system. The new crossing would be located west of the TH 169 crossing in Anoka and east of the TH 101 crossing in Elk River. The Scoping Document has established the purpose and need for the study and the Draft Scoping Decision has identified a corridor for the crossing.

It is anticipated that the northern terminus of the crossing will likely be west of Armstrong Boulevard and will likely connect to an extension of Industry Avenue. The next step for the crossing would be to start preparation of an EIS, but this work has not been initiated because of the current state budget status and issues with the City of Dayton about alignments south of the river. It is unlikely that interchanges with TH 10 would be allowed at both Armstrong and the river crossing, but might be possible and would depend on the distance separating the interchanges and the function of each in the roadway system. Detailed planning for the section of TH 10 adjacent to the project site would be part of an EIS for the river crossing, if/when it is initiated.

Traffic volumes on Armstrong Boulevard and Industry Avenue would be directly affected by the proposed river crossing if the new roadway terminates in an extension of Industry Avenue. The portion of Armstrong Boulevard south of Industry Avenue, currently a direct connection to and across TH 10 would become a local-serving street, while north of Industry Avenue, its regional role serving traffic north and west would be expanded since it would directly connect to the new river crossing. Similarly Industry Avenue would be expected to see an increase in regional traffic. Anoka County's proposal to change the functional class on these roadways to Principal Arterial is in anticipation of this increased regional role.

## Transit

The project site is located west of the portion of Anoka County served by fixed route transit service and is currently served only by Anoka County Traveler demand responsive service. The North Star commuter coach operated by Mn/DOT, which currently provides peak period, peak direction, express service between Elk River, Coon Rapids and Minneapolis, is expected to serve a park and ride at the project site in the future. The Northstar service is a demonstration project that is operating motor coaches along the proposed route for the Northstar commuter rail service and is currently carrying between 500 and 600 passenger trips per day[4].

A Final Environmental Impact Statement[5] has been completed for the Northstar Corridor. The preferred alternative for the corridor is a commuter rail service that would operate on the freight railroad tracks that are adjacent to the site. In the FEIS, the Ramsey station location was dropped in favor of the Anoka station location for the preferred alternative. However, the Ramsey station location is listed in the EIS as a candidate for expansion once service has commenced. Accordingly, this traffic analysis assumes that a rail station is active on the site in the future and that 450 riders per day would use the Ramsey stop[6].

---

[3] *Northwest Metro Corridor and River Crossing Study*, Mn/DOT, Draft, April 2002
[4] *Rider Report, Northstar Commuter Coach*, Mn/DOT, October 2002
[5] BRW, Inc., *Northstar Corridor FEIS*, Mn/DOT, March 2002
[6] Ridership estimate is from the supplemental analysis commissioned by the City of Ramsey and presented to the Northstar Corridor Development Authority in support of a Ramsey station (HKGI/SRF, April 4, 2000).

# FUTURE CONDITIONS ANALYSES

Two sets of future conditions, Future Base and Future with Project, were analyzed. The Future Base represents growth in traffic from non-project sources at the year of project buildout, which was assumed to be the year 2007.

## Regional Growth and Approved Projects

A growth factor was used to account for the regional growth in traffic in the area irrespective of the proposed development. This growth factor was calculated to be two percent per year on the basis of forecasts for 2025 from the Metropolitan Council. This level of growth is consistent with the volume projections in the TH 10 IRC Study.[7]

The Future Base also includes the effects of other approved development projects in the vicinity of the project site that anticipate being constructed and occupied within the 2007 time line. The following two projects were identified as having a qualifying development time line:

- The Rivenwick 3rd Subdivision residential development, which is located south of TH 10 at Ramsey Boulevard, would have 112 townhouses and would add a fourth leg to the intersection of Ramsey Boulevard and TH 10.
- The Bright Keys residential development, located across Industry Boulevard from the project site near Ramsey Boulevard, would have 284 townhouse units.

Traffic for the Rivenwick 3rd Subdivision, as reported in that project's traffic study[8], was added into the Future Base. Traffic for the Bright Keys development was generated using standard trip generation rates and assigned to the study area street system using the data developed for the project traffic forecasts (see below). Figures 4 and 5 show the AM and PM peak hour turning movements for the Future Base conditions.

## Project Traffic Forecast

The proposed development has varied land uses that include residential, retail, civic, recreational, institutional, and office uses. The traffic forecasting process involves estimating the new trips generated by the development and assigning these trips to various study intersections depending on the directional distribution of the trips.

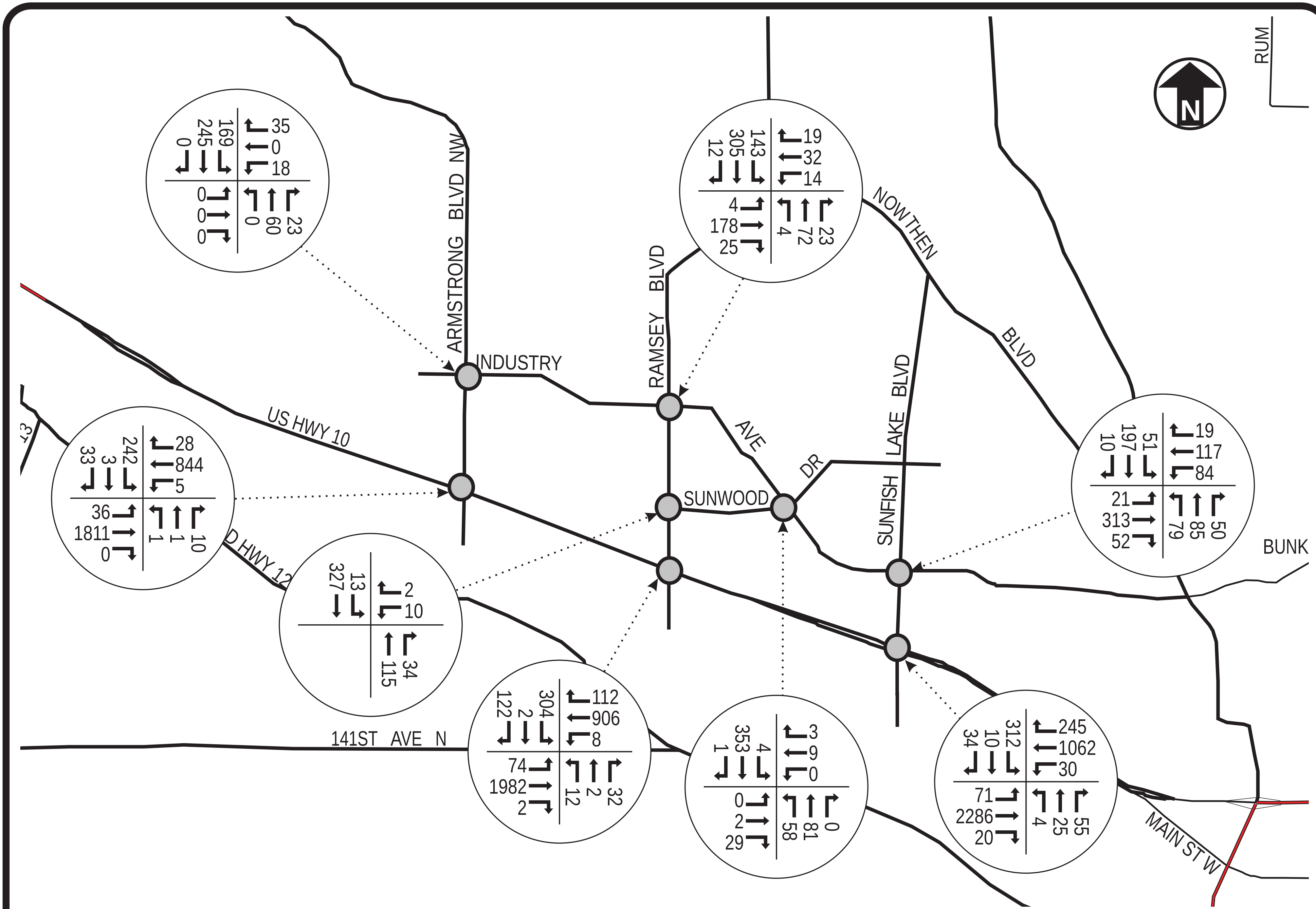
### **Trip Generation**

Trip generation for the proposed development was estimated using the rates from the 6th edition of the Institute of Transportation Engineers' (ITE) *Trip Generation Manual*. This is considered a standard reference. Table 1 shows the trip generation for the proposed redevelopment scenario estimated using the ITE rates for both the AM and PM peak hours.

**Table 1: Project Trip Generation**

| | Daily | AM PEAK HOUR | | | PM PEAK HOUR | | |
|---|---|---|---|---|---|---|---|
| | | Total | In | Out | Total | In | Out |
| Total New Trips | 51,200 | 2,920 | 1,700 | 1,220 | 5,210 | 2,480 | 2,730 |

[7] Table 3.4-5 of the TH 10 study reports growth rates of 1.66 and 1.96 percent per year for TH 10 with and without the Northstar Commuter Rail respectively.
[8] SRF, Inc., Traffic *Study for Rivenwick 3rd Subdivision Residential Development in the City of Ramsey*, October 2002.

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# AM Future Base Volumes

FIGURE 4

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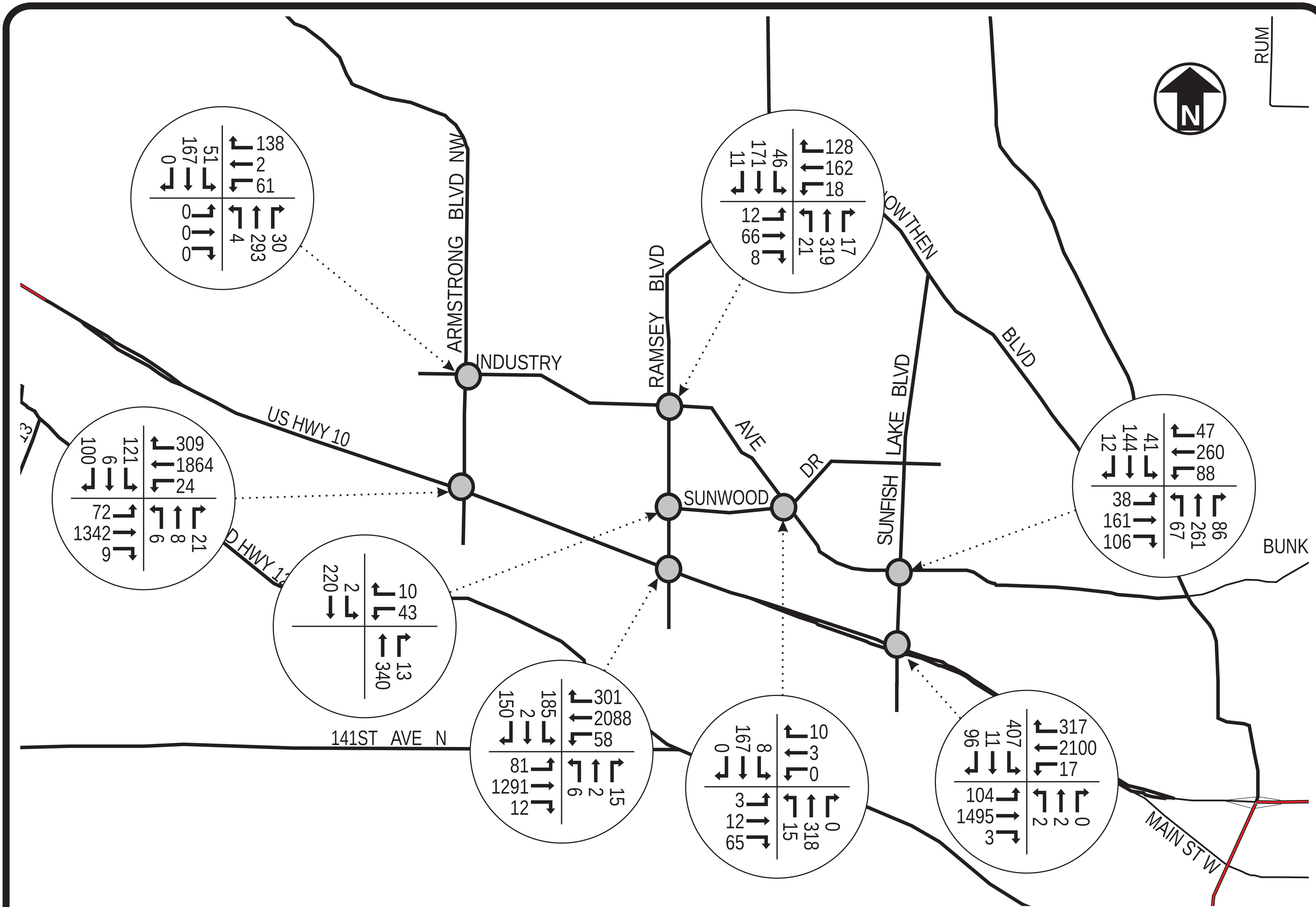


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## PM Future Base Volumes

FIGURE 5

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Some trips generated by a mixed-use development of the project type will move between uses within the development site and not reach intersections external to the site and should be excluded from traffic. assignment at those locations. This internal trip making is attributed to the interaction between various land uses in a development. Additionally, some trips will take alternate forms of transport, which can be bicycling, walking, and use of transit. The presence of sidewalks, street network density and proximity to transit facilities affect the amount of trip making by non-auto modes. Because of the limited nature of transit service to the site, no reductions have been made for alternate mode use.

Rather, a single factor was used to calculate the percentage of trips that would remain internal to the proposed redevelopment. This factor considers the diversity of uses within the project and their potential to create linked trips among the project land uses. This factor is based on ITE data for mixed-use developments and is a function of the size and mix of land uses. For the proposed project, the diversity factor indicates that approximately nine percent of AM peak trips and about 16 percent of PM peak trips would be internal.

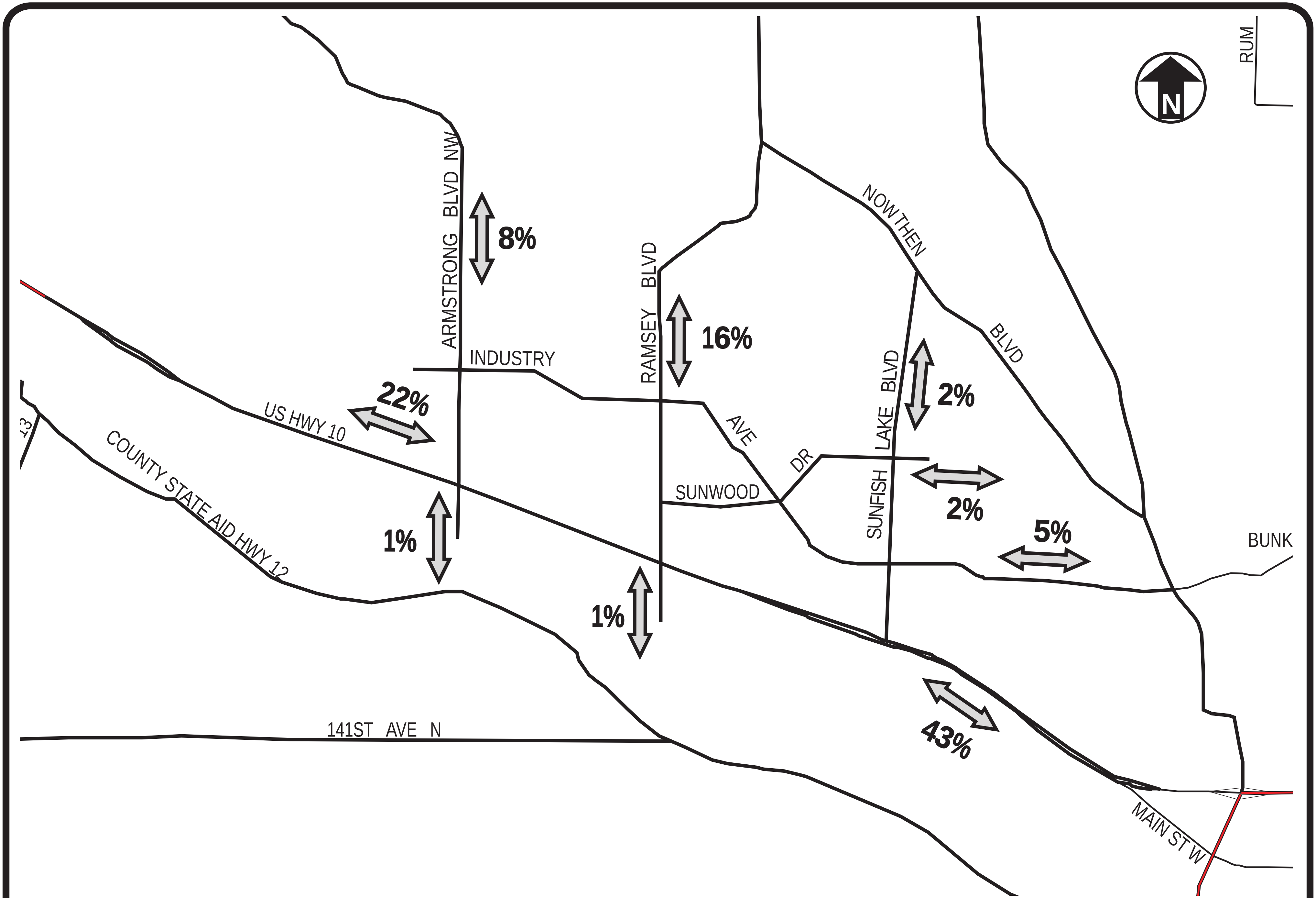
No adjustments for pass-by or diverted traffic[9] within the site were made, although some of the uses would warrant incorporation of such reductions. Accordingly, the amount of linked trips is conservatively low in relation to the scale and mix of land uses. Trip generation and linked trip calculations are shown in the Appendix. Northstar riders who would park and ride from the site were included in the analysis, but were added directly to the intersection traffic assignment and are not shown in the trip generation numbers in Table 1.

**Trip Distribution/Traffic Assignment**

Trip distribution refers to the distribution of new trips entering and exiting the site from various directions. The direction of approach percentages for the site-generated trips were estimated using forecast data for zones in the project area from the Metropolitan Council's regional travel demand forecasting model. Figure 6 shows the estimated percentage of future direction of approach trip distribution from the proposed site. The regional forecasts used for this analysis did not include the new river crossing. Accordingly, traffic distribution is highly biased with about 43 percent of the trips being made to and from the south and east along TH 10 (this also includes traffic destined south on TH 169). It should be noted that with the new Mississippi River crossing, approximately one-third to one-half of the project trips on TH 10 to the south and east would redistribute to the new crossing.[10] Assignment of the project trips to turning movements at various intersections was conducted using a TRAFFIX model of the study area. The model used the directional distribution percentages shown in Figure 6 and provided a detailed assignment of trips to streets inside the project site as well as to the external network.

The Future with Project conditions were developed by adding the project trip generation to the Future Base volumes and adding 150 peak hour Northstar rider trips to the resulting assignments. Since the existing site is largely vacant and not generating any traffic, no adjustments were made to subtract existing trips from the project site. Figures 7 and 8 show the AM and PM peak hour turning movements for the Future with Project conditions.

[9] Pass-by and diverted trips are opportunity trips that are already on the street system and divert to a new land use. As such, these trips are included in the counted traffic volumes (other than at site access points) and are double-counted in the trip generation rates for some retail uses.
[10] See *Ramsey Smart Growth Twin Cities Opportunity Site* (Calthorpe Associates, 2003)

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## Trip Distribution

FIGURE 6

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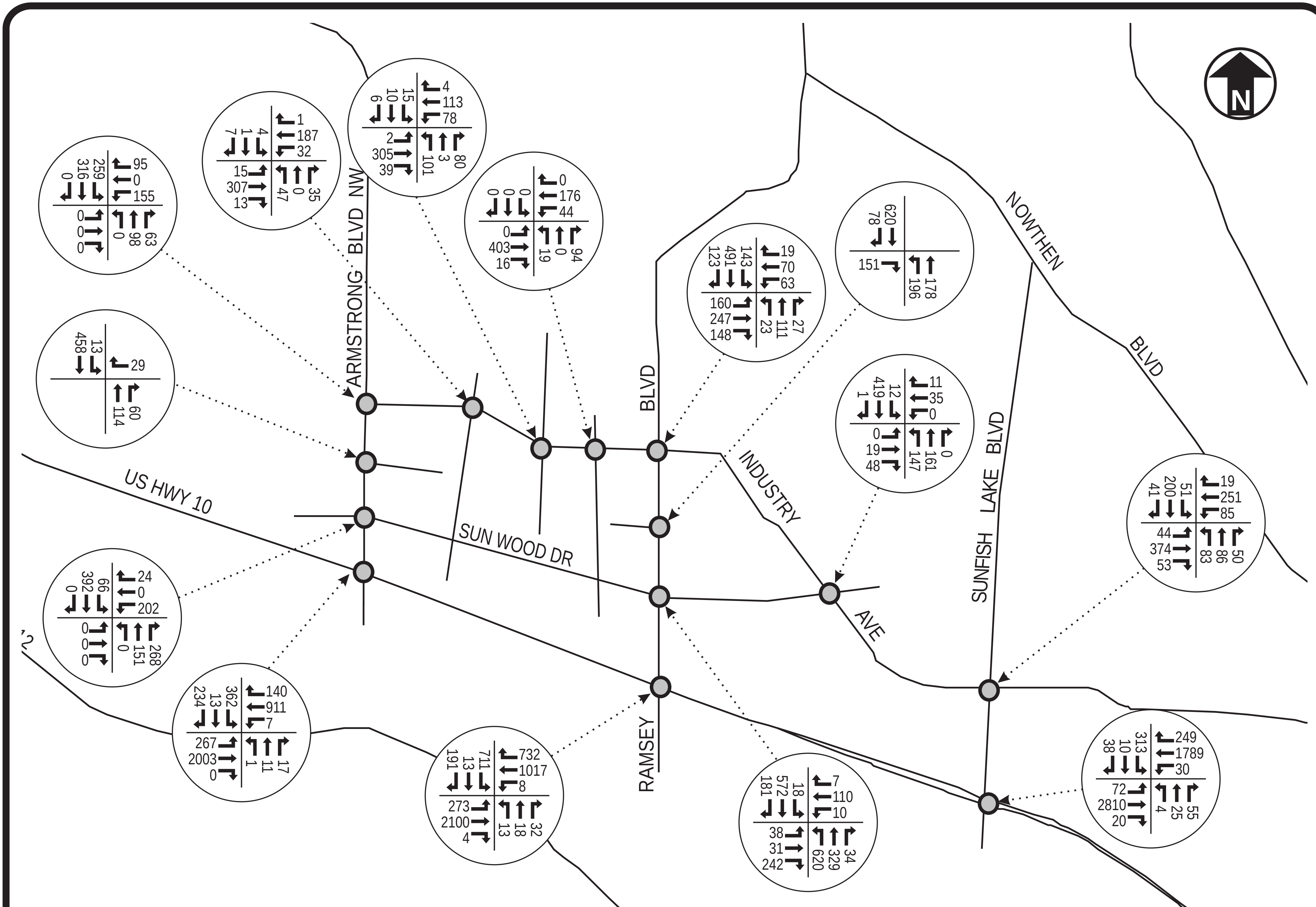


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# AM Future with Project Volumes

FIGURE 7

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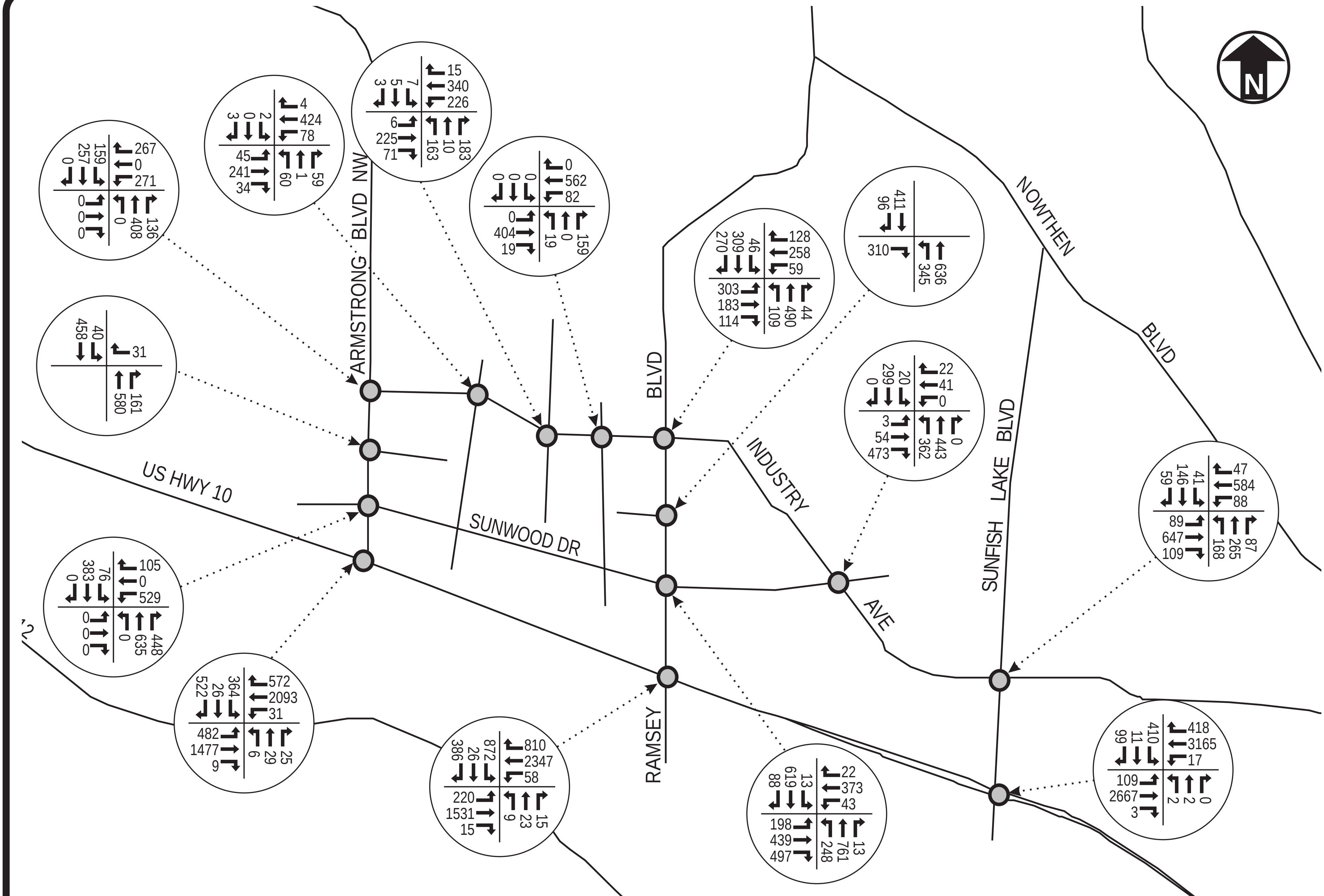


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# PM Future with Project Volumes

FIGURE 8

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## Traffic Impacts

Traffic impacts from the proposed project were determined by analyzing intersection operations for the future conditions. The intersection analyses were conducted for all the study area intersections using *Highway Capacity Manual*[11] procedures that report a Level of Service at each intersection. The Level of Service is a measure of average operating conditions at intersections and ranges from A through F, with each level defined by a range of control delay per vehicle. Signalized intersections and all-way stop control are analyzed for total intersection delay, while two-way stop control is analyzed only for minor approach delay. Table 2 summarizes the Level of Service Criteria. Conditions A, B, and C are considered excellent to good operating conditions with control delay per vehicle ranging up to 35 seconds for LOS C. Level of Service D is a generally acceptable standard for planning and design of urban transportation facilities. At Level of Service E, poor intersection operations occur as traffic volumes approach capacity and LOS F (Control Delay > 80 sec/veh) represents extremely congested conditions.

**Table 2: LOS Criteria**

| | Signalized Intersections | AWSC & TWSC Intersections |
|---|---|---|
| LOS | Control Delay (sec/veh) | Control Delay (sec/veh) |
| A | <= 10 | 0-10 |
| B | > 10- 20 | > 10- 15 |
| C | > 20- 35 | > 15- 25 |
| D | > 35- 55 | > 25- 35 |
| E | > 55- 80 | > 35- 50 |
| F | > 80 | > 50 |

Source: Highway Capacity Manual 2000

For intersections operating under two-way stop control (TWSC), LOS is defined for each minor movement rather than for the intersection as a whole. Intersections operating as All-way Stop Controlled (AWSC) use the same thresholds for defining LOS. The LOS criteria for TWSC and AWSC Intersections are also shown in Table 2. Table 3 shows the results of the capacity analyses at the study area intersections for Existing conditions and for both Future scenarios. The Appendix of this report contains the capacity analysis worksheets.

## Existing Conditions

Under existing conditions, the intersection of TH 10 and Sunfish Lake Boulevard is operating in substandard conditions (worse than LOS D) in the PM peak hour. The other intersections are operating in good conditions in both peak hours. However, the analysis of conditions at TH 10 and Ramsey and Armstrong Boulevards indicates that conditions are unstable, particularly in the PM peak hour when the Ramsey and Armstrong approaches are at LOS F and E respectively. Left turns from TH 10 are also at LOS F and E respectively at these intersections. Under these conditions, moderate increases in volumes on either Ramsey or Armstrong Boulevard or left turning from TH 10 would cause conditions to deteriorate similar to what is currently experienced at Sunfish Lake Boulevard and the intersections could quickly move into LOS E and F.

[11] Highway Capacity Manual, Special Report 209, Transportation Research Board, Washington D.C.

### Future Base Conditions

The Future Base conditions show that addition of the background growth in traffic will cause the intersection of TH 10 and Sunfish Lake Boulevard to deteriorate to LOS D during the AM peak period. The other intersections in the study area remain in acceptable conditions. Unstable conditions continue to be present at the intersections of TH 10 and Ramsey and Armstrong Boulevards.

**Table 3: Level of Service Comparison**

| Intersection | Traffic Control at Intersection | Existing[a] | | Future Base[a] | | Future w Project[a] | | Mitigated[a,b] | |
|---|---|---|---|---|---|---|---|---|---|
| | | AM Peak | PM Peak | AM Peak | PM Peak | AM Peak | PM Peak | AM Peak | PM Peak |
| Armstrong Blvd at TH 10 | Signalized | B | A | B | B | F | F | C | C |
| Ramsey Blvd at TH 10 | Signalized | B | A | C | B | F | F | C | D |
| Sunfish Lake Blvd at TH 10 | Signalized | C | F | D | F | F | F | C | E |
| Armstrong Blvd at Industry Ave | One way Stop | (B) | (B) | (B) | (B) | (C) | (E) | A[c] | A[c] |
| Ramsey Blvd at Industry Ave | All-way Stop | B | B | C | B | F | F | C[c] | C[c] |
| Industry Ave at Sunfish Lake Blvd | All-way Stop | B | C | C | C | D | F | A[c] | B[c] |
| Ramsey Blvd at Sunwood Drive | One way Stop | (B) | (B) | (B) | (B) | (F) | (F) | C[c] | C[c] |
| Sunwood Drive at Industry Ave | One way Stop | (B) | (B) | (B) | (B) | (C) | (F) | B[c] | B[c] |
| Sunwood Drive at Armstrong Blvd | One way Stop | | | | | (F) | (F) | A[c] | B[c] |
| NS2 Street at Industry Ave | One way Stop | | | | | (B) | (C) | (B) | (C) |
| NS3 Street at Industry Ave | One way Stop | | | | | (C) | (F) | A[c] | A[c] |
| NS5 Street at Industry Ave | One way Stop | | | | | (B) | (C) | (B) | (B) |
| EW1 Parkway at Ramsey Blvd | One way Stop | | | | | (F) | (F) | (B) | (B) |
| EW1 Parkway at Armstrong Blvd | One way Stop | | | | | (B) | (F) | (A) | (B) |

Notes:
(a) Values in parentheses indicate Minor Approach LOS only
(b) Mitigated conditions include lane adjustments and lane additions at intersections as noted in the text.
(c) Intersection is signalized in the mitigated condition

### Future with Project Conditions

The impacts of the proposed project trips were calculated by adding project trips to the Future Base and analyzing the intersections with the existing lane configurations. Project traffic would cause the intersections on TH 10 to deteriorate to LOS F would cause the stop-controlled intersection on Industry Avenue, Ramsey Boulevard, and Armstrong Boulevard to move into LOS E and F conditions during one or both peak periods.

New intersections created by the project with Industry Avenue would operate in acceptable conditions with the exception of the central north-south street (NS3) at Industry Avenue during the PM peak period. The two new intersections of the east-west parkway (EW1) with Ramsey and Armstrong Boulevards would operate in unacceptable conditions during at least one peak period.

## RECOMMENDED IMPROVEMENTS/PROJECT MITIGATION

Analysis of the intersection operations indicates that lane additions and installation of intersection channelization and traffic signals would be adequate to mitigate the project impacts at the intersections in the study area. The following roadway widenings are suggested:

- Ramsey Boulevard—widen to five lane cross section south of Industry Avenue to provide two through lanes in each direction and a left turn lane/center median

- Industry Avenue—widen to five lane cross section west of Ramsey Boulevard to provide two through lanes in each direction and a left turn lane/center median

The existing cross sections on Armstrong Boulevard north of the railroad, Sunwood Drive and Industry Avenue east of Ramsey, and Sunfish Lake Boulevard north of the railroad would be adequate to meet the future demand.
Turn lanes and lane adjustments would be needed at the following intersections:

- TH 10 at Armstrong Boulevard—add an eastbound and a westbound through lane on the intersection approaches; add an eastbound and a southbound left turn lane and a southbound right turn lane.
- TH 10 at Ramsey Boulevard—add an eastbound and a westbound through lane on the intersection approaches; add an eastbound and a southbound left turn lane and a westbound right turn lane. A southbound through lane and a northbound left turn lane and northbound through/right lane would need to be added to serve the Rivenwick 3rd Subdivision traffic independent of the project traffic.
- TH 10 at Sunfish Lake Boulevard—add an eastbound and a westbound through lane on the intersection approaches; convert the southbound approach from a through/left turn lane and a right turn lane to through/right turn lane and two left turn lanes (this adds one lane to the approach).
- Industry Avenue at Ramsey Boulevard—add a southbound right turn lane; eastbound and northbound approaches would be widened by the above recommendations.
- Sunwood Drive at Industry Avenue—modify the shared lanes on the northbound, eastbound and westbound approaches to provide left turn lanes and shared through/right turn lanes

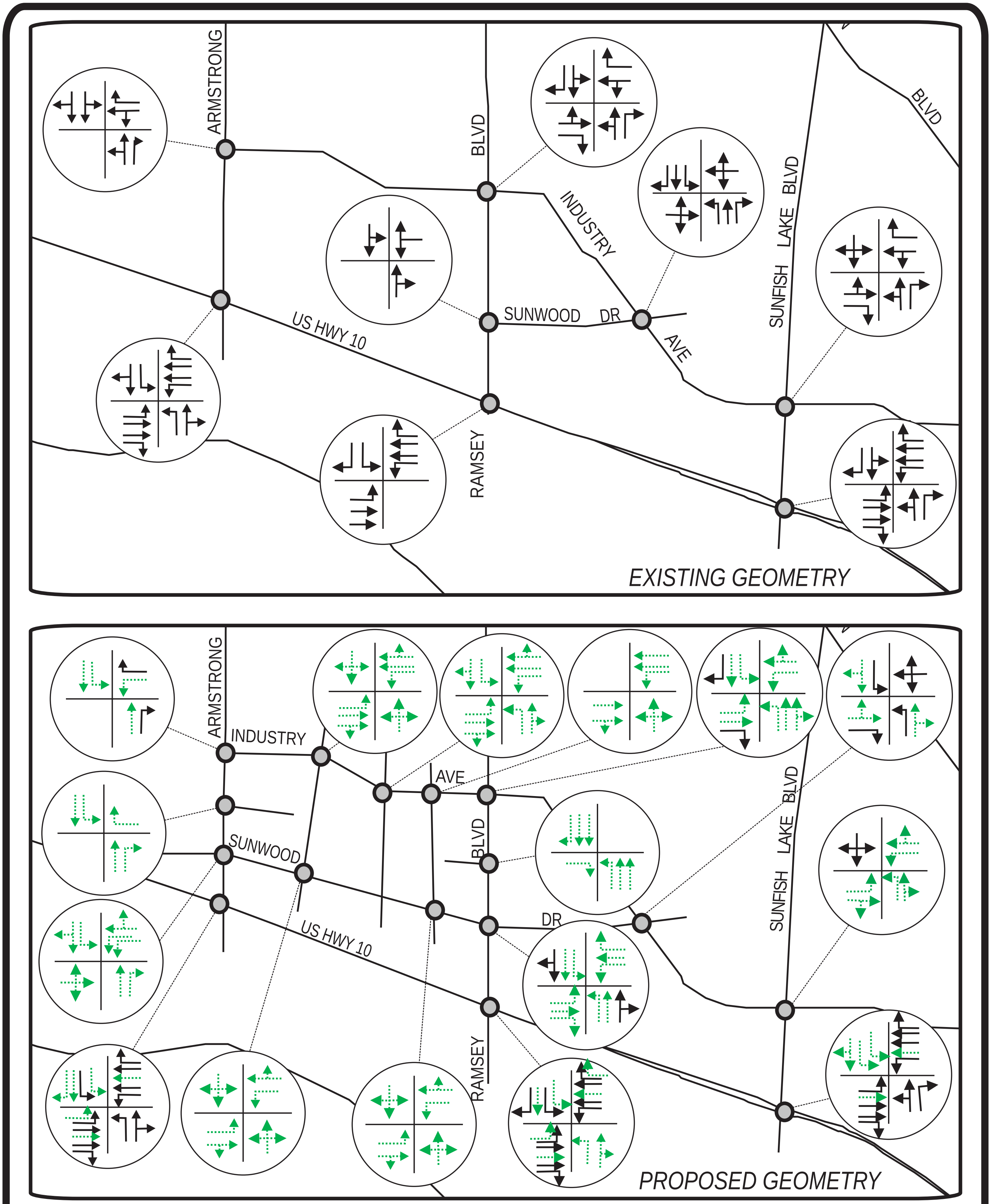
Lane modifications and additions are shown in Figure 9.
The following stop-controlled intersections would need to be signalized:

- Ramsey Boulevard at Industry Avenue
- Armstrong Boulevard at Industry Avenue
- Industry Avenue at Sunfish Lake Boulevard
- Ramsey Boulevard at Sunwood Drive
- Sunwood Drive at Industry Avenue
- Sunwood Drive at Armstrong Boulevard
- NS3 Street at Industry Avenue

The left turn volumes from the EW1 parkway onto both Armstrong and Ramsey Boulevard cannot be accommodated at an acceptable LOS under stop control and require signalization to achieve acceptable operations. However, the close spacing between the intersections of the EW1 parkway and the intersections of Armstrong and Ramsey Boulevard with Industry Avenue limits the potential for the two parkway intersections to be signalized. Accordingly the parkway intersections should be channelized to provide right-in/right-out and left-in access (¾ access). Left out from the parkway would be prohibited and would redistribute to the north-south streets and to Industry Avenue (these volumes have been included in the mitigated calculations for the other intersections).

### Project Streets

The extension of Sunwood Drive would be the primary east-west connector street in the project site and is estimated to carry 10,000 to 13,000 vehicles per day (vpd) west of NS6 Street. Volumes on Sunwood west of Ramsey would be about 18,000 vpd as shown in Figure 10. West of NS6 Street, the volume on Sunwood Drive would be adequately handled by a two-lane cross section (one lane in each direction). However, left-turn lanes would be needed at cross streets. Between NS6 Street and Ramsey Boulevard, four lanes would be needed to accommodate the projected volumes. Two-way or all-way stop control at the intersections of Sunwood Drive internal to the site would provide LOS C or better conditions for the

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Proposed Intersection Improvements

FIGURE 9

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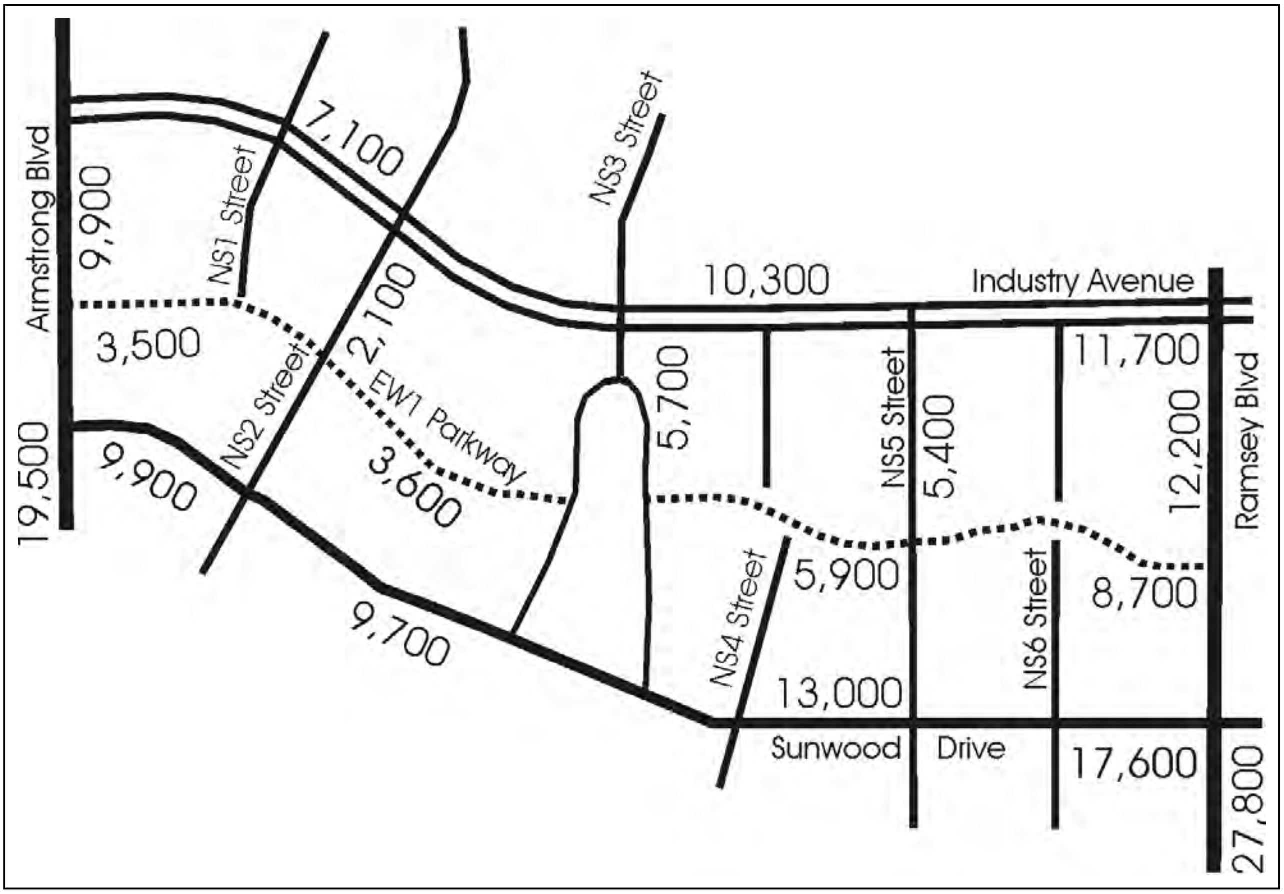



**Figure 10: Estimated Average Daily Traffic**

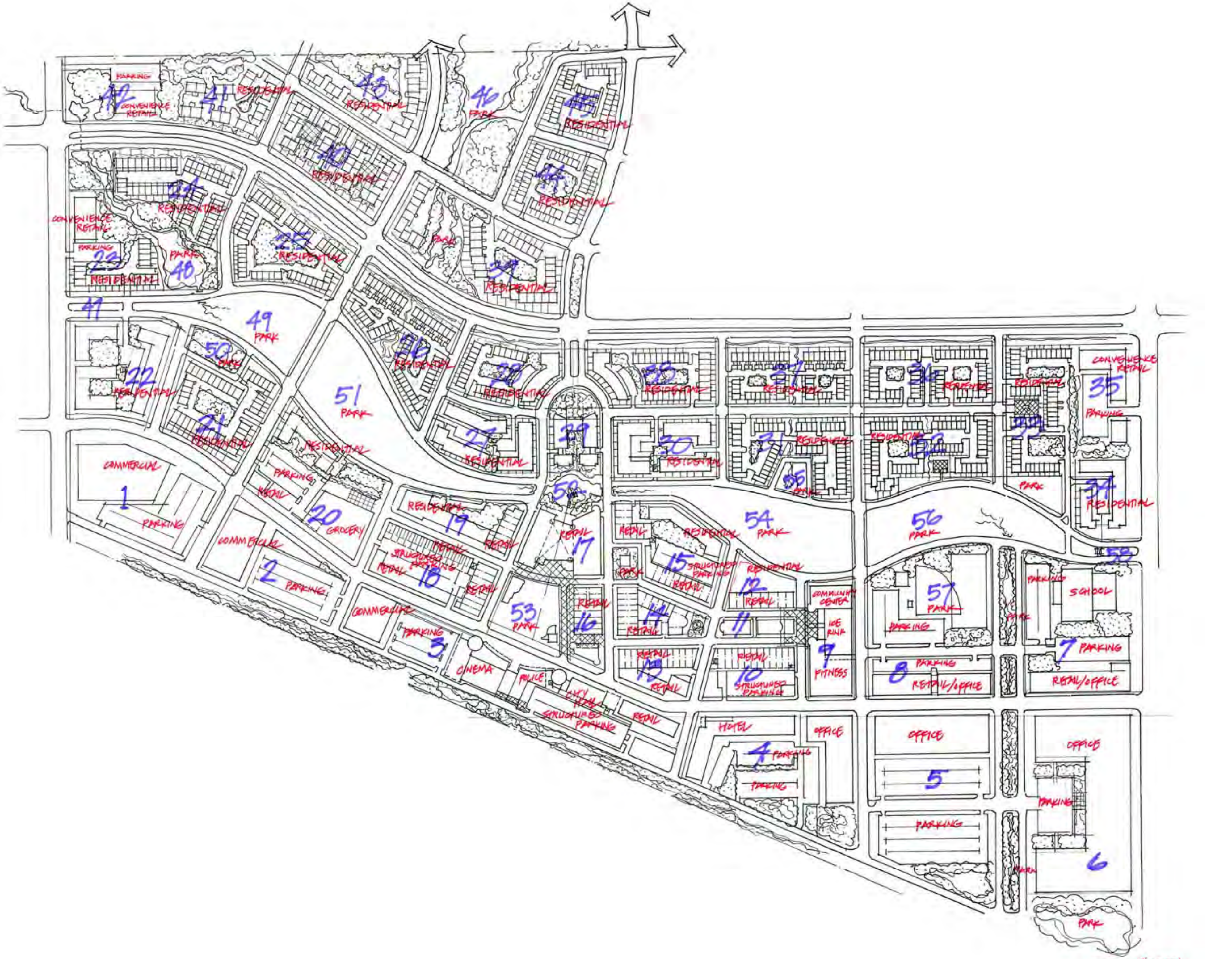
level of traffic projected at those locations, although the intersections with NS6 and/or NS5 Streets may require signalization for acceptable PM peak hour operations.

The EW1 parkway would carry about 3,600 vpd on the western end of the project and between 5,000 and 9,000 vpd on the eastern end. The proposed one-lane parkway cross section would be adequate for the segments of the EW1 parkway.

The other east-west streets internal to the project, because of their discontinuous nature would carry less volume than either Sunwood Drive or the EW1 Parkway and would generally be under 4,000 vehicles per day (and some would be in the under 1,000 range). Two-lane cross sections and stop (or yield control on the lower volume ones) would be appropriate.

The north-south streets internal to the project would carry slightly higher volumes, particularly the three streets that would have full access intersections with Industry Avenue. Those streets would have between 2,100 and 5,700 vehicles per day. The other north-south streets inside the project would be expected to have less than 2,000 vehicles per day, with the exception of the NS6 Street that serves the employment cluster in the southeast corner of the site, which would have upwards of 4,000 vpd. Two-lane cross sections and stop (or yield control on the lower volume ones) would be appropriate although signals may be required at the NS6 and/or NS5 Streets intersections with Sunwood Drive.

# APPENDIX A – TRIP GENERATION



42 PARKING CONVENIENCE RETAIL
41 RESIDENTIAL
43 RESIDENTIAL
46 PARK
45 RESIDENTIAL
40 RESIDENTIAL
44 RESIDENTIAL
24 RESIDENTIAL
CONVENIENCE RETAIL
PARKING
23 RESIDENTIAL
PARK 48
25 RESIDENTIAL
PARK
37 RESIDENTIAL
47
49 PARK
50 PARK
22 RESIDENTIAL
21 RESIDENTIAL
51 PARK
26 RESIDENTIAL
28 RESIDENTIAL
33 RESIDENTIAL
37 RESIDENTIAL
36 RESIDENTIAL
RESIDENTIAL
35 CONVENIENCE RETAIL
PARKING
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29
30 RESIDENTIAL
31 RESIDENTIAL
RESIDENTIAL 32
33
55 PARK
PARK
34 RESIDENTIAL
RESIDENTIAL
COMMERCIAL
1
PARKING
PARKING
RETAIL
20 GROCERY
52
RESIDENTIAL
19
RETAIL
17 RETAIL
RETAIL
RESIDENTIAL
54 PARK
56 PARK
58
COMMERCIAL
2 PARKING
STRUCTURED PARKING
RETAIL 18
RETAIL
RETAIL
PARK
15 STRUCTURED PARKING RETAIL
RESIDENTIAL
12 RETAIL
COMMUNITY CENTER
ICE RINK
57 PARK
PARKING
PARK
PARKING
SCHOOL
COMMERCIAL
PARKING 3
53 PARK
RETAIL 16
14 RETAIL
11
RETAIL 13 RETAIL
RETAIL 10 STRUCTURED PARKING
9 FITNESS
8 PARKING RETAIL/OFFICE
7 PARKING RETAIL/OFFICE
CINEMA
POLICE
CITY HALL
STRUCTURED PARKING
RETAIL
HOTEL
OFFICE
4 PARKING
PARKING
OFFICE
5
PARKING
OFFICE
PARKING
PARK
6
PARK


SCALE: 1" = 200'

**Ramsey Town Center Trip Generation Tables**
(Data: Feb 25)

| Zone/ Block | Land Use | DU | SF | ITE Code | AM Peak | | | PM Peak | | | Daily |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | TOTAL | IN | OUT | TOTAL | IN | OUT | Total |
| 1A | Speciality Retail | | 100,000 | 820 | 103 | 63 | 40 | 374 | 180 | 194 | 4292 |
| 2A | Speciality Retail | | 54,000 | 820 | 56 | 34 | 22 | 202 | 97 | 105 | 2318 |
| 3A | Speciality Retail | | 40,000 | 820 | 41 | 25 | 16 | 150 | 72 | 78 | 1717 |
| 3B | Cinema | | 50,000 | 444 | 0 | 0 | 0 | 190 | 122 | 68 | 1462 |
| 3C | City Hall/ Police/ Transit | | 50,000 | 710 | 78 | 69 | 9 | 75 | 13 | 62 | 551 |
| 3D | Retail/ Bowling Alley | | 28,000 | 494 | 88 | 53 | 35 | 99 | 35 | 64 | 933 |
| 4A | Hotel | 50 | 38,000 | 310 | 17 | 10 | 7 | 20 | 11 | 9 | 79 |
| 4B | Office | | 60,000 | 710 | 94 | 83 | 11 | 89 | 15 | 74 | 661 |
| 5A | Office | | 99,000 | 710 | 154 | 136 | 18 | 148 | 25 | 123 | 1090 |
| 6A | Office | | 280,000 | 710 | 437 | 385 | 52 | 417 | 71 | 346 | 3083 |
| 7A | School (Elementary) | | 55,000 | 520 | 185 | 113 | 72 | 172 | 45 | 127 | 662 |
| 7B | Retail/Office/Clinic | | 48,000 | 710 | 75 | 66 | 9 | 72 | 12 | 60 | 528 |
| 8A | Retail/Office/Clinic | | 54,000 | 710 | 84 | 74 | 10 | 80 | 14 | 66 | 595 |
| Building 9A | Fitness | | 40,000 | 493 | 12 | 6 | 6 | 172 | 105 | 67 | 1147 |
| Building 9B | Community Center | | 25,000 | 495 | 33 | 22 | 11 | 44 | 15 | 29 | 572 |
| Building 9C | Ice Rink | | 38,000 | 465 | 0 | 0 | 0 | 90 | 41 | 50 | 600 |
| Building 10A | Speciality Retail | | 40,000 | 820 | 41 | 25 | 16 | 150 | 72 | 78 | 1717 |
| Building 10B | Speciality Retail | | 7,000 | 820 | 7 | 4 | 3 | 26 | 12 | 14 | 300 |
| Building 10C | Speciality Retail | | 3,000 | 820 | 3 | 2 | 1 | 11 | 5 | 6 | 129 |
| Building 11A | Speciality Retail | | 10,000 | 820 | 10 | 6 | 4 | 37 | 18 | 19 | 429 |
| Building 11B | Restaurant | | 8,000 | 831 | 6 | 3 | 3 | 60 | 40 | 20 | 720 |
| Building 12A | Speciality Retail | | 21,000 | 820 | 22 | 13 | 9 | 79 | 38 | 41 | 901 |
| Building 12B | Residential | 60 | 8,000 | 221 | 28 | 6 | 22 | 35 | 23 | 12 | 395 |
| Building 13A | Speciality Retail | | 33,000 | 820 | 34 | 21 | 13 | 123 | 59 | 64 | 1416 |
| Building 13B | Speciality Retail | | 22,000 | 820 | 23 | 14 | 9 | 82 | 39 | 43 | 944 |
| Building 14A | Speciality Retail | | 45,000 | 820 | 46 | 28 | 18 | 168 | 81 | 87 | 1931 |
| Building 14A | Restaurant | | 10,000 | 831 | 8 | 4 | 4 | 75 | 50 | 25 | 900 |
| Building 15A | Residential | 90 | 25,000 | 221 | 42 | 8 | 34 | 52 | 34 | 18 | 593 |
| Building 15B | Speciality Retail | | 26,000 | 820 | 27 | 16 | 11 | 97 | 47 | 50 | 1116 |
| Building 15C | Speciality Retail | | 21,000 | 820 | 22 | 13 | 9 | 79 | 38 | 41 | 901 |
| Building 16A | Speciality Retail | | 30,000 | 820 | 31 | 19 | 12 | 112 | 54 | 58 | 1288 |
| Building 16B | Restaurant | | 10,000 | 831 | 8 | 4 | 4 | 75 | 50 | 25 | 900 |
| Building 17A | Speciality Retail | | 68,000 | 820 | 70 | 43 | 27 | 254 | 122 | 132 | 2919 |
| Building 17A | Restaurant | | 20,000 | 831 | 16 | 7 | 9 | 150 | 101 | 50 | 1799 |
| Building 18A | Live / Work | 40 | 32,000 | 221 | 19 | 4 | 15 | 23 | 15 | 8 | 264 |
| Building 18B | Retail / office | | 24,000 | 710 | 37 | 33 | 4 | 36 | 6 | 30 | 264 |
| Building 18C | Speciality Retail | | 20,000 | 820 | 21 | 13 | 8 | 75 | 36 | 39 | 858 |
| Building 19A | Residential | 120 | 34,000 | 221 | 56 | 11 | 45 | 70 | 46 | 24 | 791 |
| Building 19B | Speciality Retail | | 5,000 | 820 | 5 | 3 | 2 | 19 | 9 | 10 | 215 |
| Building 20A | Grocery | | 60,000 | 850 | 250 | 153 | 98 | 642 | 327 | 315 | 6691 |
| Building 20B | Residential | 50 | 25,000 | 221 | 24 | 5 | 19 | 29 | 19 | 10 | 330 |
| Building 21A-D | Townhouse (2 story) | 94 | 66,000 | 230 | 41 | 7 | 34 | 51 | 34 | 17 | 551 |
| Building 22A-C | Apartment | 172 | 76,000 | 221 | 81 | 16 | 65 | 100 | 66 | 34 | 1133 |
| Building 23A-B | Townhouse (2 Story) | 18 | 18,000 | 230 | 8 | 1 | 7 | 10 | 7 | 3 | 105 |
| Building 23C | Convenience Retail | | 20,000 | 820 | 21 | 13 | 8 | 75 | 36 | 39 | 858 |
| Building 24A-E | Townhouse (2 Story) | 48 | 54,000 | 230 | 21 | 4 | 17 | 26 | 17 | 9 | 281 |
| Building 25A-G | Townhouse (2 Story) | 43 | | 230 | 19 | 3 | 16 | 23 | 15 | 8 | 252 |
| Building 26A-G | Townhouse (2 Story) | 50 | | 230 | 22 | 4 | 18 | 27 | 18 | 9 | 293 |
| Building 27A-B | Townhouse with Flats (3 story) | 60 | | 232 | 20 | 4 | 16 | 23 | 14 | 9 | 251 |
| Building 27C | Townhouse (2 story) | 60 | | 230 | 26 | 4 | 22 | 32 | 21 | 11 | 352 |
| Building 28A-C | Townhouse (2 story) | 23 | | 230 | 10 | 2 | 8 | 12 | 8 | 4 | 135 |
| Building 28D | Townhouse with Flats (4 story) | 50 | | 232 | 17 | 3 | 14 | 19 | 12 | 7 | 209 |
| Building 29A | Townhouse with Flats (4 story) | 70 | | 232 | 24 | 5 | 19 | 27 | 17 | 10 | 293 |
| Building 30A-B | Townhouse with Flats (3 story) | 50 | | 232 | 17 | 3 | 14 | 19 | 12 | 7 | 209 |
| Building 30C | Townhouse with Flats (4 story) | 64 | | 232 | 22 | 4 | 18 | 24 | 15 | 9 | 268 |
| Building 31A-I | Townhouse (2 story) | 51 | | 230 | 22 | 4 | 18 | 28 | 19 | 9 | 299 |
| Building 32A-I | Townhouse (2 Story) | 58 | | 230 | 26 | 4 | 22 | 31 | 21 | 10 | 340 |
| Building 33A-F | Townhouse (2 story) | 47 | | 230 | 21 | 4 | 17 | 25 | 17 | 8 | 275 |
| Building 34A-B | Residential | 120 | | 221 | 56 | 11 | 45 | 70 | 46 | 24 | 791 |
| Building 35A-B | Gas station, convenience | | 3,000 | 845 | 233 | 119 | 114 | 289 | 145 | 145 | 1015 |
| Builidng 36A-H | Single family detached | 49 | | 210 | 37 | 9 | 28 | 49 | 31 | 18 | 469 |
| Building 37A-I | Townhouse (2 story) | 45 | | 230 | 20 | 3 | 17 | 24 | 16 | 8 | 264 |
| Building 38A-C | Townhouse (2 story) | 23 | | 230 | 10 | 2 | 8 | 12 | 8 | 4 | 135 |
| Building 38D | Townhouse with Flats (4 story) | 50 | | 232 | 17 | 3 | 14 | 19 | 12 | 7 | 209 |
| Building 39A-E | Townhouse (2 story) | 51 | | 230 | 22 | 4 | 18 | 28 | 19 | 9 | 299 |
| Building 40A | Duplex (2 story) | 28 | | 230 | 12 | 2 | 10 | 15 | 10 | 5 | 164 |
| Building 41A- | Duplex (2 story) | 16 | | 230 | 7 | 1 | 6 | 9 | 6 | 3 | 94 |
| Building 42A | Speciality Retail | | 30,000 | 820 | 31 | 19 | 12 | 112 | 54 | 58 | 1288 |
| Building 43A- | Duplex | 18 | | 230 | 8 | 1 | 7 | 10 | 7 | 3 | 105 |
| Building 44A-F | Townhouse (2 story) | 26 | | 230 | 11 | 2 | 9 | 14 | 9 | 5 | 152 |
| Building 45A-G | Townhouse (2 story) | 22 | | 230 | 10 | 2 | 8 | 12 | 8 | 4 | 129 |
| | Total | 1,816 | 1,933,000 | | 3,205 | 1,860 | 1,346 | 6,168 | 2,934 | 3,237 | 60,219 |
| | | | | | | | | | with 15% internal capture | | 51,186 |
| | Residential Totals | 1766 | 338000 | | 776 | 146 | 630 | 948 | 622 | 326 | 10430 |
| | Office Totals | | 695000 | | 1177 | 981 | 196 | 1133 | 216 | 917 | 8006 |
| | Retail Totals | | 900000 | | 1252 | 733 | 520 | 4087 | 2096 | 1994 | 41783 |
| | | | 1,933,000 | | 3205 | 1860 | 1346 | 6168 | 2934 | 3237 | 60219 |

**Ramsey Town Center Trip Generation Tables**
(Data: Feb 25)

| Zone/ Block | Land Use | Trips after Internal Capture Reductions | | | | | |
|---|---|---|---|---|---|---|---|
| | | | 9% | | | 16% | |
| | | AM Peak | | | PM Peak | | |
| | | TOTAL | IN | OUT | TOTAL | IN | OUT |
| 1A | Speciality Retail | 94 | 57 | 36 | 316 | 152 | 164 |
| 2A | Speciality Retail | 51 | 31 | 20 | 171 | 82 | 89 |
| 3A | Speciality Retail | 37 | 23 | 15 | 127 | 61 | 66 |
| 3B | Cinema | 0 | 0 | 0 | 160 | 103 | 57 |
| 3C | City Hall/ Police/ Transit | 71 | 63 | 8 | 63 | 11 | 52 |
| 3D | Retail/ Bowling Alley | 80 | 48 | 32 | 84 | 30 | 54 |
| 4A | Hotel | 15 | 9 | 6 | 17 | 9 | 8 |
| 4B | Office | 85 | 75 | 10 | 75 | 13 | 62 |
| 5A | Office | 140 | 124 | 16 | 125 | 21 | 104 |
| 6A | Office | 397 | 350 | 47 | 352 | 60 | 292 |
| 7A | School (Elementary) | 168 | 103 | 65 | 145 | 38 | 107 |
| 7B | Retail/Office/Clinic | 68 | 60 | 8 | 61 | 10 | 51 |
| 8A | Retail/Office/Clinic | 76 | 67 | 9 | 68 | 12 | 56 |
| Building 9A | Fitness | 11 | 5 | 5 | 145 | 89 | 57 |
| Building 9B | Community Center | 30 | 20 | 10 | 37 | 13 | 24 |
| Building 9C | Ice Rink | 0 | 0 | 0 | 76 | 35 | 42 |
| Building 10A | Speciality Retail | 37 | 23 | 15 | 127 | 61 | 66 |
| Building 10B | Speciality Retail | 6 | 4 | 3 | 22 | 10 | 12 |
| Building 10C | Speciality Retail | 3 | 2 | 1 | 9 | 4 | 5 |
| Building 11A | Speciality Retail | 9 | 5 | 4 | 31 | 15 | 16 |
| Building 11B | Restaurant | 5 | 3 | 3 | 51 | 34 | 17 |
| Building 12A | Speciality Retail | 20 | 12 | 8 | 67 | 32 | 35 |
| Building 12B | Residential | 25 | 5 | 20 | 30 | 19 | 10 |
| Building 13A | Speciality Retail | 31 | 19 | 12 | 104 | 50 | 54 |
| Building 13B | Speciality Retail | 21 | 13 | 8 | 69 | 33 | 36 |
| Building 14A | Speciality Retail | 42 | 25 | 16 | 142 | 68 | 73 |
| Building 14A | Restaurant | 7 | 4 | 4 | 63 | 42 | 21 |
| Building 15A | Residential | 38 | 7 | 31 | 44 | 29 | 15 |
| Building 15B | Speciality Retail | 25 | 15 | 10 | 82 | 40 | 42 |
| Building 15C | Speciality Retail | 20 | 12 | 8 | 67 | 32 | 35 |
| Building 16A | Speciality Retail | 28 | 17 | 11 | 95 | 46 | 49 |
| Building 16B | Restaurant | 7 | 4 | 4 | 63 | 42 | 21 |
| Building 17A | Speciality Retail | 64 | 39 | 25 | 214 | 103 | 111 |
| Building 17A | Restaurant | 15 | 6 | 8 | 127 | 85 | 42 |
| Building 18A | Live / Work | 17 | 4 | 14 | 19 | 13 | 7 |
| Building 18B | Retail / office | 34 | 30 | 4 | 30 | 5 | 25 |
| Building 18C | Speciality Retail | 19 | 12 | 7 | 63 | 30 | 33 |
| Building 19A | Residential | 51 | 10 | 41 | 59 | 39 | 20 |
| Building 19B | Speciality Retail | 5 | 3 | 2 | 16 | 8 | 8 |
| Building 20A | Grocery | 227 | 139 | 89 | 542 | 276 | 266 |
| Building 20B | Residential | 22 | 5 | 17 | 24 | 16 | 8 |
| Building 21A-D | Townhouse (2 story) | 37 | 6 | 31 | 43 | 29 | 14 |
| Building 22A-C | Apartment | 74 | 15 | 59 | 84 | 56 | 29 |
| Building 23A-B | Townhouse (2 Story) | 7 | 1 | 6 | 8 | 6 | 3 |
| Building 23C | Convenience Retail | 19 | 12 | 7 | 63 | 30 | 33 |
| Building 24A-E | Townhouse (2 Story) | 19 | 4 | 15 | 22 | 14 | 8 |
| Building 25A-G | Townhouse (2 Story) | 17 | 3 | 15 | 19 | 13 | 7 |
| Building 26A-G | Townhouse (2 Story) | 20 | 4 | 16 | 23 | 15 | 8 |
| Building 27A-B | Townhouse with Flats (3 story) | 18 | 4 | 15 | 19 | 12 | 8 |
| Building 27C | Townhouse (2 story) | 24 | 4 | 20 | 27 | 18 | 9 |
| Building 28A-C | Townhouse (2 story) | 9 | 2 | 7 | 10 | 7 | 3 |
| Building 28D | Townhouse with Flats (4 story) | 15 | 3 | 13 | 16 | 10 | 6 |
| Building 29A | Townhouse with Flats (4 story) | 22 | 5 | 17 | 23 | 14 | 8 |
| Building 30A-B | Townhouse with Flats (3 story) | 15 | 3 | 13 | 16 | 10 | 6 |
| Building 30C | Townhouse with Flats (4 story) | 20 | 4 | 16 | 20 | 13 | 8 |
| Building 31A-I | Townhouse (2 story) | 20 | 4 | 16 | 24 | 16 | 8 |
| Building 32A-I | Townhouse (2 Story) | 24 | 4 | 20 | 26 | 18 | 8 |
| Building 33A-F | Townhouse (2 story) | 19 | 4 | 15 | 21 | 14 | 7 |
| Building 34A-B | Residential | 51 | 10 | 41 | 59 | 39 | 20 |
| Building 35A-B | Gas station, convenience | 212 | 108 | 104 | 244 | 122 | 122 |
| Builidng 36A-H | Single family detached | 34 | 8 | 25 | 41 | 26 | 15 |
| Building 37A-I | Townhouse (2 story) | 18 | 3 | 15 | 20 | 14 | 7 |
| Building 38A-C | Townhouse (2 story) | 9 | 2 | 7 | 10 | 7 | 3 |
| Building 38D | Townhouse with Flats (4 story) | 15 | 3 | 13 | 16 | 10 | 6 |
| Building 39A-E | Townhouse (2 story) | 20 | 4 | 16 | 24 | 16 | 8 |
| Building 40A | Duplex (2 story) | 11 | 2 | 9 | 13 | 8 | 4 |
| Building 41A- | Duplex (2 story) | 6 | 1 | 5 | 8 | 5 | 3 |
| Building 42A | Speciality Retail | 28 | 17 | 11 | 95 | 46 | 49 |
| Building 43A- | Duplex | 7 | 1 | 6 | 8 | 6 | 3 |
| Building 44A-F | Townhouse (2 story) | 10 | 2 | 8 | 12 | 8 | 4 |
| Building 45A-G | Townhouse (2 story) | 9 | 2 | 7 | 10 | 7 | 3 |
| | Total | 2,910 | 1,698 | 1,220 | 5,206 | 2,480 | 2,732 |
| | Residential Totals | | | | | | |
| | Office Totals | | | | | | |
| | Retail Totals | | | | | | |

## Multi-Use Trip Generation Calculation Work Sheet

Analyst RMK
Date 14-Mar-03

Name of Dvlpt Ramsey AUAR
Time Period AM Peak Hour

**LAND USE A** *Retail*

| *ITE LU CODE* | 820 | | |
|---|---|---|---|
| *SIZE* | | | |
| | *TOTAL* | *INTERNAL* | *EXTERNAL* |
| *ENTER* | 733 | **81** | **652** |
| *EXIT* | 520 | **61** | **459** |
| *TOTAL* | 1253 | **142** | **1111** |
| *%* | 100% | **11%** | **89%** |

Exit to External **459**
**652** Enter to External

| | | |
|---|---|---|
| 3% | 16 | Demand |
| 16 | Balanced | |
| 31% | 304 | Demand |

| | | |
|---|---|---|
| 2% | 15 | Demand |
| 15 | Balanced | |
| 23% | 45 | Demand |

| | | |
|---|---|---|
| 12% | 62 | Demand |
| 45 | Balanced | |
| 31% | 45 | Demand |

| | | |
|---|---|---|
| 9% | 66 | Demand |
| 66 | Balanced | |
| 53% | 334 | Demand |

**LAND USE B** *Office*

| *ITE LU CODE* | 710 | | |
|---|---|---|---|
| *SIZE* | 0 | | |
| | *TOTAL* | *INTERNAL* | *EXTERNAL* |
| *ENTER* | 981 | **16** | **965** |
| *EXIT* | 196 | **18** | **178** |
| *TOTAL* | 1177 | **34** | **1143** |
| *%* | 100% | **3%** | **97%** |

Exit to External **178**
**965** Enter from External

| Demand | | Balanced | Demand | |
|---|---|---|---|---|
| 0% | 0 | 0 | 0% | 0 |
| 2% | 4 | 3 | 2% | 3 |
| Demand | | Balanced | Demand | |

**LAND USE C** *Residential*

| *ITE LU CODE* | Varies | | |
|---|---|---|---|
| *SIZE* | | | |
| | *TOTAL* | *INTERNAL* | *EXTERNAL* |
| *ENTER* | 146 | **48** | **98** |
| *EXIT* | 630 | **66** | **564** |
| *TOTAL* | 776 | **114** | **662** |
| *%* | 100% | **15%** | **85%** |

Enter from External **98**
**564** Exit to External

**Net External Trips for Multi-Use Development**

| | LAND USE A | LAND USE B | LAND USE C | TOTAL |
|---|---|---|---|---|
| Enter | 652 | 965 | 98 | 1715 |
| Exit | 459 | 178 | 564 | 1201 |
| Total | 1111 | 1143 | 662 | 2916 |
| Single-Use Trip Gen. Est. | 1253 | 1177 | 776 | 3206 |
| | | | | |

**Internal Capture**
**9%**

# Multi-Use Trip Generation Calculation Work Sheet

Analyst: RMK
Date: 14-Mar-03

Name of Dvlpt: Ramsey AUAR
Time Period: PM Peak Hour

**LAND USE A** *Retail*

*ITE LU CODE* 820
*SIZE*

| | *TOTAL* | *INTERNAL* | *EXTERNAL* |
|---|---|---|---|
| *ENTER* | 2096 | **215** | **1881** |
| *EXIT* | 1994 | **253** | **1741** |
| *TOTAL* | 4090 | **468** | **3622** |
| *%* | 100% | **11%** | **89%** |

Exit to External **1741**
**1881** Enter to External

A–B:

| 3% | 60 |
|---|---|
| | Demand |
| 60 | |
| Balanced | |
| 31% | 67 |
| Demand | |

| 2% | 42 |
|---|---|
| | Demand |
| 42 | |
| Balanced | |
| 23% | 211 |
| Demand | |

A–C:

| 12% | 239 |
|---|---|
| Demand | |
| | 193 |
| | Balanced |
| 31% | 193 |
| | Demand |

| 9% | 189 |
|---|---|
| Demand | |
| | 173 |
| | Balanced |
| 53% | 173 |
| | Demand |

**LAND USE B** *Office*

*ITE LU CODE* 710
*SIZE* 0

| | *TOTAL* | *INTERNAL* | *EXTERNAL* |
|---|---|---|---|
| *ENTER* | 216 | **60** | **156** |
| *EXIT* | 917 | **54** | **863** |
| *TOTAL* | 1133 | **114** | **1019** |
| *%* | 100% | **10%** | **90%** |

Exit to External **863**
**156** Enter from External

B–C:

| Demand | | Balanced | Demand | |
|---|---|---|---|---|
| 0% | 0 | 0 | 0% | 0 |
| 2% | 18 | 12 | 2% | 12 |
| Demand | | Balanced | Demand | |

**LAND USE C** *Residential*

*ITE LU CODE* Varies
*SIZE*

| | *TOTAL* | *INTERNAL* | *EXTERNAL* |
|---|---|---|---|
| *ENTER* | 622 | **205** | **417** |
| *EXIT* | 326 | **173** | **153** |
| *TOTAL* | 948 | **378** | **570** |
| *%* | 100% | **40%** | **60%** |

Enter from External **417**
**153** Exit to External

**Net External Trips for Multi-Use Development**

| | LAND USE A | LAND USE B | LAND USE C | TOTAL |
|---|---|---|---|---|
| Enter | 1881 | 156 | 417 | 2454 |
| Exit | 1741 | 863 | 153 | 2757 |
| Total | 3622 | 1019 | 570 | 5211 |
| Single-Use Trip Gen. Est. | 4090 | 1133 | 948 | 6171 |
| | | | | |

**Internal Capture** **16%**

# Multi-Use Trip Generation Calculation Work Sheet

Analyst: FCD
Date: 20-Mar-03

Name of Dvlpt: Ramsey AUAR
Time Period: Daily

**LAND USE A** *Retail*

| *ITE LU CODE* | 820 | | |
|---|---|---|---|
| *SIZE* | | | |
| | *TOTAL* | *INTERNAL* | *EXTERNAL* |
| *ENTER* | 20891.5 | **2298** | **18594** |
| *EXIT* | 20891.5 | **2244** | **18648** |
| *TOTAL* | 41783 | **4542** | **37241** |
| *%* | 100% | **11%** | **89%** |

Exit to External: **18648**
Enter to External: **18594**

| | | |
|---|---|---|
| 3% | 627 | Demand |
| 627 | | Balanced |
| 31% | 1241 | Demand |
| 2% | 418 | Demand |
| 418 | | Balanced |
| 23% | 921 | Demand |

| | | |
|---|---|---|
| 12% | 2507 | Demand |
| 1617 | | Balanced |
| 31% | 1617 | Demand |
| 9% | 1880 | Demand |
| 1880 | | Balanced |
| 53% | 2764 | Demand |

**LAND USE B** *Office*

| *ITE LU CODE* | 710 | | |
|---|---|---|---|
| *SIZE* | 0 | | |
| | *TOTAL* | *INTERNAL* | *EXTERNAL* |
| *ENTER* | 4003 | **627** | **3376** |
| *EXIT* | 4003 | **498** | **3505** |
| *TOTAL* | 8006 | **1125** | **6881** |
| *%* | 100% | **14%** | **86%** |

Exit to External: **3505**
Enter from External: **3376**

| | Demand | | Balanced | | Demand |
|---|---|---|---|---|---|
| 0% | 0 | 0 | 0% | 0 | |
| 2% | 80 | 80 | 2% | 104 | |

(Lower row: Demand / Balanced / Demand)

**LAND USE C** *Residential*

| *ITE LU CODE* | Varies | | |
|---|---|---|---|
| *SIZE* | | | |
| | *TOTAL* | *INTERNAL* | *EXTERNAL* |
| *ENTER* | 5215 | **1697** | **3518** |
| *EXIT* | 5215 | **1880** | **3335** |
| *TOTAL* | 10430 | **3577** | **6853** |
| *%* | 100% | **34%** | **66%** |

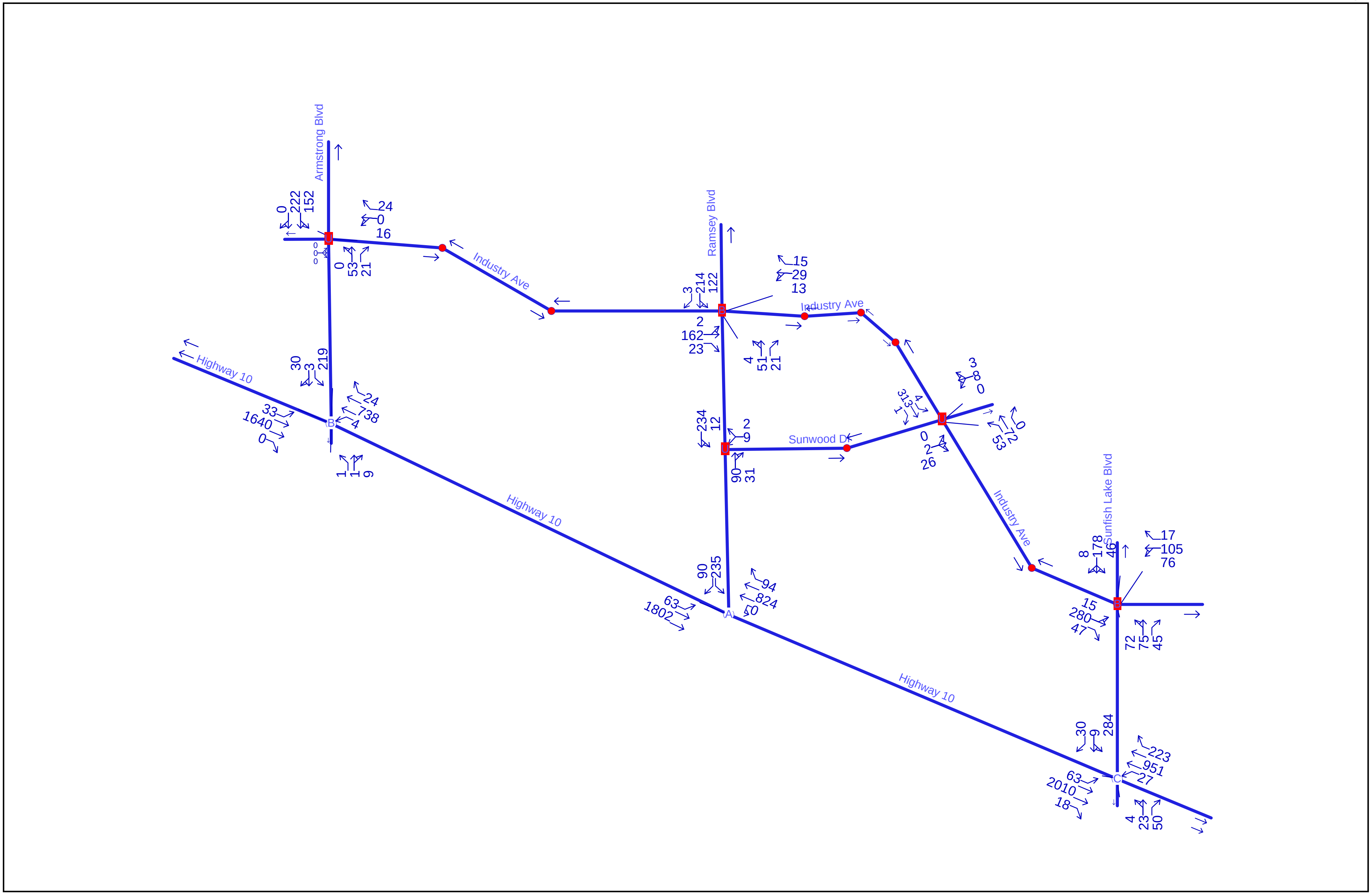
Enter from External: **3518**
Exit to External: **3335**

**Net External Trips for Multi-Use Development**

| | LAND USE A | LAND USE B | LAND USE C | TOTAL |
|---|---|---|---|---|
| Enter | 18593.5 | 3376 | 3518 | 25487.5 |
| Exit | 18647.5 | 3505 | 3335 | 25487.5 |
| Total | 37241 | 6881 | 6853 | 50975 |
| Single-Use Trip Gen. Est. | 41783 | 8006 | 10430 | 60219 |
| | | | | |

**Internal Capture**: 15%

# APPENDIX B – INTERSECTION CAPACITY ANALYSES


Armstrong Blvd
Industry Ave
Ramsey Blvd
Industry Ave
Highway 10
Sunwood Dr
Industry Ave
Sunfish Lake Blvd
Highway 10
Highway 10

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | 1.00 | 1.00 | | 1.00 | 1.00 | 0.85 | 1.00 | 0.86 | | 1.00 | 0.86 | |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | 1770 | 3539 | | 1770 | 3539 | 1583 | 1770 | 1609 | | 1770 | 1607 | |
| Flt Permitted | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.73 | 1.00 | | 0.75 | 1.00 | |
| Satd. Flow (perm) | 1770 | 3539 | | 1770 | 3539 | 1583 | 1367 | 1609 | | 1398 | 1607 | |
| Volume (vph) | 33 | 1640 | 0 | 4 | 738 | 24 | 1 | 1 | 9 | 219 | 3 | 30 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 36 | 1783 | 0 | 4 | 802 | 26 | 1 | 1 | 10 | 238 | 3 | 33 |
| Lane Group Flow (vph) | 36 | 1783 | 0 | 4 | 802 | 26 | 1 | 11 | 0 | 238 | 36 | 0 |
| Turn Type | Prot | | Perm | Prot | | Perm | Perm | | | Perm | | |
| Protected Phases | 5 | 2 | | 1 | 6 | | | 8 | | | 4 | |
| Permitted Phases | | | 2 | | | 6 | 8 | | | 4 | | |
| Actuated Green, G (s) | 3.6 | 81.2 | | 1.2 | 78.8 | 78.8 | 25.1 | 25.1 | | 25.1 | 25.1 | |
| Effective Green, g (s) | 3.6 | 84.7 | | 1.2 | 82.3 | 82.3 | 27.1 | 27.1 | | 27.1 | 27.1 | |
| Actuated g/C Ratio | 0.03 | 0.68 | | 0.01 | 0.66 | 0.66 | 0.22 | 0.22 | | 0.22 | 0.22 | |
| Clearance Time (s) | 4.0 | 7.5 | | 4.0 | 7.5 | 7.5 | 6.0 | 6.0 | | 6.0 | 6.0 | |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 51 | 2398 | | 17 | 2330 | 1042 | 296 | 349 | | 303 | 348 | |
| v/s Ratio Prot | 0.02 | c0.50 | | 0.00 | c0.23 | | | 0.01 | | | 0.02 | |
| v/s Ratio Perm | | | | | | 0.02 | 0.00 | | | c0.17 | | |
| v/c Ratio | 0.71 | 0.74 | | 0.24 | 0.34 | 0.02 | 0.00 | 0.03 | | 0.79 | 0.10 | |
| Uniform Delay, d1 | 60.2 | 13.1 | | 61.4 | 9.4 | 7.4 | 38.4 | 38.6 | | 46.2 | 39.2 | |
| Progression Factor | 1.00 | 1.00 | | 0.86 | 0.24 | 0.08 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 36.0 | 2.1 | | 6.7 | 0.4 | 0.0 | 0.0 | 0.0 | | 12.6 | 0.1 | |
| Delay (s) | 96.1 | 15.2 | | 59.7 | 2.6 | 0.6 | 38.4 | 38.6 | | 58.8 | 39.3 | |
| Level of Service | F | B | | E | A | A | D | D | | E | D | |
| Approach Delay (s) | | 16.8 | | | 2.8 | | | 38.6 | | | 56.2 | |
| Approach LOS | | B | | | A | | | D | | | E | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 16.6 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.73 | | |
| Actuated Cycle Length (s) | 125.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 75.8% | ICU Level of Service | C |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBU | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 | 4.0 |
| Lane Util. Factor | 1.00 | 0.95 | | 0.95 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | | 1.00 | 0.85 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 1770 | 3539 | | 3539 | 1583 | 1770 | 1583 |
| Flt Permitted | 0.95 | 1.00 | | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 1770 | 3539 | | 3539 | 1583 | 1770 | 1583 |
| Volume (vph) | 63 | 1802 | 0 | 824 | 94 | 235 | 90 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 68 | 1959 | 0 | 896 | 102 | 255 | 98 |
| Lane Group Flow (vph) | 68 | 1959 | 0 | 896 | 102 | 255 | 98 |
| Turn Type | Prot | | Prot | | Perm | | Perm |
| Protected Phases | 5 | 2 | 1 | 6 | | 4 | |
| Permitted Phases | | | | | 6 | | 4 |
| Actuated Green, G (s) | 7.7 | 90.3 | | 78.6 | 78.6 | 21.7 | 21.7 |
| Effective Green, g (s) | 7.7 | 93.3 | | 81.6 | 81.6 | 23.7 | 23.7 |
| Actuated g/C Ratio | 0.06 | 0.75 | | 0.65 | 0.65 | 0.19 | 0.19 |
| Clearance Time (s) | 4.0 | 7.0 | | 7.0 | 7.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | 6.0 | | 6.0 | 6.0 | 4.0 | 4.0 |
| Lane Grp Cap (vph) | 109 | 2642 | | 2310 | 1033 | 336 | 300 |
| v/s Ratio Prot | 0.04 | c0.55 | | 0.25 | | c0.14 | |
| v/s Ratio Perm | | | | | 0.06 | | 0.06 |
| v/c Ratio | 0.62 | 0.74 | | 0.39 | 0.10 | 0.76 | 0.33 |
| Uniform Delay, d1 | 57.2 | 9.0 | | 10.1 | 8.1 | 47.9 | 43.8 |
| Progression Factor | 0.91 | 0.50 | | 0.06 | 0.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 7.5 | 1.3 | | 0.4 | 0.2 | 10.0 | 0.9 |
| Delay (s) | 59.5 | 5.9 | | 1.0 | 0.2 | 58.0 | 44.6 |
| Level of Service | E | A | | A | A | E | D |
| Approach Delay (s) | | 7.7 | | 0.9 | | 54.3 | |
| Approach LOS | | A | | A | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 10.6 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.75 | | |
| Actuated Cycle Length (s) | 125.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 83.3% | ICU Level of Service | D |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 |
| Lane Util. Factor | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | | 1.00 | 0.85 | | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | | 0.99 | 1.00 | | 0.95 | 1.00 |
| Satd. Flow (prot) | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 | | 1850 | 1583 | | 1777 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | | 0.96 | 1.00 | | 0.71 | 1.00 |
| Satd. Flow (perm) | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 | | 1781 | 1583 | | 1325 | 1583 |
| Volume (vph) | 63 | 2010 | 18 | 27 | 951 | 223 | 4 | 23 | 50 | 284 | 9 | 30 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 68 | 2185 | 20 | 29 | 1034 | 242 | 4 | 25 | 54 | 309 | 10 | 33 |
| Lane Group Flow (vph) | 68 | 2185 | 20 | 29 | 1034 | 242 | 0 | 29 | 54 | 0 | 319 | 33 |
| Turn Type | Prot | | Perm | Prot | | Perm | Perm | | Perm | Perm | | Perm |
| Protected Phases | 1 | 6 | | 5 | 2 | | | 8 | | | 4 | |
| Permitted Phases | | | 6 | | | 2 | 8 | | 8 | 4 | | 4 |
| Actuated Green, G (s) | 8.5 | 76.4 | 76.4 | 3.6 | 71.5 | 71.5 | | 28.5 | 28.5 | | 27.5 | 27.5 |
| Effective Green, g (s) | 8.5 | 79.4 | 79.4 | 3.6 | 74.5 | 74.5 | | 30.0 | 30.0 | | 30.0 | 30.0 |
| Actuated g/C Ratio | 0.07 | 0.64 | 0.64 | 0.03 | 0.60 | 0.60 | | 0.24 | 0.24 | | 0.24 | 0.24 |
| Clearance Time (s) | 4.0 | 7.0 | 7.0 | 4.0 | 7.0 | 7.0 | | 5.5 | 5.5 | | 6.5 | 6.5 |
| Vehicle Extension (s) | 3.0 | 5.5 | 5.5 | 3.0 | 5.5 | 5.5 | | 3.0 | 3.0 | | 4.5 | 4.5 |
| Lane Grp Cap (vph) | 120 | 2248 | 1006 | 51 | 2109 | 943 | | 427 | 380 | | 318 | 380 |
| v/s Ratio Prot | c0.04 | c0.62 | | 0.02 | 0.29 | | | | | | | |
| v/s Ratio Perm | | | 0.01 | | | 0.15 | | 0.02 | 0.03 | | c0.24 | 0.02 |
| v/c Ratio | 0.57 | 0.97 | 0.02 | 0.57 | 0.49 | 0.26 | | 0.07 | 0.14 | | 1.00 | 0.09 |
| Uniform Delay, d1 | 56.5 | 21.7 | 8.4 | 59.9 | 14.4 | 12.0 | | 36.7 | 37.4 | | 47.5 | 36.9 |
| Progression Factor | 0.93 | 0.73 | 0.24 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 |
| Incremental Delay, d2 | 4.1 | 10.4 | 0.0 | 13.7 | 0.8 | 0.7 | | 0.1 | 0.2 | | 51.3 | 0.2 |
| Delay (s) | 56.8 | 26.2 | 2.1 | 73.7 | 15.2 | 12.7 | | 36.8 | 37.5 | | 98.8 | 37.0 |
| Level of Service | E | C | A | E | B | B | | D | D | | F | D |
| Approach Delay (s) | | 26.9 | | | 16.1 | | | 37.3 | | | 93.0 | |
| Approach LOS | | C | | | B | | | D | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 29.4 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.95 | | |
| Actuated Cycle Length (s) | 125.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 99.7% | ICU Level of Service | E |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 0 | 0 | 0 | 16 | 0 | 24 | 0 | 53 | 21 | 152 | 222 | 0 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 0 | 0 | 0 | 17 | 0 | 26 | 0 | 58 | 23 | 165 | 241 | 0 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | 8 | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 642 | 652 | 121 | 509 | 629 | 58 | 241 | | | 80 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 642 | 652 | 121 | 509 | 629 | 58 | 241 | | | 80 | | |
| tC, single (s) | 7.5 | 6.5 | 6.9 | 7.5 | 6.5 | 6.9 | 4.1 | | | 4.1 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 | 2.2 | | | 2.2 | | |
| p0 queue free % | 100 | 100 | 100 | 96 | 100 | 97 | 100 | | | 89 | | |
| cM capacity (veh/h) | 320 | 344 | 908 | 410 | 354 | 996 | 1322 | | | 1515 | | |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 |
|---|---|---|---|---|---|---|
| Volume Total | 0 | 43 | 58 | 23 | 286 | 121 |
| Volume Left | 0 | 17 | 0 | 0 | 165 | 0 |
| Volume Right | 0 | 26 | 0 | 23 | 0 | 0 |
| cSH | 1700 | 1025 | 1322 | 1700 | 1515 | 1700 |
| Volume to Capacity | 0.00 | 0.04 | 0.00 | 0.01 | 0.11 | 0.07 |
| Queue Length (ft) | 0 | 3 | 0 | 0 | 9 | 0 |
| Control Delay (s) | 0.0 | 10.9 | 0.0 | 0.0 | 4.8 | 0.0 |
| Lane LOS | A | B | | | A | |
| Approach Delay (s) | 0.0 | 10.9 | 0.0 | | 3.4 | |
| Approach LOS | A | B | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 3.5 | | |
| Intersection Capacity Utilization | 25.8% | ICU Level of Service | A |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (veh/h) | 2 | 162 | 23 | 13 | 29 | 15 | 4 | 51 | 21 | 122 | 214 | 3 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 2 | 176 | 25 | 14 | 32 | 16 | 4 | 55 | 23 | 133 | 233 | 3 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | NB 2 | SB 1 | SB 2 |
|---|---|---|---|---|---|---|---|---|
| Volume Total (vph) | 178 | 25 | 46 | 16 | 60 | 23 | 365 | 3 |
| Volume Left (vph) | 2 | 0 | 14 | 0 | 4 | 0 | 133 | 0 |
| Volume Right (vph) | 0 | 25 | 0 | 16 | 0 | 23 | 0 | 3 |
| Hadj (s) | 0.0 | -0.6 | 0.1 | -0.6 | 0.0 | -0.6 | 0.1 | -0.6 |
| Departure Headway (s) | 5.8 | 5.2 | 6.1 | 5.4 | 5.7 | 5.1 | 5.4 | 4.8 |
| Degree Utilization, x | 0.29 | 0.04 | 0.08 | 0.02 | 0.09 | 0.03 | 0.55 | 0.00 |
| Capacity (veh/h) | 582 | 641 | 544 | 606 | 597 | 663 | 641 | 719 |
| Control Delay (s) | 9.9 | 7.2 | 8.4 | 7.3 | 8.1 | 7.0 | 13.7 | 6.6 |
| Approach Delay (s) | 9.6 | | 8.1 | | 7.8 | | 13.6 | |
| Approach LOS | A | | A | | A | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 11.3 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 42.5% | ICU Level of Service | A |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (veh/h) | 15 | 280 | 47 | 76 | 105 | 17 | 72 | 75 | 45 | 46 | 178 | 8 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 16 | 304 | 51 | 83 | 114 | 18 | 78 | 82 | 49 | 50 | 193 | 9 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|---|
| Volume Total (vph) | 321 | 51 | 197 | 18 | 160 | 49 | 252 |
| Volume Left (vph) | 16 | 0 | 83 | 0 | 78 | 0 | 50 |
| Volume Right (vph) | 0 | 51 | 0 | 18 | 0 | 49 | 9 |
| Hadj (s) | 0.0 | -0.6 | 0.1 | -0.6 | 0.1 | -0.6 | 0.1 |
| Departure Headway (s) | 6.3 | 5.7 | 6.6 | 5.9 | 6.8 | 6.1 | 6.6 |
| Degree Utilization, x | 0.56 | 0.08 | 0.36 | 0.03 | 0.30 | 0.08 | 0.46 |
| Capacity (veh/h) | 546 | 595 | 510 | 560 | 486 | 543 | 512 |
| Control Delay (s) | 15.9 | 8.0 | 12.1 | 7.9 | 11.5 | 8.4 | 15.3 |
| Approach Delay (s) | 14.9 | | 11.8 | | 10.8 | | 15.3 |
| Approach LOS | B | | B | | B | | C |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 13.5 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 62.9% | ICU Level of Service | B |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Volume (veh/h) | 9 | 2 | 90 | 31 | 12 | 234 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 10 | 2 | 98 | 34 | 13 | 254 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 395 | 115 | | | 132 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 395 | 115 | | | 132 | |
| tC, single (s) | 6.4 | 6.2 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 98 | 100 | | | 99 | |
| cM capacity (veh/h) | 604 | 938 | | | 1454 | |

| Direction, Lane # | WB 1 | NB 1 | SB 1 |
|---|---|---|---|
| Volume Total | 12 | 132 | 267 |
| Volume Left | 10 | 0 | 13 |
| Volume Right | 2 | 34 | 0 |
| cSH | 646 | 1700 | 1454 |
| Volume to Capacity | 0.02 | 0.08 | 0.01 |
| Queue Length (ft) | 1 | 0 | 1 |
| Control Delay (s) | 10.7 | 0.0 | 0.4 |
| Lane LOS | B | | A |
| Approach Delay (s) | 10.7 | 0.0 | 0.4 |
| Approach LOS | B | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.6 | | |
| Intersection Capacity Utilization | 27.1% | ICU Level of Service | A |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 0 | 2 | 26 | 0 | 8 | 3 | 53 | 72 | 0 | 4 | 313 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 0 | 2 | 28 | 0 | 9 | 3 | 58 | 78 | 0 | 4 | 340 | 1 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 550 | 542 | 340 | 572 | 543 | 78 | 341 | | | 78 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 550 | 542 | 340 | 572 | 543 | 78 | 341 | | | 78 | | |
| tC, single (s) | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 | 4.1 | | | 4.1 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 | 2.2 | | | 2.2 | | |
| p0 queue free % | 100 | 99 | 96 | 100 | 98 | 100 | 95 | | | 100 | | |
| cM capacity (veh/h) | 421 | 425 | 702 | 396 | 424 | 982 | 1218 | | | 1520 | | |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|---|
| Volume Total | 30 | 12 | 58 | 78 | 0 | 4 | 340 | 1 |
| Volume Left | 0 | 0 | 58 | 0 | 0 | 4 | 0 | 0 |
| Volume Right | 28 | 3 | 0 | 0 | 0 | 0 | 0 | 1 |
| cSH | 671 | 502 | 1218 | 1700 | 1700 | 1520 | 1700 | 1700 |
| Volume to Capacity | 0.05 | 0.02 | 0.05 | 0.05 | 0.00 | 0.00 | 0.20 | 0.00 |
| Queue Length (ft) | 4 | 2 | 4 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 10.6 | 12.3 | 8.1 | 0.0 | 0.0 | 7.4 | 0.0 | 0.0 |
| Lane LOS | B | B | A | | | A | | |
| Approach Delay (s) | 10.6 | 12.3 | 3.4 | | | 0.1 | | |
| Approach LOS | B | B | | | | | | |

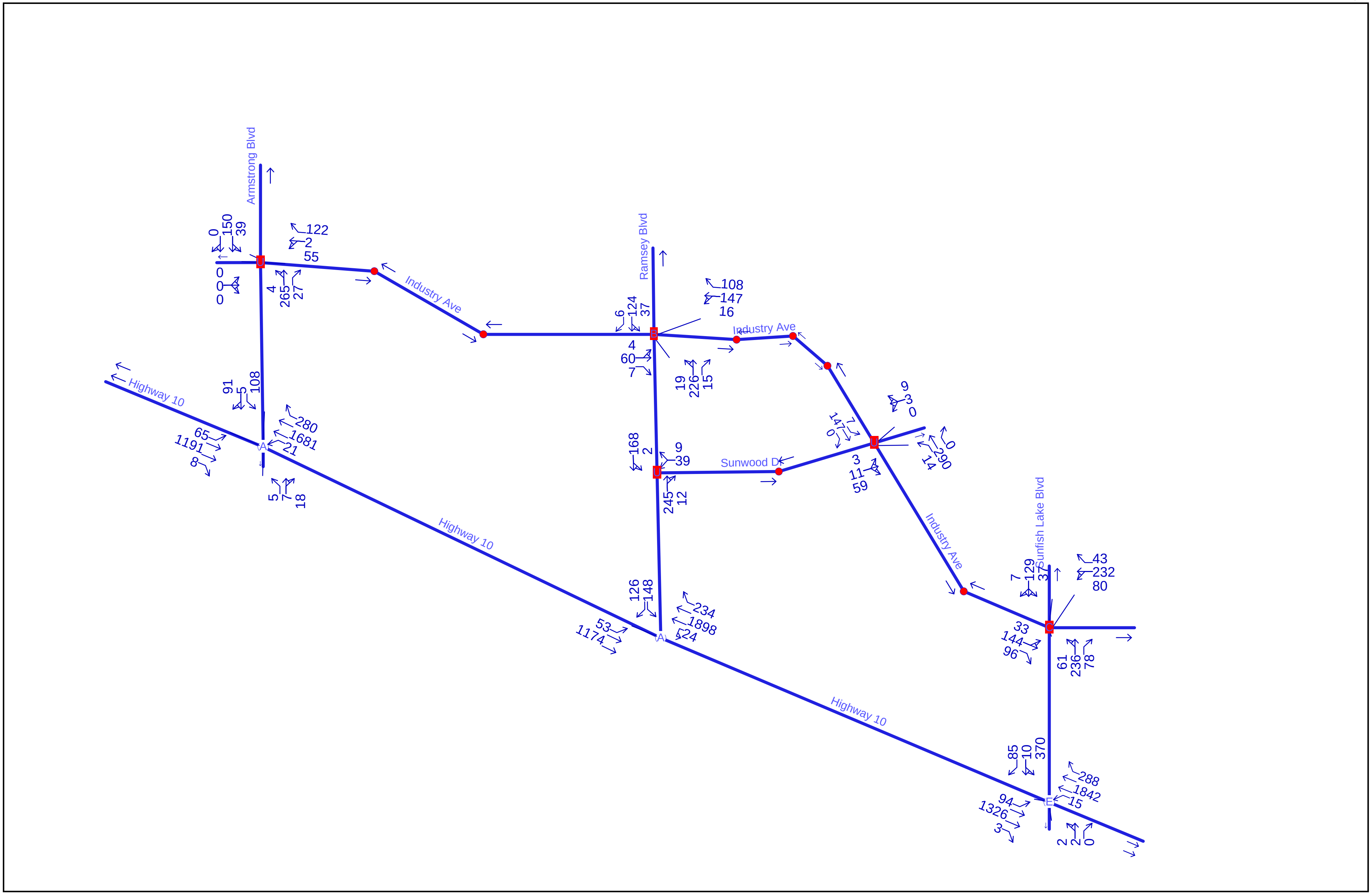
| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.9 | | |
| Intersection Capacity Utilization | 27.9% | ICU Level of Service | A |

**Map - Ramsey AUAR**

**Levels of Service**

**Timing Plan: PM Peak**

**Ramsey AUAR PM Existing**




**03/19/2003**

**Meyer, Mohaddes Associates Inc.**

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 0.89 | | 1.00 | 0.86 | |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 | 1770 | 1663 | | 1770 | 1597 | |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.59 | 1.00 | | 0.74 | 1.00 | |
| Satd. Flow (perm) | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 | 1093 | 1663 | | 1377 | 1597 | |
| Volume (vph) | 65 | 1191 | 8 | 21 | 1681 | 280 | 5 | 7 | 18 | 108 | 5 | 91 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 71 | 1295 | 9 | 23 | 1827 | 304 | 5 | 8 | 20 | 117 | 5 | 99 |
| Lane Group Flow (vph) | 71 | 1295 | 9 | 23 | 1827 | 304 | 5 | 28 | 0 | 117 | 104 | 0 |
| Turn Type | Prot | | Perm | Prot | | Perm | Perm | | | Perm | | |
| Protected Phases | 5 | 2 | | 1 | 6 | | | 8 | | | 4 | |
| Permitted Phases | | | 2 | | | 6 | 8 | | | 4 | | |
| Actuated Green, G (s) | 9.0 | 88.5 | 88.5 | 3.6 | 83.1 | 83.1 | 16.4 | 16.4 | | 15.4 | 15.4 | |
| Effective Green, g (s) | 9.0 | 92.0 | 92.0 | 3.6 | 86.6 | 86.6 | 17.4 | 17.4 | | 17.4 | 17.4 | |
| Actuated g/C Ratio | 0.07 | 0.74 | 0.74 | 0.03 | 0.69 | 0.69 | 0.14 | 0.14 | | 0.14 | 0.14 | |
| Clearance Time (s) | 4.0 | 7.5 | 7.5 | 4.0 | 7.5 | 7.5 | 5.0 | 5.0 | | 6.0 | 6.0 | |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 127 | 2605 | 1165 | 51 | 2452 | 1097 | 152 | 231 | | 192 | 222 | |
| v/s Ratio Prot | 0.04 | c0.37 | | 0.01 | c0.52 | | | 0.02 | | | 0.07 | |
| v/s Ratio Perm | | | 0.01 | | | 0.19 | 0.00 | | | c0.08 | | |
| v/c Ratio | 0.56 | 0.50 | 0.01 | 0.45 | 0.75 | 0.28 | 0.03 | 0.12 | | 0.61 | 0.47 | |
| Uniform Delay, d1 | 56.1 | 6.9 | 4.4 | 59.7 | 12.2 | 7.3 | 46.5 | 47.1 | | 50.6 | 49.5 | |
| Progression Factor | 1.00 | 1.00 | 1.00 | 0.72 | 0.17 | 0.04 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 5.3 | 0.7 | 0.0 | 3.7 | 1.3 | 0.4 | 0.1 | 0.2 | | 5.4 | 1.6 | |
| Delay (s) | 61.3 | 7.6 | 4.4 | 46.7 | 3.3 | 0.6 | 46.6 | 47.3 | | 56.0 | 51.1 | |
| Level of Service | E | A | A | D | A | A | D | D | | E | D | |
| Approach Delay (s) | | 10.3 | | | 3.4 | | | 47.2 | | | 53.7 | |
| Approach LOS | | B | | | A | | | D | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.2 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.71 | | |
| Actuated Cycle Length (s) | 125.0 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 78.7% | ICU Level of Service | C |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBU | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| Lane Util. Factor | 1.00 | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 1.00 | 1.00 | 0.85 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 1770 | 3539 | 1770 | 3539 | 1583 | 1770 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 1770 | 3539 | 1770 | 3539 | 1583 | 1770 | 1583 |
| Volume (vph) | 53 | 1174 | 24 | 1898 | 234 | 148 | 126 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 58 | 1276 | 26 | 2063 | 254 | 161 | 137 |
| Lane Group Flow (vph) | 58 | 1276 | 26 | 2063 | 254 | 161 | 137 |
| Turn Type | Prot | | Prot | | Perm | | Perm |
| Protected Phases | 5 | 2 | 1 | 6 | | 4 | |
| Permitted Phases | | | | | 6 | | 4 |
| Actuated Green, G (s) | 5.6 | 88.1 | 3.6 | 86.1 | 86.1 | 16.3 | 16.3 |
| Effective Green, g (s) | 5.6 | 91.1 | 3.6 | 89.1 | 89.1 | 18.3 | 18.3 |
| Actuated g/C Ratio | 0.04 | 0.73 | 0.03 | 0.71 | 0.71 | 0.15 | 0.15 |
| Clearance Time (s) | 4.0 | 7.0 | 4.0 | 7.0 | 7.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | 6.0 | 3.0 | 6.0 | 6.0 | 4.0 | 4.0 |
| Lane Grp Cap (vph) | 79 | 2579 | 51 | 2523 | 1128 | 259 | 232 |
| v/s Ratio Prot | c0.03 | 0.36 | 0.01 | c0.58 | | c0.09 | |
| v/s Ratio Perm | | | | | 0.16 | | 0.09 |
| v/c Ratio | 0.73 | 0.49 | 0.51 | 0.82 | 0.23 | 0.62 | 0.59 |
| Uniform Delay, d1 | 59.0 | 7.2 | 59.8 | 12.4 | 6.1 | 50.1 | 49.8 |
| Progression Factor | 1.31 | 0.39 | 0.81 | 0.39 | 0.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 26.9 | 0.6 | 0.7 | 0.3 | 0.0 | 5.2 | 4.6 |
| Delay (s) | 104.0 | 3.4 | 49.2 | 5.1 | 0.0 | 55.3 | 54.5 |
| Level of Service | F | A | D | A | A | E | D |
| Approach Delay (s) | | 7.8 | | 5.0 | | 54.9 | |
| Approach LOS | | A | | A | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.7 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.78 | | |
| Actuated Cycle Length (s) | 125.0 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 72.6% | ICU Level of Service | C |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | | 4.0 | 4.0 |
| Lane Util. Factor | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 1.00 | | | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | | 1.00 | | | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | | 0.98 | | | 0.95 | 1.00 |
| Satd. Flow (prot) | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 | | 1817 | | | 1776 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | | 0.83 | | | 0.73 | 1.00 |
| Satd. Flow (perm) | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 | | 1541 | | | 1359 | 1583 |
| Volume (vph) | 94 | 1326 | 3 | 15 | 1842 | 288 | 2 | 2 | 0 | 370 | 10 | 85 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 102 | 1441 | 3 | 16 | 2002 | 313 | 2 | 2 | 0 | 402 | 11 | 92 |
| Lane Group Flow (vph) | 102 | 1441 | 3 | 16 | 2002 | 313 | 0 | 4 | 0 | 0 | 413 | 92 |
| Turn Type | Prot | | Perm | Prot | | Perm | Perm | | Perm | Perm | | Perm |
| Protected Phases | 1 | 6 | | 5 | 2 | | | 8 | | | 4 | |
| Permitted Phases | | | 6 | | | 2 | 8 | | 8 | 4 | | 4 |
| Actuated Green, G (s) | 20.0 | 67.0 | 67.0 | 8.0 | 55.0 | 55.0 | | 29.5 | | | 29.5 | 29.5 |
| Effective Green, g (s) | 23.0 | 70.0 | 70.0 | 11.0 | 58.0 | 58.0 | | 32.0 | | | 32.0 | 32.0 |
| Actuated g/C Ratio | 0.18 | 0.56 | 0.56 | 0.09 | 0.46 | 0.46 | | 0.26 | | | 0.26 | 0.26 |
| Clearance Time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 6.5 | | | 6.5 | 6.5 |
| Vehicle Extension (s) | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | | 3.0 | | | 4.5 | 4.5 |
| Lane Grp Cap (vph) | 326 | 1982 | 886 | 156 | 1642 | 735 | | 394 | | | 348 | 405 |
| v/s Ratio Prot | 0.06 | c0.41 | | 0.01 | c0.57 | | | | | | | |
| v/s Ratio Perm | | | 0.00 | | | 0.20 | | 0.00 | | | c0.30 | 0.06 |
| v/c Ratio | 0.31 | 0.73 | 0.00 | 0.10 | 1.22 | 0.43 | | 0.01 | | | 1.19 | 0.23 |
| Uniform Delay, d1 | 44.2 | 20.4 | 12.1 | 52.5 | 33.5 | 22.4 | | 34.7 | | | 46.5 | 36.7 |
| Progression Factor | 1.12 | 0.68 | 0.64 | 1.00 | 1.00 | 1.00 | | 1.00 | | | 1.00 | 1.00 |
| Incremental Delay, d2 | 1.2 | 2.1 | 0.0 | 0.7 | 104.4 | 1.8 | | 0.0 | | | 109.3 | 0.5 |
| Delay (s) | 50.7 | 16.1 | 7.8 | 53.2 | 137.9 | 24.2 | | 34.7 | | | 155.8 | 37.2 |
| Level of Service | D | B | A | D | F | C | | C | | | F | D |
| Approach Delay (s) | | 18.4 | | | 122.1 | | | 34.7 | | | 134.2 | |
| Approach LOS | | B | | | F | | | C | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 86.8 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.12 | | |
| Actuated Cycle Length (s) | 125.0 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 111.5% | ICU Level of Service | G |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 0 | 0 | 0 | 55 | 2 | 122 | 4 | 265 | 27 | 39 | 150 | 0 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 0 | 0 | 0 | 60 | 2 | 133 | 4 | 288 | 29 | 42 | 163 | 0 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | 8 | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 612 | 574 | 82 | 463 | 545 | 288 | 163 | | | 317 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 612 | 574 | 82 | 463 | 545 | 288 | 163 | | | 317 | | |
| tC, single (s) | 7.5 | 6.5 | 6.9 | 7.5 | 6.5 | 6.9 | 4.1 | | | 4.1 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 | 2.2 | | | 2.2 | | |
| p0 queue free % | 100 | 100 | 100 | 87 | 99 | 81 | 100 | | | 97 | | |
| cM capacity (veh/h) | 297 | 412 | 962 | 468 | 428 | 709 | 1413 | | | 1239 | | |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 |
|---|---|---|---|---|---|---|
| Volume Total | 0 | 195 | 292 | 29 | 124 | 82 |
| Volume Left | 0 | 60 | 4 | 0 | 42 | 0 |
| Volume Right | 0 | 133 | 0 | 29 | 0 | 0 |
| cSH | 1700 | 1040 | 1413 | 1700 | 1239 | 1700 |
| Volume to Capacity | 0.00 | 0.19 | 0.00 | 0.02 | 0.03 | 0.05 |
| Queue Length (ft) | 0 | 17 | 0 | 0 | 3 | 0 |
| Control Delay (s) | 0.0 | 12.1 | 0.1 | 0.0 | 2.9 | 0.0 |
| Lane LOS | A | B | A | | A | |
| Approach Delay (s) | 0.0 | 12.1 | 0.1 | | 1.8 | |
| Approach LOS | A | B | | | | |

| Intersection Summary | | | | |
|---|---|---|---|---|
| Average Delay | 3.8 | | | |
| Intersection Capacity Utilization | 30.3% | ICU Level of Service | | A |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (veh/h) | 4 | 60 | 7 | 16 | 147 | 108 | 19 | 226 | 15 | 37 | 124 | 6 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 4 | 65 | 8 | 17 | 160 | 117 | 21 | 246 | 16 | 40 | 135 | 7 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | NB 2 | SB 1 | SB 2 |
|---|---|---|---|---|---|---|---|---|
| Volume Total (vph) | 70 | 8 | 177 | 117 | 266 | 16 | 175 | 7 |
| Volume Left (vph) | 4 | 0 | 17 | 0 | 21 | 0 | 40 | 0 |
| Volume Right (vph) | 0 | 8 | 0 | 117 | 0 | 16 | 0 | 7 |
| Hadj (s) | 0.0 | -0.6 | 0.1 | -0.6 | 0.0 | -0.6 | 0.1 | -0.6 |
| Departure Headway (s) | 6.2 | 5.6 | 5.9 | 5.3 | 5.8 | 5.2 | 5.9 | 5.3 |
| Degree Utilization, x | 0.12 | 0.01 | 0.29 | 0.17 | 0.43 | 0.02 | 0.29 | 0.01 |
| Capacity (veh/h) | 531 | 584 | 573 | 636 | 599 | 657 | 574 | 637 |
| Control Delay (s) | 8.9 | 7.5 | 10.2 | 8.2 | 11.8 | 7.1 | 10.1 | 7.1 |
| Approach Delay (s) | 8.7 | | 9.4 | | 11.6 | | 10.0 | |
| Approach LOS | A | | A | | B | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 10.2 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 40.0% | ICU Level of Service | A |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (veh/h) | 33 | 144 | 96 | 80 | 232 | 43 | 61 | 236 | 78 | 37 | 129 | 7 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 36 | 157 | 104 | 87 | 252 | 47 | 66 | 257 | 85 | 40 | 140 | 8 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|---|
| Volume Total (vph) | 192 | 104 | 339 | 47 | 323 | 85 | 188 |
| Volume Left (vph) | 36 | 0 | 87 | 0 | 66 | 0 | 40 |
| Volume Right (vph) | 0 | 104 | 0 | 47 | 0 | 85 | 8 |
| Hadj (s) | 0.1 | -0.6 | 0.1 | -0.6 | 0.1 | -0.6 | 0.1 |
| Departure Headway (s) | 7.2 | 6.6 | 7.0 | 6.4 | 7.0 | 6.4 | 7.5 |
| Degree Utilization, x | 0.38 | 0.19 | 0.66 | 0.08 | 0.63 | 0.15 | 0.39 |
| Capacity (veh/h) | 472 | 513 | 497 | 537 | 491 | 535 | 450 |
| Control Delay (s) | 13.4 | 9.9 | 21.4 | 8.7 | 20.0 | 9.3 | 15.2 |
| Approach Delay (s) | 12.2 | | 19.9 | | 17.8 | | 15.2 |
| Approach LOS | B | | C | | C | | C |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 16.7 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 68.9% | ICU Level of Service | B |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Volume (veh/h) | 39 | 9 | 245 | 12 | 2 | 168 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 42 | 10 | 266 | 13 | 2 | 183 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 460 | 273 | | | 279 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 460 | 273 | | | 279 | |
| tC, single (s) | 6.4 | 6.2 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 92 | 99 | | | 100 | |
| cM capacity (veh/h) | 559 | 766 | | | 1283 | |

| Direction, Lane # | WB 1 | NB 1 | SB 1 |
|---|---|---|---|
| Volume Total | 52 | 279 | 185 |
| Volume Left | 42 | 0 | 2 |
| Volume Right | 10 | 13 | 0 |
| cSH | 588 | 1700 | 1283 |
| Volume to Capacity | 0.09 | 0.16 | 0.00 |
| Queue Length (ft) | 7 | 0 | 0 |
| Control Delay (s) | 11.7 | 0.0 | 0.1 |
| Lane LOS | B | | A |
| Approach Delay (s) | 11.7 | 0.0 | 0.1 |
| Approach LOS | B | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.2 | | |
| Intersection Capacity Utilization | 24.8% | ICU Level of Service | A |

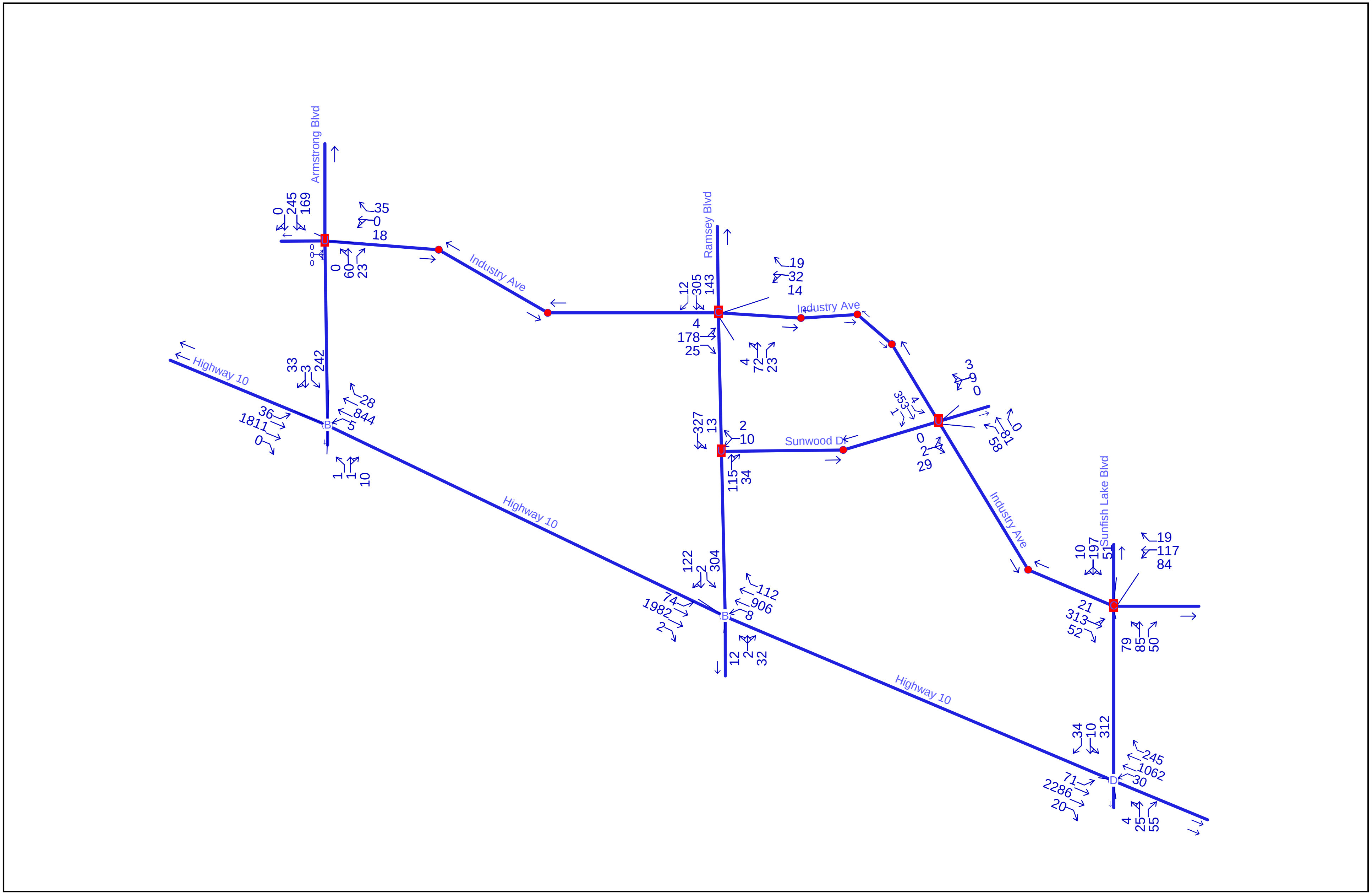
| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 3 | 11 | 59 | 0 | 3 | 9 | 14 | 290 | 0 | 7 | 147 | 0 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 3 | 12 | 64 | 0 | 3 | 10 | 15 | 315 | 0 | 8 | 160 | 0 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 532 | 521 | 160 | 591 | 521 | 315 | 160 | | | 315 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 532 | 521 | 160 | 591 | 521 | 315 | 160 | | | 315 | | |
| tC, single (s) | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 | 4.1 | | | 4.1 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 | 2.2 | | | 2.2 | | |
| p0 queue free % | 99 | 97 | 93 | 100 | 99 | 99 | 99 | | | 99 | | |
| cM capacity (veh/h) | 444 | 452 | 885 | 376 | 452 | 725 | 1419 | | | 1245 | | |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|---|
| Volume Total | 79 | 13 | 15 | 315 | 0 | 8 | 160 | 0 |
| Volume Left | 3 | 0 | 15 | 0 | 0 | 8 | 0 | 0 |
| Volume Right | 64 | 10 | 0 | 0 | 0 | 0 | 0 | 0 |
| cSH | 747 | 630 | 1419 | 1700 | 1700 | 1245 | 1700 | 1700 |
| Volume to Capacity | 0.11 | 0.02 | 0.01 | 0.19 | 0.00 | 0.01 | 0.09 | 0.00 |
| Queue Length (ft) | 9 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 10.4 | 10.8 | 7.6 | 0.0 | 0.0 | 7.9 | 0.0 | 0.0 |
| Lane LOS | B | B | A | | | A | | |
| Approach Delay (s) | 10.4 | 10.8 | 0.3 | | | 0.4 | | |
| Approach LOS | B | B | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.9 | | |
| Intersection Capacity Utilization | 28.1% | ICU Level of Service | A |

**Map - Ramsey AUAR**
**Levels of Service**

**Timing Plan: AM Peak**
**Ramsey AUAR AM Future Base (2007)**




**03/19/2003**
**Meyer, Mohaddes Associates Inc.**

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | 1.00 | 1.00 | | 1.00 | 1.00 | 0.85 | 1.00 | 0.86 | | 1.00 | 0.86 | |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | 1770 | 3539 | | 1770 | 3539 | 1583 | 1770 | 1607 | | 1770 | 1605 | |
| Flt Permitted | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.73 | 1.00 | | 0.75 | 1.00 | |
| Satd. Flow (perm) | 1770 | 3539 | | 1770 | 3539 | 1583 | 1363 | 1607 | | 1397 | 1605 | |
| Volume (vph) | 36 | 1811 | 0 | 5 | 844 | 28 | 1 | 1 | 10 | 242 | 3 | 33 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 39 | 1968 | 0 | 5 | 917 | 30 | 1 | 1 | 11 | 263 | 3 | 36 |
| Lane Group Flow (vph) | 39 | 1968 | 0 | 5 | 917 | 30 | 1 | 12 | 0 | 263 | 39 | 0 |
| Turn Type | Prot | | Perm | Prot | | Perm | Perm | | | Perm | | |
| Protected Phases | 5 | 2 | | 1 | 6 | | | 8 | | | 4 | |
| Permitted Phases | | | 2 | | | 6 | 8 | | | 4 | | |
| Actuated Green, G (s) | 4.8 | 79.5 | | 1.2 | 75.9 | 75.9 | 26.8 | 26.8 | | 26.8 | 26.8 | |
| Effective Green, g (s) | 4.8 | 83.0 | | 1.2 | 79.4 | 79.4 | 28.8 | 28.8 | | 28.8 | 28.8 | |
| Actuated g/C Ratio | 0.04 | 0.66 | | 0.01 | 0.64 | 0.64 | 0.23 | 0.23 | | 0.23 | 0.23 | |
| Clearance Time (s) | 4.0 | 7.5 | | 4.0 | 7.5 | 7.5 | 6.0 | 6.0 | | 6.0 | 6.0 | |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 68 | 2350 | | 17 | 2248 | 1006 | 314 | 370 | | 322 | 370 | |
| v/s Ratio Prot | 0.02 | c0.56 | | 0.00 | c0.26 | | | 0.01 | | | 0.02 | |
| v/s Ratio Perm | | | | | | 0.02 | 0.00 | | | c0.19 | | |
| v/c Ratio | 0.57 | 0.84 | | 0.29 | 0.41 | 0.03 | 0.00 | 0.03 | | 0.82 | 0.11 | |
| Uniform Delay, d1 | 59.1 | 15.9 | | 61.5 | 11.2 | 8.5 | 37.0 | 37.3 | | 45.6 | 37.9 | |
| Progression Factor | 1.00 | 1.00 | | 0.94 | 0.37 | 0.18 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 11.2 | 3.8 | | 8.6 | 0.5 | 0.1 | 0.0 | 0.0 | | 14.7 | 0.1 | |
| Delay (s) | 70.3 | 19.6 | | 66.3 | 4.7 | 1.6 | 37.0 | 37.3 | | 60.3 | 38.1 | |
| Level of Service | E | B | | E | A | A | D | D | | E | D | |
| Approach Delay (s) | | 20.6 | | | 4.9 | | | 37.3 | | | 57.4 | |
| Approach LOS | | C | | | A | | | D | | | E | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 19.5 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.81 | | |
| Actuated Cycle Length (s) | 125.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 82.3% | ICU Level of Service | D |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 1.00 | | 1.00 | 1.00 | |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | | 0.91 | | 1.00 | 0.85 | |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | | 0.99 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 | | 1665 | | 1770 | 1587 | |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | | 0.92 | | 0.75 | 1.00 | |
| Satd. Flow (perm) | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 | | 1554 | | 1398 | 1587 | |
| Volume (vph) | 74 | 1982 | 2 | 8 | 906 | 112 | 12 | 2 | 32 | 304 | 2 | 122 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 80 | 2154 | 2 | 9 | 985 | 122 | 13 | 2 | 35 | 330 | 2 | 133 |
| Lane Group Flow (vph) | 80 | 2154 | 2 | 9 | 985 | 122 | 0 | 50 | 0 | 330 | 135 | 0 |
| Turn Type | Prot | | Perm | Prot | | Perm | Perm | | | Perm | | |
| Protected Phases | 1 | 6 | | 5 | 2 | | | 8 | | | 4 | |
| Permitted Phases | | | 6 | | | 2 | 8 | | | 4 | | |
| Actuated Green, G (s) | 11.2 | 78.2 | 78.2 | 0.8 | 67.8 | 67.8 | | 28.0 | | 28.0 | 28.0 | |
| Effective Green, g (s) | 11.2 | 81.2 | 81.2 | 0.8 | 70.8 | 70.8 | | 31.0 | | 31.0 | 31.0 | |
| Actuated g/C Ratio | 0.09 | 0.65 | 0.65 | 0.01 | 0.57 | 0.57 | | 0.25 | | 0.25 | 0.25 | |
| Clearance Time (s) | 4.0 | 7.0 | 7.0 | 4.0 | 7.0 | 7.0 | | 7.0 | | 7.0 | 7.0 | |
| Vehicle Extension (s) | 3.0 | 6.0 | 6.0 | 3.0 | 6.0 | 6.0 | | 6.0 | | 6.0 | 6.0 | |
| Lane Grp Cap (vph) | 159 | 2299 | 1028 | 11 | 2004 | 897 | | 385 | | 347 | 394 | |
| v/s Ratio Prot | c0.05 | c0.61 | | 0.01 | 0.28 | | | | | | 0.09 | |
| v/s Ratio Perm | | | 0.00 | | | 0.08 | | 0.03 | | c0.24 | | |
| v/c Ratio | 0.50 | 0.94 | 0.00 | 0.82 | 0.49 | 0.14 | | 0.13 | | 0.95 | 0.34 | |
| Uniform Delay, d1 | 54.2 | 19.6 | 7.7 | 62.0 | 16.3 | 12.7 | | 36.5 | | 46.3 | 38.6 | |
| Progression Factor | 0.83 | 0.51 | 0.28 | 0.88 | 0.22 | 0.02 | | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 1.5 | 5.7 | 0.0 | 153.8 | 0.7 | 0.3 | | 0.4 | | 36.7 | 1.5 | |
| Delay (s) | 46.7 | 15.7 | 2.2 | 208.2 | 4.3 | 0.6 | | 37.0 | | 82.9 | 40.1 | |
| Level of Service | D | B | A | F | A | A | | D | | F | D | |
| Approach Delay (s) | | 16.8 | | | 5.5 | | | 37.0 | | | 70.5 | |
| Approach LOS | | B | | | A | | | D | | | E | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 20.2 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.92 | | |
| Actuated Cycle Length (s) | 125.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 97.9% | ICU Level of Service | E |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 |
| Lane Util. Factor | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | | 1.00 | 0.85 | | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | | 0.99 | 1.00 | | 0.95 | 1.00 |
| Satd. Flow (prot) | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 | | 1851 | 1583 | | 1777 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | | 0.94 | 1.00 | | 0.71 | 1.00 |
| Satd. Flow (perm) | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 | | 1742 | 1583 | | 1323 | 1583 |
| Volume (vph) | 71 | 2286 | 20 | 30 | 1062 | 245 | 4 | 25 | 55 | 312 | 10 | 34 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 77 | 2485 | 22 | 33 | 1154 | 266 | 4 | 27 | 60 | 339 | 11 | 37 |
| Lane Group Flow (vph) | 77 | 2485 | 22 | 33 | 1154 | 266 | 0 | 31 | 60 | 0 | 350 | 37 |
| Turn Type | Prot | | Perm | Prot | | Perm | Perm | | Perm | Perm | | Perm |
| Protected Phases | 1 | 6 | | 5 | 2 | | | 8 | | | 4 | |
| Permitted Phases | | | 6 | | | 2 | 8 | | 8 | 4 | | 4 |
| Actuated Green, G (s) | 8.6 | 76.4 | 76.4 | 3.6 | 71.4 | 71.4 | | 28.5 | 28.5 | | 27.5 | 27.5 |
| Effective Green, g (s) | 8.6 | 79.4 | 79.4 | 3.6 | 74.4 | 74.4 | | 30.0 | 30.0 | | 30.0 | 30.0 |
| Actuated g/C Ratio | 0.07 | 0.64 | 0.64 | 0.03 | 0.60 | 0.60 | | 0.24 | 0.24 | | 0.24 | 0.24 |
| Clearance Time (s) | 4.0 | 7.0 | 7.0 | 4.0 | 7.0 | 7.0 | | 5.5 | 5.5 | | 6.5 | 6.5 |
| Vehicle Extension (s) | 3.0 | 5.5 | 5.5 | 3.0 | 5.5 | 5.5 | | 3.0 | 3.0 | | 4.5 | 4.5 |
| Lane Grp Cap (vph) | 122 | 2248 | 1006 | 51 | 2106 | 942 | | 418 | 380 | | 318 | 380 |
| v/s Ratio Prot | c0.04 | c0.70 | | 0.02 | 0.33 | | | | | | | |
| v/s Ratio Perm | | | 0.01 | | | 0.17 | | 0.02 | 0.04 | | c0.26 | 0.02 |
| v/c Ratio | 0.63 | 1.11 | 0.02 | 0.65 | 0.55 | 0.28 | | 0.07 | 0.16 | | 1.10 | 0.10 |
| Uniform Delay, d1 | 56.7 | 22.8 | 8.4 | 60.1 | 15.2 | 12.3 | | 36.8 | 37.5 | | 47.5 | 37.0 |
| Progression Factor | 0.94 | 0.68 | 0.28 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 |
| Incremental Delay, d2 | 4.8 | 51.0 | 0.0 | 24.8 | 1.0 | 0.8 | | 0.1 | 0.2 | | 80.2 | 0.2 |
| Delay (s) | 57.9 | 66.5 | 2.4 | 84.9 | 16.2 | 13.1 | | 36.8 | 37.7 | | 127.7 | 37.2 |
| Level of Service | E | E | A | F | B | B | | D | D | | F | D |
| Approach Delay (s) | | 65.7 | | | 17.2 | | | 37.4 | | | 119.1 | |
| Approach LOS | | E | | | B | | | D | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 54.1 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 1.07 | | |
| Actuated Cycle Length (s) | 125.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 109.7% | ICU Level of Service | F |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 0 | 0 | 0 | 18 | 0 | 35 | 0 | 60 | 23 | 169 | 245 | 0 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 0 | 0 | 0 | 20 | 0 | 38 | 0 | 65 | 25 | 184 | 266 | 0 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | 8 | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 718 | 724 | 133 | 566 | 699 | 65 | 266 | | | 90 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 718 | 724 | 133 | 566 | 699 | 65 | 266 | | | 90 | | |
| tC, single (s) | 7.5 | 6.5 | 6.9 | 7.5 | 6.5 | 6.9 | 4.1 | | | 4.1 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 | 2.2 | | | 2.2 | | |
| p0 queue free % | 100 | 100 | 100 | 95 | 100 | 96 | 100 | | | 88 | | |
| cM capacity (veh/h) | 276 | 308 | 891 | 369 | 318 | 985 | 1295 | | | 1503 | | |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 |
|---|---|---|---|---|---|---|
| Volume Total | 0 | 58 | 65 | 25 | 317 | 133 |
| Volume Left | 0 | 20 | 0 | 0 | 184 | 0 |
| Volume Right | 0 | 38 | 0 | 25 | 0 | 0 |
| cSH | 1700 | 1086 | 1295 | 1700 | 1503 | 1700 |
| Volume to Capacity | 0.00 | 0.05 | 0.00 | 0.01 | 0.12 | 0.08 |
| Queue Length (ft) | 0 | 4 | 0 | 0 | 10 | 0 |
| Control Delay (s) | 0.0 | 11.0 | 0.0 | 0.0 | 4.9 | 0.0 |
| Lane LOS | A | B | | | A | |
| Approach Delay (s) | 0.0 | 11.0 | 0.0 | | 3.5 | |
| Approach LOS | A | B | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 3.7 | | |
| Intersection Capacity Utilization | 26.8% | ICU Level of Service | A |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (veh/h) | 4 | 178 | 25 | 14 | 32 | 19 | 4 | 72 | 23 | 143 | 305 | 12 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 4 | 193 | 27 | 15 | 35 | 21 | 4 | 78 | 25 | 155 | 332 | 13 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | NB 2 | SB 1 | SB 2 |
|---|---|---|---|---|---|---|---|---|
| Volume Total (vph) | 198 | 27 | 50 | 21 | 83 | 25 | 487 | 13 |
| Volume Left (vph) | 4 | 0 | 15 | 0 | 4 | 0 | 155 | 0 |
| Volume Right (vph) | 0 | 27 | 0 | 21 | 0 | 25 | 0 | 13 |
| Hadj (s) | 0.0 | -0.6 | 0.1 | -0.6 | 0.0 | -0.6 | 0.1 | -0.6 |
| Departure Headway (s) | 6.3 | 5.7 | 6.6 | 6.0 | 6.0 | 5.4 | 5.6 | 5.0 |
| Degree Utilization, x | 0.35 | 0.04 | 0.09 | 0.03 | 0.14 | 0.04 | 0.76 | 0.02 |
| Capacity (veh/h) | 535 | 582 | 493 | 542 | 560 | 617 | 628 | 695 |
| Control Delay (s) | 11.4 | 7.8 | 9.1 | 8.0 | 8.8 | 7.4 | 23.1 | 6.9 |
| Approach Delay (s) | 11.0 | | 8.8 | | 8.5 | | 22.7 | |
| Approach LOS | B | | A | | A | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 17.0 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 50.4% | ICU Level of Service | A |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (veh/h) | 21 | 313 | 52 | 84 | 117 | 19 | 79 | 85 | 50 | 51 | 197 | 10 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 23 | 340 | 57 | 91 | 127 | 21 | 86 | 92 | 54 | 55 | 214 | 11 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|---|
| Volume Total (vph) | 363 | 57 | 218 | 21 | 178 | 54 | 280 |
| Volume Left (vph) | 23 | 0 | 91 | 0 | 86 | 0 | 55 |
| Volume Right (vph) | 0 | 57 | 0 | 21 | 0 | 54 | 11 |
| Hadj (s) | 0.0 | -0.6 | 0.1 | -0.6 | 0.1 | -0.6 | 0.1 |
| Departure Headway (s) | 6.7 | 6.0 | 7.0 | 6.3 | 7.2 | 6.5 | 7.0 |
| Degree Utilization, x | 0.67 | 0.09 | 0.43 | 0.04 | 0.36 | 0.10 | 0.55 |
| Capacity (veh/h) | 524 | 567 | 483 | 526 | 461 | 510 | 487 |
| Control Delay (s) | 21.0 | 8.5 | 13.9 | 8.4 | 12.9 | 9.0 | 18.2 |
| Approach Delay (s) | 19.3 | | 13.5 | | 12.0 | | 18.2 |
| Approach LOS | C | | B | | B | | C |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 16.4 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 68.9% | ICU Level of Service | B |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Volume (veh/h) | 10 | 2 | 115 | 34 | 13 | 327 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 11 | 2 | 125 | 37 | 14 | 355 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 527 | 143 | | | 162 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 527 | 143 | | | 162 | |
| tC, single (s) | 6.4 | 6.2 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 98 | 100 | | | 99 | |
| cM capacity (veh/h) | 506 | 904 | | | 1417 | |

| Direction, Lane # | WB 1 | NB 1 | SB 1 |
|---|---|---|---|
| Volume Total | 13 | 162 | 370 |
| Volume Left | 11 | 0 | 14 |
| Volume Right | 2 | 37 | 0 |
| cSH | 546 | 1700 | 1417 |
| Volume to Capacity | 0.02 | 0.10 | 0.01 |
| Queue Length (ft) | 2 | 0 | 1 |
| Control Delay (s) | 11.7 | 0.0 | 0.4 |
| Lane LOS | B | | A |
| Approach Delay (s) | 11.7 | 0.0 | 0.4 |
| Approach LOS | B | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.5 | | |
| Intersection Capacity Utilization | 34.5% | ICU Level of Service | A |

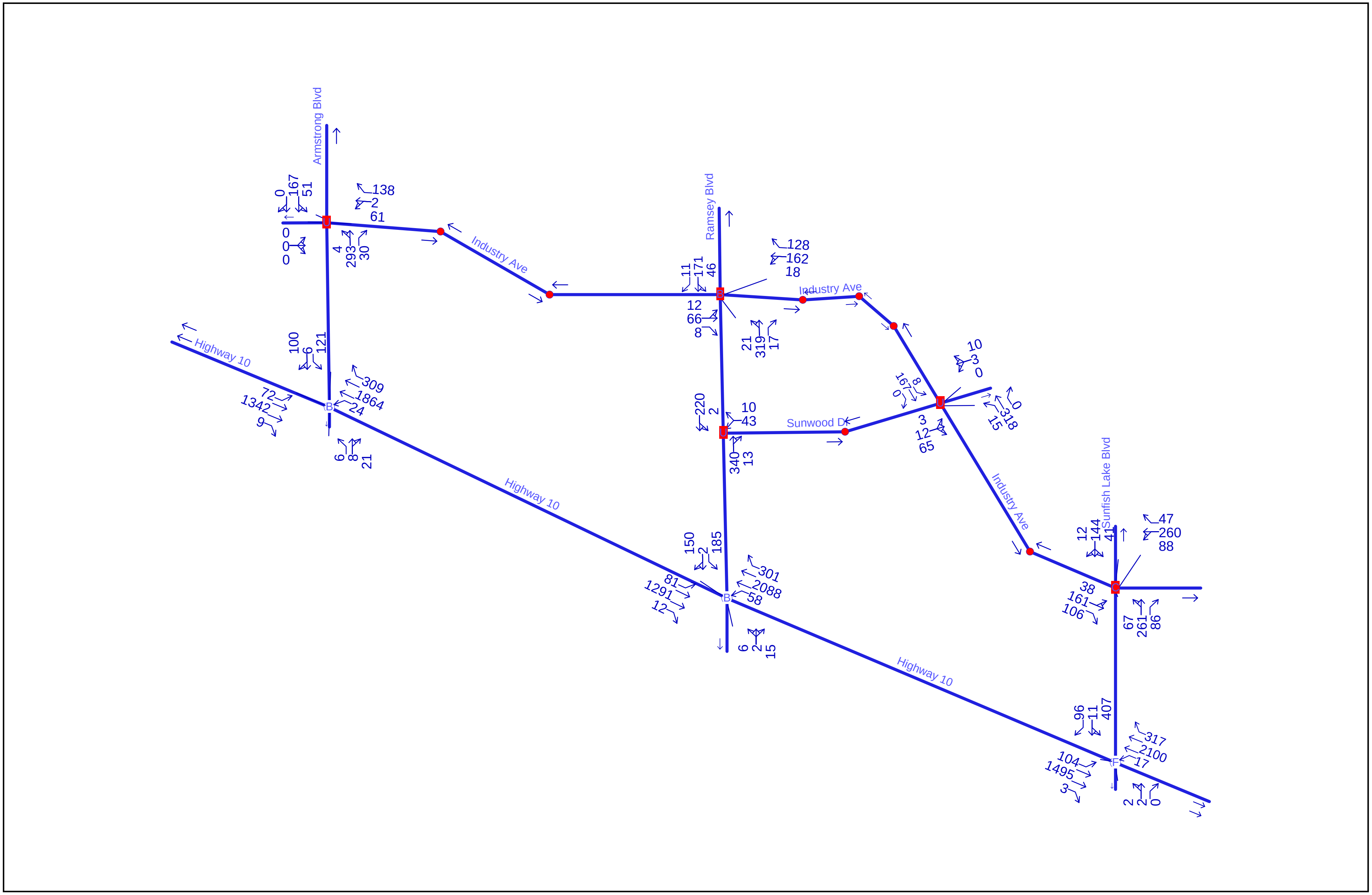
| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 0 | 2 | 29 | 0 | 9 | 3 | 58 | 81 | 0 | 4 | 353 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 0 | 2 | 32 | 0 | 10 | 3 | 63 | 88 | 0 | 4 | 384 | 1 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 615 | 607 | 384 | 639 | 608 | 88 | 385 | | | 88 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 615 | 607 | 384 | 639 | 608 | 88 | 385 | | | 88 | | |
| tC, single (s) | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 | 4.1 | | | 4.1 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 | 2.2 | | | 2.2 | | |
| p0 queue free % | 100 | 99 | 95 | 100 | 97 | 100 | 95 | | | 100 | | |
| cM capacity (veh/h) | 378 | 388 | 664 | 353 | 387 | 970 | 1174 | | | 1508 | | |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|---|
| Volume Total | 34 | 13 | 63 | 88 | 0 | 4 | 384 | 1 |
| Volume Left | 0 | 0 | 63 | 0 | 0 | 4 | 0 | 0 |
| Volume Right | 32 | 3 | 0 | 0 | 0 | 0 | 0 | 1 |
| cSH | 635 | 456 | 1174 | 1700 | 1700 | 1508 | 1700 | 1700 |
| Volume to Capacity | 0.05 | 0.03 | 0.05 | 0.05 | 0.00 | 0.00 | 0.23 | 0.00 |
| Queue Length (ft) | 4 | 2 | 4 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 11.0 | 13.1 | 8.2 | 0.0 | 0.0 | 7.4 | 0.0 | 0.0 |
| Lane LOS | B | B | A | | | A | | |
| Approach Delay (s) | 11.0 | 13.1 | 3.4 | | | 0.1 | | |
| Approach LOS | B | B | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.9 | | |
| Intersection Capacity Utilization | 37.0% | ICU Level of Service | A |

**Map - Ramsey AUAR**
**Levels of Service**

**Timing Plan: PM Peak**
**Ramsey AUAR PM Future Base (2007)**




**03/19/2003**
**Meyer, Mohaddes Associates Inc.**

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 0.89 | | 1.00 | 0.86 | |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 | 1770 | 1662 | | 1770 | 1600 | |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.56 | 1.00 | | 0.74 | 1.00 | |
| Satd. Flow (perm) | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 | 1044 | 1662 | | 1372 | 1600 | |
| Volume (vph) | 72 | 1342 | 9 | 24 | 1864 | 309 | 6 | 8 | 21 | 121 | 6 | 100 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 78 | 1459 | 10 | 26 | 2026 | 336 | 7 | 9 | 23 | 132 | 7 | 109 |
| Lane Group Flow (vph) | 78 | 1459 | 10 | 26 | 2026 | 336 | 7 | 32 | 0 | 132 | 116 | 0 |
| Turn Type | Prot | | Perm | Prot | | Perm | Perm | | | Perm | | |
| Protected Phases | 5 | 2 | | 1 | 6 | | | 8 | | | 4 | |
| Permitted Phases | | | 2 | | | 6 | 8 | | | 4 | | |
| Actuated Green, G (s) | 9.4 | 87.3 | 87.3 | 3.6 | 81.5 | 81.5 | 17.6 | 17.6 | | 16.6 | 16.6 | |
| Effective Green, g (s) | 9.4 | 90.8 | 90.8 | 3.6 | 85.0 | 85.0 | 18.6 | 18.6 | | 18.6 | 18.6 | |
| Actuated g/C Ratio | 0.08 | 0.73 | 0.73 | 0.03 | 0.68 | 0.68 | 0.15 | 0.15 | | 0.15 | 0.15 | |
| Clearance Time (s) | 4.0 | 7.5 | 7.5 | 4.0 | 7.5 | 7.5 | 5.0 | 5.0 | | 6.0 | 6.0 | |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 133 | 2571 | 1150 | 51 | 2407 | 1076 | 155 | 247 | | 204 | 238 | |
| v/s Ratio Prot | 0.04 | c0.41 | | 0.01 | c0.57 | | | 0.02 | | | 0.07 | |
| v/s Ratio Perm | | | 0.01 | | | 0.21 | 0.01 | | | c0.10 | | |
| v/c Ratio | 0.59 | 0.57 | 0.01 | 0.51 | 0.84 | 0.31 | 0.05 | 0.13 | | 0.65 | 0.49 | |
| Uniform Delay, d1 | 55.9 | 8.0 | 4.7 | 59.8 | 15.0 | 8.1 | 45.6 | 46.2 | | 50.1 | 48.8 | |
| Progression Factor | 1.00 | 1.00 | 1.00 | 0.91 | 0.63 | 0.31 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 6.5 | 0.9 | 0.0 | 2.9 | 1.4 | 0.3 | 0.1 | 0.2 | | 6.9 | 1.6 | |
| Delay (s) | 62.4 | 8.9 | 4.7 | 57.1 | 10.9 | 2.8 | 45.7 | 46.4 | | 57.0 | 50.4 | |
| Level of Service | E | A | A | E | B | A | D | D | | E | D | |
| Approach Delay (s) | | 11.5 | | | 10.2 | | | 46.3 | | | 53.9 | |
| Approach LOS | | B | | | B | | | D | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 13.6 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.79 | | |
| Actuated Cycle Length (s) | 125.0 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 85.0% | ICU Level of Service | D |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 1.00 | | 1.00 | 1.00 | |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | | 0.91 | | 1.00 | 0.85 | |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | | 0.99 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 | | 1678 | | 1770 | 1587 | |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.15 | 1.00 | 1.00 | | 0.91 | | 0.74 | 1.00 | |
| Satd. Flow (perm) | 1770 | 3539 | 1583 | 281 | 3539 | 1583 | | 1557 | | 1380 | 1587 | |
| Volume (vph) | 81 | 1291 | 12 | 58 | 2088 | 301 | 6 | 2 | 15 | 185 | 2 | 150 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 88 | 1403 | 13 | 63 | 2270 | 327 | 7 | 2 | 16 | 201 | 2 | 163 |
| Lane Group Flow (vph) | 88 | 1403 | 13 | 63 | 2270 | 327 | 0 | 25 | 0 | 201 | 165 | 0 |
| Turn Type | Prot | | Perm | Perm | | Perm | Perm | | | Perm | | |
| Protected Phases | 1 | 6 | | | 2 | | | 8 | | | 4 | |
| Permitted Phases | | | 6 | 2 | | 2 | 8 | | | 4 | | |
| Actuated Green, G (s) | 7.0 | 91.0 | 91.0 | 80.0 | 80.0 | 80.0 | | 20.0 | | 20.0 | 20.0 | |
| Effective Green, g (s) | 7.0 | 94.0 | 94.0 | 83.0 | 83.0 | 83.0 | | 23.0 | | 23.0 | 23.0 | |
| Actuated g/C Ratio | 0.06 | 0.75 | 0.75 | 0.66 | 0.66 | 0.66 | | 0.18 | | 0.18 | 0.18 | |
| Clearance Time (s) | 4.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | | 7.0 | 7.0 | |
| Vehicle Extension (s) | 3.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | | 6.0 | | 6.0 | 6.0 | |
| Lane Grp Cap (vph) | 99 | 2661 | 1190 | 187 | 2350 | 1051 | | 286 | | 254 | 292 | |
| v/s Ratio Prot | c0.05 | 0.40 | | | c0.64 | | | | | | 0.10 | |
| v/s Ratio Perm | | | 0.01 | 0.22 | | 0.21 | | 0.02 | | c0.15 | | |
| v/c Ratio | 0.89 | 0.53 | 0.01 | 0.34 | 0.97 | 0.31 | | 0.09 | | 0.79 | 0.57 | |
| Uniform Delay, d1 | 58.6 | 6.4 | 3.9 | 9.1 | 19.7 | 8.9 | | 42.3 | | 48.7 | 46.4 | |
| Progression Factor | 0.92 | 0.38 | 0.15 | 0.12 | 0.62 | 0.00 | | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 50.2 | 0.6 | 0.0 | 0.4 | 1.8 | 0.1 | | 0.4 | | 18.4 | 5.1 | |
| Delay (s) | 104.2 | 3.1 | 0.6 | 1.5 | 13.9 | 0.1 | | 42.7 | | 67.1 | 51.6 | |
| Level of Service | F | A | A | A | B | A | | D | | E | D | |
| Approach Delay (s) | | 9.0 | | | 11.9 | | | 42.7 | | | 60.1 | |
| Approach LOS | | A | | | B | | | D | | | E | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 15.0 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.93 | | |
| Actuated Cycle Length (s) | 125.0 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 95.5% | ICU Level of Service | E |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | | 4.0 | 4.0 |
| Lane Util. Factor | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 1.00 | | | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | | 1.00 | | | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | | 0.98 | | | 0.95 | 1.00 |
| Satd. Flow (prot) | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 | | 1817 | | | 1776 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | | 0.75 | | | 0.73 | 1.00 |
| Satd. Flow (perm) | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 | | 1398 | | | 1359 | 1583 |
| Volume (vph) | 104 | 1495 | 3 | 17 | 2100 | 317 | 2 | 2 | 0 | 407 | 11 | 96 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 113 | 1625 | 3 | 18 | 2283 | 345 | 2 | 2 | 0 | 442 | 12 | 104 |
| Lane Group Flow (vph) | 113 | 1625 | 3 | 18 | 2283 | 345 | 0 | 4 | 0 | 0 | 454 | 104 |
| Turn Type | Prot | | Perm | Prot | | Perm | Perm | | Perm | Perm | | Perm |
| Protected Phases | 1 | 6 | | 5 | 2 | | | 8 | | | 4 | |
| Permitted Phases | | | 6 | | | 2 | 8 | | 8 | 4 | | 4 |
| Actuated Green, G (s) | 20.0 | 67.0 | 67.0 | 8.0 | 55.0 | 55.0 | | 29.5 | | | 29.5 | 29.5 |
| Effective Green, g (s) | 23.0 | 70.0 | 70.0 | 11.0 | 58.0 | 58.0 | | 32.0 | | | 32.0 | 32.0 |
| Actuated g/C Ratio | 0.18 | 0.56 | 0.56 | 0.09 | 0.46 | 0.46 | | 0.26 | | | 0.26 | 0.26 |
| Clearance Time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 6.5 | | | 6.5 | 6.5 |
| Vehicle Extension (s) | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | | 3.0 | | | 4.5 | 4.5 |
| Lane Grp Cap (vph) | 326 | 1982 | 886 | 156 | 1642 | 735 | | 358 | | | 348 | 405 |
| v/s Ratio Prot | 0.06 | c0.46 | | 0.01 | c0.65 | | | | | | | |
| v/s Ratio Perm | | | 0.00 | | | 0.22 | | 0.00 | | | c0.33 | 0.07 |
| v/c Ratio | 0.35 | 0.82 | 0.00 | 0.12 | 1.39 | 0.47 | | 0.01 | | | 1.30 | 0.26 |
| Uniform Delay, d1 | 44.5 | 22.4 | 12.1 | 52.5 | 33.5 | 23.0 | | 34.7 | | | 46.5 | 37.0 |
| Progression Factor | 1.19 | 0.73 | 0.87 | 1.00 | 1.00 | 1.00 | | 1.00 | | | 1.00 | 1.00 |
| Incremental Delay, d2 | 1.4 | 3.4 | 0.0 | 0.8 | 179.5 | 2.1 | | 0.0 | | | 156.5 | 0.6 |
| Delay (s) | 54.0 | 19.9 | 10.6 | 53.3 | 213.0 | 25.1 | | 34.7 | | | 203.0 | 37.6 |
| Level of Service | D | B | B | D | F | C | | C | | | F | D |
| Approach Delay (s) | | 22.1 | | | 187.4 | | | 34.7 | | | 172.2 | |
| Approach LOS | | C | | | F | | | C | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 127.4 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.26 | | |
| Actuated Cycle Length (s) | 125.0 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 121.6% | ICU Level of Service | H |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 0 | 0 | 0 | 61 | 2 | 138 | 4 | 293 | 30 | 51 | 167 | 0 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 0 | 0 | 0 | 66 | 2 | 150 | 4 | 318 | 33 | 55 | 182 | 0 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | 8 | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 696 | 652 | 91 | 529 | 620 | 318 | 182 | | | 351 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 696 | 652 | 91 | 529 | 620 | 318 | 182 | | | 351 | | |
| tC, single (s) | 7.5 | 6.5 | 6.9 | 7.5 | 6.5 | 6.9 | 4.1 | | | 4.1 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 | 2.2 | | | 2.2 | | |
| p0 queue free % | 100 | 100 | 100 | 84 | 99 | 78 | 100 | | | 95 | | |
| cM capacity (veh/h) | 245 | 367 | 949 | 417 | 383 | 677 | 1391 | | | 1204 | | |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 |
|---|---|---|---|---|---|---|
| Volume Total | 0 | 218 | 323 | 33 | 146 | 91 |
| Volume Left | 0 | 66 | 4 | 0 | 55 | 0 |
| Volume Right | 0 | 150 | 0 | 33 | 0 | 0 |
| cSH | 1700 | 986 | 1391 | 1700 | 1204 | 1700 |
| Volume to Capacity | 0.00 | 0.22 | 0.00 | 0.02 | 0.05 | 0.05 |
| Queue Length (ft) | 0 | 21 | 0 | 0 | 4 | 0 |
| Control Delay (s) | 0.0 | 12.9 | 0.1 | 0.0 | 3.3 | 0.0 |
| Lane LOS | A | B | A | | A | |
| Approach Delay (s) | 0.0 | 12.9 | 0.1 | | 2.1 | |
| Approach LOS | A | B | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 4.1 | | |
| Intersection Capacity Utilization | 33.0% | ICU Level of Service | A |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (veh/h) | 12 | 66 | 8 | 18 | 162 | 128 | 21 | 319 | 17 | 46 | 171 | 11 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 13 | 72 | 9 | 20 | 176 | 139 | 23 | 347 | 18 | 50 | 186 | 12 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | NB 2 | SB 1 | SB 2 |
|---|---|---|---|---|---|---|---|---|
| Volume Total (vph) | 85 | 9 | 196 | 139 | 370 | 18 | 236 | 12 |
| Volume Left (vph) | 13 | 0 | 20 | 0 | 23 | 0 | 50 | 0 |
| Volume Right (vph) | 0 | 9 | 0 | 139 | 0 | 18 | 0 | 12 |
| Hadj (s) | 0.1 | -0.6 | 0.1 | -0.6 | 0.0 | -0.6 | 0.1 | -0.6 |
| Departure Headway (s) | 6.9 | 6.3 | 6.5 | 5.9 | 6.2 | 5.5 | 6.4 | 5.7 |
| Degree Utilization, x | 0.16 | 0.02 | 0.35 | 0.23 | 0.63 | 0.03 | 0.42 | 0.02 |
| Capacity (veh/h) | 471 | 512 | 518 | 570 | 562 | 617 | 538 | 588 |
| Control Delay (s) | 10.1 | 8.2 | 11.9 | 9.4 | 17.9 | 7.5 | 12.7 | 7.6 |
| Approach Delay (s) | 9.9 | | 10.9 | | 17.4 | | 12.4 | |
| Approach LOS | A | | B | | C | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 13.5 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 55.8% | ICU Level of Service | A |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (veh/h) | 38 | 161 | 106 | 88 | 260 | 47 | 67 | 261 | 86 | 41 | 144 | 12 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 41 | 175 | 115 | 96 | 283 | 51 | 73 | 284 | 93 | 45 | 157 | 13 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|---|
| Volume Total (vph) | 216 | 115 | 378 | 51 | 357 | 93 | 214 |
| Volume Left (vph) | 41 | 0 | 96 | 0 | 73 | 0 | 45 |
| Volume Right (vph) | 0 | 115 | 0 | 51 | 0 | 93 | 13 |
| Hadj (s) | 0.1 | -0.6 | 0.1 | -0.6 | 0.1 | -0.6 | 0.0 |
| Departure Headway (s) | 7.7 | 7.0 | 7.4 | 6.8 | 7.5 | 6.8 | 8.0 |
| Degree Utilization, x | 0.46 | 0.23 | 0.78 | 0.10 | 0.74 | 0.18 | 0.48 |
| Capacity (veh/h) | 445 | 480 | 465 | 507 | 468 | 504 | 416 |
| Control Delay (s) | 15.9 | 10.9 | 31.0 | 9.3 | 27.5 | 10.1 | 18.0 |
| Approach Delay (s) | 14.2 | | 28.4 | | 23.9 | | 18.0 |
| Approach LOS | B | | D | | C | | C |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 22.1 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 75.4% | ICU Level of Service | C |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Volume (veh/h) | 43 | 10 | 340 | 13 | 2 | 220 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 47 | 11 | 370 | 14 | 2 | 239 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 620 | 377 | | | 384 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 620 | 377 | | | 384 | |
| tC, single (s) | 6.4 | 6.2 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 90 | 98 | | | 100 | |
| cM capacity (veh/h) | 451 | 670 | | | 1175 | |

| Direction, Lane # | WB 1 | NB 1 | SB 1 |
|---|---|---|---|
| Volume Total | 58 | 384 | 241 |
| Volume Left | 47 | 0 | 2 |
| Volume Right | 11 | 14 | 0 |
| cSH | 480 | 1700 | 1175 |
| Volume to Capacity | 0.12 | 0.23 | 0.00 |
| Queue Length (ft) | 10 | 0 | 0 |
| Control Delay (s) | 13.5 | 0.0 | 0.1 |
| Lane LOS | B | | A |
| Approach Delay (s) | 13.5 | 0.0 | 0.1 |
| Approach LOS | B | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.2 | | |
| Intersection Capacity Utilization | 30.3% | ICU Level of Service | A |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 3 | 12 | 65 | 0 | 3 | 10 | 15 | 318 | 0 | 8 | 167 | 0 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 3 | 13 | 71 | 0 | 3 | 11 | 16 | 346 | 0 | 9 | 182 | 0 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 590 | 577 | 182 | 654 | 577 | 346 | 182 | | | 346 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 590 | 577 | 182 | 654 | 577 | 346 | 182 | | | 346 | | |
| tC, single (s) | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 | 4.1 | | | 4.1 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 | 2.2 | | | 2.2 | | |
| p0 queue free % | 99 | 97 | 92 | 100 | 99 | 98 | 99 | | | 99 | | |
| cM capacity (veh/h) | 405 | 419 | 861 | 335 | 419 | 697 | 1394 | | | 1213 | | |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|---|
| Volume Total | 87 | 14 | 16 | 346 | 0 | 9 | 182 | 0 |
| Volume Left | 3 | 0 | 16 | 0 | 0 | 9 | 0 | 0 |
| Volume Right | 71 | 11 | 0 | 0 | 0 | 0 | 0 | 0 |
| cSH | 717 | 605 | 1394 | 1700 | 1700 | 1213 | 1700 | 1700 |
| Volume to Capacity | 0.12 | 0.02 | 0.01 | 0.20 | 0.00 | 0.01 | 0.11 | 0.00 |
| Queue Length (ft) | 10 | 2 | 1 | 0 | 0 | 1 | 0 | 0 |
| Control Delay (s) | 10.7 | 11.1 | 7.6 | 0.0 | 0.0 | 8.0 | 0.0 | 0.0 |
| Lane LOS | B | B | A | | | A | | |
| Approach Delay (s) | 10.7 | 11.1 | 0.3 | | | 0.4 | | |
| Approach LOS | B | B | | | | | | |

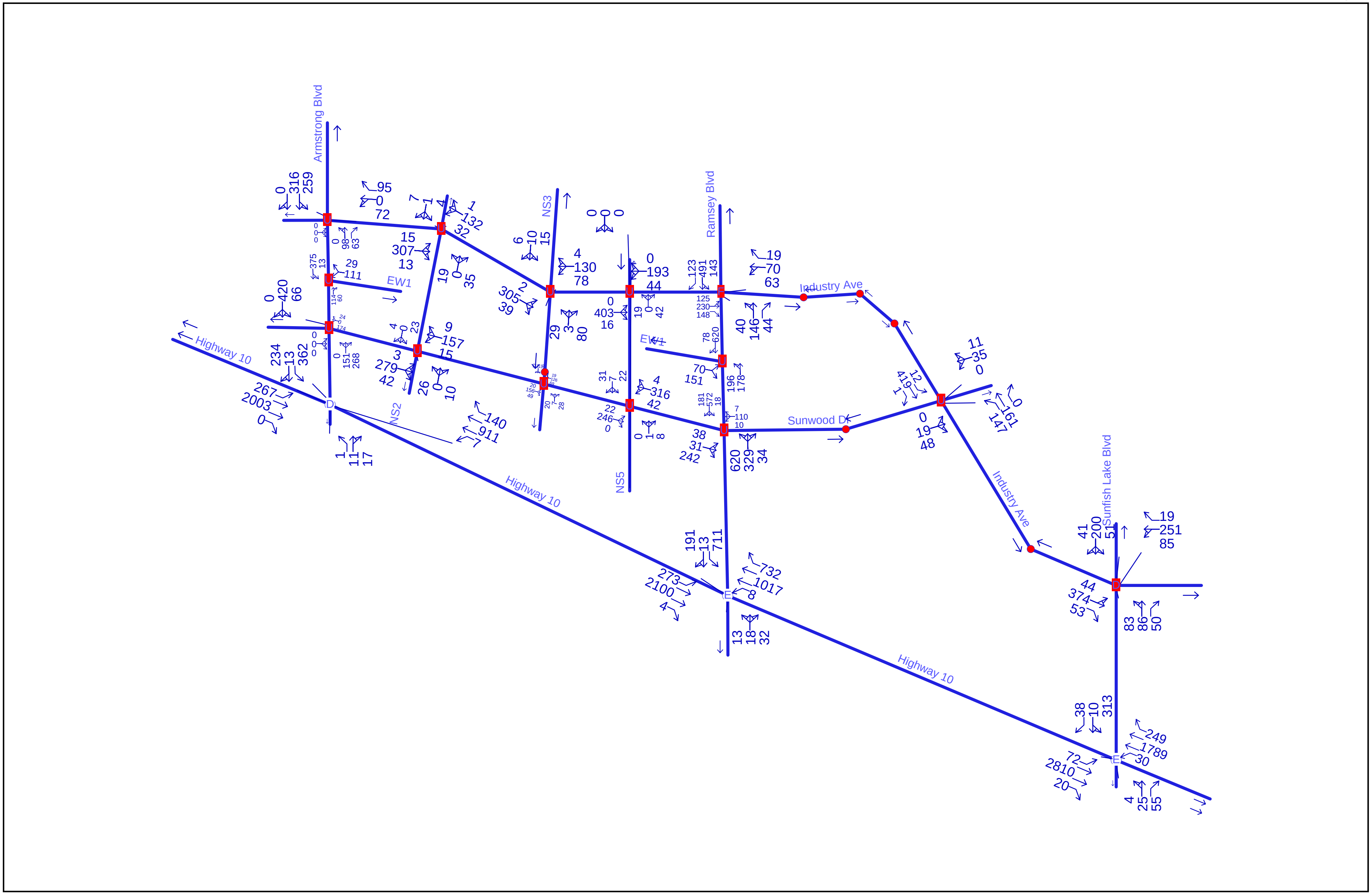
| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.0 | | |
| Intersection Capacity Utilization | 30.2% | ICU Level of Service | A |

**Map - Ramsey AUAR**

**Levels of Service**

**Timing Plan: AM Peak**

**AM Future w Proj (No Mitig)**




**03/24/2003**

**Meyer, Mohaddes Associates Inc.**

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | 1.00 | 1.00 | | 1.00 | 1.00 | 0.85 | 1.00 | 0.91 | | 1.00 | 0.86 | |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | 1770 | 3539 | | 1770 | 3539 | 1583 | 1770 | 1695 | | 1770 | 1598 | |
| Flt Permitted | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.39 | 1.00 | | 0.74 | 1.00 | |
| Satd. Flow (perm) | 1770 | 3539 | | 1770 | 3539 | 1583 | 719 | 1695 | | 1374 | 1598 | |
| Volume (vph) | 267 | 2003 | 0 | 7 | 911 | 140 | 1 | 11 | 17 | 362 | 13 | 234 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 290 | 2177 | 0 | 8 | 990 | 152 | 1 | 12 | 18 | 393 | 14 | 254 |
| Lane Group Flow (vph) | 290 | 2177 | 0 | 8 | 990 | 152 | 1 | 30 | 0 | 393 | 268 | 0 |
| Turn Type | Prot | | Perm | Prot | | Perm | Perm | | | Perm | | |
| Protected Phases | 5 | 2 | | 1 | 6 | | | 8 | | | 4 | |
| Permitted Phases | | | 2 | | | 6 | 8 | | | 4 | | |
| Actuated Green, G (s) | 6.0 | 74.3 | | 1.2 | 69.5 | 69.5 | 32.0 | 32.0 | | 32.0 | 32.0 | |
| Effective Green, g (s) | 6.0 | 77.8 | | 1.2 | 73.0 | 73.0 | 34.0 | 34.0 | | 34.0 | 34.0 | |
| Actuated g/C Ratio | 0.05 | 0.62 | | 0.01 | 0.58 | 0.58 | 0.27 | 0.27 | | 0.27 | 0.27 | |
| Clearance Time (s) | 4.0 | 7.5 | | 4.0 | 7.5 | 7.5 | 6.0 | 6.0 | | 6.0 | 6.0 | |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 85 | 2203 | | 17 | 2067 | 924 | 196 | 461 | | 374 | 435 | |
| v/s Ratio Prot | c0.16 | c0.62 | | 0.00 | c0.28 | | | 0.02 | | | 0.17 | |
| v/s Ratio Perm | | | | | | 0.10 | 0.00 | | | c0.29 | | |
| v/c Ratio | 3.41 | 0.99 | | 0.47 | 0.48 | 0.16 | 0.01 | 0.07 | | 1.05 | 0.62 | |
| Uniform Delay, d1 | 59.5 | 23.1 | | 61.6 | 15.0 | 12.0 | 33.2 | 33.7 | | 45.5 | 39.8 | |
| Progression Factor | 1.00 | 1.00 | | 0.89 | 0.43 | 0.37 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 1114.5 | 16.6 | | 16.6 | 0.7 | 0.3 | 0.0 | 0.1 | | 60.5 | 2.6 | |
| Delay (s) | 1174.0 | 39.7 | | 71.1 | 7.1 | 4.8 | 33.2 | 33.8 | | 106.0 | 42.4 | |
| Level of Service | F | D | | E | A | A | C | C | | F | D | |
| Approach Delay (s) | | 173.1 | | | 7.2 | | | 33.8 | | | 80.2 | |
| Approach LOS | | F | | | A | | | C | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 113.6 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.09 | | |
| Actuated Cycle Length (s) | 125.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 103.6% | ICU Level of Service | F |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 1.00 | | 1.00 | 1.00 | |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | | 0.93 | | 1.00 | 0.86 | |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | | 0.99 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 | | 1718 | | 1770 | 1601 | |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | | 0.92 | | 0.71 | 1.00 | |
| Satd. Flow (perm) | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 | | 1598 | | 1321 | 1601 | |
| Volume (vph) | 273 | 2100 | 4 | 8 | 1017 | 732 | 13 | 18 | 32 | 711 | 13 | 191 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 297 | 2283 | 4 | 9 | 1105 | 796 | 14 | 20 | 35 | 773 | 14 | 208 |
| Lane Group Flow (vph) | 297 | 2283 | 4 | 9 | 1105 | 796 | 0 | 69 | 0 | 773 | 222 | 0 |
| Turn Type | Prot | | Perm | Prot | | Perm | Perm | | | Perm | | |
| Protected Phases | 1 | 6 | | 5 | 2 | | | 8 | | | 4 | |
| Permitted Phases | | | 6 | | | 2 | 8 | | | 4 | | |
| Actuated Green, G (s) | 15.2 | 78.2 | 78.2 | 0.8 | 63.8 | 63.8 | | 28.0 | | 28.0 | 28.0 | |
| Effective Green, g (s) | 15.2 | 81.2 | 81.2 | 0.8 | 66.8 | 66.8 | | 31.0 | | 31.0 | 31.0 | |
| Actuated g/C Ratio | 0.12 | 0.65 | 0.65 | 0.01 | 0.53 | 0.53 | | 0.25 | | 0.25 | 0.25 | |
| Clearance Time (s) | 4.0 | 7.0 | 7.0 | 4.0 | 7.0 | 7.0 | | 7.0 | | 7.0 | 7.0 | |
| Vehicle Extension (s) | 3.0 | 6.0 | 6.0 | 3.0 | 6.0 | 6.0 | | 6.0 | | 6.0 | 6.0 | |
| Lane Grp Cap (vph) | 215 | 2299 | 1028 | 11 | 1891 | 846 | | 396 | | 328 | 397 | |
| v/s Ratio Prot | c0.17 | c0.65 | | 0.01 | 0.31 | | | | | | 0.14 | |
| v/s Ratio Perm | | | 0.00 | | | 0.50 | | 0.04 | | c0.59 | | |
| v/c Ratio | 1.38 | 0.99 | 0.00 | 0.82 | 0.58 | 0.94 | | 0.17 | | 2.36 | 0.56 | |
| Uniform Delay, d1 | 54.9 | 21.6 | 7.7 | 62.0 | 19.7 | 27.3 | | 36.9 | | 47.0 | 41.0 | |
| Progression Factor | 0.84 | 0.41 | 0.27 | 0.72 | 0.30 | 0.67 | | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 180.5 | 8.9 | 0.0 | 100.7 | 0.6 | 10.6 | | 0.6 | | 619.9 | 3.7 | |
| Delay (s) | 226.4 | 17.8 | 2.1 | 145.5 | 6.4 | 28.8 | | 37.5 | | 666.9 | 44.7 | |
| Level of Service | F | B | A | F | A | C | | D | | F | D | |
| Approach Delay (s) | | 41.8 | | | 16.4 | | | 37.5 | | | 528.1 | |
| Approach LOS | | D | | | B | | | D | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 120.1 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.43 | | |
| Actuated Cycle Length (s) | 125.0 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 125.9% | ICU Level of Service | H |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 |
| Lane Util. Factor | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | | 1.00 | 0.85 | | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | | 0.99 | 1.00 | | 0.95 | 1.00 |
| Satd. Flow (prot) | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 | | 1851 | 1583 | | 1777 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | | 0.93 | 1.00 | | 0.71 | 1.00 |
| Satd. Flow (perm) | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 | | 1738 | 1583 | | 1323 | 1583 |
| Volume (vph) | 72 | 2810 | 20 | 30 | 1789 | 249 | 4 | 25 | 55 | 313 | 10 | 38 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 78 | 3054 | 22 | 33 | 1945 | 271 | 4 | 27 | 60 | 340 | 11 | 41 |
| Lane Group Flow (vph) | 78 | 3054 | 22 | 33 | 1945 | 271 | 0 | 31 | 60 | 0 | 351 | 41 |
| Turn Type | Prot | | Perm | Prot | | Perm | Perm | | Perm | Perm | | Perm |
| Protected Phases | 1 | 6 | | 5 | 2 | | | 8 | | | 4 | |
| Permitted Phases | | | 6 | | | 2 | 8 | | 8 | 4 | | 4 |
| Actuated Green, G (s) | 8.6 | 76.4 | 76.4 | 3.6 | 71.4 | 71.4 | | 28.5 | 28.5 | | 27.5 | 27.5 |
| Effective Green, g (s) | 8.6 | 79.4 | 79.4 | 3.6 | 74.4 | 74.4 | | 30.0 | 30.0 | | 30.0 | 30.0 |
| Actuated g/C Ratio | 0.07 | 0.64 | 0.64 | 0.03 | 0.60 | 0.60 | | 0.24 | 0.24 | | 0.24 | 0.24 |
| Clearance Time (s) | 4.0 | 7.0 | 7.0 | 4.0 | 7.0 | 7.0 | | 5.5 | 5.5 | | 6.5 | 6.5 |
| Vehicle Extension (s) | 3.0 | 5.5 | 5.5 | 3.0 | 5.5 | 5.5 | | 3.0 | 3.0 | | 4.5 | 4.5 |
| Lane Grp Cap (vph) | 122 | 2248 | 1006 | 51 | 2106 | 942 | | 417 | 380 | | 318 | 380 |
| v/s Ratio Prot | c0.04 | c0.86 | | 0.02 | 0.55 | | | | | | | |
| v/s Ratio Perm | | | 0.01 | | | 0.17 | | 0.02 | 0.04 | | c0.27 | 0.03 |
| v/c Ratio | 0.64 | 1.36 | 0.02 | 0.65 | 0.92 | 0.29 | | 0.07 | 0.16 | | 1.10 | 0.11 |
| Uniform Delay, d1 | 56.7 | 22.8 | 8.4 | 60.1 | 22.7 | 12.4 | | 36.8 | 37.5 | | 47.5 | 37.1 |
| Progression Factor | 1.04 | 0.96 | 0.70 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 |
| Incremental Delay, d2 | 1.0 | 161.6 | 0.0 | 24.8 | 8.3 | 0.8 | | 0.1 | 0.2 | | 81.3 | 0.2 |
| Delay (s) | 59.8 | 183.4 | 5.9 | 84.9 | 31.1 | 13.1 | | 36.8 | 37.7 | | 128.8 | 37.3 |
| Level of Service | E | F | A | F | C | B | | D | D | | F | D |
| Approach Delay (s) | | 179.1 | | | 29.7 | | | 37.4 | | | 119.2 | |
| Approach LOS | | F | | | C | | | D | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 115.8 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.24 | | |
| Actuated Cycle Length (s) | 125.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 125.5% | ICU Level of Service | H |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 0 | 0 | 0 | 72 | 0 | 95 | 0 | 98 | 63 | 259 | 316 | 0 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 0 | 0 | 0 | 78 | 0 | 103 | 0 | 107 | 68 | 282 | 343 | 0 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | 8 | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 1065 | 1082 | 172 | 841 | 1013 | 107 | 343 | | | 175 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 1065 | 1082 | 172 | 841 | 1013 | 107 | 343 | | | 175 | | |
| tC, single (s) | 7.5 | 6.5 | 6.9 | 7.5 | 6.5 | 6.9 | 4.1 | | | 4.1 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 | 2.2 | | | 2.2 | | |
| p0 queue free % | 100 | 100 | 100 | 64 | 100 | 89 | 100 | | | 80 | | |
| cM capacity (veh/h) | 133 | 173 | 842 | 218 | 190 | 927 | 1212 | | | 1399 | | |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 |
|---|---|---|---|---|---|---|
| Volume Total | 0 | 182 | 107 | 68 | 453 | 172 |
| Volume Left | 0 | 78 | 0 | 0 | 282 | 0 |
| Volume Right | 0 | 103 | 0 | 68 | 0 | 0 |
| cSH | 1700 | 505 | 1212 | 1700 | 1399 | 1700 |
| Volume to Capacity | 0.00 | 0.36 | 0.00 | 0.04 | 0.20 | 0.10 |
| Queue Length (ft) | 0 | 40 | 0 | 0 | 19 | 0 |
| Control Delay (s) | 0.0 | 18.5 | 0.0 | 0.0 | 5.8 | 0.0 |
| Lane LOS | A | C | | | A | |
| Approach Delay (s) | 0.0 | 18.5 | 0.0 | | 4.2 | |
| Approach LOS | A | C | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 6.1 | | |
| Intersection Capacity Utilization | 33.3% | ICU Level of Service | A |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (veh/h) | 125 | 230 | 148 | 63 | 70 | 19 | 40 | 146 | 44 | 143 | 491 | 123 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 136 | 250 | 161 | 68 | 76 | 21 | 43 | 159 | 48 | 155 | 534 | 134 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | NB 2 | SB 1 | SB 2 |
|---|---|---|---|---|---|---|---|---|
| Volume Total (vph) | 386 | 161 | 145 | 21 | 202 | 48 | 689 | 134 |
| Volume Left (vph) | 136 | 0 | 68 | 0 | 43 | 0 | 155 | 0 |
| Volume Right (vph) | 0 | 161 | 0 | 21 | 0 | 48 | 0 | 134 |
| Hadj (s) | 0.1 | -0.6 | 0.1 | -0.6 | 0.1 | -0.6 | 0.1 | -0.6 |
| Departure Headway (s) | 7.6 | 7.0 | 8.4 | 7.7 | 8.0 | 7.4 | 7.4 | 6.7 |
| Degree Utilization, x | 0.82 | 0.31 | 0.34 | 0.04 | 0.45 | 0.10 | 1.41 | 0.25 |
| Capacity (veh/h) | 461 | 507 | 412 | 444 | 426 | 466 | 496 | 522 |
| Control Delay (s) | 35.5 | 11.9 | 14.4 | 9.9 | 16.3 | 10.0 | 216.7 | 10.8 |
| Approach Delay (s) | 28.6 | | 13.9 | | 15.1 | | 183.3 | |
| Approach LOS | D | | B | | C | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 96.6 | | |
| HCM Level of Service | F | | |
| Intersection Capacity Utilization | 89.2% | ICU Level of Service | D |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | ✣ | | | ✣ | | | ✣ | | | ✣ | |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 2 | 305 | 39 | 78 | 130 | 4 | 29 | 3 | 80 | 15 | 10 | 6 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 2 | 332 | 42 | 85 | 141 | 4 | 32 | 3 | 87 | 16 | 11 | 7 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | | | | | | | None | | | None | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 146 | | | 374 | | | 682 | 672 | 353 | 759 | 691 | 143 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 146 | | | 374 | | | 682 | 672 | 353 | 759 | 691 | 143 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 100 | | | 93 | | | 91 | 99 | 87 | 94 | 97 | 99 |
| cM capacity (veh/h) | 1436 | | | 1185 | | | 333 | 349 | 691 | 265 | 341 | 904 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total | 376 | 230 | 122 | 34 |
| Volume Left | 2 | 85 | 32 | 16 |
| Volume Right | 42 | 4 | 87 | 7 |
| cSH | 1436 | 1185 | 530 | 335 |
| Volume to Capacity | 0.00 | 0.07 | 0.23 | 0.10 |
| Queue Length (ft) | 0 | 6 | 22 | 8 |
| Control Delay (s) | 0.1 | 3.5 | 13.8 | 17.0 |
| Lane LOS | A | A | B | C |
| Approach Delay (s) | 0.1 | 3.5 | 13.8 | 17.0 |
| Approach LOS | | | B | C |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 4.0 | | |
| Intersection Capacity Utilization | 54.2% | ICU Level of Service | A |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (veh/h) | 44 | 374 | 53 | 85 | 251 | 19 | 83 | 86 | 50 | 51 | 200 | 41 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 48 | 407 | 58 | 92 | 273 | 21 | 90 | 93 | 54 | 55 | 217 | 45 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|---|
| Volume Total (vph) | 454 | 58 | 365 | 21 | 184 | 54 | 317 |
| Volume Left (vph) | 48 | 0 | 92 | 0 | 90 | 0 | 55 |
| Volume Right (vph) | 0 | 58 | 0 | 21 | 0 | 54 | 45 |
| Hadj (s) | 0.1 | -0.6 | 0.1 | -0.6 | 0.1 | -0.6 | 0.0 |
| Departure Headway (s) | 7.5 | 6.9 | 7.7 | 7.1 | 8.4 | 7.7 | 8.1 |
| Degree Utilization, x | 0.95 | 0.11 | 0.79 | 0.04 | 0.43 | 0.12 | 0.71 |
| Capacity (veh/h) | 454 | 505 | 449 | 484 | 396 | 432 | 420 |
| Control Delay (s) | 55.2 | 9.5 | 32.5 | 9.2 | 16.4 | 10.6 | 28.8 |
| Approach Delay (s) | 50.0 | | 31.3 | | 15.1 | | 28.8 |
| Approach LOS | F | | D | | C | | D |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 34.7 | | |
| HCM Level of Service | D | | |
| Intersection Capacity Utilization | 84.0% | ICU Level of Service | D |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | ✣ | | | ✣ | | | ↱ | | | ↰ | |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 38 | 31 | 242 | 10 | 110 | 7 | 620 | 329 | 34 | 18 | 572 | 181 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 41 | 34 | 263 | 11 | 120 | 8 | 674 | 358 | 37 | 20 | 622 | 197 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 2551 | 2502 | 720 | 2763 | 2582 | 376 | 818 | | | 395 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 2551 | 2502 | 720 | 2763 | 2582 | 376 | 818 | | | 395 | | |
| tC, single (s) | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 | 4.1 | | | 4.1 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 | 2.2 | | | 2.2 | | |
| p0 queue free % | 0 | 0 | 39 | 0 | 0 | 99 | 17 | | | 98 | | |
| cM capacity (veh/h) | 0 | 5 | 428 | 0 | 4 | 670 | 810 | | | 1164 | | |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total | 338 | 138 | 1068 | 838 |
| Volume Left | 41 | 11 | 674 | 20 |
| Volume Right | 263 | 8 | 37 | 197 |
| cSH | 0 | 0 | 810 | 1164 |
| Volume to Capacity | Err | Err | 0.83 | 0.02 |
| Queue Length (ft) | Err | Err | 238 | 1 |
| Control Delay (s) | Err | Err | 28.1 | 0.4 |
| Lane LOS | F | F | D | A |
| Approach Delay (s) | Err | Err | 28.1 | 0.4 |
| Approach LOS | F | F | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | Err | | |
| Intersection Capacity Utilization | 145.1% | ICU Level of Service | H |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 0 | 19 | 48 | 0 | 35 | 11 | 147 | 161 | 0 | 12 | 419 | 1 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 0 | 21 | 52 | 0 | 38 | 12 | 160 | 175 | 0 | 13 | 455 | 1 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 1007 | 976 | 455 | 1039 | 977 | 175 | 457 | | | 175 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 1007 | 976 | 455 | 1039 | 977 | 175 | 457 | | | 175 | | |
| tC, single (s) | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 | 4.1 | | | 4.1 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 | 2.2 | | | 2.2 | | |
| p0 queue free % | 100 | 90 | 91 | 100 | 82 | 99 | 86 | | | 99 | | |
| cM capacity (veh/h) | 165 | 213 | 605 | 156 | 212 | 868 | 1104 | | | 1401 | | |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|---|
| Volume Total | 73 | 50 | 160 | 175 | 0 | 13 | 455 | 1 |
| Volume Left | 0 | 0 | 160 | 0 | 0 | 13 | 0 | 0 |
| Volume Right | 52 | 12 | 0 | 0 | 0 | 0 | 0 | 1 |
| cSH | 397 | 259 | 1104 | 1700 | 1700 | 1401 | 1700 | 1700 |
| Volume to Capacity | 0.18 | 0.19 | 0.14 | 0.10 | 0.00 | 0.01 | 0.27 | 0.00 |
| Queue Length (ft) | 17 | 17 | 13 | 0 | 0 | 1 | 0 | 0 |
| Control Delay (s) | 16.1 | 22.2 | 8.8 | 0.0 | 0.0 | 7.6 | 0.0 | 0.0 |
| Lane LOS | C | C | A | | | A | | |
| Approach Delay (s) | 16.1 | 22.2 | 4.2 | | | 0.2 | | |
| Approach LOS | C | C | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 4.1 | | |
| Intersection Capacity Utilization | 47.1% | ICU Level of Service | A |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 15 | 307 | 13 | 32 | 132 | 1 | 19 | 0 | 35 | 4 | 1 | 7 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 16 | 334 | 14 | 35 | 143 | 1 | 21 | 0 | 38 | 4 | 1 | 8 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | | | | | | | None | | | None | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 145 | | | 348 | | | 595 | 588 | 341 | 625 | 594 | 144 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 145 | | | 348 | | | 595 | 588 | 341 | 625 | 594 | 144 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 99 | | | 97 | | | 95 | 100 | 95 | 99 | 100 | 99 |
| cM capacity (veh/h) | 1438 | | | 1211 | | | 399 | 405 | 702 | 364 | 401 | 903 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total | 364 | 179 | 59 | 13 |
| Volume Left | 16 | 35 | 21 | 4 |
| Volume Right | 14 | 1 | 38 | 8 |
| cSH | 1438 | 1211 | 554 | 566 |
| Volume to Capacity | 0.01 | 0.03 | 0.11 | 0.02 |
| Queue Length (ft) | 1 | 2 | 9 | 2 |
| Control Delay (s) | 0.4 | 1.8 | 12.3 | 11.5 |
| Lane LOS | A | A | B | B |
| Approach Delay (s) | 0.4 | 1.8 | 12.3 | 11.5 |
| Approach LOS | | | B | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.2 | | |
| Intersection Capacity Utilization | 35.6% | ICU Level of Service | A |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 0 | 0 | 0 | 174 | 0 | 24 | 0 | 151 | 268 | 66 | 420 | 0 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 0 | 0 | 0 | 189 | 0 | 26 | 0 | 164 | 291 | 72 | 457 | 0 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | 1007 | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 936 | 1055 | 457 | 910 | 910 | 310 | 457 | | | 455 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 936 | 1055 | 457 | 910 | 910 | 310 | 457 | | | 455 | | |
| tC, single (s) | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 | 4.1 | | | 4.1 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 | 2.2 | | | 2.2 | | |
| p0 queue free % | 100 | 100 | 100 | 22 | 100 | 96 | 100 | | | 94 | | |
| cM capacity (veh/h) | 225 | 211 | 604 | 243 | 257 | 730 | 1104 | | | 1105 | | |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total | 0 | 215 | 455 | 528 |
| Volume Left | 0 | 189 | 0 | 72 |
| Volume Right | 0 | 26 | 291 | 0 |
| cSH | 1700 | 264 | 1104 | 1105 |
| Volume to Capacity | 0.00 | 0.81 | 0.00 | 0.06 |
| Queue Length (ft) | 0 | 161 | 0 | 5 |
| Control Delay (s) | 0.0 | 59.0 | 0.0 | 1.8 |
| Lane LOS | A | F | | A |
| Approach Delay (s) | 0.0 | 59.0 | 0.0 | 1.8 |
| Approach LOS | A | F | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 11.4 | | |
| Intersection Capacity Utilization | 76.6% | ICU Level of Service | C |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 0 | 403 | 16 | 44 | 193 | 0 | 19 | 0 | 42 | 0 | 0 | 0 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 0 | 438 | 17 | 48 | 210 | 0 | 21 | 0 | 46 | 0 | 0 | 0 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | | | | | | | None | | | None | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 210 | | | 455 | | | 752 | 752 | 447 | 798 | 761 | 210 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 210 | | | 455 | | | 752 | 752 | 447 | 798 | 761 | 210 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 100 | | | 96 | | | 93 | 100 | 93 | 100 | 100 | 100 |
| cM capacity (veh/h) | 1361 | | | 1105 | | | 316 | 324 | 612 | 272 | 321 | 830 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total | 455 | 258 | 66 | 0 |
| Volume Left | 0 | 48 | 21 | 0 |
| Volume Right | 17 | 0 | 46 | 0 |
| cSH | 1361 | 1105 | 473 | 1700 |
| Volume to Capacity | 0.00 | 0.04 | 0.14 | 0.00 |
| Queue Length (ft) | 0 | 3 | 12 | 0 |
| Control Delay (s) | 0.0 | 1.9 | 13.8 | 0.0 |
| Lane LOS | | A | B | A |
| Approach Delay (s) | 0.0 | 1.9 | 13.8 | 0.0 |
| Approach LOS | | | B | A |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.8 | | |
| Intersection Capacity Utilization | 51.7% | ICU Level of Service | A |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Volume (veh/h) | 70 | 151 | 196 | 178 | 620 | 78 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 76 | 164 | 213 | 193 | 674 | 85 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 1336 | 716 | 759 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 1336 | 716 | 759 | | | |
| tC, single (s) | 6.4 | 6.2 | 4.1 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 40 | 62 | 75 | | | |
| cM capacity (veh/h) | 127 | 430 | 853 | | | |

| Direction, Lane # | EB 1 | NB 1 | SB 1 |
|---|---|---|---|
| Volume Total | 240 | 407 | 759 |
| Volume Left | 76 | 213 | 0 |
| Volume Right | 164 | 0 | 85 |
| cSH | 245 | 853 | 1700 |
| Volume to Capacity | 0.98 | 0.25 | 0.45 |
| Queue Length (ft) | 230 | 25 | 0 |
| Control Delay (s) | 96.1 | 7.0 | 0.0 |
| Lane LOS | F | A | |
| Approach Delay (s) | 96.1 | 7.0 | 0.0 |
| Approach LOS | F | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 18.5 | | |
| Intersection Capacity Utilization | 86.9% | ICU Level of Service | D |

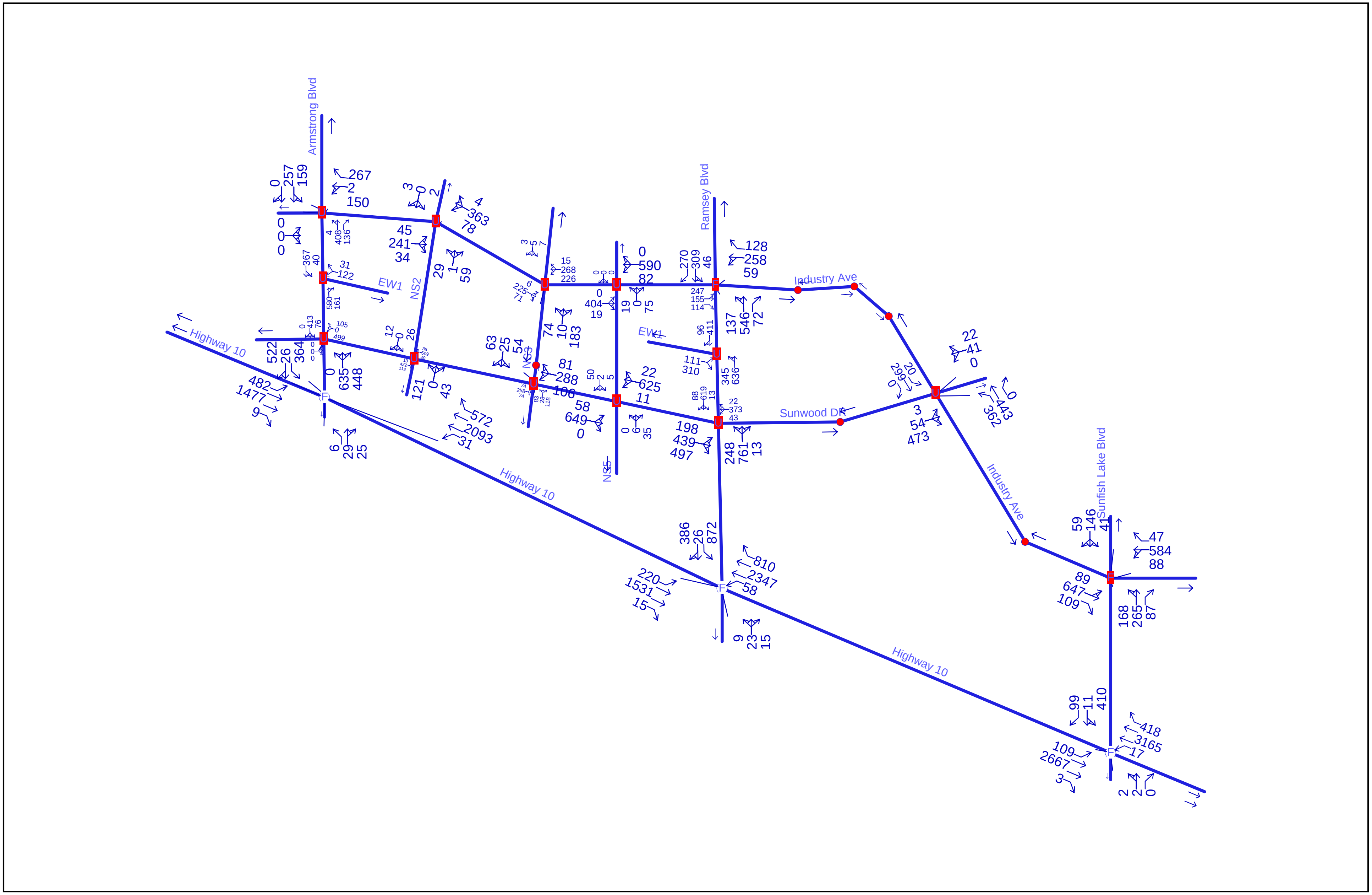
| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Volume (veh/h) | 111 | 29 | 114 | 60 | 13 | 375 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 121 | 32 | 124 | 65 | 14 | 408 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 592 | 157 | | | 189 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 592 | 157 | | | 189 | |
| tC, single (s) | 6.4 | 6.2 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 74 | 96 | | | 99 | |
| cM capacity (veh/h) | 464 | 889 | | | 1385 | |

| Direction, Lane # | WB 1 | NB 1 | SB 1 |
|---|---|---|---|
| Volume Total | 152 | 189 | 422 |
| Volume Left | 121 | 0 | 14 |
| Volume Right | 32 | 65 | 0 |
| cSH | 515 | 1700 | 1385 |
| Volume to Capacity | 0.30 | 0.11 | 0.01 |
| Queue Length (ft) | 31 | 0 | 1 |
| Control Delay (s) | 14.9 | 0.0 | 0.4 |
| Lane LOS | B | | A |
| Approach Delay (s) | 14.9 | 0.0 | 0.4 |
| Approach LOS | B | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 3.2 | | |
| Intersection Capacity Utilization | 43.3% | ICU Level of Service | A |

**Map - Ramsey AUAR**
**Levels of Service**

**Timing Plan: PM Peak**
**Ramsey AUAR PM Future w Proj (No Mitig)**




**03/24/2003**
**Meyer, Mohaddes Associates Inc.**

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 0.93 | | 1.00 | 0.86 | |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 | 1770 | 1735 | | 1770 | 1596 | |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.12 | 1.00 | | 0.72 | 1.00 | |
| Satd. Flow (perm) | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 | 219 | 1735 | | 1338 | 1596 | |
| Volume (vph) | 482 | 1477 | 9 | 31 | 2093 | 572 | 6 | 29 | 25 | 364 | 26 | 522 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 524 | 1605 | 10 | 34 | 2275 | 622 | 7 | 32 | 27 | 396 | 28 | 567 |
| Lane Group Flow (vph) | 524 | 1605 | 10 | 34 | 2275 | 622 | 7 | 59 | 0 | 396 | 595 | 0 |
| Turn Type | Prot | | Perm | Prot | | Perm | Perm | | | Perm | | |
| Protected Phases | 5 | 2 | | 1 | 6 | | | 8 | | | 4 | |
| Permitted Phases | | | 2 | | | 6 | 8 | | | 4 | | |
| Actuated Green, G (s) | 16.0 | 71.9 | 71.9 | 3.6 | 59.5 | 59.5 | 33.0 | 33.0 | | 32.0 | 32.0 | |
| Effective Green, g (s) | 16.0 | 75.4 | 75.4 | 3.6 | 63.0 | 63.0 | 34.0 | 34.0 | | 34.0 | 34.0 | |
| Actuated g/C Ratio | 0.13 | 0.60 | 0.60 | 0.03 | 0.50 | 0.50 | 0.27 | 0.27 | | 0.27 | 0.27 | |
| Clearance Time (s) | 4.0 | 7.5 | 7.5 | 4.0 | 7.5 | 7.5 | 5.0 | 5.0 | | 6.0 | 6.0 | |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 227 | 2135 | 955 | 51 | 1784 | 798 | 60 | 472 | | 364 | 434 | |
| v/s Ratio Prot | c0.30 | 0.45 | | 0.02 | c0.64 | | | 0.03 | | | c0.37 | |
| v/s Ratio Perm | | | 0.01 | | | 0.39 | 0.03 | | | 0.30 | | |
| v/c Ratio | 2.31 | 0.75 | 0.01 | 0.67 | 1.28 | 0.78 | 0.12 | 0.12 | | 1.09 | 1.37 | |
| Uniform Delay, d1 | 54.5 | 18.0 | 9.9 | 60.1 | 31.0 | 25.3 | 34.2 | 34.3 | | 45.5 | 45.5 | |
| Progression Factor | 1.00 | 1.00 | 1.00 | 0.98 | 0.95 | 0.79 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 602.4 | 2.5 | 0.0 | 3.0 | 124.3 | 0.7 | 0.9 | 0.1 | | 72.8 | 181.1 | |
| Delay (s) | 656.9 | 20.5 | 9.9 | 61.9 | 153.8 | 20.7 | 35.1 | 34.4 | | 118.3 | 226.6 | |
| Level of Service | F | C | A | E | F | C | D | C | | F | F | |
| Approach Delay (s) | | 176.4 | | | 124.5 | | | 34.5 | | | 183.3 | |
| Approach LOS | | F | | | F | | | C | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 151.1 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.45 | | |
| Actuated Cycle Length (s) | 125.0 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 138.5% | ICU Level of Service | H |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 1.00 | | 1.00 | 1.00 | |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | | 0.96 | | 1.00 | 0.86 | |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | | 0.99 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 | | 1767 | | 1770 | 1601 | |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.10 | 1.00 | 1.00 | | 0.38 | | 0.74 | 1.00 | |
| Satd. Flow (perm) | 1770 | 3539 | 1583 | 190 | 3539 | 1583 | | 687 | | 1385 | 1601 | |
| Volume (vph) | 220 | 1531 | 15 | 58 | 2347 | 810 | 9 | 23 | 15 | 872 | 26 | 386 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 239 | 1664 | 16 | 63 | 2551 | 880 | 10 | 25 | 16 | 948 | 28 | 420 |
| Lane Group Flow (vph) | 239 | 1664 | 16 | 63 | 2551 | 880 | 0 | 51 | 0 | 948 | 448 | 0 |
| Turn Type | Prot | | Perm | Perm | | Perm | Perm | | | Perm | | |
| Protected Phases | 1 | 6 | | | 2 | | | 8 | | | 4 | |
| Permitted Phases | | | 6 | 2 | | 2 | 8 | | | 4 | | |
| Actuated Green, G (s) | 7.0 | 91.0 | 91.0 | 80.0 | 80.0 | 80.0 | | 20.0 | | 20.0 | 20.0 | |
| Effective Green, g (s) | 7.0 | 94.0 | 94.0 | 83.0 | 83.0 | 83.0 | | 23.0 | | 23.0 | 23.0 | |
| Actuated g/C Ratio | 0.06 | 0.75 | 0.75 | 0.66 | 0.66 | 0.66 | | 0.18 | | 0.18 | 0.18 | |
| Clearance Time (s) | 4.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 7.0 | | 7.0 | 7.0 | |
| Vehicle Extension (s) | 3.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | | 6.0 | | 6.0 | 6.0 | |
| Lane Grp Cap (vph) | 99 | 2661 | 1190 | 126 | 2350 | 1051 | | 126 | | 255 | 295 | |
| v/s Ratio Prot | c0.14 | 0.47 | | | c0.72 | | | | | | 0.28 | |
| v/s Ratio Perm | | | 0.01 | 0.33 | | 0.56 | | 0.07 | | c0.68 | | |
| v/c Ratio | 2.41 | 0.63 | 0.01 | 0.50 | 1.09 | 0.84 | | 0.40 | | 3.72 | 1.52 | |
| Uniform Delay, d1 | 59.0 | 7.3 | 3.9 | 10.6 | 21.0 | 15.9 | | 45.0 | | 51.0 | 51.0 | |
| Progression Factor | 0.89 | 0.34 | 0.22 | 0.41 | 0.91 | 1.43 | | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 653.8 | 0.6 | 0.0 | 1.3 | 39.3 | 0.8 | | 5.9 | | 1232.5 | 250.1 | |
| Delay (s) | 706.2 | 3.1 | 0.9 | 5.6 | 58.5 | 23.5 | | 50.9 | | 1283.5 | 301.1 | |
| Level of Service | F | A | A | A | E | C | | D | | F | F | |
| Approach Delay (s) | | 90.7 | | | 48.7 | | | 50.9 | | | 968.2 | |
| Approach LOS | | F | | | D | | | D | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 247.6 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.70 | | |
| Actuated Cycle Length (s) | 125.0 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 152.9% | ICU Level of Service | H |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | | 4.0 | 4.0 |
| Lane Util. Factor | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 1.00 | | | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | | 1.00 | | | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | | 0.98 | | | 0.95 | 1.00 |
| Satd. Flow (prot) | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 | | 1817 | | | 1776 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | | 0.74 | | | 0.73 | 1.00 |
| Satd. Flow (perm) | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 | | 1384 | | | 1359 | 1583 |
| Volume (vph) | 109 | 2667 | 3 | 17 | 3165 | 418 | 2 | 2 | 0 | 410 | 11 | 99 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 118 | 2899 | 3 | 18 | 3440 | 454 | 2 | 2 | 0 | 446 | 12 | 108 |
| Lane Group Flow (vph) | 118 | 2899 | 3 | 18 | 3440 | 454 | 0 | 4 | 0 | 0 | 458 | 108 |
| Turn Type | Prot | | Perm | Prot | | Perm | Perm | | Perm | Perm | | Perm |
| Protected Phases | 1 | 6 | | 5 | 2 | | | 8 | | | 4 | |
| Permitted Phases | | | 6 | | | 2 | 8 | | 8 | 4 | | 4 |
| Actuated Green, G (s) | 20.0 | 67.0 | 67.0 | 8.0 | 55.0 | 55.0 | | 29.5 | | | 29.5 | 29.5 |
| Effective Green, g (s) | 23.0 | 70.0 | 70.0 | 11.0 | 58.0 | 58.0 | | 32.0 | | | 32.0 | 32.0 |
| Actuated g/C Ratio | 0.18 | 0.56 | 0.56 | 0.09 | 0.46 | 0.46 | | 0.26 | | | 0.26 | 0.26 |
| Clearance Time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 6.5 | | | 6.5 | 6.5 |
| Vehicle Extension (s) | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | | 3.0 | | | 4.5 | 4.5 |
| Lane Grp Cap (vph) | 326 | 1982 | 886 | 156 | 1642 | 735 | | 354 | | | 348 | 405 |
| v/s Ratio Prot | 0.07 | c0.82 | | 0.01 | c0.97 | | | | | | | |
| v/s Ratio Perm | | | 0.00 | | | 0.29 | | 0.00 | | | c0.34 | 0.07 |
| v/c Ratio | 0.36 | 1.46 | 0.00 | 0.12 | 2.10 | 0.62 | | 0.01 | | | 1.32 | 0.27 |
| Uniform Delay, d1 | 44.6 | 27.5 | 12.1 | 52.5 | 33.5 | 25.2 | | 34.7 | | | 46.5 | 37.1 |
| Progression Factor | 0.87 | 1.03 | 0.86 | 1.00 | 1.00 | 1.00 | | 1.00 | | | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.2 | 208.5 | 0.0 | 0.8 | 494.8 | 3.9 | | 0.0 | | | 161.2 | 0.6 |
| Delay (s) | 38.8 | 236.9 | 10.5 | 53.3 | 528.3 | 29.0 | | 34.7 | | | 207.7 | 37.7 |
| Level of Service | D | F | B | D | F | C | | C | | | F | D |
| Approach Delay (s) | | 228.9 | | | 468.2 | | | 34.7 | | | 175.3 | |
| Approach LOS | | F | | | F | | | C | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 349.5 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.77 | | |
| Actuated Cycle Length (s) | 125.0 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 153.7% | ICU Level of Service | H |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 0 | 0 | 0 | 150 | 2 | 267 | 4 | 408 | 136 | 159 | 257 | 0 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 0 | 0 | 0 | 163 | 2 | 290 | 4 | 443 | 148 | 173 | 279 | 0 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | 8 | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 1223 | 1225 | 140 | 938 | 1077 | 443 | 279 | | | 591 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 1223 | 1225 | 140 | 938 | 1077 | 443 | 279 | | | 591 | | |
| tC, single (s) | 7.5 | 6.5 | 6.9 | 7.5 | 6.5 | 6.9 | 4.1 | | | 4.1 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 | 2.2 | | | 2.2 | | |
| p0 queue free % | 100 | 100 | 100 | 14 | 99 | 48 | 100 | | | 82 | | |
| cM capacity (veh/h) | 56 | 146 | 883 | 189 | 179 | 562 | 1280 | | | 980 | | |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 |
|---|---|---|---|---|---|---|
| Volume Total | 0 | 455 | 448 | 148 | 312 | 140 |
| Volume Left | 0 | 163 | 4 | 0 | 173 | 0 |
| Volume Right | 0 | 290 | 0 | 148 | 0 | 0 |
| cSH | 1700 | 521 | 1280 | 1700 | 980 | 1700 |
| Volume to Capacity | 0.00 | 0.87 | 0.00 | 0.09 | 0.18 | 0.08 |
| Queue Length (ft) | 0 | 240 | 0 | 0 | 16 | 0 |
| Control Delay (s) | 0.0 | 43.0 | 0.1 | 0.0 | 6.0 | 0.0 |
| Lane LOS | A | E | A | | A | |
| Approach Delay (s) | 0.0 | 43.0 | 0.1 | | 4.2 | |
| Approach LOS | A | E | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 14.3 | | |
| Intersection Capacity Utilization | 55.5% | ICU Level of Service | A |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (veh/h) | 247 | 155 | 114 | 59 | 258 | 128 | 137 | 546 | 72 | 46 | 309 | 270 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 268 | 168 | 124 | 64 | 280 | 139 | 149 | 593 | 78 | 50 | 336 | 293 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | NB 2 | SB 1 | SB 2 |
|---|---|---|---|---|---|---|---|---|
| Volume Total (vph) | 437 | 124 | 345 | 139 | 742 | 78 | 386 | 293 |
| Volume Left (vph) | 268 | 0 | 64 | 0 | 149 | 0 | 50 | 0 |
| Volume Right (vph) | 0 | 124 | 0 | 139 | 0 | 78 | 0 | 293 |
| Hadj (s) | 0.2 | -0.6 | 0.1 | -0.6 | 0.1 | -0.6 | 0.1 | -0.6 |
| Departure Headway (s) | 9.5 | 8.8 | 9.5 | 8.9 | 9.5 | 8.8 | 9.3 | 8.7 |
| Degree Utilization, x | 1.15 | 0.30 | 0.91 | 0.34 | 1.95 | 0.19 | 1.00 | 0.71 |
| Capacity (veh/h) | 392 | 404 | 375 | 401 | 386 | 400 | 386 | 404 |
| Control Delay (s) | 123.6 | 14.3 | 56.5 | 15.2 | 458.7 | 12.7 | 75.2 | 28.9 |
| Approach Delay (s) | 99.5 | | 44.6 | | 416.2 | | 55.2 | |
| Approach LOS | F | | E | | F | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 179.4 | | |
| HCM Level of Service | F | | |
| Intersection Capacity Utilization | 115.3% | ICU Level of Service | G |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 6 | 225 | 71 | 226 | 268 | 15 | 74 | 10 | 183 | 7 | 5 | 3 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 7 | 245 | 77 | 246 | 291 | 16 | 80 | 11 | 199 | 8 | 5 | 3 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | | | | | | | None | | | None | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 308 | | | 322 | | | 1093 | 1095 | 283 | 1291 | 1126 | 299 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 308 | | | 322 | | | 1093 | 1095 | 283 | 1291 | 1126 | 299 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 99 | | | 80 | | | 49 | 94 | 74 | 91 | 97 | 100 |
| cM capacity (veh/h) | 1253 | | | 1238 | | | 157 | 170 | 756 | 83 | 163 | 740 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total | 328 | 553 | 290 | 16 |
| Volume Left | 7 | 246 | 80 | 8 |
| Volume Right | 77 | 16 | 199 | 3 |
| cSH | 1253 | 1238 | 346 | 126 |
| Volume to Capacity | 0.01 | 0.20 | 0.84 | 0.13 |
| Queue Length (ft) | 0 | 18 | 188 | 11 |
| Control Delay (s) | 0.2 | 5.0 | 51.5 | 37.7 |
| Lane LOS | A | A | F | E |
| Approach Delay (s) | 0.2 | 5.0 | 51.5 | 37.7 |
| Approach LOS | | | F | E |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 15.5 | | |
| Intersection Capacity Utilization | 81.8% | ICU Level of Service | D |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (veh/h) | 89 | 647 | 109 | 88 | 584 | 47 | 168 | 265 | 87 | 41 | 146 | 59 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 97 | 703 | 118 | 96 | 635 | 51 | 183 | 288 | 95 | 45 | 159 | 64 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|---|
| Volume Total (vph) | 800 | 118 | 730 | 51 | 471 | 95 | 267 |
| Volume Left (vph) | 97 | 0 | 96 | 0 | 183 | 0 | 45 |
| Volume Right (vph) | 0 | 118 | 0 | 51 | 0 | 95 | 64 |
| Hadj (s) | 0.1 | -0.6 | 0.1 | -0.6 | 0.1 | -0.6 | -0.1 |
| Departure Headway (s) | 8.8 | 8.2 | 8.9 | 8.2 | 8.9 | 8.2 | 9.6 |
| Degree Utilization, x | 1.96 | 0.27 | 1.80 | 0.12 | 1.16 | 0.22 | 0.72 |
| Capacity (veh/h) | 412 | 433 | 411 | 431 | 409 | 432 | 367 |
| Control Delay (s) | 462.0 | 13.0 | 389.3 | 11.1 | 125.1 | 12.3 | 33.6 |
| Approach Delay (s) | 404.1 | | 364.6 | | 106.2 | | 33.6 |
| Approach LOS | F | | F | | F | | D |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 286.3 | | |
| HCM Level of Service | F | | |
| Intersection Capacity Utilization | 134.4% | ICU Level of Service | H |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 198 | 439 | 497 | 43 | 373 | 22 | 248 | 761 | 13 | 13 | 619 | 88 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 215 | 477 | 540 | 47 | 405 | 24 | 270 | 827 | 14 | 14 | 673 | 96 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 2349 | 2129 | 721 | 2901 | 2170 | 834 | 768 | | | 841 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 2349 | 2129 | 721 | 2901 | 2170 | 834 | 768 | | | 841 | | |
| tC, single (s) | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 | 4.1 | | | 4.1 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 | 2.2 | | | 2.2 | | |
| p0 queue free % | 0 | 0 | 0 | 0 | 0 | 94 | 68 | | | 98 | | |
| cM capacity (veh/h) | 0 | 33 | 428 | 0 | 31 | 368 | 846 | | | 794 | | |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total | 1233 | 476 | 1111 | 783 |
| Volume Left | 215 | 47 | 270 | 14 |
| Volume Right | 540 | 24 | 14 | 96 |
| cSH | 0 | 0 | 846 | 794 |
| Volume to Capacity | Err | Err | 0.32 | 0.02 |
| Queue Length (ft) | Err | Err | 34 | 1 |
| Control Delay (s) | Err | Err | 8.1 | 0.5 |
| Lane LOS | F | F | A | A |
| Approach Delay (s) | Err | Err | 8.1 | 0.5 |
| Approach LOS | F | F | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | Err | | |
| Intersection Capacity Utilization | 210.1% | ICU Level of Service | H |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | ✣ | | | ✣ | | ↰ | ↑ | ↱ | ↰ | ↑ | ↱ |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 3 | 54 | 473 | 0 | 41 | 22 | 362 | 443 | 0 | 20 | 299 | 0 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 3 | 59 | 514 | 0 | 45 | 24 | 393 | 482 | 0 | 22 | 325 | 0 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 1683 | 1637 | 325 | 2180 | 1637 | 482 | 325 | | | 482 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 1683 | 1637 | 325 | 2180 | 1637 | 482 | 325 | | | 482 | | |
| tC, single (s) | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 | 4.1 | | | 4.1 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 | 2.2 | | | 2.2 | | |
| p0 queue free % | 87 | 13 | 28 | 100 | 34 | 96 | 68 | | | 98 | | |
| cM capacity (veh/h) | 26 | 67 | 716 | 2 | 67 | 585 | 1235 | | | 1081 | | |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|---|
| Volume Total | 576 | 68 | 393 | 482 | 0 | 22 | 325 | 0 |
| Volume Left | 3 | 0 | 393 | 0 | 0 | 22 | 0 | 0 |
| Volume Right | 514 | 24 | 0 | 0 | 0 | 0 | 0 | 0 |
| cSH | 335 | 97 | 1235 | 1700 | 1700 | 1081 | 1700 | 1700 |
| Volume to Capacity | 1.72 | 0.70 | 0.32 | 0.28 | 0.00 | 0.02 | 0.19 | 0.00 |
| Queue Length (ft) | 902 | 89 | 35 | 0 | 0 | 2 | 0 | 0 |
| Control Delay (s) | 362.7 | 102.6 | 9.3 | 0.0 | 0.0 | 8.4 | 0.0 | 0.0 |
| Lane LOS | F | F | A | | | A | | |
| Approach Delay (s) | 362.7 | 102.6 | 4.2 | | | 0.5 | | |
| Approach LOS | F | F | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 117.8 | | |
| Intersection Capacity Utilization | 85.7% | ICU Level of Service | D |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 45 | 241 | 34 | 78 | 363 | 4 | 29 | 1 | 59 | 2 | 0 | 3 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 49 | 262 | 37 | 85 | 395 | 4 | 32 | 1 | 64 | 2 | 0 | 3 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | | | | | | | None | | | None | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 399 | | | 299 | | | 948 | 947 | 280 | 1009 | 963 | 397 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 399 | | | 299 | | | 948 | 947 | 280 | 1009 | 963 | 397 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 96 | | | 93 | | | 86 | 100 | 92 | 99 | 100 | 100 |
| cM capacity (veh/h) | 1160 | | | 1262 | | | 220 | 233 | 758 | 183 | 228 | 653 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total | 348 | 484 | 97 | 5 |
| Volume Left | 49 | 85 | 32 | 2 |
| Volume Right | 37 | 4 | 64 | 3 |
| cSH | 1160 | 1262 | 416 | 322 |
| Volume to Capacity | 0.04 | 0.07 | 0.23 | 0.02 |
| Queue Length (ft) | 3 | 5 | 22 | 1 |
| Control Delay (s) | 1.5 | 2.0 | 16.3 | 16.4 |
| Lane LOS | A | A | C | C |
| Approach Delay (s) | 1.5 | 2.0 | 16.3 | 16.4 |
| Approach LOS | | | C | C |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 3.4 | | |
| Intersection Capacity Utilization | 62.9% | ICU Level of Service | B |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 0 | 0 | 0 | 499 | 0 | 105 | 0 | 635 | 448 | 76 | 413 | 0 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 0 | 0 | 0 | 542 | 0 | 114 | 0 | 690 | 487 | 83 | 449 | 0 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | 772 | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 1662 | 1791 | 449 | 1548 | 1548 | 934 | 449 | | | 1177 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 1662 | 1791 | 449 | 1548 | 1548 | 934 | 449 | | | 1177 | | |
| tC, single (s) | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 | 4.1 | | | 4.1 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 | 2.2 | | | 2.2 | | |
| p0 queue free % | 100 | 100 | 100 | 0 | 100 | 65 | 100 | | | 86 | | |
| cM capacity (veh/h) | 45 | 70 | 610 | 83 | 98 | 322 | 1111 | | | 593 | | |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total | 0 | 657 | 1177 | 532 |
| Volume Left | 0 | 542 | 0 | 83 |
| Volume Right | 0 | 114 | 487 | 0 |
| cSH | 1700 | 95 | 1111 | 593 |
| Volume to Capacity | 0.00 | 6.89 | 0.00 | 0.14 |
| Queue Length (ft) | 0 | Err | 0 | 12 |
| Control Delay (s) | 0.0 | Err | 0.0 | 3.8 |
| Lane LOS | A | F | | A |
| Approach Delay (s) | 0.0 | Err | 0.0 | 3.8 |
| Approach LOS | A | F | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2776.3 | | |
| Intersection Capacity Utilization | 141.3% | ICU Level of Service | H |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Volume (veh/h) | 122 | 31 | 580 | 161 | 40 | 367 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 133 | 34 | 630 | 175 | 43 | 399 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 1204 | 718 | | | 805 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 1204 | 718 | | | 805 | |
| tC, single (s) | 6.4 | 6.2 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 31 | 92 | | | 95 | |
| cM capacity (veh/h) | 193 | 429 | | | 819 | |

| Direction, Lane # | WB 1 | NB 1 | SB 1 |
|---|---|---|---|
| Volume Total | 166 | 805 | 442 |
| Volume Left | 133 | 0 | 43 |
| Volume Right | 34 | 175 | 0 |
| cSH | 217 | 1700 | 819 |
| Volume to Capacity | 0.77 | 0.47 | 0.05 |
| Queue Length (ft) | 134 | 0 | 4 |
| Control Delay (s) | 61.3 | 0.0 | 1.6 |
| Lane LOS | F | | A |
| Approach Delay (s) | 61.3 | 0.0 | 1.6 |
| Approach LOS | F | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 7.7 | | |
| Intersection Capacity Utilization | 86.6% | ICU Level of Service | D |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 0 | 404 | 19 | 82 | 590 | 0 | 19 | 0 | 75 | 0 | 0 | 0 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 0 | 439 | 21 | 89 | 641 | 0 | 21 | 0 | 82 | 0 | 0 | 0 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | | | | | | | None | | | None | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 641 | | | 460 | | | 1269 | 1269 | 449 | 1351 | 1279 | 641 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 641 | | | 460 | | | 1269 | 1269 | 449 | 1351 | 1279 | 641 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 100 | | | 92 | | | 85 | 100 | 87 | 100 | 100 | 100 |
| cM capacity (veh/h) | 943 | | | 1101 | | | 136 | 155 | 610 | 104 | 152 | 475 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 | SB 1 |
|---|---|---|---|---|
| Volume Total | 460 | 730 | 102 | 0 |
| Volume Left | 0 | 89 | 21 | 0 |
| Volume Right | 21 | 0 | 82 | 0 |
| cSH | 943 | 1101 | 358 | 1700 |
| Volume to Capacity | 0.00 | 0.08 | 0.29 | 0.00 |
| Queue Length (ft) | 0 | 7 | 29 | 0 |
| Control Delay (s) | 0.0 | 2.0 | 19.0 | 0.0 |
| Lane LOS | | A | C | A |
| Approach Delay (s) | 0.0 | 2.0 | 19.0 | 0.0 |
| Approach LOS | | | C | A |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.6 | | |
| Intersection Capacity Utilization | 79.2% | ICU Level of Service | C |

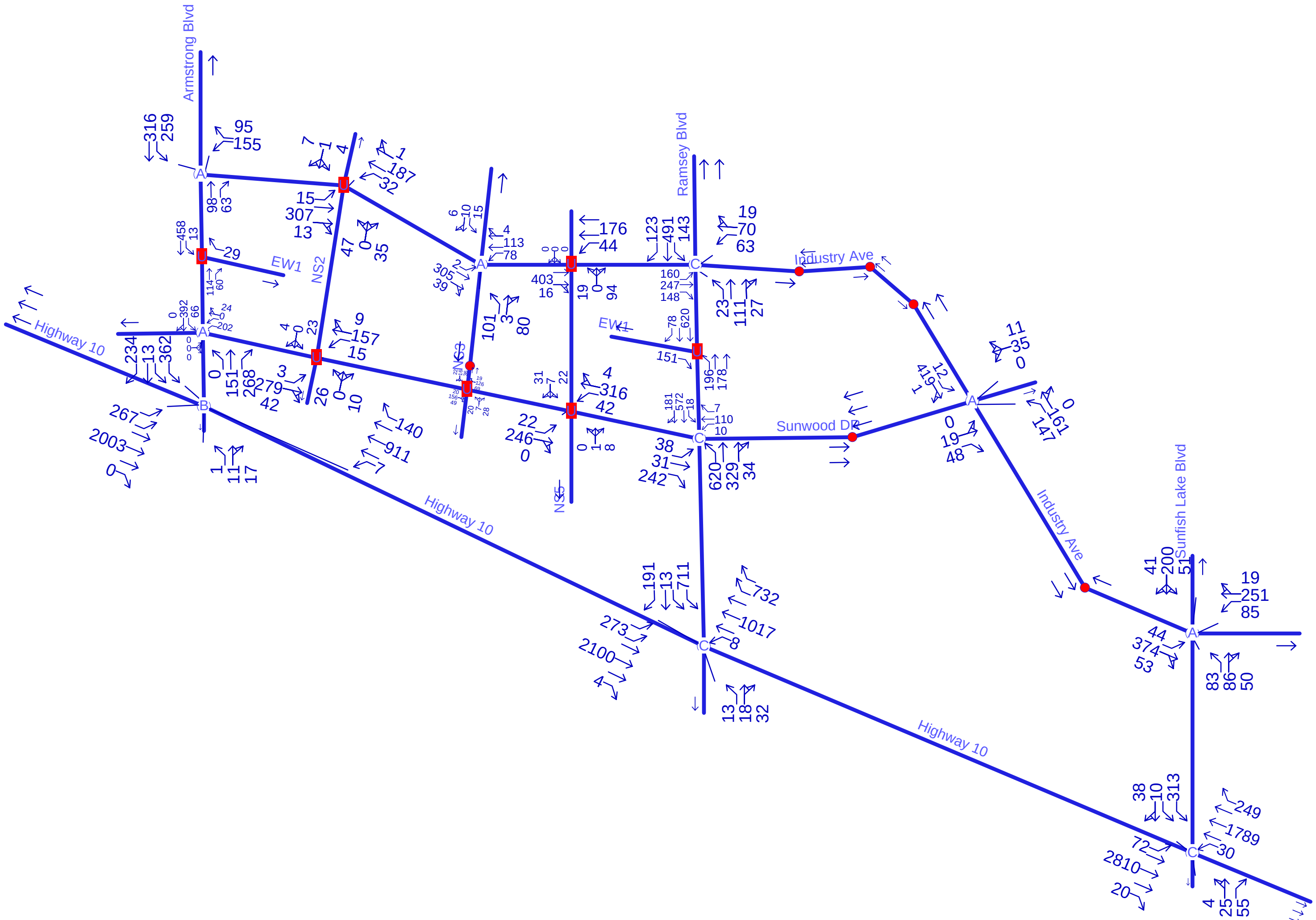
| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Volume (veh/h) | 111 | 310 | 345 | 636 | 411 | 96 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 121 | 337 | 375 | 691 | 447 | 104 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 1940 | 499 | 551 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 1940 | 499 | 551 | | | |
| tC, single (s) | 6.4 | 6.2 | 4.1 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 0 | 41 | 63 | | | |
| cM capacity (veh/h) | 45 | 572 | 1019 | | | |

| Direction, Lane # | EB 1 | NB 1 | SB 1 |
|---|---|---|---|
| Volume Total | 458 | 1066 | 551 |
| Volume Left | 121 | 375 | 0 |
| Volume Right | 337 | 0 | 104 |
| cSH | 141 | 1019 | 1700 |
| Volume to Capacity | 3.25 | 0.37 | 0.32 |
| Queue Length (ft) | Err | 43 | 0 |
| Control Delay (s) | Err | 8.0 | 0.0 |
| Lane LOS | F | A | |
| Approach Delay (s) | Err | 8.0 | 0.0 |
| Approach LOS | F | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2209.2 | | |
| Intersection Capacity Utilization | 124.4% | ICU Level of Service | H |

**Map - Ramsey AUAR**
**Levels of Service**

**Timing Plan: AM Peak**
**Ramsey AUAR AM Future w Proj (Mitigated)**




**03/24/2003**
**Meyer, Mohaddes Associates Inc.**

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| Lane Util. Factor | 0.97 | 0.91 | | 1.00 | 0.91 | 1.00 | 1.00 | 1.00 | | 0.97 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | | 1.00 | 1.00 | 0.85 | 1.00 | 0.91 | | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | 5085 | | 1770 | 5085 | 1583 | 1770 | 1695 | | 3433 | 1863 | 1583 |
| Flt Permitted | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.75 | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | 5085 | | 1770 | 5085 | 1583 | 1394 | 1695 | | 3433 | 1863 | 1583 |
| Volume (vph) | 267 | 2003 | 0 | 7 | 911 | 140 | 1 | 11 | 17 | 362 | 13 | 234 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 290 | 2177 | 0 | 8 | 990 | 152 | 1 | 12 | 18 | 393 | 14 | 254 |
| Lane Group Flow (vph) | 290 | 2177 | 0 | 8 | 990 | 152 | 1 | 30 | 0 | 393 | 14 | 254 |
| Turn Type | Prot | | Perm | Prot | | Perm | Perm | | | Prot | | Free |
| Protected Phases | 5 | 2 | | 1 | 6 | | | 8 | | 7 | 4 | |
| Permitted Phases | | | 2 | | | 6 | 8 | | | | | Free |
| Actuated Green, G (s) | 25.2 | 96.1 | | 1.5 | 72.4 | 72.4 | 10.0 | 10.0 | | 21.9 | 34.9 | 150.0 |
| Effective Green, g (s) | 25.2 | 99.6 | | 1.5 | 75.9 | 75.9 | 11.0 | 11.0 | | 21.9 | 36.9 | 150.0 |
| Actuated g/C Ratio | 0.17 | 0.66 | | 0.01 | 0.51 | 0.51 | 0.07 | 0.07 | | 0.15 | 0.25 | 1.00 |
| Clearance Time (s) | 4.0 | 7.5 | | 4.0 | 7.5 | 7.5 | 5.0 | 5.0 | | 4.0 | 6.0 | |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 577 | 3376 | | 18 | 2573 | 801 | 102 | 124 | | 501 | 458 | 1583 |
| v/s Ratio Prot | 0.08 | c0.43 | | 0.00 | c0.19 | | | c0.02 | | c0.11 | 0.01 | |
| v/s Ratio Perm | | | | | | 0.10 | 0.00 | | | | | 0.16 |
| v/c Ratio | 0.50 | 0.64 | | 0.44 | 0.38 | 0.19 | 0.01 | 0.24 | | 0.78 | 0.03 | 0.16 |
| Uniform Delay, d1 | 56.7 | 14.8 | | 73.8 | 22.7 | 20.2 | 64.4 | 65.6 | | 61.8 | 43.0 | 0.0 |
| Progression Factor | 1.00 | 1.00 | | 1.32 | 0.25 | 0.05 | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.7 | 1.0 | | 15.1 | 0.4 | 0.5 | 0.0 | 1.0 | | 7.9 | 0.0 | 0.2 |
| Delay (s) | 57.4 | 15.8 | | 112.3 | 6.1 | 1.6 | 64.5 | 66.6 | | 69.7 | 43.0 | 0.2 |
| Level of Service | E | B | | F | A | A | E | E | | E | D | A |
| Approach Delay (s) | | 20.7 | | | 6.2 | | | 66.5 | | | 42.4 | |
| Approach LOS | | C | | | A | | | E | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 20.5 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.64 | | |
| Actuated Cycle Length (s) | 150.0 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 75.0% | ICU Level of Service | C |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| Lane Util. Factor | 0.97 | 0.91 | 1.00 | 1.00 | 0.91 | 0.88 | 1.00 | 1.00 | | 0.97 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 0.90 | | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | 5085 | 1583 | 1770 | 5085 | 2787 | 1770 | 1685 | | 3433 | 1863 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | 5085 | 1583 | 1770 | 5085 | 2787 | 1770 | 1685 | | 3433 | 1863 | 1583 |
| Volume (vph) | 273 | 2100 | 4 | 8 | 1017 | 732 | 13 | 18 | 32 | 711 | 13 | 191 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 297 | 2283 | 4 | 9 | 1105 | 796 | 14 | 20 | 35 | 773 | 14 | 208 |
| Lane Group Flow (vph) | 297 | 2283 | 4 | 9 | 1105 | 796 | 14 | 55 | 0 | 773 | 14 | 208 |
| Turn Type | Prot | | Perm | Prot | | Free | Prot | | | Prot | | Free |
| Protected Phases | 1 | 6 | | 5 | 2 | | 3 | 8 | | 7 | 4 | |
| Permitted Phases | | | 6 | | | Free | | | | | | Free |
| Actuated Green, G (s) | 19.5 | 72.7 | 72.7 | 1.6 | 54.8 | 150.0 | 19.8 | 16.0 | | 37.7 | 33.9 | 150.0 |
| Effective Green, g (s) | 19.5 | 75.7 | 75.7 | 1.6 | 57.8 | 150.0 | 19.8 | 19.0 | | 37.7 | 36.9 | 150.0 |
| Actuated g/C Ratio | 0.13 | 0.50 | 0.50 | 0.01 | 0.39 | 1.00 | 0.13 | 0.13 | | 0.25 | 0.25 | 1.00 |
| Clearance Time (s) | 4.0 | 7.0 | 7.0 | 4.0 | 7.0 | | 4.0 | 7.0 | | 4.0 | 7.0 | |
| Vehicle Extension (s) | 3.0 | 6.0 | 6.0 | 3.0 | 6.0 | | 3.0 | 6.0 | | 3.0 | 6.0 | |
| Lane Grp Cap (vph) | 446 | 2566 | 799 | 19 | 1959 | 2787 | 234 | 213 | | 863 | 458 | 1583 |
| v/s Ratio Prot | c0.09 | c0.45 | | 0.01 | 0.22 | | 0.01 | 0.03 | | c0.23 | 0.01 | |
| v/s Ratio Perm | | | 0.00 | | | c0.29 | | | | | | 0.13 |
| v/c Ratio | 0.67 | 0.89 | 0.01 | 0.47 | 0.56 | 0.29 | 0.06 | 0.26 | | 0.90 | 0.03 | 0.13 |
| Uniform Delay, d1 | 62.1 | 33.4 | 18.4 | 73.8 | 36.2 | 0.0 | 57.0 | 59.1 | | 54.3 | 43.0 | 0.0 |
| Progression Factor | 0.90 | 0.77 | 0.51 | 0.89 | 0.41 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 2.9 | 4.1 | 0.0 | 13.4 | 0.9 | 0.2 | 0.1 | 1.8 | | 11.8 | 0.1 | 0.2 |
| Delay (s) | 58.7 | 29.8 | 9.4 | 79.0 | 15.9 | 0.2 | 57.1 | 61.0 | | 66.0 | 43.0 | 0.2 |
| Level of Service | E | C | A | E | B | A | E | E | | E | D | A |
| Approach Delay (s) | | 33.1 | | | 9.6 | | | 60.2 | | | 52.0 | |
| Approach LOS | | C | | | A | | | E | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 28.8 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.78 | | |
| Actuated Cycle Length (s) | 150.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 86.2% | ICU Level of Service | D |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 | 4.0 | |
| Lane Util. Factor | 1.00 | 0.91 | 1.00 | 1.00 | 0.91 | 1.00 | | 1.00 | 1.00 | 0.97 | 1.00 | |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 0.88 | |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | | 0.99 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | 1770 | 5085 | 1583 | 1770 | 5085 | 1583 | | 1851 | 1583 | 3433 | 1642 | |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (perm) | 1770 | 5085 | 1583 | 1770 | 5085 | 1583 | | 1783 | 1583 | 3433 | 1642 | |
| Volume (vph) | 72 | 2810 | 20 | 30 | 1789 | 249 | 4 | 25 | 55 | 313 | 10 | 38 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 78 | 3054 | 22 | 33 | 1945 | 271 | 4 | 27 | 60 | 340 | 11 | 41 |
| Lane Group Flow (vph) | 78 | 3054 | 22 | 33 | 1945 | 271 | 0 | 31 | 60 | 340 | 52 | 0 |
| Turn Type | Prot | | Perm | Prot | | Perm | Perm | | Perm | Prot | | |
| Protected Phases | 1 | 6 | | 5 | 2 | | | 8 | | 7 | 4 | |
| Permitted Phases | | | 6 | | | 2 | 8 | | 8 | | | |
| Actuated Green, G (s) | 20.0 | 91.8 | 91.8 | 12.0 | 83.8 | 83.8 | | 8.7 | 8.7 | 13.0 | 25.7 | |
| Effective Green, g (s) | 23.0 | 94.8 | 94.8 | 15.0 | 86.8 | 86.8 | | 11.2 | 11.2 | 13.0 | 28.2 | |
| Actuated g/C Ratio | 0.15 | 0.63 | 0.63 | 0.10 | 0.58 | 0.58 | | 0.07 | 0.07 | 0.09 | 0.19 | |
| Clearance Time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 6.5 | 6.5 | 4.0 | 6.5 | |
| Vehicle Extension (s) | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | | 3.0 | 3.0 | 3.0 | 4.5 | |
| Lane Grp Cap (vph) | 271 | 3214 | 1000 | 177 | 2943 | 916 | | 133 | 118 | 298 | 309 | |
| v/s Ratio Prot | 0.04 | c0.60 | | 0.02 | c0.38 | | | | | c0.10 | 0.03 | |
| v/s Ratio Perm | | | 0.01 | | | 0.17 | | 0.02 | c0.04 | | | |
| v/c Ratio | 0.29 | 0.95 | 0.02 | 0.19 | 0.66 | 0.30 | | 0.23 | 0.51 | 1.14 | 0.17 | |
| Uniform Delay, d1 | 56.2 | 25.4 | 10.3 | 61.9 | 21.6 | 16.1 | | 65.4 | 66.8 | 68.5 | 51.1 | |
| Progression Factor | 1.20 | 0.50 | 0.43 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | 0.8 | 4.7 | 0.0 | 1.3 | 1.2 | 0.8 | | 0.9 | 3.4 | 95.8 | 0.4 | |
| Delay (s) | 68.2 | 17.4 | 4.4 | 63.2 | 22.7 | 16.9 | | 66.3 | 70.2 | 164.3 | 51.5 | |
| Level of Service | E | B | A | E | C | B | | E | E | F | D | |
| Approach Delay (s) | | 18.5 | | | 22.6 | | | 68.8 | | | 149.3 | |
| Approach LOS | | B | | | C | | | E | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 29.6 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.89 | | |
| Actuated Cycle Length (s) | 150.0 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 102.1% | ICU Level of Service | F |
| c Critical Lane Group | | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 0.85 | 1.00 | 1.00 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 1770 | 1583 | 1863 | 1583 | 1770 | 1863 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 1.00 | 0.69 | 1.00 |
| Satd. Flow (perm) | 1770 | 1583 | 1863 | 1583 | 1281 | 1863 |
| Volume (vph) | 155 | 95 | 98 | 63 | 259 | 316 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 168 | 103 | 107 | 68 | 282 | 343 |
| Lane Group Flow (vph) | 168 | 103 | 107 | 68 | 282 | 343 |
| Turn Type | | Perm | | Perm | Perm | |
| Protected Phases | 8 | | 2 | | | 6 |
| Permitted Phases | | 8 | | 2 | 6 | |
| Actuated Green, G (s) | 8.9 | 8.9 | 22.8 | 22.8 | 22.8 | 22.8 |
| Effective Green, g (s) | 8.9 | 8.9 | 22.8 | 22.8 | 22.8 | 22.8 |
| Actuated g/C Ratio | 0.22 | 0.22 | 0.57 | 0.57 | 0.57 | 0.57 |
| Clearance Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 397 | 355 | 1070 | 909 | 736 | 1070 |
| v/s Ratio Prot | c0.09 | | 0.06 | | | 0.18 |
| v/s Ratio Perm | | 0.07 | | 0.04 | c0.22 | |
| v/c Ratio | 0.42 | 0.29 | 0.10 | 0.07 | 0.38 | 0.32 |
| Uniform Delay, d1 | 13.2 | 12.8 | 3.8 | 3.8 | 4.6 | 4.4 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.7 | 0.5 | 0.0 | 0.0 | 0.3 | 0.2 |
| Delay (s) | 13.9 | 13.2 | 3.9 | 3.8 | 4.9 | 4.6 |
| Level of Service | B | B | A | A | A | A |
| Approach Delay (s) | 13.7 | | 3.8 | | | 4.7 |
| Approach LOS | B | | A | | | A |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 6.9 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.39 | | |
| Actuated Cycle Length (s) | 39.7 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 38.3% | ICU Level of Service | A |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 0.95 | | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 0.97 | | 1.00 | 0.97 | | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 1770 | 1802 | | 1770 | 3437 | | 1770 | 1863 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1583 | 1770 | 1802 | | 1770 | 3437 | | 1770 | 1863 | 1583 |
| Volume (vph) | 160 | 247 | 148 | 63 | 70 | 19 | 23 | 111 | 27 | 143 | 491 | 123 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 174 | 268 | 161 | 68 | 76 | 21 | 25 | 121 | 29 | 155 | 534 | 134 |
| Lane Group Flow (vph) | 174 | 268 | 161 | 68 | 97 | 0 | 25 | 150 | 0 | 155 | 534 | 134 |
| Turn Type | Prot | | pm+ov | Prot | | | Prot | | | Prot | | pm+ov |
| Protected Phases | 7 | 4 | 5 | 3 | 8 | | 5 | 2 | | 1 | 6 | 7 |
| Permitted Phases | | | 4 | | | | | | | | | 6 |
| Actuated Green, G (s) | 5.9 | 12.3 | 15.3 | 3.2 | 9.6 | | 3.0 | 22.3 | | 5.9 | 25.2 | 31.1 |
| Effective Green, g (s) | 5.9 | 12.3 | 15.3 | 3.2 | 9.6 | | 3.0 | 22.3 | | 5.9 | 25.2 | 31.1 |
| Actuated g/C Ratio | 0.10 | 0.21 | 0.26 | 0.05 | 0.16 | | 0.05 | 0.37 | | 0.10 | 0.42 | 0.52 |
| Clearance Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 175 | 384 | 512 | 95 | 290 | | 89 | 1284 | | 175 | 786 | 931 |
| v/s Ratio Prot | c0.10 | c0.14 | 0.02 | 0.04 | 0.05 | | 0.01 | 0.04 | | c0.09 | c0.29 | 0.01 |
| v/s Ratio Perm | | | 0.09 | | | | | | | | | 0.07 |
| v/c Ratio | 0.99 | 0.70 | 0.31 | 0.72 | 0.33 | | 0.28 | 0.12 | | 0.89 | 0.68 | 0.14 |
| Uniform Delay, d1 | 26.9 | 22.0 | 18.0 | 27.8 | 22.2 | | 27.3 | 12.2 | | 26.6 | 14.0 | 7.4 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 66.0 | 5.5 | 0.4 | 22.5 | 0.7 | | 1.7 | 0.0 | | 37.3 | 2.3 | 0.1 |
| Delay (s) | 92.9 | 27.4 | 18.3 | 50.3 | 22.9 | | 29.0 | 12.3 | | 63.9 | 16.3 | 7.5 |
| Level of Service | F | C | B | D | C | | C | B | | E | B | A |
| Approach Delay (s) | | 43.9 | | | 34.2 | | | 14.7 | | | 23.8 | |
| Approach LOS | | D | | | C | | | B | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 30.7 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.79 | | |
| Actuated Cycle Length (s) | 59.7 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 62.7% | ICU Level of Service | B |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | 1.00 | 0.95 | | 1.00 | 0.95 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | 1.00 | 0.98 | | 1.00 | 1.00 | | 1.00 | 0.85 | | 1.00 | 0.94 | |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | 1770 | 3480 | | 1770 | 3522 | | 1770 | 1593 | | 1770 | 1754 | |
| Flt Permitted | 0.67 | 1.00 | | 0.53 | 1.00 | | 0.75 | 1.00 | | 0.70 | 1.00 | |
| Satd. Flow (perm) | 1251 | 3480 | | 986 | 3522 | | 1389 | 1593 | | 1301 | 1754 | |
| Volume (vph) | 2 | 305 | 39 | 78 | 113 | 4 | 101 | 3 | 80 | 15 | 10 | 6 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 2 | 332 | 42 | 85 | 123 | 4 | 110 | 3 | 87 | 16 | 11 | 7 |
| Lane Group Flow (vph) | 2 | 374 | 0 | 85 | 127 | 0 | 110 | 90 | 0 | 16 | 18 | 0 |
| Turn Type | Perm | | | Perm | | | Perm | | | Perm | | |
| Protected Phases | | 4 | | | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | |
| Actuated Green, G (s) | 7.9 | 7.9 | | 7.9 | 7.9 | | 9.0 | 9.0 | | 9.0 | 9.0 | |
| Effective Green, g (s) | 7.9 | 7.9 | | 7.9 | 7.9 | | 9.0 | 9.0 | | 9.0 | 9.0 | |
| Actuated g/C Ratio | 0.32 | 0.32 | | 0.32 | 0.32 | | 0.36 | 0.36 | | 0.36 | 0.36 | |
| Clearance Time (s) | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 397 | 1104 | | 313 | 1117 | | 502 | 576 | | 470 | 634 | |
| v/s Ratio Prot | | c0.11 | | | 0.04 | | | 0.06 | | | 0.01 | |
| v/s Ratio Perm | 0.00 | | | 0.09 | | | c0.08 | | | 0.01 | | |
| v/c Ratio | 0.01 | 0.34 | | 0.27 | 0.11 | | 0.22 | 0.16 | | 0.03 | 0.03 | |
| Uniform Delay, d1 | 5.8 | 6.5 | | 6.4 | 6.0 | | 5.5 | 5.4 | | 5.1 | 5.1 | |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 0.0 | 0.2 | | 0.5 | 0.0 | | 0.2 | 0.1 | | 0.0 | 0.0 | |
| Delay (s) | 5.8 | 6.7 | | 6.8 | 6.1 | | 5.7 | 5.5 | | 5.2 | 5.1 | |
| Level of Service | A | A | | A | A | | A | A | | A | A | |
| Approach Delay (s) | | 6.7 | | | 6.4 | | | 5.6 | | | 5.2 | |
| Approach LOS | | A | | | A | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 6.3 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.28 | | |
| Actuated Cycle Length (s) | 24.9 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 38.0% | ICU Level of Service | A |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | | 4.0 | |
| Lane Util. Factor | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | | 1.00 | |
| Frt | 1.00 | 0.98 | | 1.00 | 0.99 | | 1.00 | 0.94 | | | 0.98 | |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | | | 0.99 | |
| Satd. Flow (prot) | 1770 | 1828 | | 1770 | 1843 | | 1770 | 1760 | | | 1811 | |
| Flt Permitted | 0.58 | 1.00 | | 0.39 | 1.00 | | 0.60 | 1.00 | | | 0.93 | |
| Satd. Flow (perm) | 1081 | 1828 | | 736 | 1843 | | 1111 | 1760 | | | 1692 | |
| Volume (vph) | 44 | 374 | 53 | 85 | 251 | 19 | 83 | 86 | 50 | 51 | 200 | 41 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 48 | 407 | 58 | 92 | 273 | 21 | 90 | 93 | 54 | 55 | 217 | 45 |
| Lane Group Flow (vph) | 48 | 465 | 0 | 92 | 294 | 0 | 90 | 147 | 0 | 0 | 317 | 0 |
| Turn Type | Perm | | | Perm | | | Perm | | | Perm | | |
| Protected Phases | | 4 | | | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | |
| Actuated Green, G (s) | 13.7 | 13.7 | | 13.7 | 13.7 | | 11.5 | 11.5 | | | 11.5 | |
| Effective Green, g (s) | 13.7 | 13.7 | | 13.7 | 13.7 | | 11.5 | 11.5 | | | 11.5 | |
| Actuated g/C Ratio | 0.41 | 0.41 | | 0.41 | 0.41 | | 0.35 | 0.35 | | | 0.35 | |
| Clearance Time (s) | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | | 4.0 | |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | | 3.0 | |
| Lane Grp Cap (vph) | 446 | 754 | | 304 | 761 | | 385 | 610 | | | 586 | |
| v/s Ratio Prot | | c0.25 | | | 0.16 | | | 0.08 | | | | |
| v/s Ratio Perm | 0.04 | | | 0.13 | | | 0.08 | | | | c0.19 | |
| v/c Ratio | 0.11 | 0.62 | | 0.30 | 0.39 | | 0.23 | 0.24 | | | 0.54 | |
| Uniform Delay, d1 | 6.0 | 7.7 | | 6.5 | 6.8 | | 7.7 | 7.7 | | | 8.7 | |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | | 1.00 | |
| Incremental Delay, d2 | 0.1 | 1.5 | | 0.6 | 0.3 | | 0.3 | 0.2 | | | 1.0 | |
| Delay (s) | 6.1 | 9.2 | | 7.1 | 7.1 | | 8.0 | 7.9 | | | 9.7 | |
| Level of Service | A | A | | A | A | | A | A | | | A | |
| Approach Delay (s) | | 8.9 | | | 7.1 | | | 8.0 | | | 9.7 | |
| Approach LOS | | A | | | A | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 8.5 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.58 | | |
| Actuated Cycle Length (s) | 33.2 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 68.8% | ICU Level of Service | B |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | | 1.00 | 0.95 | |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 0.99 | | 1.00 | 0.96 | |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 | 1770 | 3489 | | 1770 | 3412 | |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.73 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.52 | 1.00 | |
| Satd. Flow (perm) | 1770 | 1863 | 1583 | 1369 | 1863 | 1583 | 1770 | 3489 | | 967 | 3412 | |
| Volume (vph) | 38 | 31 | 242 | 10 | 110 | 7 | 620 | 329 | 34 | 18 | 572 | 181 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 41 | 34 | 263 | 11 | 120 | 8 | 674 | 358 | 37 | 20 | 622 | 197 |
| Lane Group Flow (vph) | 41 | 34 | 263 | 11 | 120 | 8 | 674 | 395 | 0 | 20 | 819 | 0 |
| Turn Type | Prot | | pm+ov | Perm | | Perm | Prot | | | Perm | | |
| Protected Phases | 7 | 4 | 5 | | 8 | | 5 | 2 | | | 6 | |
| Permitted Phases | | | 4 | 8 | | 8 | | | | 6 | | |
| Actuated Green, G (s) | 2.2 | 14.9 | 48.6 | 8.7 | 8.7 | 8.7 | 33.7 | 58.7 | | 21.0 | 21.0 | |
| Effective Green, g (s) | 2.2 | 14.9 | 48.6 | 8.7 | 8.7 | 8.7 | 33.7 | 58.7 | | 21.0 | 21.0 | |
| Actuated g/C Ratio | 0.03 | 0.18 | 0.60 | 0.11 | 0.11 | 0.11 | 0.41 | 0.72 | | 0.26 | 0.26 | |
| Clearance Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 48 | 340 | 1020 | 146 | 199 | 169 | 731 | 2510 | | 249 | 878 | |
| v/s Ratio Prot | c0.02 | 0.02 | 0.11 | | c0.06 | | c0.38 | 0.11 | | | c0.24 | |
| v/s Ratio Perm | | | 0.06 | 0.01 | | 0.01 | | | | 0.02 | | |
| v/c Ratio | 0.85 | 0.10 | 0.26 | 0.08 | 0.60 | 0.05 | 0.92 | 0.16 | | 0.08 | 0.93 | |
| Uniform Delay, d1 | 39.5 | 27.8 | 7.9 | 32.8 | 34.8 | 32.7 | 22.7 | 3.6 | | 23.0 | 29.6 | |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 76.9 | 0.1 | 0.1 | 0.2 | 5.1 | 0.1 | 17.1 | 0.0 | | 0.1 | 16.4 | |
| Delay (s) | 116.4 | 27.9 | 8.0 | 33.0 | 39.9 | 32.8 | 39.8 | 3.7 | | 23.1 | 46.0 | |
| Level of Service | F | C | A | C | D | C | D | A | | C | D | |
| Approach Delay (s) | | 23.2 | | | 38.9 | | | 26.4 | | | 45.5 | |
| Approach LOS | | C | | | D | | | C | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 33.4 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.88 | | |
| Actuated Cycle Length (s) | 81.6 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 77.1% | ICU Level of Service | C |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | 4.0 | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 1.00 | 0.85 | | 0.97 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Flt Protected | | 1.00 | 1.00 | | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1863 | 1583 | | 1802 | | 1770 | 1863 | | 1770 | 1862 | |
| Flt Permitted | | 1.00 | 1.00 | | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (perm) | | 1863 | 1583 | | 1802 | | 1770 | 1863 | | 1770 | 1862 | |
| Volume (vph) | 0 | 19 | 48 | 0 | 35 | 11 | 147 | 161 | 0 | 12 | 419 | 1 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 21 | 52 | 0 | 38 | 12 | 160 | 175 | 0 | 13 | 455 | 1 |
| Lane Group Flow (vph) | 0 | 21 | 52 | 0 | 50 | 0 | 160 | 175 | 0 | 13 | 456 | 0 |
| Turn Type | Perm | | pm+ov | Perm | | | Prot | | | Prot | | |
| Protected Phases | | 4 | 5 | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | | | | | | | |
| Actuated Green, G (s) | | 3.0 | 11.6 | | 3.0 | | 8.6 | 37.6 | | 0.7 | 29.7 | |
| Effective Green, g (s) | | 3.0 | 11.6 | | 3.0 | | 8.6 | 37.6 | | 0.7 | 29.7 | |
| Actuated g/C Ratio | | 0.06 | 0.22 | | 0.06 | | 0.16 | 0.71 | | 0.01 | 0.56 | |
| Clearance Time (s) | | 4.0 | 4.0 | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 105 | 463 | | 101 | | 286 | 1314 | | 23 | 1038 | |
| v/s Ratio Prot | | 0.01 | 0.02 | | c0.03 | | c0.09 | 0.09 | | 0.01 | c0.24 | |
| v/s Ratio Perm | | | 0.01 | | | | | | | | | |
| v/c Ratio | | 0.20 | 0.11 | | 0.50 | | 0.56 | 0.13 | | 0.57 | 0.44 | |
| Uniform Delay, d1 | | 24.0 | 16.7 | | 24.4 | | 20.6 | 2.6 | | 26.1 | 6.9 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.9 | 0.1 | | 3.8 | | 2.4 | 0.0 | | 28.1 | 0.3 | |
| Delay (s) | | 24.9 | 16.8 | | 28.2 | | 23.0 | 2.6 | | 54.3 | 7.2 | |
| Level of Service | | C | B | | C | | C | A | | D | A | |
| Approach Delay (s) | | 19.2 | | | 28.2 | | | 12.3 | | | 8.5 | |
| Approach LOS | | B | | | C | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 11.8 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.47 | | |
| Actuated Cycle Length (s) | 53.3 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 46.2% | ICU Level of Service | A |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | 4.0 | 4.0 | | | 4.0 | 4.0 | 4.0 | 4.0 | |
| Lane Util. Factor | | | | 0.97 | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | |
| Frt | | | | 1.00 | 0.85 | | | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | | | 0.95 | 1.00 | | | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | | | 3433 | 1583 | | | 1863 | 1583 | 1770 | 1863 | |
| Flt Permitted | | | | 0.76 | 1.00 | | | 1.00 | 1.00 | 0.65 | 1.00 | |
| Satd. Flow (perm) | | | | 2736 | 1583 | | | 1863 | 1583 | 1217 | 1863 | |
| Volume (vph) | 0 | 0 | 0 | 202 | 0 | 24 | 0 | 151 | 268 | 66 | 392 | 0 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 220 | 0 | 26 | 0 | 164 | 291 | 72 | 426 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 220 | 26 | 0 | 0 | 164 | 291 | 72 | 426 | 0 |
| Turn Type | Perm | | | Perm | | | Perm | | Perm | Perm | | |
| Protected Phases | | 4 | | | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | | | 8.5 | 8.5 | | | 19.3 | 19.3 | 19.3 | 19.3 | |
| Effective Green, g (s) | | | | 8.5 | 8.5 | | | 19.3 | 19.3 | 19.3 | 19.3 | |
| Actuated g/C Ratio | | | | 0.24 | 0.24 | | | 0.54 | 0.54 | 0.54 | 0.54 | |
| Clearance Time (s) | | | | 4.0 | 4.0 | | | 4.0 | 4.0 | 4.0 | 4.0 | |
| Vehicle Extension (s) | | | | 3.0 | 3.0 | | | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | | | 650 | 376 | | | 1004 | 853 | 656 | 1004 | |
| v/s Ratio Prot | | | | | 0.02 | | | 0.09 | | | c0.23 | |
| v/s Ratio Perm | | | | c0.08 | | | | | 0.18 | 0.06 | | |
| v/c Ratio | | | | 0.34 | 0.07 | | | 0.16 | 0.34 | 0.11 | 0.42 | |
| Uniform Delay, d1 | | | | 11.3 | 10.6 | | | 4.2 | 4.7 | 4.0 | 4.9 | |
| Progression Factor | | | | 1.00 | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | | | 0.3 | 0.1 | | | 0.1 | 0.2 | 0.1 | 0.3 | |
| Delay (s) | | | | 11.6 | 10.7 | | | 4.2 | 4.9 | 4.1 | 5.2 | |
| Level of Service | | | | B | B | | | A | A | A | A | |
| Approach Delay (s) | | 0.0 | | | 11.5 | | | 4.7 | | | 5.1 | |
| Approach LOS | | A | | | B | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 6.2 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.40 | | |
| Actuated Cycle Length (s) | 35.8 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 42.0% | ICU Level of Service | A |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 15 | 307 | 13 | 32 | 187 | 1 | 47 | 0 | 35 | 4 | 1 | 7 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 16 | 334 | 14 | 35 | 203 | 1 | 51 | 0 | 38 | 4 | 1 | 8 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | | | | | | | None | | | None | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 204 | | | 348 | | | 553 | 647 | 174 | 511 | 654 | 102 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 204 | | | 348 | | | 553 | 647 | 174 | 511 | 654 | 102 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.5 | 6.5 | 6.9 | 7.5 | 6.5 | 6.9 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 99 | | | 97 | | | 87 | 100 | 95 | 99 | 100 | 99 |
| cM capacity (veh/h) | 1364 | | | 1208 | | | 399 | 372 | 839 | 412 | 369 | 933 |

| Direction, Lane # | EB 1 | EB 2 | EB 3 | WB 1 | WB 2 | WB 3 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|---|---|
| Volume Total | 16 | 222 | 125 | 35 | 136 | 69 | 89 | 13 |
| Volume Left | 16 | 0 | 0 | 35 | 0 | 0 | 51 | 4 |
| Volume Right | 0 | 0 | 14 | 0 | 0 | 1 | 38 | 8 |
| cSH | 1364 | 1700 | 1700 | 1208 | 1700 | 1700 | 514 | 603 |
| Volume to Capacity | 0.01 | 0.13 | 0.07 | 0.03 | 0.08 | 0.04 | 0.17 | 0.02 |
| Queue Length (ft) | 1 | 0 | 0 | 2 | 0 | 0 | 16 | 2 |
| Control Delay (s) | 7.7 | 0.0 | 0.0 | 8.1 | 0.0 | 0.0 | 13.5 | 11.1 |
| Lane LOS | A | | | A | | | B | B |
| Approach Delay (s) | 0.3 | | | 1.2 | | | 13.5 | 11.1 |
| Approach LOS | | | | | | | B | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.5 | | |
| Intersection Capacity Utilization | 28.2% | ICU Level of Service | A |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Volume (veh/h) | 0 | 29 | 114 | 60 | 13 | 458 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 0 | 32 | 124 | 65 | 14 | 498 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | 796 | | | 866 |
| pX, platoon unblocked | 0.98 | | | | | |
| vC, conflicting volume | 650 | 124 | | | 189 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 643 | 124 | | | 189 | |
| tC, single (s) | 6.4 | 6.2 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 100 | 97 | | | 99 | |
| cM capacity (veh/h) | 425 | 927 | | | 1385 | |

| Direction, Lane # | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 |
|---|---|---|---|---|---|
| Volume Total | 32 | 124 | 65 | 14 | 498 |
| Volume Left | 0 | 0 | 0 | 14 | 0 |
| Volume Right | 32 | 0 | 65 | 0 | 0 |
| cSH | 927 | 1700 | 1700 | 1385 | 1700 |
| Volume to Capacity | 0.03 | 0.07 | 0.04 | 0.01 | 0.29 |
| Queue Length (ft) | 3 | 0 | 0 | 1 | 0 |
| Control Delay (s) | 9.0 | 0.0 | 0.0 | 7.6 | 0.0 |
| Lane LOS | A | | | A | |
| Approach Delay (s) | 9.0 | 0.0 | | 0.2 | |
| Approach LOS | A | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.5 | | |
| Intersection Capacity Utilization | 29.5% | ICU Level of Service | A |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 0 | 403 | 16 | 44 | 176 | 0 | 19 | 0 | 94 | 0 | 0 | 0 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 0 | 438 | 17 | 48 | 191 | 0 | 21 | 0 | 102 | 0 | 0 | 0 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | | | | | | | None | | | None | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | 950 | | | 1302 | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 191 | | | 455 | | | 638 | 734 | 228 | 608 | 742 | 96 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 191 | | | 455 | | | 638 | 734 | 228 | 608 | 742 | 96 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.5 | 6.5 | 6.9 | 7.5 | 6.5 | 6.9 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 100 | | | 96 | | | 94 | 100 | 87 | 100 | 100 | 100 |
| cM capacity (veh/h) | 1380 | | | 1102 | | | 349 | 331 | 775 | 319 | 327 | 942 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | WB 3 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|---|
| Volume Total | 292 | 163 | 48 | 96 | 96 | 123 | 0 |
| Volume Left | 0 | 0 | 48 | 0 | 0 | 21 | 0 |
| Volume Right | 0 | 17 | 0 | 0 | 0 | 102 | 0 |
| cSH | 1700 | 1700 | 1102 | 1700 | 1700 | 643 | 1700 |
| Volume to Capacity | 0.17 | 0.10 | 0.04 | 0.06 | 0.06 | 0.19 | 0.00 |
| Queue Length (ft) | 0 | 0 | 3 | 0 | 0 | 18 | 0 |
| Control Delay (s) | 0.0 | 0.0 | 8.4 | 0.0 | 0.0 | 11.9 | 0.0 |
| Lane LOS | | | A | | | B | A |
| Approach Delay (s) | 0.0 | | 1.7 | | | 11.9 | 0.0 |
| Approach LOS | | | | | | B | A |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.3 | | |
| Intersection Capacity Utilization | 26.8% | ICU Level of Service | A |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Volume (veh/h) | 0 | 151 | 196 | 178 | 620 | 78 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 0 | 164 | 213 | 193 | 674 | 85 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | 910 | 918 | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 1197 | 337 | 759 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 1197 | 337 | 759 | | | |
| tC, single (s) | 6.8 | 6.9 | 4.1 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 100 | 75 | 75 | | | |
| cM capacity (veh/h) | 134 | 659 | 849 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|
| Volume Total | 164 | 213 | 97 | 97 | 337 | 337 | 85 |
| Volume Left | 0 | 213 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 164 | 0 | 0 | 0 | 0 | 0 | 85 |
| cSH | 659 | 849 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 0.25 | 0.25 | 0.06 | 0.06 | 0.20 | 0.20 | 0.05 |
| Queue Length (ft) | 24 | 25 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 12.3 | 10.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | B | B | | | | | |
| Approach Delay (s) | 12.3 | 5.6 | | | 0.0 | | |
| Approach LOS | B | | | | | | |

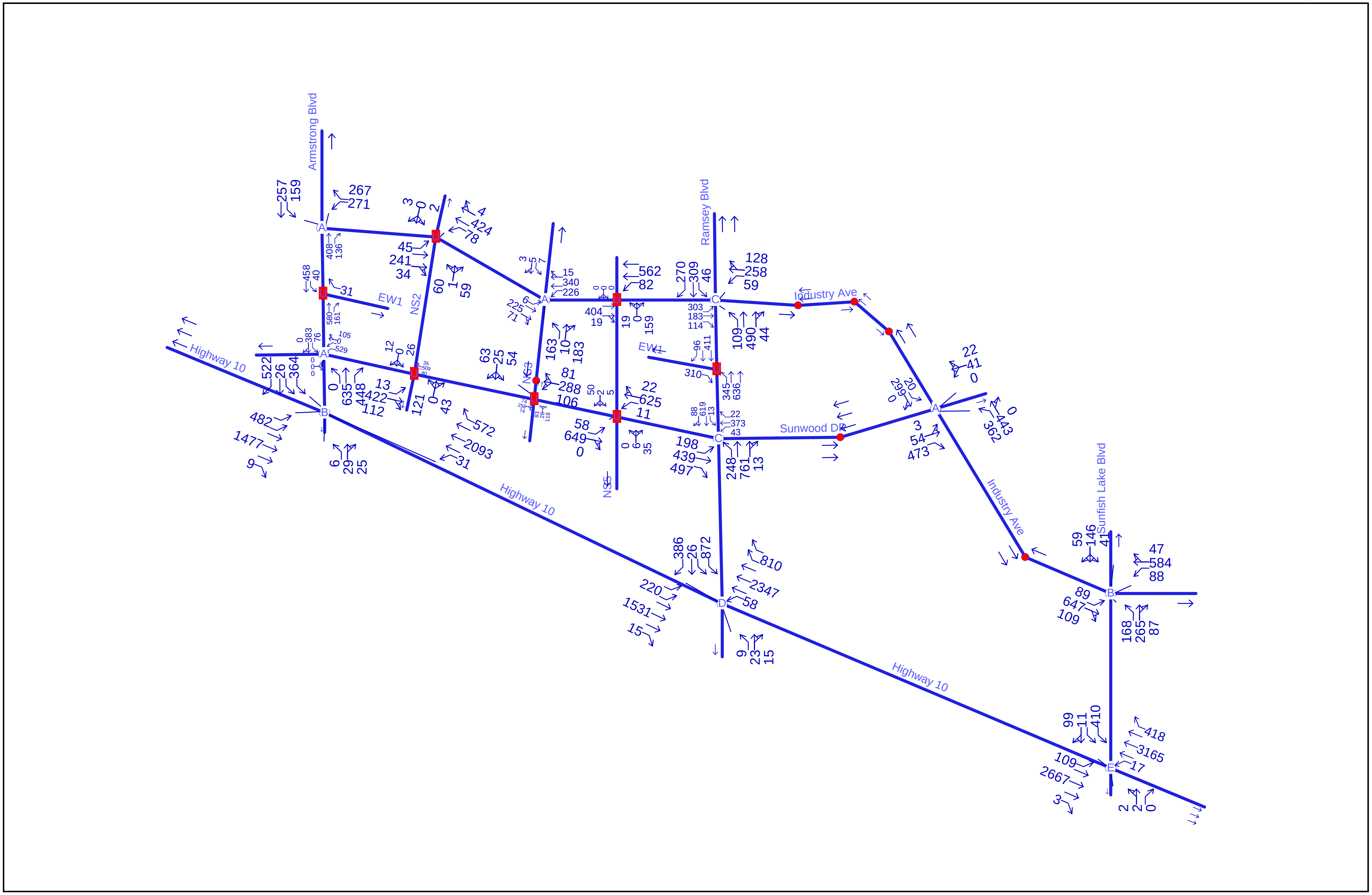
| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 3.2 | | |
| Intersection Capacity Utilization | 37.1% | ICU Level of Service | A |

Map - Ramsey AUAR

Levels of Service

Timing Plan: PM Peak

Ramsey AUAR PM Future w Proj (Mitigated)




03/24/2003

Meyer, Mohaddes Associates Inc.

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| Lane Util. Factor | 0.97 | 0.91 | 1.00 | 1.00 | 0.91 | 1.00 | 1.00 | 1.00 | | 0.97 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 0.93 | | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | 5085 | 1583 | 1770 | 5085 | 1583 | 1770 | 1735 | | 3433 | 1863 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.74 | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | 5085 | 1583 | 1770 | 5085 | 1583 | 1377 | 1735 | | 3433 | 1863 | 1583 |
| Volume (vph) | 482 | 1477 | 9 | 31 | 2093 | 572 | 6 | 29 | 25 | 364 | 26 | 522 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 524 | 1605 | 10 | 34 | 2275 | 622 | 7 | 32 | 27 | 396 | 28 | 567 |
| Lane Group Flow (vph) | 524 | 1605 | 10 | 34 | 2275 | 622 | 7 | 59 | 0 | 396 | 28 | 567 |
| Turn Type | Prot | | Perm | Prot | | Perm | Perm | | | Prot | | Free |
| Protected Phases | 5 | 2 | | 1 | 6 | | | 8 | | 7 | 4 | |
| Permitted Phases | | | 2 | | | 6 | 8 | | | | | Free |
| Actuated Green, G (s) | 24.6 | 94.5 | 94.5 | 5.6 | 75.5 | 75.5 | 10.5 | 10.5 | | 18.9 | 32.4 | 150.0 |
| Effective Green, g (s) | 24.6 | 98.0 | 98.0 | 5.6 | 79.0 | 79.0 | 11.5 | 11.5 | | 18.9 | 34.4 | 150.0 |
| Actuated g/C Ratio | 0.16 | 0.65 | 0.65 | 0.04 | 0.53 | 0.53 | 0.08 | 0.08 | | 0.13 | 0.23 | 1.00 |
| Clearance Time (s) | 4.0 | 7.5 | 7.5 | 4.0 | 7.5 | 7.5 | 5.0 | 5.0 | | 4.0 | 6.0 | |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 563 | 3322 | 1034 | 66 | 2678 | 834 | 106 | 133 | | 433 | 427 | 1583 |
| v/s Ratio Prot | c0.15 | 0.32 | | 0.02 | c0.45 | | | 0.03 | | c0.12 | 0.02 | |
| v/s Ratio Perm | | | 0.01 | | | 0.39 | 0.01 | | | | | c0.36 |
| v/c Ratio | 0.93 | 0.48 | 0.01 | 0.52 | 0.85 | 0.75 | 0.07 | 0.44 | | 0.91 | 0.07 | 0.36 |
| Uniform Delay, d1 | 61.9 | 13.2 | 9.1 | 70.9 | 30.4 | 27.7 | 64.3 | 66.2 | | 64.8 | 45.2 | 0.0 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.16 | 0.12 | 0.02 | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 22.3 | 0.5 | 0.0 | 2.3 | 1.3 | 2.1 | 0.3 | 2.4 | | 23.6 | 0.1 | 0.6 |
| Delay (s) | 84.1 | 13.7 | 9.1 | 84.2 | 4.9 | 2.8 | 64.5 | 68.5 | | 88.4 | 45.3 | 0.6 |
| Level of Service | F | B | A | F | A | A | E | E | | F | D | A |
| Approach Delay (s) | | 30.9 | | | 5.4 | | | 68.1 | | | 36.9 | |
| Approach LOS | | C | | | A | | | E | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 20.1 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.82 | | |
| Actuated Cycle Length (s) | 150.0 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 86.9% | ICU Level of Service | D |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| Lane Util. Factor | 0.97 | 0.91 | 1.00 | 1.00 | 0.91 | 0.88 | 1.00 | 1.00 | | 0.97 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 0.94 | | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | 5085 | 1583 | 1770 | 5085 | 2787 | 1770 | 1754 | | 3433 | 1863 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | 5085 | 1583 | 1770 | 5085 | 2787 | 1770 | 1754 | | 3433 | 1863 | 1583 |
| Volume (vph) | 220 | 1531 | 15 | 58 | 2347 | 810 | 9 | 23 | 15 | 872 | 26 | 386 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 239 | 1664 | 16 | 63 | 2551 | 880 | 10 | 25 | 16 | 948 | 28 | 420 |
| Lane Group Flow (vph) | 239 | 1664 | 16 | 63 | 2551 | 880 | 10 | 41 | 0 | 948 | 28 | 420 |
| Turn Type | Prot | | Perm | Prot | | Free | Prot | | | Prot | | Free |
| Protected Phases | 1 | 6 | | 5 | 2 | | 3 | 8 | | 7 | 4 | |
| Permitted Phases | | | 6 | | | Free | | | | | | Free |
| Actuated Green, G (s) | 9.8 | 66.2 | 66.2 | 8.8 | 65.2 | 150.0 | 1.6 | 16.0 | | 37.0 | 51.4 | 150.0 |
| Effective Green, g (s) | 9.8 | 69.2 | 69.2 | 8.8 | 68.2 | 150.0 | 1.6 | 19.0 | | 37.0 | 54.4 | 150.0 |
| Actuated g/C Ratio | 0.07 | 0.46 | 0.46 | 0.06 | 0.45 | 1.00 | 0.01 | 0.13 | | 0.25 | 0.36 | 1.00 |
| Clearance Time (s) | 4.0 | 7.0 | 7.0 | 4.0 | 7.0 | | 4.0 | 7.0 | | 4.0 | 7.0 | |
| Vehicle Extension (s) | 3.0 | 6.0 | 6.0 | 3.0 | 6.0 | | 3.0 | 6.0 | | 3.0 | 6.0 | |
| Lane Grp Cap (vph) | 224 | 2346 | 730 | 104 | 2312 | 2787 | 19 | 222 | | 847 | 676 | 1583 |
| v/s Ratio Prot | c0.07 | 0.33 | | 0.04 | c0.50 | | 0.01 | 0.02 | | c0.28 | 0.02 | |
| v/s Ratio Perm | | | 0.01 | | | c0.32 | | | | | | 0.27 |
| v/c Ratio | 1.07 | 0.71 | 0.02 | 0.61 | 1.10 | 0.32 | 0.53 | 0.18 | | 1.12 | 0.04 | 0.27 |
| Uniform Delay, d1 | 70.1 | 32.3 | 22.0 | 68.9 | 40.9 | 0.0 | 73.8 | 58.6 | | 56.5 | 30.9 | 0.0 |
| Progression Factor | 0.98 | 1.03 | 0.98 | 0.73 | 0.27 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 73.8 | 1.5 | 0.0 | 0.9 | 47.3 | 0.0 | 23.9 | 1.1 | | 69.1 | 0.1 | 0.4 |
| Delay (s) | 142.2 | 34.7 | 21.6 | 51.2 | 58.1 | 0.0 | 97.7 | 59.7 | | 125.6 | 31.0 | 0.4 |
| Level of Service | F | C | C | D | E | A | F | E | | F | C | A |
| Approach Delay (s) | | 48.0 | | | 43.4 | | | 67.2 | | | 86.1 | |
| Approach LOS | | D | | | D | | | E | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 53.5 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.95 | | |
| Actuated Cycle Length (s) | 150.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 99.8% | ICU Level of Service | E |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | 1.00 | 0.91 | 1.00 | 1.00 | 0.91 | 1.00 | | 1.00 | | 0.97 | 1.00 | |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | | 1.00 | | 1.00 | 0.86 | |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | | 0.98 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | 1770 | 5085 | 1583 | 1770 | 5085 | 1583 | | 1817 | | 3433 | 1611 | |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | | 0.69 | | 0.95 | 1.00 | |
| Satd. Flow (perm) | 1770 | 5085 | 1583 | 1770 | 5085 | 1583 | | 1292 | | 3433 | 1611 | |
| Volume (vph) | 109 | 2667 | 3 | 17 | 3165 | 418 | 2 | 2 | 0 | 410 | 11 | 99 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 118 | 2899 | 3 | 18 | 3440 | 454 | 2 | 2 | 0 | 446 | 12 | 108 |
| Lane Group Flow (vph) | 118 | 2899 | 3 | 18 | 3440 | 454 | 0 | 4 | 0 | 446 | 120 | 0 |
| Turn Type | Prot | | Perm | Prot | | Perm | Perm | | Perm | Prot | | |
| Protected Phases | 1 | 6 | | 5 | 2 | | | 8 | | 7 | 4 | |
| Permitted Phases | | | 6 | | | 2 | 8 | | 8 | | | |
| Actuated Green, G (s) | 20.0 | 94.5 | 94.5 | 8.0 | 82.5 | 82.5 | | 8.0 | | 15.0 | 27.0 | |
| Effective Green, g (s) | 23.0 | 97.5 | 97.5 | 11.0 | 85.5 | 85.5 | | 10.5 | | 15.0 | 29.5 | |
| Actuated g/C Ratio | 0.15 | 0.65 | 0.65 | 0.07 | 0.57 | 0.57 | | 0.07 | | 0.10 | 0.20 | |
| Clearance Time (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | | 6.5 | | 4.0 | 6.5 | |
| Vehicle Extension (s) | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | | 3.0 | | 3.0 | 4.5 | |
| Lane Grp Cap (vph) | 271 | 3305 | 1029 | 130 | 2898 | 902 | | 90 | | 343 | 317 | |
| v/s Ratio Prot | 0.07 | c0.57 | | 0.01 | c0.68 | | | | | c0.13 | c0.07 | |
| v/s Ratio Perm | | | 0.00 | | | 0.29 | | 0.00 | | | | |
| v/c Ratio | 0.44 | 0.88 | 0.00 | 0.14 | 1.19 | 0.50 | | 0.04 | | 1.30 | 0.38 | |
| Uniform Delay, d1 | 57.6 | 21.4 | 9.2 | 65.1 | 32.2 | 19.4 | | 65.1 | | 67.5 | 52.3 | |
| Progression Factor | 1.11 | 0.68 | 0.23 | 1.00 | 1.00 | 1.00 | | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 1.8 | 2.5 | 0.0 | 1.2 | 87.9 | 2.0 | | 0.2 | | 154.9 | 1.3 | |
| Delay (s) | 65.9 | 17.1 | 2.1 | 66.3 | 120.2 | 21.5 | | 65.3 | | 222.4 | 53.6 | |
| Level of Service | E | B | A | E | F | C | | E | | F | D | |
| Approach Delay (s) | | 19.0 | | | 108.5 | | | 65.3 | | | 186.7 | |
| Approach LOS | | B | | | F | | | E | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 78.3 | HCM Level of Service | E |
| HCM Volume to Capacity ratio | 1.10 | | |
| Actuated Cycle Length (s) | 150.0 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 112.5% | ICU Level of Service | G |
| c Critical Lane Group | | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 0.85 | 1.00 | 1.00 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 1770 | 1583 | 1863 | 1583 | 1770 | 1863 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 1.00 | 0.43 | 1.00 |
| Satd. Flow (perm) | 1770 | 1583 | 1863 | 1583 | 800 | 1863 |
| Volume (vph) | 271 | 267 | 408 | 136 | 159 | 257 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 295 | 290 | 443 | 148 | 173 | 279 |
| Lane Group Flow (vph) | 295 | 290 | 443 | 148 | 173 | 279 |
| Turn Type | | Perm | | Perm | Perm | |
| Protected Phases | 8 | | 2 | | | 6 |
| Permitted Phases | | 8 | | 2 | 6 | |
| Actuated Green, G (s) | 11.5 | 11.5 | 15.6 | 15.6 | 15.6 | 15.6 |
| Effective Green, g (s) | 11.5 | 11.5 | 15.6 | 15.6 | 15.6 | 15.6 |
| Actuated g/C Ratio | 0.33 | 0.33 | 0.44 | 0.44 | 0.44 | 0.44 |
| Clearance Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 580 | 519 | 828 | 704 | 356 | 828 |
| v/s Ratio Prot | 0.17 | | c0.24 | | | 0.15 |
| v/s Ratio Perm | | c0.18 | | 0.09 | 0.22 | |
| v/c Ratio | 0.51 | 0.56 | 0.54 | 0.21 | 0.49 | 0.34 |
| Uniform Delay, d1 | 9.5 | 9.7 | 7.1 | 6.0 | 6.9 | 6.4 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.7 | 1.3 | 0.7 | 0.1 | 1.0 | 0.2 |
| Delay (s) | 10.2 | 11.0 | 7.8 | 6.1 | 8.0 | 6.6 |
| Level of Service | B | B | A | A | A | A |
| Approach Delay (s) | 10.6 | | 7.4 | | | 7.1 |
| Approach LOS | B | | A | | | A |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 8.5 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.55 | | |
| Actuated Cycle Length (s) | 35.1 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 59.2% | ICU Level of Service | A |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 0.95 | | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 0.95 | | 1.00 | 0.99 | | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 1770 | 1770 | | 1770 | 3495 | | 1770 | 1863 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1583 | 1770 | 1770 | | 1770 | 3495 | | 1770 | 1863 | 1583 |
| Volume (vph) | 303 | 183 | 114 | 59 | 258 | 128 | 109 | 490 | 44 | 46 | 309 | 270 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 329 | 199 | 124 | 64 | 280 | 139 | 118 | 533 | 48 | 50 | 336 | 293 |
| Lane Group Flow (vph) | 329 | 199 | 124 | 64 | 419 | 0 | 118 | 581 | 0 | 50 | 336 | 293 |
| Turn Type | Prot | | pm+ov | Prot | | | Prot | | | Prot | | pm+ov |
| Protected Phases | 7 | 4 | 5 | 3 | 8 | | 5 | 2 | | 1 | 6 | 7 |
| Permitted Phases | | | 4 | | | | | | | | | 6 |
| Actuated Green, G (s) | 17.8 | 34.5 | 40.2 | 5.6 | 22.3 | | 5.7 | 21.6 | | 3.1 | 19.0 | 36.8 |
| Effective Green, g (s) | 17.8 | 34.5 | 40.2 | 5.6 | 22.3 | | 5.7 | 21.6 | | 3.1 | 19.0 | 36.8 |
| Actuated g/C Ratio | 0.22 | 0.43 | 0.50 | 0.07 | 0.28 | | 0.07 | 0.27 | | 0.04 | 0.24 | 0.46 |
| Clearance Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 390 | 795 | 866 | 123 | 489 | | 125 | 934 | | 68 | 438 | 799 |
| v/s Ratio Prot | c0.19 | 0.11 | 0.01 | 0.04 | c0.24 | | c0.07 | c0.17 | | 0.03 | c0.18 | 0.08 |
| v/s Ratio Perm | | | 0.07 | | | | | | | | | 0.10 |
| v/c Ratio | 0.84 | 0.25 | 0.14 | 0.52 | 0.86 | | 0.94 | 0.62 | | 0.74 | 0.77 | 0.37 |
| Uniform Delay, d1 | 30.2 | 14.9 | 11.0 | 36.3 | 27.7 | | 37.4 | 26.0 | | 38.4 | 28.8 | 14.4 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 15.2 | 0.2 | 0.1 | 3.9 | 13.8 | | 62.8 | 1.3 | | 33.4 | 7.9 | 0.3 |
| Delay (s) | 45.4 | 15.0 | 11.1 | 40.2 | 41.5 | | 100.2 | 27.3 | | 71.9 | 36.7 | 14.7 |
| Level of Service | D | B | B | D | D | | F | C | | E | D | B |
| Approach Delay (s) | | 29.6 | | | 41.4 | | | 39.6 | | | 29.8 | |
| Approach LOS | | C | | | D | | | D | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 34.7 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.87 | | |
| Actuated Cycle Length (s) | 80.8 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 79.1% | ICU Level of Service | C |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | 1.00 | 0.95 | | 1.00 | 0.95 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | 1.00 | 0.96 | | 1.00 | 0.99 | | 1.00 | 0.86 | | 1.00 | 0.94 | |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | 1770 | 3412 | | 1770 | 3517 | | 1770 | 1598 | | 1770 | 1758 | |
| Flt Permitted | 0.52 | 1.00 | | 0.56 | 1.00 | | 0.75 | 1.00 | | 0.63 | 1.00 | |
| Satd. Flow (perm) | 975 | 3412 | | 1037 | 3517 | | 1402 | 1598 | | 1167 | 1758 | |
| Volume (vph) | 6 | 225 | 71 | 226 | 340 | 15 | 163 | 10 | 183 | 7 | 5 | 3 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 7 | 245 | 77 | 246 | 370 | 16 | 177 | 11 | 199 | 8 | 5 | 3 |
| Lane Group Flow (vph) | 7 | 322 | 0 | 246 | 386 | 0 | 177 | 210 | 0 | 8 | 8 | 0 |
| Turn Type | Perm | | | Perm | | | Perm | | | Perm | | |
| Protected Phases | | 4 | | | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | |
| Actuated Green, G (s) | 13.1 | 13.1 | | 13.1 | 13.1 | | 9.8 | 9.8 | | 9.8 | 9.8 | |
| Effective Green, g (s) | 13.1 | 13.1 | | 13.1 | 13.1 | | 9.8 | 9.8 | | 9.8 | 9.8 | |
| Actuated g/C Ratio | 0.42 | 0.42 | | 0.42 | 0.42 | | 0.32 | 0.32 | | 0.32 | 0.32 | |
| Clearance Time (s) | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 413 | 1447 | | 440 | 1491 | | 445 | 507 | | 370 | 558 | |
| v/s Ratio Prot | | 0.09 | | | 0.11 | | | c0.13 | | | 0.00 | |
| v/s Ratio Perm | 0.01 | | | c0.24 | | | 0.13 | | | 0.01 | | |
| v/c Ratio | 0.02 | 0.22 | | 0.56 | 0.26 | | 0.40 | 0.41 | | 0.02 | 0.01 | |
| Uniform Delay, d1 | 5.2 | 5.7 | | 6.7 | 5.8 | | 8.2 | 8.3 | | 7.3 | 7.2 | |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 0.0 | 0.1 | | 1.5 | 0.1 | | 0.6 | 0.6 | | 0.0 | 0.0 | |
| Delay (s) | 5.2 | 5.7 | | 8.3 | 5.9 | | 8.8 | 8.8 | | 7.3 | 7.2 | |
| Level of Service | A | A | | A | A | | A | A | | A | A | |
| Approach Delay (s) | | 5.7 | | | 6.8 | | | 8.8 | | | 7.3 | |
| Approach LOS | | A | | | A | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 7.1 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.50 | | |
| Actuated Cycle Length (s) | 30.9 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 49.3% | ICU Level of Service | A |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | | 4.0 | |
| Lane Util. Factor | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | | 1.00 | |
| Frt | 1.00 | 0.98 | | 1.00 | 0.99 | | 1.00 | 0.96 | | | 0.97 | |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | | | 0.99 | |
| Satd. Flow (prot) | 1770 | 1823 | | 1770 | 1842 | | 1770 | 1793 | | | 1788 | |
| Flt Permitted | 0.25 | 1.00 | | 0.17 | 1.00 | | 0.56 | 1.00 | | | 0.80 | |
| Satd. Flow (perm) | 466 | 1823 | | 312 | 1842 | | 1037 | 1793 | | | 1447 | |
| Volume (vph) | 89 | 647 | 109 | 88 | 584 | 47 | 168 | 265 | 87 | 41 | 146 | 59 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 97 | 703 | 118 | 96 | 635 | 51 | 183 | 288 | 95 | 45 | 159 | 64 |
| Lane Group Flow (vph) | 97 | 821 | 0 | 96 | 686 | 0 | 183 | 383 | 0 | 0 | 268 | 0 |
| Turn Type | Perm | | | Perm | | | Perm | | | Perm | | |
| Protected Phases | | 4 | | | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | |
| Actuated Green, G (s) | 23.9 | 23.9 | | 23.9 | 23.9 | | 13.3 | 13.3 | | | 13.3 | |
| Effective Green, g (s) | 23.9 | 23.9 | | 23.9 | 23.9 | | 13.3 | 13.3 | | | 13.3 | |
| Actuated g/C Ratio | 0.53 | 0.53 | | 0.53 | 0.53 | | 0.29 | 0.29 | | | 0.29 | |
| Clearance Time (s) | 4.0 | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | | | 4.0 | |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | | | 3.0 | |
| Lane Grp Cap (vph) | 246 | 964 | | 165 | 974 | | 305 | 528 | | | 426 | |
| v/s Ratio Prot | | c0.45 | | | 0.37 | | | c0.21 | | | | |
| v/s Ratio Perm | 0.21 | | | 0.31 | | | 0.18 | | | | 0.19 | |
| v/c Ratio | 0.39 | 0.85 | | 0.58 | 0.70 | | 0.60 | 0.73 | | | 0.63 | |
| Uniform Delay, d1 | 6.3 | 9.1 | | 7.2 | 8.0 | | 13.7 | 14.3 | | | 13.8 | |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | | | 1.00 | |
| Incremental Delay, d2 | 1.0 | 7.3 | | 5.1 | 2.3 | | 3.2 | 4.9 | | | 2.9 | |
| Delay (s) | 7.4 | 16.5 | | 12.4 | 10.3 | | 16.8 | 19.2 | | | 16.7 | |
| Level of Service | A | B | | B | B | | B | B | | | B | |
| Approach Delay (s) | | 15.5 | | | 10.6 | | | 18.5 | | | 16.7 | |
| Approach LOS | | B | | | B | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 14.8 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.81 | | |
| Actuated Cycle Length (s) | 45.2 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 98.5% | ICU Level of Service | E |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | | 1.00 | 0.95 | |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | | 1.00 | 0.98 | |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 | 1770 | 3530 | | 1770 | 3473 | |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.49 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.34 | 1.00 | |
| Satd. Flow (perm) | 1770 | 1863 | 1583 | 914 | 1863 | 1583 | 1770 | 3530 | | 625 | 3473 | |
| Volume (vph) | 198 | 439 | 497 | 43 | 373 | 22 | 248 | 761 | 13 | 13 | 619 | 88 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 215 | 477 | 540 | 47 | 405 | 24 | 270 | 827 | 14 | 14 | 673 | 96 |
| Lane Group Flow (vph) | 215 | 477 | 540 | 47 | 405 | 24 | 270 | 841 | 0 | 14 | 769 | 0 |
| Turn Type | Prot | | pm+ov | Perm | | Perm | Prot | | | Perm | | |
| Protected Phases | 7 | 4 | 5 | | 8 | | 5 | 2 | | | 6 | |
| Permitted Phases | | | 4 | 8 | | 8 | | | | 6 | | |
| Actuated Green, G (s) | 11.0 | 33.5 | 47.1 | 18.5 | 18.5 | 18.5 | 13.6 | 36.9 | | 19.3 | 19.3 | |
| Effective Green, g (s) | 11.0 | 33.5 | 47.1 | 18.5 | 18.5 | 18.5 | 13.6 | 36.9 | | 19.3 | 19.3 | |
| Actuated g/C Ratio | 0.14 | 0.43 | 0.60 | 0.24 | 0.24 | 0.24 | 0.17 | 0.47 | | 0.25 | 0.25 | |
| Clearance Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 248 | 796 | 1032 | 216 | 440 | 374 | 307 | 1661 | | 154 | 855 | |
| v/s Ratio Prot | c0.12 | 0.26 | 0.09 | | c0.22 | | c0.15 | 0.24 | | | c0.22 | |
| v/s Ratio Perm | | | 0.25 | 0.05 | | 0.02 | | | | 0.02 | | |
| v/c Ratio | 0.87 | 0.60 | 0.52 | 0.22 | 0.92 | 0.06 | 0.88 | 0.51 | | 0.09 | 0.90 | |
| Uniform Delay, d1 | 33.0 | 17.3 | 9.1 | 24.1 | 29.2 | 23.2 | 31.6 | 14.4 | | 22.8 | 28.6 | |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 25.7 | 1.2 | 0.5 | 0.5 | 24.5 | 0.1 | 23.6 | 0.2 | | 0.3 | 12.2 | |
| Delay (s) | 58.7 | 18.5 | 9.6 | 24.6 | 53.7 | 23.3 | 55.2 | 14.7 | | 23.0 | 40.8 | |
| Level of Service | E | B | A | C | D | C | E | B | | C | D | |
| Approach Delay (s) | | 21.6 | | | 49.3 | | | 24.5 | | | 40.5 | |
| Approach LOS | | C | | | D | | | C | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 30.3 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.90 | | |
| Actuated Cycle Length (s) | 78.4 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 83.2% | ICU Level of Service | D |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | 4.0 | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 1.00 | 0.85 | | 0.95 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Flt Protected | | 1.00 | 1.00 | | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1858 | 1583 | | 1775 | | 1770 | 1863 | | 1770 | 1863 | |
| Flt Permitted | | 0.98 | 1.00 | | 1.00 | | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (perm) | | 1820 | 1583 | | 1775 | | 1770 | 1863 | | 1770 | 1863 | |
| Volume (vph) | 3 | 54 | 473 | 0 | 41 | 22 | 362 | 443 | 0 | 20 | 299 | 0 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 3 | 59 | 514 | 0 | 45 | 24 | 393 | 482 | 0 | 22 | 325 | 0 |
| Lane Group Flow (vph) | 0 | 62 | 514 | 0 | 69 | 0 | 393 | 482 | 0 | 22 | 325 | 0 |
| Turn Type | Perm | | pm+ov | Perm | | | Prot | | | Prot | | |
| Protected Phases | | 4 | 5 | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | | | | | | | |
| Actuated Green, G (s) | | 3.9 | 18.1 | | 3.9 | | 14.2 | 29.6 | | 0.6 | 16.0 | |
| Effective Green, g (s) | | 3.9 | 18.1 | | 3.9 | | 14.2 | 29.6 | | 0.6 | 16.0 | |
| Actuated g/C Ratio | | 0.08 | 0.39 | | 0.08 | | 0.31 | 0.64 | | 0.01 | 0.35 | |
| Clearance Time (s) | | 4.0 | 4.0 | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 154 | 759 | | 150 | | 545 | 1196 | | 23 | 647 | |
| v/s Ratio Prot | | | c0.21 | | 0.04 | | c0.22 | 0.26 | | 0.01 | c0.17 | |
| v/s Ratio Perm | | 0.03 | 0.12 | | | | | | | | | |
| v/c Ratio | | 0.40 | 0.68 | | 0.46 | | 0.72 | 0.40 | | 0.96 | 0.50 | |
| Uniform Delay, d1 | | 20.0 | 11.6 | | 20.1 | | 14.2 | 4.0 | | 22.7 | 11.9 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 1.7 | 2.4 | | 2.2 | | 4.7 | 0.2 | | 166.5 | 0.6 | |
| Delay (s) | | 21.7 | 14.0 | | 22.3 | | 18.9 | 4.2 | | 189.3 | 12.5 | |
| Level of Service | | C | B | | C | | B | A | | F | B | |
| Approach Delay (s) | | 14.8 | | | 22.3 | | | 10.8 | | | 23.7 | |
| Approach LOS | | B | | | C | | | B | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 14.9 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.62 | | |
| Actuated Cycle Length (s) | 46.1 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 62.7% | ICU Level of Service | B |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | 4.0 | 4.0 | | | 4.0 | 4.0 | 4.0 | 4.0 | |
| Lane Util. Factor | | | | 0.97 | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | |
| Frt | | | | 1.00 | 0.85 | | | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | | | 0.95 | 1.00 | | | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | | | 3433 | 1583 | | | 1863 | 1583 | 1770 | 1863 | |
| Flt Permitted | | | | 0.76 | 1.00 | | | 1.00 | 1.00 | 0.22 | 1.00 | |
| Satd. Flow (perm) | | | | 2736 | 1583 | | | 1863 | 1583 | 408 | 1863 | |
| Volume (vph) | 0 | 0 | 0 | 529 | 0 | 105 | 0 | 635 | 448 | 76 | 383 | 0 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 575 | 0 | 114 | 0 | 690 | 487 | 83 | 416 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 575 | 114 | 0 | 0 | 690 | 487 | 83 | 416 | 0 |
| Turn Type | Perm | | | Perm | | | Perm | | Perm | Perm | | |
| Protected Phases | | 4 | | | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | | | 16.9 | 16.9 | | | 25.2 | 25.2 | 25.2 | 25.2 | |
| Effective Green, g (s) | | | | 16.9 | 16.9 | | | 25.2 | 25.2 | 25.2 | 25.2 | |
| Actuated g/C Ratio | | | | 0.34 | 0.34 | | | 0.50 | 0.50 | 0.50 | 0.50 | |
| Clearance Time (s) | | | | 4.0 | 4.0 | | | 4.0 | 4.0 | 4.0 | 4.0 | |
| Vehicle Extension (s) | | | | 3.0 | 3.0 | | | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | | | 923 | 534 | | | 937 | 796 | 205 | 937 | |
| v/s Ratio Prot | | | | | 0.07 | | | c0.37 | | | 0.22 | |
| v/s Ratio Perm | | | | c0.21 | | | | | 0.31 | 0.20 | | |
| v/c Ratio | | | | 0.62 | 0.21 | | | 0.74 | 0.61 | 0.40 | 0.44 | |
| Uniform Delay, d1 | | | | 13.9 | 11.9 | | | 9.8 | 8.9 | 7.8 | 8.0 | |
| Progression Factor | | | | 1.00 | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | | | 1.3 | 0.2 | | | 3.0 | 1.4 | 1.3 | 0.3 | |
| Delay (s) | | | | 15.2 | 12.1 | | | 12.9 | 10.3 | 9.1 | 8.3 | |
| Level of Service | | | | B | B | | | B | B | A | A | |
| Approach Delay (s) | | 0.0 | | | 14.7 | | | 11.8 | | | 8.4 | |
| Approach LOS | | A | | | B | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 12.0 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.69 | | |
| Actuated Cycle Length (s) | 50.1 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 67.3% | ICU Level of Service | B |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 45 | 241 | 34 | 78 | 424 | 4 | 60 | 1 | 59 | 2 | 0 | 3 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 49 | 262 | 37 | 85 | 461 | 4 | 65 | 1 | 64 | 2 | 0 | 3 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | | | | | | | None | | | None | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 465 | | | 299 | | | 782 | 1013 | 149 | 926 | 1029 | 233 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 465 | | | 299 | | | 782 | 1013 | 149 | 926 | 1029 | 233 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.5 | 6.5 | 6.9 | 7.5 | 6.5 | 6.9 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 96 | | | 93 | | | 75 | 99 | 93 | 99 | 100 | 100 |
| cM capacity (veh/h) | 1092 | | | 1259 | | | 260 | 212 | 870 | 189 | 207 | 769 |

| Direction, Lane # | EB 1 | EB 2 | EB 3 | WB 1 | WB 2 | WB 3 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|---|---|
| Volume Total | 49 | 175 | 124 | 85 | 307 | 158 | 130 | 5 |
| Volume Left | 49 | 0 | 0 | 85 | 0 | 0 | 65 | 2 |
| Volume Right | 0 | 0 | 37 | 0 | 0 | 4 | 64 | 3 |
| cSH | 1092 | 1700 | 1700 | 1259 | 1700 | 1700 | 395 | 345 |
| Volume to Capacity | 0.04 | 0.10 | 0.07 | 0.07 | 0.18 | 0.09 | 0.33 | 0.02 |
| Queue Length (ft) | 4 | 0 | 0 | 5 | 0 | 0 | 35 | 1 |
| Control Delay (s) | 8.4 | 0.0 | 0.0 | 8.1 | 0.0 | 0.0 | 18.5 | 15.6 |
| Lane LOS | A | | | A | | | C | C |
| Approach Delay (s) | 1.2 | | | 1.2 | | | 18.5 | 15.6 |
| Approach LOS | | | | | | | C | C |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 3.5 | | |
| Intersection Capacity Utilization | 40.5% | ICU Level of Service | A |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Volume (veh/h) | 0 | 31 | 580 | 161 | 40 | 458 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 0 | 34 | 630 | 175 | 43 | 498 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | 796 | | | 866 |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 1215 | 630 | | | 805 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 1215 | 630 | | | 805 | |
| tC, single (s) | 6.4 | 6.2 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 100 | 93 | | | 95 | |
| cM capacity (veh/h) | 190 | 481 | | | 819 | |

| Direction, Lane # | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 |
|---|---|---|---|---|---|
| Volume Total | 34 | 630 | 175 | 43 | 498 |
| Volume Left | 0 | 0 | 0 | 43 | 0 |
| Volume Right | 34 | 0 | 175 | 0 | 0 |
| cSH | 481 | 1700 | 1700 | 819 | 1700 |
| Volume to Capacity | 0.07 | 0.37 | 0.10 | 0.05 | 0.29 |
| Queue Length (ft) | 6 | 0 | 0 | 4 | 0 |
| Control Delay (s) | 13.0 | 0.0 | 0.0 | 9.6 | 0.0 |
| Lane LOS | B | | | A | |
| Approach Delay (s) | 13.0 | 0.0 | | 0.8 | |
| Approach LOS | B | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.6 | | |
| Intersection Capacity Utilization | 43.2% | ICU Level of Service | A |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Volume (veh/h) | 0 | 404 | 19 | 82 | 562 | 0 | 19 | 0 | 159 | 0 | 0 | 0 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 0 | 439 | 21 | 89 | 611 | 0 | 21 | 0 | 173 | 0 | 0 | 0 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | | | | | | | None | | | None | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | 950 | | | 1302 | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 611 | | | 460 | | | 933 | 1239 | 230 | 1182 | 1249 | 305 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 611 | | | 460 | | | 933 | 1239 | 230 | 1182 | 1249 | 305 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.5 | 6.5 | 6.9 | 7.5 | 6.5 | 6.9 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 100 | | | 92 | | | 90 | 100 | 78 | 100 | 100 | 100 |
| cM capacity (veh/h) | 964 | | | 1098 | | | 207 | 160 | 773 | 106 | 158 | 691 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | WB 3 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|---|
| Volume Total | 293 | 167 | 89 | 305 | 305 | 193 | 0 |
| Volume Left | 0 | 0 | 89 | 0 | 0 | 21 | 0 |
| Volume Right | 0 | 21 | 0 | 0 | 0 | 173 | 0 |
| cSH | 1700 | 1700 | 1098 | 1700 | 1700 | 598 | 1700 |
| Volume to Capacity | 0.17 | 0.10 | 0.08 | 0.18 | 0.18 | 0.32 | 0.00 |
| Queue Length (ft) | 0 | 0 | 7 | 0 | 0 | 35 | 0 |
| Control Delay (s) | 0.0 | 0.0 | 8.6 | 0.0 | 0.0 | 13.9 | 0.0 |
| Lane LOS | | | A | | | B | A |
| Approach Delay (s) | 0.0 | | 1.1 | | | 13.9 | 0.0 |
| Approach LOS | | | | | | B | A |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.5 | | |
| Intersection Capacity Utilization | 39.6% | ICU Level of Service | A |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Volume (veh/h) | 0 | 310 | 345 | 636 | 411 | 96 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (veh/h) | 0 | 337 | 375 | 691 | 447 | 104 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | None | | | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | 910 | 918 | |
| pX, platoon unblocked | 0.95 | | | | | |
| vC, conflicting volume | 1542 | 223 | 551 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 1517 | 223 | 551 | | | |
| tC, single (s) | 6.8 | 6.9 | 4.1 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 100 | 57 | 63 | | | |
| cM capacity (veh/h) | 66 | 780 | 1015 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|
| Volume Total | 337 | 375 | 346 | 346 | 223 | 223 | 104 |
| Volume Left | 0 | 375 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 337 | 0 | 0 | 0 | 0 | 0 | 104 |
| cSH | 780 | 1015 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 0.43 | 0.37 | 0.20 | 0.20 | 0.13 | 0.13 | 0.06 |
| Queue Length (ft) | 55 | 43 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 13.1 | 10.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | B | B | | | | | |
| Approach Delay (s) | 13.1 | 3.7 | | | 0.0 | | |
| Approach LOS | B | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 4.3 | | |
| Intersection Capacity Utilization | 39.9% | ICU Level of Service | A |

# RAMSEY STATION
# WETLAND DELINEATION REPORT

ORIGINAL ISSUE DATE - NOVEMBER 25, 2002
REVISED – MARCH 14, 2003

PREPARED BY: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**WETLAND DELINEATION REPORT**
Ramsey Station
Anoka County, Minnesota
November 25, 2002
**Revised March 14, 2003**

## SITE DESCRIPTION:

North American Wetland Engineering, P.A. (NAWE) at the request of Ramsey Station performed a wetland delineation of approximately 275 acres of property located in Ramsey, Minnesota. The project site is located in Section 28, Township 32N and Range 25W. See Appendix A for the limits of the project area. The delineation was performed October 29-31, 2002.

## WETLAND DELINEATION PROCEDURES AND METHODS:

The presence of wetlands was determined with a procedure consistent with the definitions and methods outlined in the Corps of Engineers (COE) 1987 Wetlands Delineation Manual.

The wetland indicator status of observed plant species was determined using the National List of Plant Species that Occur in Wetlands for US Fish and Wildlife Service Region 3. Soil conditions were documented with the aid of Munsell color charts. Wetland types were classified according to the methodologies in Wetlands of the United States (FWS Circular No. 39; Shaw and Fredin 1971).

To determine the upland/wetland boundary, a modification of the Routine Onsite Determination method was used. This procedure involved establishing multiple transects throughout the project area. Team members walked 75 to 125-foot transects using compasses from property line to property line. When potential wetlands were encountered, a soil pit was dug and soils and hydrology were classified. Vegetation was classified and wetland delineation flagging hung or pin flags inserted, depicting the delineation line based upon the upland/wetland vegetation break.

Vegetation was primarily documented through the use of the COE's 50:20 rule. Dominant wetland/upland vegetation was logged on the datasheets for the four stratums present (tree, shrub, forb and vine).

Soils were classified through the use of the Munsell soil color charts. A 4-6 inch diameter soil pit was dug to a depth of 18-24 inches, when possible. The presence or absences of hydrological characteristics were noted as observed.

Wetland boundaries were flagged with pink survey ribbon/pin flags with the words "WETLAND DELINEATION" printed on it. Each flag is labeled with a letter, which indicates the name of the wetland in this report. A site map of the surveyed wetlands is available in Appendix B.

## LAND USES AND EXISTING SOIL CONDITIONS:

The site consists of two different types of land uses: 1) agricultural production, and 2) wetlands. Table 1 outlines an estimated acreage of the land types observed in the field:

***Table 1: Estimated Acreage of Project Site***

| Land Use | Approximate Acreage | Percentage |
|---|---|---|
| Agricultural Production | 270.67 acres | 95.5 % |
| Wetlands | 8.13 acres | 4.5 % |
| **TOTAL** | **275 acres** | **100%** |

Below is a description of the land types during 2002.

AGRICULTURAL PRODUCTION – The property is currently in soybean and corn row crops. Crops were harvested in October and November of 2002. Corn and soybeans have been rotated throughout the years.

WETLANDS – Four wetlands were located on the site. The wetlands are Types 2 (wet meadow), Type 3 (shallow marsh) and Type 4 (shallow open water). Hydrology from the area has been modified in the past leading to wetland conditions observed in 2002. Wetland hydrology is supplied through natural drainage patterns creating isolated wetland basins. Refer to Appendix C for photos of wetland areas. Below are brief descriptions of the wetlands delineated on-site.

**Wetland A** – Wetland A is an isolated wetland basin that consists of type 2 and Type 3 wetland vegetation. The open water in Wetland A existed in 1981 and a ditch was dug in 1982 to facilitate drainage. Spoil was cast on the south side of the wetland and is visible in the aerial photos. Dominant wetland vegetation includes *Typha angustifolia* (narrow leaved cattail), *Scirpus fluviatilis* (river bulrush), *Phalaris arundinacea* (reedcanary grass), *Verbena hastata* (Blue vervain) and *Solidago gigantea* (Giant goldenrod).

**Wetland B** – Wetland B is an isolated wetland basin excavated in 1999 for the County Road 116 road project. The wetland consists of Types 2, 3, and 4 wetland vegetation. Wetland B was created as a mitigation site for the construction of the County Road 116 extension project completed in 1999. Dominant wetland vegetation includes *Typha angustifolia* (narrow leaved cattail), *Scirpus fluviatilis* (river bulrush), *Scirpus validus* (hardstem bulrush), Carex sp. (sedge) and *Verbena hastata* (Blue vervain).

**Wetland C** – Wetland C is an isolated wetland basin that was likely connected hydrologically to other wetland complexes prior to County Road 83 and County Road 116 construction. Road construction bisected the wetland and may have disrupted the historical flow of hydrology.

Dominant wetland vegetation includes *Typha angustifolia* (narrow leaved cattail), *Scirpus fluviatilis* (river bulrush), *Scirpus acutus* (hardstem bulrush), *Carex sp*. (sedge) and *Verbena hastata* (Blue vervain).

**Wetland D** – Wetland D is an isolated wetland basin that abuts the north property line. Dominant wetland vegetation includes *Phalaris arundinacea (*reedcanary grass) and *Urtica dioca* (stinging nettle). This wetland is identified as a DNR Protected Water (Inventory No. 2-670W).

**Wetland E** – Wetland E was identified through aerial photo interpretation with TEP members. This area has no wetland vegetation since it was in agricultural production. Based upon recent aerial photos (1996-present) Wetland E is defined as a Type 1 wetland.

The project site is located within the Anoka sand plain. According to the Anoka County Soil Survey, the project site consists of the Hubbard-Nymore association. These soils are nearly level to gently sloping, are excessively drained and are sandy throughout. Depressional areas on-site are consisted of the Isan sandy loam, a hydric component within the association. A list of the Anoka County Hydric Soils List is available in Appendix D. Soils on site consist of the following soil types.

***Table 2: Summaries of Soils Within Project Area***

| Series No. | Series Name | Hydric Soil Status |
|---|---|---|
| HuA | Hubbard coarse sand | Non-Hydric* |
| Dp | Duelm loamy coarse sand | Non-Hydric* |
| DnA | Dickman sandy loam | Non-Hydric* |
| **IS** | **Isan sandy loam** | **Hydric** |
| **Mc** | **Marsh** | **Hydric** |

* - *Has hydric components (Isan soil unit is the hydric component).*

## AERIAL PHOTO INTERPRETATION:

Aerial photos were collected in order to assess wetland conditions prior to the project. Below is a summary of significant changes in landforms or hydrology based upon the aerial photo interpretation. Aerial photos are appended in Appendix E.

The Anoka/Sherburne County Farm Services Agency and Natural Resources Conservation Service summarized precipitation totals from 1979-2001. The summary calculates a monthly wetness evaluation to determine if the year is classified as a dry, normal or wet year. The results are used to assess wetland conditions observed in the aerial photos and are summarized in the following table and appended in Appendix F.

***Table 3: Aerial Photo Summary***

| Year | Change in Landform | Aerial Photo Interpretation Description | USDA Determination for Wet/Dry/Normal Year for Precipitation |
|---|---|---|---|
| 1981 | N/a | First year of aerial photos. County Road 116 not constructed. Land in agricultural use. Major swale appears to bisect northwest portion of the property, which was too wet for agricultural production. | Normal |
| 1982 | Portions of swale farmed | Eighty percent of swale area in 1982 farmed and cultivated. | Normal |
| 1983 | Ditch excavated | Ditch excavated adjacent to Wetland A. Portions of Wetland A and Wetland B connected hydrologically. | Normal |
| 1984 | Swale visible | Swale visible and was not farmed. | Wet |
| 1985 | Swale visible | Swale visible and was not farmed. | Wet |
| 1986 | Swale visible | Swale visible and was not farmed. Swale area noticeably larger in size from previous years. | Normal |
| 1987 | Swale visible | Swale visible and was farmed to a greater extent than 1986. | Dry |
| 1988 | Swale visible | Swale visible and was not farmed. | Dry |
| 1989 | Swale visible | Swale visible and was not farmed. | Normal |
| 1990 | Portions of swale farmed | Seventy percent of swale area in 1990 farmed and cultivated. | Wet |
| 1991 | Swale visible | Swale visible and was not farmed. | Wet |
| 1992 | Swale visible | Swale visible and was not farmed. | Normal |
| 1993 | Swale visible | Swale visible and was not farmed. | Wet |
| 1994 | Swale visible | Swale visible and was not farmed. Swale area noticeably larger in size from previous years. | Normal |
| 1995 | Swale visible | Swale visible and was not farmed. Swale is approximately the same size as in 1994. | Normal |
| 1996 | Swale visible | Swale visible and was not farmed. Swale is approximately the same size as in 1995. | Normal |
| 1997 | CR 116 constructed | County Road 116 constructed. A mitigation wetland was constructed on the northwest corner of the property in swale area. Swale size noticeably smaller than in 1996. | Dry |
| 1998 | N/a | Aerial photo not available. | Wet |
| 1999 | Swale visible | Swale visible but noticeably smaller than 1996. | Wet |
| 2000 | Swale modified | Swale appears to have been modified – perhaps re-graded with spoil from mitigation project. | Normal |
| 2001 | N/a | Aerial photo not available. | Wet |
| 2002 | Site Visit | Site walkthrough showed no evidence of a swale and topography does not support the evidence of a flow-through wetland. | Unknown |

**Summary of Aerial Interpretation and Site Visit** – The swale visible on the aerial photos correspond to the Isan sandy loam, a hydric soil unit. From 1981-1996, the swale area had limited agricultural production due to wetness (as indicated by aerial photo interpretation).

During an interview with the land lessee, the swale area was used as pasture over the past 20 years. The swale was not maintained in order for cattle to utilize the area because pasture grass did not grow well on the excessively drained soils of the site. Although this may be true, results of the aerial photo interpretation suggests portions of the swale historically had water ponded at or above the surface, especially in wet years. This indicates portions of the swale area were likely jurisdictional wetlands (farmed wetlands). The size of the wetlands depended upon the amount of precipitation received during the calendar year. During 1997 it appears hydrology was modified at the site and affected the swale and wetland areas. In October 1997, Halranson Anderson Associates performed a wetland-banking plan for impacts on construction of the County Road 116 extension project. The plan delineated a wetland on the subject property and proposed a wetland excavation (i.e. Wetland B) to compensate for existing wetland losses from the road project.

Construction of County Road 116 occurred in 1997. The new road bisected Wetland C (as delineated in this report) and appears to have modified the natural drainage of the larger wetland complex. Wetland C has also been reduced in size through construction of the road and by right of way ditches located in County Road 116.

The spoil from the mitigation wetland may have been used to raise the elevation around the banking project. It appears that water does not flow through the property as it did prior to 1997. Construction of the project and/or other recent man-made alterations have converted the classification of the wetland from a flow-through wetland from 1981-1997 to isolated wetland basins in 2002. Currently the entire swale area as shown in the aerial photos is now in agricultural production. Hydric soils exist in portions of the swale, but primary and secondary hydrologic indicators are lacking. Visible crop stress of the soybeans due to wetness was minimal.

Results of the aerial photo interpretation and the site visit indicate portions of the former swale area currently in agricultural production are not jurisdictional wetland areas. Therefore, these areas were not delineated as wetland areas based upon the following reasons: 1) lack of wetland hydrology; 2) lack of wetland vegetation; 3) elevation modifications around Wetland B; 4) no visible signs of crop stress; 5) construction of County Road 116 with designed drainage modifications; and 6) aerial photo interpretation.

## SUMMARY OF DISPUTED WETLAND CONDITIONS

For the time period of 1981 – 1996 aerial photos indicated a flow through wetland existed, transecting the western half of the project site in a northwest to northeast direction. Interpretation during this time period suggested a predominance of type 2 (wet meadow) and type 3 (shallow marsh) wetland existed on the site.

Changes in wetland hydrology were observed in the aerial photos beginning in 1997. Wetland hydrology for the following four years is progressively less with each year. Based upon the 2002 aerial photo for the project and field observations of the 2002 delineation, no indications of a flow through wetland existed at the site. Rather, the delineation fieldwork concluded the wetlands at the site were isolated wetland basins.

Based upon fieldwork conducted by Emmons and Olivier Resources, a groundwater elevation study was conducted to evaluate if the wetlands were influenced by groundwater interaction. Results of the study indicated the wetlands at and adjacent to the site were groundwater fed. From 1997 to present, aerial photo interpretation indicate these wetlands on and adjacent to the RTC site were consistently loosing hydrology and eventually, open water features and wetland areas previously observed prior to 1996 could not be observed to the same extent in 2000 aerial photos or in the 2002 field delineation study. The changes in the site hydrology are complex and resulted in a dispute over whether conditions existed to identify Wetland E as a jurisdictional wetland. In order to resolve this issue, a meeting with the Technical Evaluation Panel (TEP) was held to discuss alternative methodologies to determine if wetland hydrology existed.

The TEP approved a methodology to delineate wetland conditions based upon the historical aerial record. Although wetland conditions have appeared to significantly change after 1996, the TEP's methodology included aerial photo interpretation including the photos prior to 1996 during normal years of precipitation. Based upon this data it is likely that the TEP's delineation methodology of Wetland E identified in this report may not be observed in the field since the hydrologic record has been modified post 1997. Due to the changed hydrologic conditions observed after 1997, the wetland is identified as a Type 1 seasonal flooded wetland.

**WETLAND TYPE CLASSIFICATION (USFWS Circular 39 Classification System):**

Table 4 provides a listing of wetland types encountered in the field. Wetland types are classified in accordance with the US Fish and Wildlife Services publication *Wetlands of the United States, FWS Circular 39.*

***Table 4: FWS Circular 39 Classification of Wetlands***

| **Wetland** | **Type 1** | **Type 2** | **Type 3** | **Type 4** | **Type 5** | **Type 6** | **Type 7** | **Type 8** | **Acreage*** |
|---|---|---|---|---|---|---|---|---|---|
| A | | 40% | 60% | | | | | | 0.72 acres |
| B | | 5% | 15% | 80% | | | | | 1.18 acres |
| C | | 50% | 50% | | | | | | 0.20 acres |
| D | | 90% | 10% | | | | | | 2.23 acres |
| E | 100% | | | | | | | | 8.13 acres |
| **Total** | | | | | | | | | **12.46 acres** |

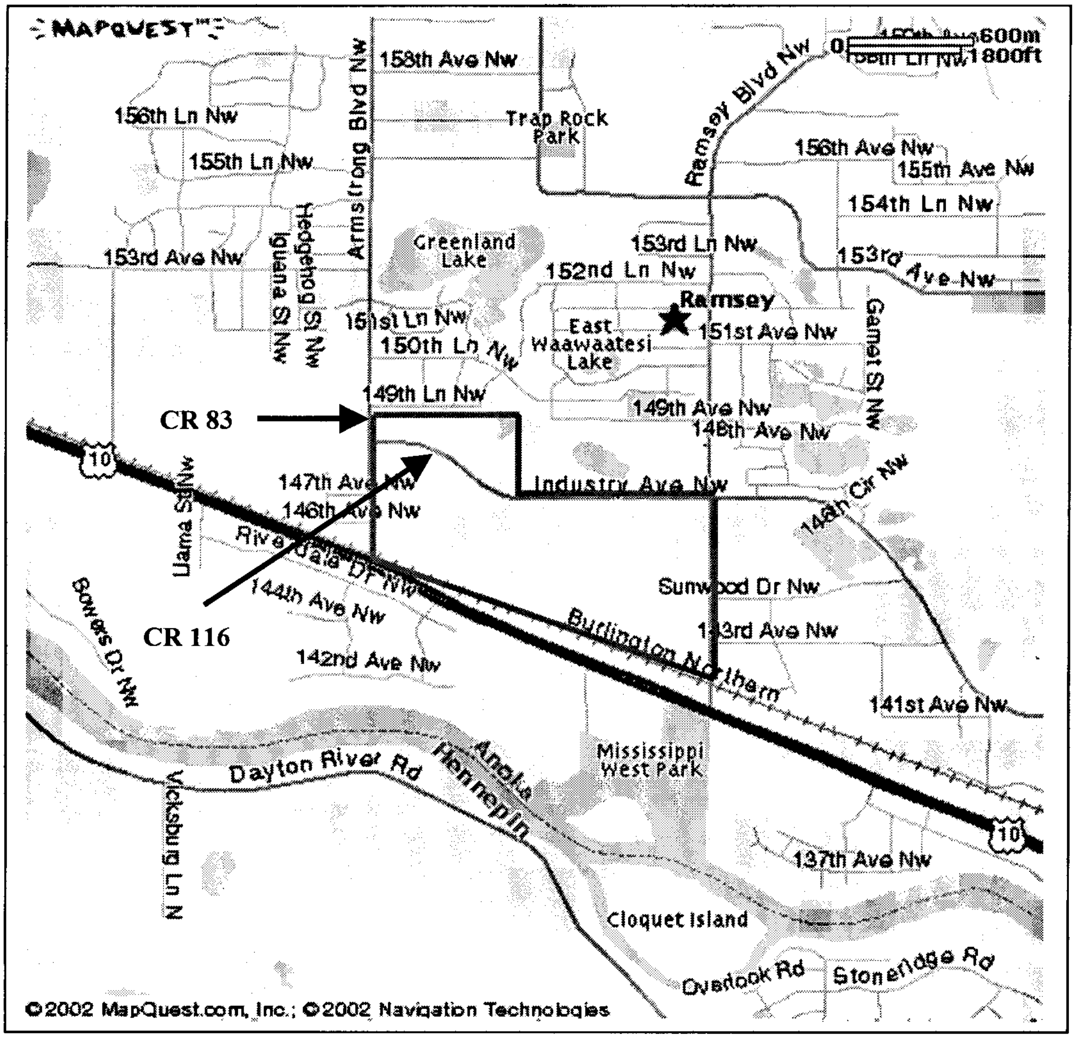
* - *Calculated by Global Positioning System.*

Wetland and upland datasheets are provided in Appendix G (except for Wetland E, which utilized an alternative methodology). Acreage estimates are based upon closed wetland loops. When a wetland crosses a property line without closing the loop, the wetland is calculated to the property line, even though the wetland may be larger in area.

Any questions associated with this wetland delineation report can be directed to North American Wetland Engineering at (651)-433-2115.

# Appendix A

## Site Location



# Appendix B

# Map of Wetland Areas


Wetland C
4,962 square feet
Wetland C
Wetland B
Wetland E
Wetland A
Wetland D
Wetland E
N

# Appendix C

# Photos of Wetlands and Other Features

**Figure 0 -** Wetland A - Looking West

**Figure 2 -** Wetland B - Looking West

**Figure 3 -** Wetland C - Looking East. Note lack of crop stress.

**Figure 4 -** Wetland D - Looking North

**Figure 5 –** Wetland E in October 2003.

**Figure 6 –** Hydric soil at Wetland C.

# Appendix D

# Anoka County Soils Map and Hydric Soils List


### *Soils Within Project Area*

| **Series No.** | **Series Name** | **Hydric Soil Status** |
|---|---|---|
| HuA | Hubbard coarse sand | Non-Hydric* |
| Dp | Duelm loamy coarse sand | Non-Hydric* |
| DnA | Dickman sandy loam | Non-Hydric* |
| **IS** | **Isan sandy loam** | **Hydric** |
| **Mc** | **Marsh** | **Hydric** |

* - *Has hydric components (Isan soil unit is the hydric component).*

(I) = inclusio
(C) = componen

HYDRIC SOILS MAP UNIT LIST
ANOKA COUNTY
November 25, 1997

| MAP SYMBOL | MAP UNIT NAME | HYDRIC COMPONENT | LOCATION CODE | HYDRIC CRITERIA | NATURAL WOODLAND |
|---|---|---|---|---|---|
| Af | ALLUVIAL LAND, MIXED, FREQUENTLY FLOODED | Whole Unit | FP | 2B2,3,4 | Yes |
| AnA | ANOKA LOAMY FINE SAND, 0 TO 2 PERCENT SLOPES | Isanti (I) | FL,DP | 2B3,3 | No |
| AnB | ANOKA LOAMY FINE SAND, 2 TO 6 PERCENT SLOPES | Isanti (I) | FL,DP | 2B3,3 | No |
| AnC | ANOKA LOAMY FINE SAND, 6 TO 12 PERCENT SLOPES | Isanti (I) | FL,DP | 2B3,3 | No |
| Ba | BECKER VERY FINE SANDY LOAM | Fordum (I) | FP | 2B3,3,4 | Yes |
| Bm | BLOMFORD LOAMY FINE SAND | Whole Unit | DQ,FL | 2B2 | Yes |
| BtB | BRAHAM LOAMY FINE SAND, 2 TO 6 PERCENT SLOPES | Blomford (I) | DQ | 2B2 | Yes |
| BtB | BRAHAM LOAMY FINE SAND, 2 TO 6 PERCENT SLOPES | Kratka (I) | DP | 2B2,3 | Yes |
| BtC | BRAHAM LOAMY FINE SAND, 6 TO 18 PERCENT SLOPES | Blomford (I) | DQ | 2B2 | Yes |
| BtC | BRAHAM LOAMY FINE SAND, 6 TO 18 PERCENT SLOPES | Kratka (I) | DP | 2B2,3 | No |
| Bx | BRICKTON SILT LOAM | Whole Unit | DQ,FL | 2B3 | Yes |
| Cb | CATHRO MUCK | Whole Unit | DP | 1,3 | No |
| CkB | CHETEK SANDY LOAM, 2 TO 6 PERCENT SLOPES | Isan (I) | FL,DP | 2B3,3 | No |
| CkC | CHETEK SANDY LOAM, 6 TO 12 PERCENT SLOPES | Isan (I) | FL,DP | 2B3,3 | No |
| Cu | CUT AND FILL LAND | Poorly Drained (I) | DQ | 2B3 | No |
| DlA | DALBO SILT LOAM, 1 TO 5 PERCENT SLOPES | Dundas (I) | DQ | 2B3 | Yes |
| DnA | DICKMAN SANDY LOAM, 0 TO 2 PERCENT SLOPES | Isan (I) | FL,DP | 2B3,3 | No |
| DnB | DICKMAN SANDY LOAM, 2 TO 6 PERCENT SLOPES | Isan (I) | FL,DP | 2B3,3 | No |
| DP | DUELM LOAMY COARSE SAND | Isan (I) | FL,DP | 2B3,3 | No |
| Du | DUNDAS LOAM | Whole Unit | DQ,FL | 2B3 | Yes |
| EmC | EMMERT GRAVELLY COARSE SANDY LOAM, 6 TO 12 PERCENT SLOPES | Isan (I) | FL,DP | 2B3,3 | No |
| EmC | EMMERT GRAVELLY COARSE SANDY LOAM, 6 TO 12 PERCENT SLOPES | Seelyeville (I) | DP | 1,3 | No |
| EmD | EMMERT GRAVELLY COARSE SANDY LOAM, 12 TO 25 PERCENT SLOPES | Isan (I) | FL,DP | 2B3,3 | No |
| EmD | EMMERT GRAVELLY COARSE SANDY LOAM, 12 TO 25 PERCENT SLOPES | Seelyeville (I) | DP | 1,3 | No |
| EpC | EMMERT COMPLEX, 4 TO 12 PERCENT SLOPES | Isan (I) | FL,DP | 2B3,3 | No |
| EpD | EMMERT COMPLEX, 12 TO 25 PERCENT SLOPES | Isan (I) | FL,DP | 2B3,3 | No |
| EpD | EMMERT COMPLEX, 12 TO 25 PERCENT SLOPES | Seelyeville (I) | DP | 1,3 | No |
| Gc | GLENCOE LOAM, DEPRESSIONAL | Whole Unit | DP | 2B3,3 | No |
| GrA | GROWTOW FINE SANDY LOAM, 1 TO 4 PERCENT SLOPES | Nowen (I) | DQ | 2B3 | Yes |
| HdB | HAYDEN FINE SANDY LOAM, 2 TO 6 PERCENT SLOPES | Talmoon (I) | DQ | 2B3 | Yes |
| HdB | HAYDEN FINE SANDY LOAM, 2 TO 6 PERCENT SLOPES | Bluffton (I) | DP | 2B3,3 | No |
| HdC2 | HAYDEN FINE SANDY LOAM, 6 TO 12 PERCENT SLOPES, ERODED | Talmoon (I) | DQ | 2B3 | Yes |
| HdC2 | HAYDEN FINE SANDY LOAM, 6 TO 12 PERCENT SLOPES, ERODED | Bluffton (I) | DP | 2B3,3 | No |
| HdD | HAYDEN FINE SANDY LOAM, 12 TO 24 PERCENT SLOPES | Talmoon (I) | DQ | 2B3 | Yes |
| HdD | HAYDEN FINE SANDY LOAM, 12 TO 24 PERCENT SLOPES | Bluffton (I) | DP | 2B3,3 | No |
| HeB | HEYDER FINE SANDY LOAM, 2 TO 6 PERCENT SLOPES | Talmoon (I) | DQ | 2B3 | Yes |
| HeB | HEYDER FINE SANDY LOAM, 2 TO 6 PERCENT SLOPES | Bluffton (I) | DP | 2B3,3 | No |
| HeC2 | HEYDER FINE SANDY LOAM, 6 TO 12 PERCENT SLOPES, ERODED | Talmoon (I) | DQ | 2B3 | Yes |
| HeC2 | HEYDER FINE SANDY LOAM, 6 TO 12 PERCENT SLOPES, ERODED | Bluffton (I) | DP | 2B3,3 | No |
| HeD | HEYDER FINE SANDY LOAM, 12 TO 18 PERCENT SLOPES, ERODED | Talmoon (I) | DQ | 2B3 | Yes |
| HeD | HEYDER FINE SANDY LOAM, 12 TO 18 PERCENT SLOPES, ERODED | Bluffton (I) | DP | 2B3,3 | No |
| HeE | HEYDER FINE SANDY LOAM, 18 TO 30 PERCENT SLOPES | Talmoon (I) | DQ | 2B3 | Yes |
| HeE | HEYDER FINE SANDY LOAM, 18 TO 30 PERCENT SLOPES | Bluffton (I) | DP | 2B3,3 | No |
| HlC | HEYDER COMPLEX, 4 TO 12 PERCENT SLOPES | Talmoon (I) | DQ | 2B3 | Yes |
| HlC | HEYDER COMPLEX, 4 TO 12 PERCENT SLOPES | Bluffton (I) | DP | 2B3,3 | No |
| HlD | HEYDER COMPLEX, 12 TO 25 PERCENT SLOPES | Talmoon (I) | DQ | 2B3 | Yes |
| HlD | HEYDER COMPLEX, 12 TO 25 PERCENT SLOPES | Bluffton (I) | DP | 2B3,3 | No |
| HuA | HUBBARD COARSE SAND, 0 TO 2 PERCENT SLOPES | Isan (I) | FL,DP | 2B3,3 | No |

| MAP SYMBOL | MAP UNIT NAME | HYDRIC COMPONENT | LOCATION CODE | HYDRIC CRITERIA | NATURAL WOODLAND |
|---|---|---|---|---|---|
| HuB | HUBBARD COARSE SAND, 2 TO 6 PERCENT SLOPES | Isan (I) | FL,DP | 2B3,3 | No |
| HuC | HUBBARD COARSE SAND, 6 TO 12 PERCENT SLOPES | Isan (I) | FL,DP | 2B3,3 | No |
| Is | ISAN SANDY LOAM | Whole Unit | FL,DP | 2B3,3 | No |
| Iw | ISANTI FINE SANDY LOAM | Whole Unit | FL,DP | 2B3,3 | No |
| KmB | KINGSLEY FINE SANDY LOAM, 2 TO 6 PERCENT SLOPES | Nowen (I) | DQ | 2B3 | Yes |
| KmB | KINGSLEY FINE SANDY LOAM, 2 TO 6 PERCENT SLOPES | Cathro (I) | DP | 1,3 | No |
| KmC2 | KINGSLEY FINE SANDY LOAM, 6 TO 12 PERCENT SLOPES, ERODED | Nowen (I) | DQ | 2B3 | Yes |
| KmC2 | KINGSLEY FINE SANDY LOAM, 6 TO 12 PERCENT SLOPES, ERODED | Cathro (I) | DP | 1,3 | No |
| KmD | KINGSLEY FINE SANDY LOAM, 12 TO 18 PERCENT SLOPES | Nowen (I) | DQ | 2B3 | Yes |
| KmD | KINGSLEY FINE SANDY LOAM, 12 TO 18 PERCENT SLOPES | Cathro (I) | DP | 1,3 | No |
| KmE | KINGSLEY FINE SANDY LOAM, 18 TO 30 PERCENT SLOPES | Nowen (I) | DQ | 2B3 | Yes |
| KmE | KINGSLEY FINE SANDY LOAM, 18 TO 30 PERCENT SLOPES | Cathro (I) | DP | 1,3 | No |
| Kr | KRATKA LOAMY FINE SAND, DEPRESSIONAL | Whole Unit | DP | 2B2,3 | No |
| Lb | LAKE BEACHES | Isan (C) | DP | 2B3,3 | No |
| LgB | LANGOLA LOAMY SAND, 0 TO 6 PERCENT SLOPES | Isanti (I) | FL,DP | 2B3,3 | No |
| LnA | LINO LOAMY FINE SAND, 0 TO 4 PERCENT SLOPES | Isanti (I) | FL,DP | 2B3,3 | No |
| Lw | LOAMY WET LAND | Whole Unit | DP | 2B3,3 | No |
| Lx | LUPTON MUCK | Whole Unit | DP | 1,3 | No |
| Ma | MARKEY MUCK | Whole Unit | DP | 1,3 | No |
| Mc | MARSH | Whole Unit | DP | 1,3 | No |
| Me | MEEHAN SAND | Isan (I) | FL,DP | 2B3,3 | No |
| Mk | MILLERVILLE MUCKY PEAT | Whole Unit | DP | 1,3 | No |
| MoA | MORA FINE SANDY LOAM, 1 TO 4 PERCENT SLOPES | Prebish (I) | DP | 2B3,3 | No |
| NeA | NESSEL FINE SANDY LOAM, 1 TO 4 PERCENT SLOPES | Talmoon (I) | DQ | 2B3 | Yes |
| NeA | NESSEL FINE SANDY LOAM, 1 TO 4 PERCENT SLOPES | Bluffton (I) | DP | 2B3,3 | No |
| No | NOWEN SANDY LOAM | Whole Unit | DQ,FL | 2B3 | Yes |
| NrD | NYMORE LOAMY COARSE SAND, 12 TO 25 PERCENT SLOPES | Isan (I) | DP,FL | 2B3,3 | No |
| NyA | NYMORE LOAMY SAND, 0 TO 2 PERCENT SLOPES | Isan (I) | FL,DP | 2B3,3 | No |
| NyB | NYMORE LOAMY SAND, 2 TO 6 PERCENT SLOPES | Isan (I) | FL,DP | 2B3,3 | No |
| NyC | NYMORE LOAMY SAND, 6 TO 12 PERCENT SLOPES | Isan (I) | FL,DP | 2B3,3 | No |
| Rf | RIFLE MUCKY PEAT | Whole Unit | DP | 1,3 | No |
| Rg | RIFLE MUCK, WOODY | Whole Unit | DP | 1,3 | No |
| Rh | RIFLE SOILS, PONDED | Whole Unit | DP | 1,3 | No |
| Ru | RONDEAU MUCK | Whole Unit | DP | 1,3 | No |
| Ry | RONNEBY FINE SANDY LOAM | Prebish (I) | DP | 2B3,3 | No |
| SbB | SARTELL FINE SAND, 2 TO 6 PERCENT SLOPES | Isanti (I) | FL,DP | 2B3,3 | No |
| SbC | SARTELL FINE SAND, 6 TO 12 PERCENT SLOPES | Isanti (I) | FL,DP | 2B3,3 | No |
| SbC2 | SARTELL FINE SAND, 6 TO 12 PERCENT SLOPES, ERODED | Isanti (I) | FL,DP | 2B3,3 | No |
| SbD2 | SARTELL FINE SAND, 12 TO 24 PERCENT SLOPES, ERODED | Isanti (I) | FL,DP | 2B3,3 | No |
| Se | SEELYEVILLE MUCK | Whole Unit | DP | 1,3 | No |
| SoA | SODERVILLE FINE SAND, 0 TO 4 PERCENT SLOPES | Isanti (I) | FL,DP | 2B3,3 | No |
| Wb | WEBSTER LOAM | Whole Unit | DP | 2B3,3 | No |
| ZmA | ZIMMERMAN FINE SAND, 0 TO 2 PERCENT SLOPES | Isanti (I) | FL,DP | 2B3,3 | No |
| ZmB | ZIMMERMAN FINE SAND, 2 TO 6 PERCENT SLOPES | Isanti (I) | FL,DP | 2B3,3 | No |
| ZmC | ZIMMERMAN FINE SAND, 6 TO 12 PERCENT SLOPES | Isanti (I) | FL,DP | 2B3,3 | No |
| ZmD | ZIMMERMAN FINE SAND, 12 TO 24 PERCENT SLOPES | Isanti (I) | FL,DP | 2B3,3 | No |

# Appendix E

# Historical Aerial Photos (1981-2000)

# Aerial Photo from 1981


**North**

# Aerial Photo from 1982

# Aerial Photo from 1983

# Aerial Photo from 1984

# Aerial Photo from 1985

# Aerial Photo from 1986

# Aerial Photo from 1987

# Aerial Photo from 1988

# Aerial Photo from 1989

# Aerial Photo from 1990

# Aerial Photo from 1991

# Aerial Photo from 1992

# Aerial Photo from 1993

# Aerial Photo from 1994

# Aerial Photo from 1995

# Aerial Photo from 1996

# Aerial Photo from 1997

# Aerial Photo from 1999

*(Note: Aerial Photo from 1998 not available)*

# Aerial Photo from 2000

# Appendix F

# Sherburne County Wet/Dry Year Tabulation

| Rainfall Data | Elk River, MN | | | Sherburne County, MN | | | Station # 21-2500 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|

| | **Monthly Rainfall in Inches** | | | | | **Monthly Wetness Evaluation 30 % Chance** | | | | | **July Slides April - June** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | April | May | June | July | August | April | May | June | July | August | Product | Evaluation |
| 1979 | 0.45 | 4.69 | 6.73 | 2.61 | 5.94 | 1 | 3 | 3 | 1 | 3 | 16 | 3 |
| 1980 | 0.83 | 2.03 | 4.94 | 3.44 | 7.10 | 1 | 1 | 2 | 2 | 3 | 9 | 1 |
| 1981 | 3.65 | 1.34 | 6.32 | 3.98 | 3.13 | 3 | 1 | 3 | 2 | 2 | 14 | 2 |
| 1982 | 2.12 | 5.26 | 2.69 | 3.92 | 2.42 | 2 | 3 | 2 | 2 | 1 | 14 | 2 |
| 1983 | 2.37 | 2.26 | 7.65 | 3.82 | 4.94 | 2 | 1 | 3 | 2 | 3 | 13 | 2 |
| 1984 | 4.00 | 4.24 | 7.07 | 2.84 | 4.32 | 3 | 3 | 3 | 2 | 2 | 18 | 3 |
| 1985 | 4.19 | 3.93 | 5.37 | 4.57 | 5.79 | 3 | 3 | 3 | 2 | 3 | 18 | 3 |
| 1986 | 6.06 | 3.36 | 3.53 | 3.67 | 4.12 | 3 | 2 | 2 | 2 | 2 | 13 | 2 |
| 1987 | 0.15 | 1.78 | 1.88 | 7.07 | 4.48 | 1 | 1 | 1 | 3 | 3 | 6 | 1 |
| 1988 | 1.21 | 2.56 | 0.03 | 2.31 | 3.52 | 1 | 2 | 1 | 1 | 2 | 8 | 1 |
| 1989 | 1.68 | 4.11 | 2.85 | 3.04 | 4.35 | 2 | 3 | 2 | 2 | 2 | 14 | 2 |
| 1990 | 2.98 | 4.21 | 9.89 | 6.04 | 3.70 | 2 | 3 | 3 | 3 | 2 | 17 | 3 |
| 1991 | 3.94 | 6.94 | 4.23 | 6.53 | 3.49 | 3 | 3 | 2 | 3 | 2 | 15 | 3 |
| 1992 | 2.41 | 1.73 | 4.40 | 4.33 | 2.52 | 2 | 1 | 2 | 2 | 1 | 10 | 2 |
| 1993 | 2.43 | 5.36 | 6.46 | 3.56 | 8.23 | 2 | 3 | 3 | 2 | 3 | 17 | 3 |
| 1994 | 6.32 | 1.88 | 2.78 | 5.58 | 3.74 | 3 | 1 | 2 | 3 | 2 | 11 | 2 |
| *1995 | 2.43 | 3.13 | 3.25 | 4.33 | 5.90 | 2 | 2 | 2 | 2 | 3 | 12 | 2 |
| *1996 | 0.83 | 3.60 | 2.91 | 2.51 | 2.54 | 1 | 2 | 2 | 1 | 1 | 11 | 2 |
| 1997 | 0.66 | 1.48 | 3.08 | 7.80 | 4.79 | 1 | 1 | 2 | 3 | 3 | 9 | 1 |
| *1998 | 1.73 | 4.44 | 5.82 | 3.60 | 3.28 | 2 | 3 | 3 | 2 | 2 | 17 | 3 |
| *1999 | 3.03 | 6.11 | 6.89 | 6.66 | 3.11 | 2 | 3 | 3 | 3 | 2 | 17 | 3 |
| 2000 | 1.62 | 2.16 | 4.08 | 3.55 | 1.80 | 2 | 1 | 2 | 2 | 1 | 10 | 2 |
| 2001 | 7.96 | 4.06 | 3.26 | 1.43 | 4.14 | 3 | 3 | 2 | 1 | 2 | 15 | 3 |

| Month | 30% Lower Bound | N | 30% Upper Bound |
|---|---|---|---|
| | 1.62 | 2.41 | 3.16 |
| | 2.41 | 3.42 | 3.9 |
| | 2.63 | 4.53 | 5.13 |
| July | 2.63 | 3.84 | 4.61 |
| August | 2.63 | 4.01 | 4.35 |
| PGS-AMJ | 6.66 | 10.36 | 12.19 |

1 = Dry, 2 = Normal, 3 = Wet

Normal: Inside 30% chance values
Dry: < lower bound for 30% chance
Wet: > upperr bound for 30% chance

* Divisional Data
1999 used Cedar

PGS - Partial Growing Season

**Normals are for 1961-1990 data**

# Appendix G

# Wetland and Upland Datasheets

**DATA FORM**

Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

| | | | |
|---|---|---|---|
| Project/Site: | Ramsey Town Station | Date: | 10/29 to 10/31/02 |
| Applicant/Owner: | Ramsey Town Station, LLC | County: | Anoka |
| Investigator: | R. Brandt, North American Wetland Engineering, P.A. | State: | Minnesota |

| | | | | |
|---|---|---|---|---|
| Do Normal Circumstances exist on the site? | ☒ Yes | ☐ No | Community ID: | Wetland A |
| Is the site significantly disturbed (Atypical Situation)? | ☐ Yes | ☒ No | Transect ID: | |
| Is the area a potential Problem Area? | ☐ Yes | ☒ No | Plot ID: | |
| (If needed, explain on reverse) | | | | |

## VEGETATION

| Dominant Plant Species | Stratum | Indicator | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|
| 1. Typha angustifolia (Narrow leaved cattail) | F | OBL | 9. | | |
| 2. Scirpus fluviatilis (River bulrush) | F | OBL | 10. | | |
| 3. Phaslaris arundinacea (Reedcanary grass) | F | FACW+ | 11. | | |
| 4. Verbena hastata (Blue vervain) | F | FACW+ | 12. | | |
| 5. Solidago gigantea (Giant goldenrod) | F | FACW | 13. | | |
| 6. | | | 14. | | |
| 7. | | | 15. | | |
| 8. | | | 16. | | |

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). >50%

**Remarks:**

## HYDROLOGY

☒ Recorded Data (Describe in Remarks):
- ☐ Stream, Lake, or Tide Guage
- ☒ Aerial Photographs
- ☐ Other

☐ No Recorded Data Available

Field Observations:

Depth of Surface Water: 3 (in.)

Depth to Free Water in Pit: 0 (in.)

Depth to Saturated Soil: 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☒ Inundated
- ☒ Saturated in Upper 12 inches
- ☐ Water Marks
- ☐ Drift Lines
- ☐ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators:
- ☐ Oxidized Root Channels in Upper 12 Inches
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☐ Other (Describe in Remarks)

**Remarks:** Surface water observed in wetland.

## SOILS

Map Unit Name (Series and Phase): Isan Sandy Loam

Drainage Class: Very Poorly Drained

Taxonomy (Subgroup): Typic Haplaquolls

Field Observations Confirm Mapped Type? ☒ Yes ☐ No

Profile Description

| Depth | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/ Size/Contast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-8 | A | 10YR 2/1 | - | - | Sandy loam/peat |
| 8-16 | B | 2.5Y 6/2 | - | - | Coarse sand |
| | | | | | |
| | | | | | |
| | | | | | |

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☒ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☒ Listed on Local Hydric Soils List
- ☒ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

**Remarks:**

## WETLAND DETERMINATION

Hydrophytic Vegetation Present? ☒ Yes ☐ No

Wetland Hydrology Present? ☒ Yes ☐ No

Hydric Soils Present? ☒ Yes ☐ No

Is this Sampling Point Within a Wetland? ☒ Yes ☐ No

**Remarks:** Type 3 – 60%; Type 2 – 40%

Wet/Up Identification: Wetland A

**DATA FORM**

Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

| | | | |
|---|---|---|---|
| Project/Site: | Ramsey Town Station | Date: | 10/29 to 10/31/02 |
| Applicant/Owner: | Ramsey Town Station, LLC | County: | Anoka |
| Investigator: | R. Brandt, North American Wetland Engineering, P.A. | State: | Minnesota |

| | | | | |
|---|---|---|---|---|
| Do Normal Circumstances exist on the site? | [x] Yes | [ ] No | Community ID: | Upland By Wetland A |
| Is the site significantly disturbed (Atypical Situation)? | [ ] Yes | [x] No | Transect ID: | - |
| Is the area a potential Problem Area? (If needed, explain on reverse) | [ ] Yes | [x] No | Plot ID: | - |

## VEGETATION

| Dominant Plant Species | Stratum | Indicator | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|
| 1. Ulmus Americana (American Elm) | T | FACW- | 9. | | |
| 2. Bromus inermis (Brome grass) | F | UPL | 10. | | |
| 3. Ribes hirtellum (Gooseberry) | S | FACW | 11. | | |
| 4. | | | 12. | | |
| 5. | | | 13. | | |
| 6. | | | 14. | | |
| 7. | | | 15. | | |
| 8. | | | 16. | | |

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). >50%

**Remarks:**

## HYDROLOGY

[x] Recorded Data (Describe in Remarks):
- [ ] Stream, Lake, or Tide Guage
- [x] Aerial Photographs
- [ ] Other

[ ] No Recorded Data Available

Field Observations:

Depth of Surface Water: none (in.)

Depth to Free Water in Pit: none (in.)

Depth to Saturated Soil: none (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- [ ] Inundated
- [ ] Saturated in Upper 12 inches
- [ ] Water Marks
- [ ] Drift Lines
- [ ] Sediment Deposits
- [ ] Drainage Patterns in Wetlands

Secondary Indicators:
- [ ] Oxidized Root Channels in Upper 12 Inches
- [ ] Water-Stained Leaves
- [ ] Local Soil Survey Data
- [ ] FAC-Neutral Test
- [ ] Other (Describe in Remarks)

**Remarks:** No hydrologic indicators observed.

## SOILS

Map Unit Name (Series and Phase): Hubbard Coarse Sand

Drainage Class: Excessively drained

Taxonomy (Subgroup): Udorthentic Haploborolls

Field Observations Confirm Mapped Type? ☒ Yes ☐ No

Profile Description

| Depth | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/ Size/Contast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-8 | A | 10YR 3/2 | - | - | Fine sandy loam |
| 8-16 | B | 2.5Y 3/3 | - | - | Fine sandy loam |
| | | | | | |
| | | | | | |
| | | | | | |

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☐ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

**Remarks:**

## WETLAND DETERMINATION

Hydrophytic Vegetation Present? ☒ Yes ☐ No

Wetland Hydrology Present? ☐ Yes ☒ No

Hydric Soils Present? ☐ Yes ☒ No

Is this Sampling Point Within a Wetland? ☐ Yes ☒ No

**Remarks:**

Wet/Up Identification: Upland By Wetland A

# DATA FORM

Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

| | | | |
|---|---|---|---|
| Project/Site: | Ramsey Town Station | Date: | 10/29 to 10/31/02 |
| Applicant/Owner: | Ramsey Town Station, LLC | County: | Anoka |
| Investigator: | R. Brandt, North American Wetland Engineering, P.A. | State: | Minnesota |

| | | | | |
|---|---|---|---|---|
| Do Normal Circumstances exist on the site? | ☒ Yes | ☐ No | Community ID: | Swale |
| Is the site significantly disturbed (Atypical Situation)? | ☒ Yes | ☐ No | Transect ID: | - |
| Is the area a potential Problem Area? (If needed, explain on reverse) | ☐ Yes | ☒ No | Plot ID: | - |

## VEGETATION

| Dominant Plant Species | Stratum | Indicator | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|
| 1. None. | | | 9. | | |
| 2. | | | 10. | | |
| 3. | | | 11. | | |
| 4. | | | 12. | | |
| 5. | | | 13. | | |
| 6. | | | 14. | | |
| 7. | | | 15. | | |
| 8. | | | 16. | | |

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).

**Remarks:** No vegetation in field. Land currently in agricultural production. Vegetation significantly different from historical aerial photos.

## HYDROLOGY

☒ Recorded Data (Describe in Remarks):
- ☐ Stream, Lake, or Tide Guage
- ☒ Aerial Photographs
- ☐ Other

☐ No Recorded Data Available

Field Observations:

Depth of Surface Water: none (in.)

Depth to Free Water in Pit: none (in.)

Depth to Saturated Soil: none (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☐ Inundated
- ☐ Saturated in Upper 12 inches
- ☐ Water Marks
- ☐ Drift Lines
- ☐ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators:
- ☐ Oxidized Root Channels in Upper 12 Inches
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☐ Other (Describe in Remarks)

**Remarks:** No hydrologic indicators observed.

## SOILS

Map Unit Name (Series and Phase): Isan Sandy Loam

Drainage Class: Very Poorly Drained

Taxonomy (Subgroup): Typic Haplaquolls

Field Observations Confirm Mapped Type? ☒ Yes ☐ No

Profile Description

| Depth | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/ Size/Contast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-14 | A | 10YR 2/1 | - | - | Sandy loam/peat |
| 14-26 | B | 2.5Y 5/3 | 10YR 4/6 | Few-med-prom | Coarse sand |
| | | | | | |
| | | | | | |
| | | | | | |

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☒ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☒ Listed on Local Hydric Soils List
- ☒ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

**Remarks:**

## WETLAND DETERMINATION

Hydrophytic Vegetation Present? ☐ Yes ☒ No

Wetland Hydrology Present? ☐ Yes ☒ No

Hydric Soils Present? ☒ Yes ☐ No

Is this Sampling Point Within a Wetland? ☐ Yes ☒ No

**Remarks:** Vegetation significantly different from historical aerial photos. Wetland hydrology lacking in sample area.

Wet/Up Identification: Swale Sampling Plot

Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

| | | | |
|---|---|---|---|
| Project/Site: | Ramsey Town Station | Date: | 10/29 to 10/31/02 |
| Applicant/Owner: | Ramsey Town Station, LLC | County: | Anoka |
| Investigator: | R. Brandt, North American Wetland Engineering, P.A. | State: | Minnesota |

| | | | | |
|---|---|---|---|---|
| Do Normal Circumstances exist on the site? | ☒ Yes | ☐ No | Community ID: | Wetland B |
| Is the site significantly disturbed (Atypical Situation)? | ☐ Yes | ☒ No | Transect ID: | |
| Is the area a potential Problem Area? (If needed, explain on reverse) | ☐ Yes | ☒ No | Plot ID: | |

## VEGETATION

| Dominant Plant Species | Stratum | Indicator | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|
| 1. Typha angustifolia (Narrow leaved cattail) | F | OBL | 9. | | |
| 2. Scirpus fluviatilis (River bulrush) | F | OBL | 10. | | |
| 3. Scirpus acutus (Hardstem bulrush) | F | OBL | 11. | | |
| 4. Verbena hastata (Blue vervain) | F | FACW + | 12. | | |
| 5. Carex sp. (Sedge) | F | FAC* | 13. | | |
| 6. Potamogeton pectinatus (Sago pondweed) | F | OBL | 14. | | |
| 7. | | | 15. | | |
| 8. | | | 16. | | |

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). >50%

**Remarks:** * - No seed head available to classify. Assumed to be FAC or wetter.

## HYDROLOGY

☒ Recorded Data (Describe in Remarks):
- ☐ Stream, Lake, or Tide Guage
- ☒ Aerial Photographs
- ☐ Other

☐ No Recorded Data Available

Field Observations:

Depth of Surface Water: 8 (in.)

Depth to Free Water in Pit: 0 (in.)

Depth to Saturated Soil: 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☒ Inundated
- ☒ Saturated in Upper 12 inches
- ☐ Water Marks
- ☐ Drift Lines
- ☐ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators:
- ☐ Oxidized Root Channels in Upper 12 Inches
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☐ Other (Describe in Remarks)

**Remarks:** Surface water observed in wetland.

## SOILS

Map Unit Name (Series and Phase): Isan Sandy Loam

Drainage Class: Very Poorly Drained

Taxonomy (Subgroup): Typic Haplaquolls

Field Observations Confirm Mapped Type? ☐ Yes ☐ No

Profile Description

| Depth | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/ Size/Contast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☐ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☒ Listed on Local Hydric Soils List
- ☒ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

**Remarks:** No soil pit dug due to inundation of surface water.

## WETLAND DETERMINATION

Hydrophytic Vegetation Present? ☒ Yes ☐ No

Wetland Hydrology Present? ☒ Yes ☐ No

Hydric Soils Present? ☒ Yes ☐ No

Is this Sampling Point Within a Wetland? ☒ Yes ☐ No

**Remarks:** Type 2 – 5%; Type 3 – 15%; Type 4 – 80%

Wet/Up Identification: Wetland B

# DATA FORM

Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

| | | | |
|---|---|---|---|
| Project/Site: | Ramsey Town Station | Date: | 10/29 to 10/31/02 |
| Applicant/Owner: | Ramsey Town Station, LLC | County: | Anoka |
| Investigator: | R. Brandt, North American Wetland Engineering, P.A. | State: | Minnesota |

| | | | |
|---|---|---|---|
| Do Normal Circumstances exist on the site? | ☒ Yes ☐ No | Community ID: | Wetland C |
| Is the site significantly disturbed (Atypical Situation)? | ☐ Yes ☒ No | Transect ID: | |
| Is the area a potential Problem Area? (If needed, explain on reverse) | ☐ Yes ☒ No | Plot ID: | |

## VEGETATION

| Dominant Plant Species | Stratum | Indicator | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|
| 1. Typha angustifolia (Narrow leaved cattail) | F | OBL | 9. | | |
| 2. Allisma plantago aquaticus (Water plantain) | F | OBL | 10. | | |
| 3. Scirpus acutus (Hardstem bulrush) | F | OBL | 11. | | |
| 4. Verbena hastata (Blue vervain) | F | FACW + | 12. | | |
| 5. Carex sp. (Sedge) | F | FAC* | 13. | | |
| 6. | | | 14. | | |
| 7. | | | 15. | | |
| 8. | | | 16. | | |

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). >50%

**Remarks:** * - No seed head available to classify. Assumed to be FAC or wetter.

## HYDROLOGY

☒ Recorded Data (Describe in Remarks):
- ☐ Stream, Lake, or Tide Guage
- ☒ Aerial Photographs
- ☐ Other

☐ No Recorded Data Available

Field Observations:

Depth of Surface Water: 4 (in.)

Depth to Free Water in Pit: 0 (in.)

Depth to Saturated Soil: 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☒ Inundated
- ☒ Saturated in Upper 12 inches
- ☐ Water Marks
- ☐ Drift Lines
- ☐ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators:
- ☐ Oxidized Root Channels in Upper 12 Inches
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☐ Other (Describe in Remarks)

**Remarks:** Hydrology still exists in Wetland C despite construction of County Road 116 and County Road 83. Wetland bisected by County Road 116.

## SOILS

Map Unit Name (Series and Phase): Isan Sandy Loam

Drainage Class: Very Poorly Drained

Taxonomy (Subgroup): Typic Haplaquolls

Field Observations Confirm Mapped Type? ☒ Yes ☐ No

Profile Description

| Depth | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/ Size/Contast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-15 | A | 10YR 2/1 | | | Peat |
| 15-20 | B | 10YR 3/1 | | | Coarse sandy clay |
| | | | | | |
| | | | | | |
| | | | | | |

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☐ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☒ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☒ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

**Remarks:** Some wood chip fill placed in right-of-way. High amount of organic material opbserved in surface layer.

## WETLAND DETERMINATION

Hydrophytic Vegetation Present? ☒ Yes ☐ No

Wetland Hydrology Present? ☒ Yes ☐ No

Hydric Soils Present? ☒ Yes ☐ No

Is this Sampling Point Within a Wetland? ☒ Yes ☐ No

**Remarks:** Type 2 – 50%; Type 3 – 50%

Wet/Up Identification: Wetland C

**DATA FORM**

Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

| | | | |
|---|---|---|---|
| Project/Site: | Ramsey Town Station | Date: | 10/29 to 10/31/02 |
| Applicant/Owner: | Ramsey Town Station, LLC | County: | Anoka |
| Investigator: | R. Brandt, North American Wetland Engineering, P.A. | State: | Minnesota |

| | | | | |
|---|---|---|---|---|
| Do Normal Circumstances exist on the site? | ☒ Yes | ☐ No | Community ID: | Upland by Wetland C |
| Is the site significantly disturbed (Atypical Situation)? | ☒ Yes | ☐ No | Transect ID: | - |
| Is the area a potential Problem Area? (If needed, explain on reverse) | ☐ Yes | ☒ No | Plot ID: | - |

## VEGETATION

| Dominant Plant Species | Stratum | Indicator | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|
| 1. Soybeans | | | 9. | | |
| 2. | | | 10. | | |
| 3. | | | 11. | | |
| 4. | | | 12. | | |
| 5. | | | 13. | | |
| 6. | | | 14. | | |
| 7. | | | 15. | | |
| 8. | | | 16. | | |

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-).

**Remarks:** Vegetation consists entirely of soybeans. Majority of crops do not show signs of crop stress due to wetness. Land currently in agricultural production. Vegetation significantly different from historical aerial photos.

## HYDROLOGY

☒ Recorded Data (Describe in Remarks):
- ☐ Stream, Lake, or Tide Guage
- ☒ Aerial Photographs
- ☐ Other

☐ No Recorded Data Available

Field Observations:

Depth of Surface Water: none (in.)

Depth to Free Water in Pit: none (in.)

Depth to Saturated Soil: none (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☐ Inundated
- ☐ Saturated in Upper 12 inches
- ☐ Water Marks
- ☐ Drift Lines
- ☐ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators:
- ☐ Oxidized Root Channels in Upper 12 Inches
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☐ Other (Describe in Remarks)

**Remarks:** No hydrologic indicators observed. Ditch holds majority of water.

## SOILS

Map Unit Name (Series and Phase): Isan Sandy Loam

Drainage Class: Very Poorly Drained

Taxonomy (Subgroup): Typic Haplaquolls

Field Observations Confirm Mapped Type? ☒ Yes ☐ No

Profile Description

| Depth | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/ Size/Contast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-12 | A | 10YR 2/1 | - | - | Sandy loam/peat |
| 12-18 | B | 2.5Y 5/3 | 10YR 4/6 | Few-med-prom | Coarse sand |

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☒ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☒ Listed on Local Hydric Soils List
- ☒ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

**Remarks:** Surface soils of lower elevations are dark.

## WETLAND DETERMINATION

Hydrophytic Vegetation Present? ☐ Yes ☒ No

Wetland Hydrology Present? ☐ Yes ☒ No

Hydric Soils Present? ☒ Yes ☐ No

Is this Sampling Point Within a Wetland? ☐ Yes ☒ No

**Remarks:** Vegetation significantly different from historical aerial photos. Wetland hydrology lacking in sample area.

Wet/Up Identification: Upland by Wetland C

## DATA FORM

Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

| | | | |
|---|---|---|---|
| Project/Site: | Ramsey Town Station | Date: | 10/29 to 10/31/02 |
| Applicant/Owner: | Ramsey Town Station, LLC | County: | Anoka |
| Investigator: | R. Brandt, North American Wetland Engineering, P.A. | State: | Minnesota |

| | | | | |
|---|---|---|---|---|
| Do Normal Circumstances exist on the site? | ☒ Yes | ☐ No | Community ID: | Wetland D |
| Is the site significantly disturbed (Atypical Situation)? | ☐ Yes | ☒ No | Transect ID: | |
| Is the area a potential Problem Area? | ☐ Yes | ☒ No | Plot ID: | |
| (If needed, explain on reverse) | | | | |

## VEGETATION

| Dominant Plant Species | Stratum | Indicator | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|
| 1. Phalaris arundinacea (Reedcanary grass) | F | FACW+ | 9. | | |
| 2. Urtica dioica (Stinging nettle) | F | FAC+ | 10. | | |
| 3. | | | 11. | | |
| 4. | | | 12. | | |
| 5. | | | 13. | | |
| 6. | | | 14. | | |
| 7. | | | 15. | | |
| 8. | | | 16. | | |

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). >50%

**Remarks:**

## HYDROLOGY

☒ Recorded Data (Describe in Remarks):
- ☐ Stream, Lake, or Tide Guage
- ☒ Aerial Photographs
- ☐ Other

☐ No Recorded Data Available

Field Observations:

Depth of Surface Water: 6 (in.)

Depth to Free Water in Pit: - (in.)

Depth to Saturated Soil: 0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ☒ Inundated
- ☒ Saturated in Upper 12 inches
- ☐ Water Marks
- ☐ Drift Lines
- ☐ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators:
- ☐ Oxidized Root Channels in Upper 12 Inches
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☐ Other (Describe in Remarks)

**Remarks:** Reedcanary grass matted down due to fluctuating water levels.

## SOILS

Map Unit Name (Series and Phase): Marsh

Drainage Class: Very Poorly Drained

Taxonomy (Subgroup): N/a

Field Observations Confirm Mapped Type? ☒ Yes ☐ No

Profile Description

| Depth | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/ Size/Contast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-12 | A | 10YR 2/1 | | | Peat/sandy loam |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☒ Gleyed or Low-Chroma Colors
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soils
- ☐ Organic Streaking in Sandy Soils
- ☒ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

**Remarks:**

## WETLAND DETERMINATION

Hydrophytic Vegetation Present? ☒ Yes ☐ No

Wetland Hydrology Present? ☒ Yes ☐ No

Hydric Soils Present? ☒ Yes ☐ No

Is this Sampling Point Within a Wetland? ☒ Yes ☐ No

**Remarks:** Type 2 – 90%; Type 3 – 10% - Identified as DNR Protected Water 2-670W.

Wet/Up Identification: Wetland D