OMNNI ASSOCIATES

Report of

# Project I.D. 1123-09-01

## Interchange Study

for

## CTH A at USH 41

## Outagamie County, Wisconsin

February 2000

OMNNI Project No. E1408A98

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## I. PURPOSE

The purpose of this study is to investigate the feasibility, costs, and impacts of building a full or a partial diamond interchange at CTH A and USH 41 intersection in Outagamie County as well as investigating the impacts of not building an interchange. The partial interchange option would consist of constructing the west ramps.

For sake of brevity, the three alternates will be called the "no interchange", "partial interchange", and "full interchange", and will refer to the intersection of USH 41 and CTH A.

## II. BACKGROUND

Highway 41 in Outagamie County was designed and built at its present location at around 1960. At that time, right-of-way was purchased for a full diamond interchange at CTH A (Lynndale Avenue) and USH 41 intersection in the Town of Grand Chute. However, at the time a two-lane structure on CTH A over USH 41 was built with no interchange.

Currently, USH 41 is being upgraded to a freeway from Milwaukee to Green Bay. In 1960+/- much of USH 41 in Outagamie County including the location of the CTH A intersection was built to WisDOT's 1960 freeway standards.

The current freeway standards require 16.5 ft. of clearance above the freeway pavement. Since the clearance under the 1960 vintage bridges is only 15+/- ft., they are being raised or replaced. The structure on CTH A at USH 41 is scheduled for reconstruction in year 2005 while the interchange at STH 47 located 1.5 miles east of CTH A is currently being designed by WisDOT District staff and is scheduled for construction in year 2003. The STH 15/CTH OO interchange with USH 41 located 1.5 miles west of CTH A was constructed in 1998.

There are positive impacts for building an interchange at CTH A for the general traveling public and for the local street system. There are also negative impacts primarily to the USH 41 traffic. There is strong local support for a partial interchange at CTH A and USH 41 making the interchange alternates viable options. The selection among the alternates needs to be made at this time. Primarily because each of the alternates would have a different impact on the design of the STH 47 interchange.

WisDOT has conducted traffic studies and projected traffic volumes for the three basic alternate designs along with "worst case scenario" projections for the alternates at CTH A. OMNNI Associates was retained to study the alternates and prepare this report.

## III. EXISTING CONDITIONS

CTH A is a north-south route at the intersection with USH 41 with a rural two-lane typical section. USH 41 runs in an east-west direction at CTH A even though USH 41 in general is a north-south route. USH 41 at CTH A is a four-lane divided freeway with a 60-foot median. Just west of CTH A, USH 41 curves to the south and then parallels CTH A one mile to the west. Exhibits A-1 and A-2 show the general area of this study.

The recently completed interchange of USH 41 with STH 15 and CTH OO is located one and one half miles westerly of CTH A. South of this interchange, USH 41 is a six-lane facility.

There is a full diamond interchange at the USH 41 intersection with STH 47. At USH 41, STH 47 runs in a true north-south direction. About six miles north of USH 41, STH 47 bears to the north-west and merges with CTH A at about eight miles north of USH 41. From there both routes run concurrently for a short distance where STH 47 heads due north toward Black Creek and CTH A heads west toward Shiocton. Exhibit A-3 shows the roadway configuration at the merger point.

From the merger point of CTH A and STH 47, traffic wishing to reach USH 41 to travel south has two choices, either to take STH 47 to its interchange with USH 41 or take CTH A across USH 41 to CTH OO, turn right and enter USH 41 at the interchange one mile to the west of CTH A. The STH 47 route is 2.1 miles longer. The 1993 origin-destination study shows that the percentage of traffic traveling through the urbanized area on CTH A is more than double that on STH 47. Traveling through means that the origin and the designations of a trip are located outside the Appleton urbanized area. About one fourth of the trucks on CTH A from the north, use the CTH A to CTH OO route to head south on USH 41 or west of USH 41 on various routes. Additional heavy truck traffic on CTH A is generated be several quarries along CTH A north of USH 41. Due to lack of a satisfactory alternate route, most of the quarry traffic destined to Appleton and points south comes down CTH A across USH 41 to CTH OO intersection with CTH A and then beyond.

The area along CTH A south of USH 41 is nearly fully developed. The area north of USH 41, for the most part, is agricultural or vacant. In the fall of 1998, the Town of Grand Chute adopted a comprehensive development plan. Exhibits A-5 and A-6 are maps copied from the comprehensive development plan. Exhibit A-5 shows the current land use while Exhibit A-6 also includes the proposed development and collector roads to serve this area. The development to the north of USH 41 is limited by large environmentally sensitive wetlands and flood plains. This area contains the Bubolz Nature Preserve. The wetlands and flood plain location is shown on Exhibit A-7.

The signalized CTH A intersection with Capitol Drive was built in 1992. The intersection is located about one-fourth mile south of USH 41. Exhibit A-4 shows the lane configurations at the intersection.

In the fall of 1999, the Town will be installing a watermain across USH 41 just east of CTH A to serve the area north of USH 41 and will install a sanitary sewer along Gillett Street to serve the same area.

Along the south side of USH 41 single family residences abut the USH 41 right-of-way on both sides of CTH A. The backs of the homes are located approximately 120 to 180 feet from USH 41 traffic. Using computer modeling, the noise impacts on the residences are classified as severe even with todays traffic volumes.

## IV. METHODOLOGY

Highway Capacity Software by McTrans was used to analyze capacity and levels of service for roadway segments, intersections, and ramp junctures for this study. Appendix A discusses the assumptions and parameters used in computing traffic capacities and levels of service within the study area. Actual computer printouts are not attached to this study but are available from OMNNI Associates. Appendix A also discusses the relevant findings of the 1993 origin – destination study conducted for the entire Appleton Urban Area.

Appendix B addresses the economics of the three alternates including an explanation of the values and assumptions made in the computation of road user costs, construction costs, and relative cost of the pavement structures.

Since the no interchange alternate can be considered a reconstruction of an existing facility, the impacts and costs of the other two alternates will be addressed in terms relative to the no interchange alternate.

This study also assumes that an urban typical section will be built along CTH A in the area of the USH 41 intersection.

Wisconsin reportable statewide crash rates for 1994 – 1998 were used to compare the relative safety of the three alternate designs excluding hit deer crashes.

The impacts of each alternate will be discussed separately and then combined in a summary of impacts. The impacts are based on traffic projections that assume that development is orderly and adheres to the "Town of Grand Chute Comprehensive Plan". Since there is a possibility that the plan might be abandoned or revised a "Worst Case" traffic projection was made and these impacts discussed in a separate section of this report.

## V. IMPACTS OF THE NO INTERCHANGE ALTERNATE

### A. Impacts on CTH A

The no interchange alternate would keep the traffic patterns at their present location. Exhibits B-1 and C-1 show the current and projected traffic for the no interchange alternate.

The projected year 2020 traffic on CTH A is 17,000 vehicles for the no interchange alternate. Based on the projected traffic, according to procedure 11-20-1 of the WisDOT's Facilities Development Manual (FDM), the urban design class for CTH A is on the border of Class 3 and Class 4. The difference between the two classes is that Class 4 calls for a median and both call for four traffic lanes. However, building a median on a bridge on a fairly high fill would serve no purpose. Therefore, a median on the bridge for this alternate will not be considered.

The signalized CTH A intersection with Capitol Drive was built in 1992. The intersection is located about one-fourth mile south of USH 41. Exhibit A-4 shows the lane configurations at the intersection. Using rough assumptions of traffic movements, a capacity analysis indicates that about 1,600 vehicles per hour on CTH A should put the intersection with Capitol Drive at its capacity. (Level of Service "F"). With a 2001 volume of 14,300 vehicles per day on CTH A south of USH 41 and a K30 factor of 11.2, the intersection would reach capacity one year after the construction of a new structure over USH 41 and modifications to the intersection would be warranted at that time.

The first three miles of CTH A north of USH 41 have been graded to accommodate a rural four lane section but only the center two lanes consisting of the pre-existing roadway were resurfaced. The County has scheduled reconstruction of this segment in year 2003 anticipating the possible construction of a partial interchange at the USH 41 intersection. If the no interchange alternate is selected, the reconstruction of this segment could be delayed.

Figure B-4 shows the year 2000 and year 2020 traffic projections for CTH A, STH 47 and CTH JJ north of USH 41. CTH JJ from the east forms a "T" intersection with CTH A about one mile north of USH 41. CTH JJ would be used by southbound CTH A traffic wishing to head east and north on USH 41. This traffic would turn left on CTH JJ then right on STH 47 to enter eastbound USH 41 at the STH 47 interchange. Currently there is a stop sign on CTH JJ. This intersection would be at or near capacity for the year 2000 traffic, and over capacity in the year 2020. With four lanes on CTH A and no separate left turn lane, a signalized intersection would be at a LOS "B" in the year 2000 and a LOS "C" in the year 2020.

For about one mile CTH A and CTH JJ run concurrently toward the north where CTH JJ turns to the west forming another "T" intersection with CTH A. With a stop sign on CTH JJ this intersection would be at a LOS B in the year 2000 as well as in the year 2020.

The five mile segment of CTH A just south of CTH A and STH 47 intersection was reconstructed in 1996. The typical section consists of two twelve foot driving lanes and ten foot shoulders. No additional work is needed on this section for the no interchange alternate.

**B. Impacts on USH 41**

Traffic analysis indicates that the capacity of the existing four lane facility on USH 41 is 66,000 vehicles per day. Using the year 2000 and year 2020 projections, this capacity will be reached in year 2019. However, the segment from CTH OO to STH 47 has the least amount of traffic projected for the four lane facility from CTH OO to STH 441. Therefore, the conversion to six lanes from CTH OO, where six lanes currently end, would be governed by the traffic warrants on the segments east of STH 47. (See Exhibit B-7)

The level of service for a six lane facility in year 2020 will be "D" if no interchange is built at CTH A. Exhibit D-1 shows the traffic volumes and levels of service (LOS) along USH 41 for both year 2000 and year 2020.

**C. Impacts on STH 47**

By not building an interchange at CTH A, the projected 2020 traffic on STH 47 would be 26,600 vehicles north of USH 41 and 28,400 vehicles south of USH 41. These volumes would put STH 47 in Urban Design Class 5 which calls for a 6 lane facility according to the FDM.

The level of service in the year 2020 at both of the west ramps at STH 47/USH 41 interchange would be a LOS "F" for a four lane facility. For a six lane facility on USH 41 the level of service would be "C" for the northwest on ramp and a LOS "D" for the southwest off ramp. As part of the STH 47/USH 41 Interchange reconstruction project, STH 47 will be reconstructed to four lanes from USH 41 to CTH JJ and will be resurfaced from CTH JJ to CTH A.

**D. Impacts on STH 47 and CTH A Intersection**

Eight miles north of USH 41, CTH A makes a right turn to form a "T" intersection with STH 47. STH 47 runs in a north-south direction with CTH A abutting from the west. This intersection handles all of the traffic on STH 47 but only the northbound traffic from CTH A. The southbound traffic on CTH A has a separate roadway and avoids the "T" intersection. See Exhibit A-3 for a sketch of the area.

Currently all legs of the "T" intersection have two lanes with a stop condition for CTH A traffic. With this configuration, the level of service for STH 47 through the intersection is a LOS "A" for the years 2000 and 2020. The left turn movement from CTH A would drop from a LOS "D" in year 2000 to a LOS "F" in the year 2020. In other words, for the no interchange alternate the intersection would have to be signalized or capacity increased through the construction of additional lanes by the year 2020.

This intersection receives a large amount of use by vacationers on weekends and has experienced congestion not indicated by the traffic projections shown on Exhibit B-4. The discrepancy is due to projections being based on weekday traffic counts. To fully analyze the intersection additional counts would be needed for turning movements and weekend traffic.

## E. Road User Costs

Road user costs are based on the fact that with no interchange at CTH A, traffic from the north needs to travel extra distance to reach USH 41 and travel southbound toward Oshkosh and Milwaukee.

In the year 2020, traffic from the north to the west (south via USH 41) at STH 47 interchange for the no interchange alternate is 5,000 vehicles and 2,400 vehicles for the partial interchange alternative (See Exhibits C-1 & C-2). This means that 2,600 vehicles avoided the indirection of STH 47 and used the westbound on-ramp at CTH A. This also applies from the west to north movement. The road user costs associated with the indirection is $7,000,000 over a 20 year period. The reduction in the overall length of travel would also eliminate 50 accidents over the same 20 years and the costs associated with the accidents.

Exhibits C-1 and C-2 also shown that the southbound traffic volume on CTH A in year 2020 south of STH 41 is 8,500 vehicles for the no interchange alternate and 5,500 vehicles for the partial interchange alternate. This means that a total of 3,000 vehicles are avoiding the inconvenience and indirection of getting to southbound USH 41 via CTH A and CTH OO. This also applies to the northbound movement. The reduction in traffic from the north to the west at STH 47 plus the reduction in traffic from the north to the south at CTH A (namely 5600 vehicles) should equal the movement from the north to the west for the interchange alternates at CTH A. This movement, as shown on exhibits C-2 and C-3, is 5,500 vehicles which is close to the 5,600 vehicles used in computing the road user costs. The road user costs of this indirection and inconvenience is $2,500,000 over a 20 year period. By putting the traffic on a safer facility, 20 accidents and the associated costs would be eliminated.

The total cost of not providing the west ramps at CTH A is $9,500,000 in road user costs. The parameters and assumptions used to compute the road user costs are contained in Appendix B.

## F. Impacts on Communities

The south side of USH 41 on both sides of CTH A is a fully developed residential area. Noise predictions were made at five house locations utilizing the FHWA Traffic Noise Model. Both the year 2000 and year 2020 noise impacts are severe, with year 2000 noise levels ranging from 70.1dB to 70.9dB. The year 2020 noise levels are about 1.5 dB higher than the year 2000 levels. For the no interchange alternative possible noise mitigation along USH 41 should not need to be addressed at this time. However, the severe noise impacts would have to be addressed when USH 41 is converted to six lanes as per current guidelines for implementing noise mitigation measures.

Under this alternative 5,000 to 6,000 vehicles would continue using CTH A south of USH 41 and using CTH OO west of CTH A. This traffic would contain a relatively large truck traffic coming from quarries north of USH 41. This traffic volume is of particular concern to the local government because it passes by Twin Willows School and passes within a block of Houdini Elementary School.

The 1993 comprehensive origin-destination study for Appleton Urban Area found that the highest concentration of heavy trucks in the entire urban area is on CTH A north of USH 41 at 16.2%. The origin-destination study also shows that the amount of through-traffic on CTH A is double that on STH 47 even though the total number of trips on STH 47 and CTH A were similar. Through Traffic is traffic whose origin and destination are outside the Appleton Urban Area. This through traffic rightfully belongs on USH 41 and not through residential area with school zones. The origin-destination study is discussed more fully in Appendix A.

## G. Construction Costs

The recently completed Meade Street over USH 41 project is very similar to the no interchange alternate. Adjusting the Meade Street project costs for inflation, wider lanes, and box culvert extension at CTH A, the rough construction cost estimate of the no interchange alternate is $1,500,000.

# VI. IMPACTS OF THE PARTIAL INTERCHANGE ALTERNATE

## A. Impacts on CTH A

Building the west ramps at the CTH A and USH 41 intersection would increase the traffic on CTH A north of USH 41 and reduce the traffic on CTH A south of USH 41. Exhibits B-2, B-5 and C-2 show the current and projected traffic volumes and movements for the partial interchange alternate. Based on traffic alone, the urban design class for CTH A north of USH 41 would be 4 and south of USH 41 the class would be 3.

Under this alternate, the capacity of CTH A south of USH 41 would be reached in the year 2021 or 20 years later when compared to the no interchange alternate. Conversion of a rural two lane road to a four lane urban street costs about $2,000,000 per mile. The delay of 20 years results in a savings of $400,000 when compared to the no interchange alternate.

The added traffic would warrant a stronger pavement structure for the segment of CTH A north of USH 41. However, the increase of traffic on CTH A is offset by a similar drop in traffic on STH 47. Assuming uniform soil conditions throughout the entire area, the structure number for flexible pavement was computed for each segment of CTH A. The reduced traffic south of USH 41 results in a savings of $40,000 while the increase traffic from the north of USH 41 results in $60,000 additional cost due to increased pavement thickness. These costs are relative to the no interchange alternate and based on $2.50 per inch of asphalt per sq. yard of pavement.

The existing south CTH A intersection with CTH JJ would be over capacity based on the year 2000 traffic. The intersection would have to be reconstructed and signalized at the time of construction of a partial interchange at USH 41. The signals would be warranted primarily due to increase in left turns from CTH JJ onto CTH A because the traffic generated along CTH JJ would access southbound USH 41 at CTH A instead of STH 47. A signalized intersection with no separate left turn lane on CTH A would function at a LOS "C" in the year 2000 and a LOS "D" in the year 2020. It is reasonable to assume that a left turn lane would be built on CTH A under this alternate. The approximate cost for reconstruction and signalization is $200,000.00

With a stop sign control on CTH JJ, the north intersection with CTH A would be at a LOS "B" in the year 2000 and at a LOS "C" in the year 2020.

The five mile segment of CTH A north of USH 41 and just south of juncture of STH 47 and CTH A was built in 1996. Since traffic under this alternate would increase 18 to 20 percent, an overlay would be warranted by the year 2020. The overlay would cost about $350,000 for the five mile segment including added shouldering.

## B. Impacts on USH 41

Under the partial interchange alternate, anticipated traffic on USH 41 west of CTH A would increase from 67,000 vehicles to 74,400 vehicles per day. The USH 41 traffic east of CTH A, however, would drop from 67,000 vehicles to 61,400 vehicles. This means that a six-lane facility west of CTH A would be warranted in year 2011 or eight years earlier when compared to the no interchange alternate. East of CTH A six lanes would be warranted in year 2026 or seven years later than for the no interchange alternate. The estimate for adding two lanes and median barrier to USH 41 is roughly $800,000 per mile. The hastening of six lane conversion west of CTH A would result in a $200,000 cost to the partial interchange alternative while delay to the east of CTH A would result in $140,000 savings. Even with a 10% increase in traffic on USH 41 west of CTH A. The segments of USH 41 east of STH 47 would dictate when six lane conversion takes place. This is shown in Exhibit B-7. Therefor, these savings are valid only for the comparison of the alternatives.

The ramp terminals onto USH 41 would have an adverse impact on USH 41 traffic. However, converting USH 41 to a six-lane facility at the time of ramp construction would mitigate this adverse impact. Exhibit D-2 shows the traffic volumes and level of service (LOS) for year 2000 and year 2020.

Ramp spacing adversely affects the level of service if the merge or diverge influence areas overlap. Intersections with diamond interchanges would have to be spaced less than one mile apart for this to happen. CTH A is a mile and a half from the nearest cross road with an interchange.

The level of service in general, is based on the density of vehicles on a given section of road in terms of passenger cars per lane per mile. It should be noted that the density allowed for levels of service B, C, and D in ramp-freeway junction areas is higher than that on a freeway segment alone. For this reason, the level of service in a ramp influence area can be higher than on a freeway segment alone. Therefore, discussion of level of service for a non-existent ramp is of little value unless it is to evaluate alternate ramp designs.

## C. Impacts on STH 47

A partial interchange at CTH A would reduce the traffic on STH 47 to the extent that the urban design class for STH 47 would be reduced from 5 to 4. This drop in design class was not used in computing savings in the construction costs of the STH 47 interchange. However, the reduced traffic in this interchange would result in the reduction of lengths of turning lanes that would result in $20,000 savings in construction costs because reduced turning movements require less storage space.

The decreased traffic would reduce the required pavement structure resulting in savings of about $180,000 when compared to the no interchange alternate.

Due to reduction of traffic, the level of service at the northwest on ramp would improve from a LOS "F to a LOS "D" in the year 2020 for a four-lane facility on USH 41. The level of service would remain at a LOS "C" for a six-lane facility when compared to the no build alternate.

## D. Impacts on STH 47 and CTH A Intersection

For the partial interchange alternate about 1,000 vehicles per day would be shifted from STH 47 to CTH A in the year 2000 and 1,500 vehicles in year 2020 when compared to the no interchange alternate. However, the amount of traffic at the "T" intersection would be reduced by one half of the shifted vehicles because the southbound traffic on CTH A by passes the "T" intersection shown on Exhibit A-3. As a result, the level of service remains the same, a LOS "A" on STH 47 and a LOS "D" on CTH A in the year 2000 and a LOS "F" in the year 2020. The timing of when all way stop or signals are warranted also remains nearly the same. However, the capacity for the critical left turn movement from CTH A to northbound STH 47 is about 20 percent higher for the partial interchange alternate. The level of service computations are based on assumed traffic movements. To more precisely analyze this intersection, additional traffic analysis would be warranted including traffic counts on weekends.

## E. Road User Costs

The partial interchange alternate eliminates the road user costs associated with the no interchange alternate because the indirection of using STH 47 to go west on USH 41 would be eliminated as well as eliminating the indirection and inconvenience of the CTH A to CTH OO route.

The partial interchange would eliminate about 170 traffic accidents over the next 20 years and eliminate the costs associated with the accidents.

## F. Impacts on Communities

The noise impact on the residences on the south side of USH 41 is already severe. The construction of the southwest ramp would require consideration of noise abatement measures. FDM states that plans will not be approved unless noise abatement measures which are reasonable and feasible are incorporated in the plans. Therefore the construction of noise walls or berms for this alternate are inevitable along the southwest ramp. The estimated cost of this noise wall is $500,000.00

Traffic under this alternate would be reduced throughout the developed areas along CTH A south of USH 41. The reduced traffic would improve the traffic related safely along CTH A and CTH OO which is particularly significant in the school zone at Houdini and Twin Willows Schools. Removing traffic from CTH A and CTH OO and shifting it to USH 41 would eliminate 120 accidents over the next 20 years. The inconvenience due to construction along CTH A would also be delayed.

Preliminary design indicated that slight amounts of right-of-way may be needed for ramp construction and that proximity damages might have to be paid to the owner of a group of farm buildings at the northwest ramp. $100,000 should cover the right-of-way, fencing and proximity costs.

## G. Construction Costs

Adjusting the actual costs of the completed USH 41 and Ballard Road interchange, the cost of the partial interchange alternate, including noise wall along the southwest ramp would be about $2,500,000.00.

# VII. IMPACTS OF THE FULL INTERCHANGE ALTERNATE

## A. Impacts on CTH A

Building a full diamond interchange at CTH A would increase the traffic on CTH A on both sides of USH 41 when compared to the no build alternate. The urban design class on CTH A would be 4 on both sides of USH 41. Exhibit B-3, B-6, and C-3 show the current and projected traffic for this alternate.

Under this alternate, CTH A south of USH 41 would exceed capacity in the year 2000. Based on the $2,000,000 reconstruction cost, moving up the reconstruction date results in a $60,000 cost when compared to the no interchange alternate.

As with the partial interchange alternate, the stop sign controlled south intersection with CTH JJ would have to be signalized at the time of construction of the full interchange. A signalized intersection in the year 2000 would function at a level of service a LOS "B" and a LOS "C" in the year 2020 without a left turn lane on CTH A. The construction of a left turn lane on CTH A would not be warranted. This alternate reduces the traffic on CTH JJ to the east by about one third, because traffic along CTH A destined for northbound USH 41 would not have to make a jog on CTH JJ to access USH 41 at STH 47.

The north CTH JJ intersection with CTH A would function at a LOS "B" in year 2000 and a LOS "C" in the year 2020 with a stop sign control on CTH JJ. These levels of service are the same as for the partial interchange alternate.

North of USH 41, the traffic on CTH A for a full interchange increases about 10 percent when compared to the partial interchange alternate with a similar reduction in traffic on STH 47. The increase in pavement structure for the first three miles of CTH A north of USH 41 would cost an additional $90,000 when compared to the no interchange alternate. For the next five mile segment which was completed in 1996, the traffic will increase 30 percent when compared to the no interchange alternate and 10% when compared to the partial interchange alternate. An overlay of one and one half inches at a cost of $350,000.00 should compensate for the increase in traffic.

South of USH 41 the increased traffic would result in additional $60,000 in pavement structure costs when compared to the no interchange alternate.

### B. Impacts on USH 41

Under the full interchange alternate, the traffic on USH 41 would increase on both sides of CTH A as compared to the no build alternate. The traffic would warrant upgrading USH 41 to six lanes in the year 2014 west of CTH A and in the year 2013 east of CTH A. The cost of moving up the date of six lanes of USH 41 would be $260,000 when compared to the no interchange alternate. Exhibit D-3 shows the traffic volumes and levels of service (LOS) for this alternate. However, even with a full interchange at CTH A, the segment of USH 41 at CTH A should not control the timing of six lane conversion of USH 41. This alternate increases the traffic on USH 41 east of STH 47 by 4,000 vehicles when compared to the other two alternatives. This 4,000 vehicle increase is balanced by a reduction of traffic on CTH OO and Capitol Drive east of CTH A.

The addition of the east ramps at CTH A would have a further adverse impact on USH 41 traffic as compared to the partial interchange alternate, but the discussion of impacts of the ramps for the partial interchange alternate also apply to the full interchange alternate. However, the total number of merges at the east ramps should remain constant, meaning that the east ramp traffic at CTH A equals the reduction in traffic on the east ramps at STH 47.

### C. Impacts on STH 47

Traffic on STH 47 would be further reduced for the full interchange alternate as compared to the partial interchange alternate. This would result in a savings of $40,000 in turning lane construction costs when compared to the no interchange alternate.

Due to the increase in traffic on USH 41 the level of service at the northwest ramp would be back to the level "F" in the year 2020 for a four lane facility on USH 41, but would remain at a level of service "C" for a six lane facility.

The decreased traffic on STH 47 would result in a savings of $340,000 in pavement structure costs when compared to the no interchange alternate.

### D. Impacts on STH 47 and CTH A Intersection

For the full interchange alternate, about 2,300 vehicles would be shifted from STH 47 to CTH A as compared to the no interchange alternate. Again, since southbound CTH A traffic bypasses the "T" intersection, the traffic at the intersection is reduced by 1,150 vehicles when compared to the no interchange alternate. As a result, this alternate has no additional adverse impacts on the intersection.

As with the partial interchange alternate, further traffic analysis would be warranted to fully access the impacts on this intersection.

### E. Road User Costs

The full interchange alternate eliminates the road user costs associated with the no interchange alternate. The same 170 accidents and associated costs would be eliminated under this alternate as under the partial interchange alternate.

### F. Impacts on Communities

The noise impacts along USH 41 are severe and the construction of the south ramps would warrant the construction of noise barrier walls at a cost of roughly $1,000,000.

The full interchange would place more traffic on CTH A between Capitol Drive and USH 41 when compared to the no interchange alternate. This segment would be at capacity at the time when a full interchange is constructed. The traffic on Capitol Drive west of CTH A would be increased. These increases would have an adverse effect on the two schools in the area and the primarily residential development in the area.

The volume of traffic along CTH A between CTH OO and Capitol Drive would not be significantly different than that for the no interchange alternate. The characteristics of traffic would change because the through traffic consisting of a large percentage of heavy trucks would be onto USH 41.

Preliminary design indicates that minor amounts of right-of-way may be required for ramp construction and that there may be damages to a set of farm buildings at both north ramps. A rough estimate of right-of-way costs and damages is $200,000.00

### G. Construction Costs

Adjusting the actual costs of the completed USH 41 and Ballard Road interchange, the cost of a full diamond interchange with noise walls along the south side should be about $3,500,000 for the full interchange alternate.

## VIII. WORST CASE SCENARIO

The area along CTH A south of USH 41 is nearly fully developed and a full or partial interchange at CTH A and USH 41 would have no impact on the further development of this area. The area along CTH A and STH 47 north of USH 41 for the most part is open to development. However, large tracks of environmentally sensitive wetland which included the Buboltz Nature Center, limit the area that can be developed.

The traffic projections on which the impacts of the three alternates are based, assume the orderly development of the area north of USH 41 in accordance with the adopted "Town of Grand Chute Comprehensive Plan". Since the comprehensive plan is based on no interchange at CTH A and USH 41, the construction of a full or partial interchange could result in changes to the plan.

Figures B-8, B-9 and B-10 show the traffic projections for the three alternates for the worst-case scenario. These projections assume that some of the planned residential areas on CTH A north of USH 41 will be replaced by an industrial park.

For the no interchange alternate, the industrial park would have a significant impact on the amount of traffic on CTH A and other local streets when compared to the traffic projected for development in accordance to be approved comprehensive plan.. The traffic on CTH A at USH 41 would increase by 20 to 25 percent. The increase on Capitol Drive would be about 20 percent and increase on CTH A south of Capitol would be 12 percent. The traffic on USH 41 at CTH A is actually projected to decrease slightly.

The worst case scenario for the partial interchange alternate results in a 15-20 percent increase in traffic on CTH A north of USH 41 and about 10% increase south of USH 41. The impact on USH 41 traffic would be minimal with a slight decrease on USH 41 in the year 2000 and about a 2 percent increase in the year 2020 for the segment of USH 41 west of CTH A.

The worst case scenario for the full interchange alternate on CTH A and local streets is the same as for the partial interchange. The traffic on USH 41 on both sides of CTH A increases by about 2,000 vehicles per day. This 3-4 percent increase should have no or little effect on the timing of conversion to six lanes or on the level of service.

In general, if the town revises the zoning along CTH A north of USH 41 to create the worst-case scenario, the impact on USH 41 would be minimal for any of the alternates. The impacts on CTH A and other local streets would be significant and the town would have to consider this when possible changes in the zoning plan are addressed.

## IX. SUMMARY

The purpose of this study is to investigate the feasibility, impacts, and costs associated with building a full or a partial diamond interchange at the intersection of CTH A and USH 41 in Outagamie County. There is no interchange currently at this location, however right-of-way was acquired for a full diamond interchange at this location in approximately 1960. The Town of Grand Chute is in favor of a partial interchange at CTH A and USH 41 and has requested that this interchange study be made at this time.

CTH A will be rebuilt in the near future from a rural two lane facility to a four lane urban section from Capitol Drive on the South side of USH 41 to about one fourth mile north of USH 41. At or near the same time, Outagamie County will upgrade the contiguous three miles of CTH A to the north from the present 2 lanes to 4 lanes. If an interchange is not built at USH 41, the upgrading of CTH A to four lanes would probably be delayed. The STH 47 interchange with USH 41 will be reconstructed within the next 5 years. From the interchange north, STH 47 will be upgraded to 4 lanes to CTH JJ and then resurfaced to its intersection with CTH A 8 miles to the north.

A full or partial interchange will have significant impacts not only on CTH A and USH 41 but also STH 47, CTH OO, Capitol Drive, and intersections along these streets and highways. Tables 1 through 5 summarize the costs and impacts to these roadways. The costs and impacts of the full and partial interchange alternates are analyzed relative to the no interchange alternate because the no interchange alternate will be built in the near future if the interchange alternates are not accepted due to financial and other considerations.

In the tables the LOS for roadways that will not be upgraded within the next 20 years is based on changes in the alphabetic designation for that level of service. For roadways that will be reconstructed to more lanes within the next 20 years, the impact is based on change in the design class. The cost due to differences in pavement structure assume uniform soil conditions throughout the area. Costs associated with the timing of reconstruction assume a 1.5% inflation rate and 5% value of money.

The accident reduction shown in the tables is relative to the no interchange alternate and is primarily due to the fact that the statewide average crash rates on urban interstate (USH 41) is about 100 per 100 million miles traveled as compared to a rate of about 300 accidents for urban streets such as CTH A and CTH OO south of USH 41.

The data in the tables is based on traffic projections that assume normal development of the area in accordance with the Town's comprehensive plan. Worst case scenario traffic projections made for this study and their impacts are not included in the tables to avoid confusion. In general, the worst case scenario shows major adverse impacts on local road system but only a minor impact on USH 41.

## ALTERNATE EVALUATION
### Table 1

| USH 41 | Impacts and Costs | No Interchange | Partial Interchange | Full Interchange |
|---|---|---|---|---|
| West of A | Average Daily Traffic 2000 (2020) 1000's | 49.3(67.0) | 55.4(74.4) | 54.0(71.0) |
| | Traffic Increase 2000 (2020) % | - | +12(+11) | +10(+6) |
| | LOS 2000 4-Lane (6-lane) | D (C) | D (C) | D (C) |
| | LOS 2020 4-Lane (6-lane) | F (D) | F (D) | F (D) |
| | *Year 6-Lane Conversion Warranted | 2019 | 2011 | 2014 |
| | *Conversion Costs Differential | - | +200,000 | +120,000 |
| | Traffic Impacts | - | Negative | Negative |
| | LOS Impacts | - | None | None |
| East of A | Average Daily Traffic 2000 (2020) 1000's | 49.3(67.0) | 46.8(61.4) | 54.8(72.0) |
| | Traffic Increase 2000 (2020) % | - | -5(-8) | +11(+7) |
| | LOS 2000 4-Lane (6-lane) | D (C) | D (C) | D (C) |
| | LOS 2020 4-Lane (6-lane) | F (D) | E (C) | F(D) |
| | *Year 6-Lane Conversion Warranted | 2019 | 2026 | 2013 |
| | Conversion Costs Differential | - | -140,000 | +140,000 |
| | Traffic Impacts | - | Positive | Negative |
| | LOS Impacts | - | Positive | None |
| East of STH 47 | Year 2020 Average Daily Traffic 1000's | 74.0 | 74.0 | 78.0 |
| | Traffic Increase 2020 % | - | 0 | +5 |
| | Traffic Impacts | - | None | Negligible |
| CTH 15 Interchange | *** Traffic Impacts | - | Positive | Positive |
| STH 15-STH 47 | **Noise Impacts | Severe | Severe | Severe |
| | ****Impact on Safety | - | Negative | Negative |

* For the purpose of comparison of alternates only. Actual conversion would be dictated by segments of USH 41 beyond this interchange.

** Noise mitigation for the no interchange alternate would not have to be made at this time. It would take place at time of conversion to 6-lanes.

*** Positive impact due to considerable reduction in traffic on southbound USH 41 "on-ramp" and reduction in associated left turn on CTH 15.

**** The addition of ramp terminals creates new points of friction for USH 41 traffic.

**ALTERNATE EVALUATION**
**Table 2**

| CTH A | Impacts and Costs | No Interchange | Partial Interchange | Full Interchange |
|---|---|---|---|---|
| South of CTH OO | Average Daily Traffic 2000 (2020) 1000's | 20.2(29.0) | 20.2(29.0) | 22.4(33.8) |
| | Traffic Increase 2000 (2020) % | - | 0 (0) | +11 (+17) |
| | Urban Design Class | 5 | 5 | 5 |
| | Traffic Impacts | - | None | Negative |
| | LOS Impacts | - | None | None |
| CTH OO to Capitol | Average Daily Traffic 2000 (2020) 1000's | 14.1(21.0) | 9.2(14.0) | 14.5(21.0) |
| | Traffic Increase 2000 (2020) % | - | -35 (-33) | +3 (0) |
| | Urban Design Class | 4 | 4 | 4 |
| | Year Conversion 2-4 lanes warranted | 2001 | 2021 | 2000 |
| | Cost of Timing of Conversion | - | -400,000 | +60,000 |
| | Traffic Impact | - | Very Positive | Negligible |
| | LOS Impact | - | None | None |
| Capitol to USH 41 | Average Daily Traffic 2000 (2020) 1000's | 11.1(17.0) | 8.5(13.0) | 15.9(23.0) |
| | Traffic Increase 2000 (2020) % | - | -23 (-24) | +43 (+35) |
| | Urban Design Class | 4 | 3 | 4 |
| | Year of Reconstruction | 2000 | 2000 | 2000 |
| | Traffic Impact | - | Positive | Severe |
| | LOS Impacts | - | Positive | None |
| USH 41 - JJ East | Average Daily Traffic 2000 (2020) 1000's | 11.1(17.0) | 13.9(22.0) | 15.8(24.8) |
| | Traffic Increase 2000 (2020) % | - | +25 (+29) | +42 (+46) |
| | Urban Design Class | 4 | 4 | 4 |
| | Year of Reconstruction | 2000 | 2000 | 2000 |
| | Traffic Impacts | - | Negative | Severe |
| | LOS Impacts | - | None | None |
| JJ East - JJ West | Average Daily Traffic 2000 (2020) 1000's | 11.4(15.8) | 12.6(17.7) | 13.4(18.7) |
| | Traffic Increase 2000 (2020) % | - | +11 (+12) | +18 (+18) |
| | Year of Conversion 2-4 Lanes | - | 2000 | 2000 |
| | Traffic Impacts | - | Negative | More Negative |
| | LOS Impacts | - | None | None |
| JJ West - CTH O | Average Daily Traffic 2000 (2020) 1000's | 7.0(10.1) | 8.0(11.5) | 8.6(12.3) |
| | Traffic Increase 2000 (2020) % | - | +14 (+15) | +23 (+23) |
| | Level of Service 2000 (2020) | C (D) | C (D) | C (D) |
| | Traffic Impacts | - | Negative | More Negative |
| | LOS Impacts | - | None | None |
| CTH S to STH 47 | Average Daily Traffic 2000 (2020) 1000's | 5.6(7.4) | 6.6(8.9) | 7.2(9.7) |

| CTH A | Impacts and Costs | No Interchange | Partial Interchange | Full Interchange |
|---|---|---|---|---|
| | Traffic Increase 2000 (2020) % | - | +18 (+20) | +29 (+31) |
| | Level of Service 2000 (2020) | B (C) | C (C) | C (D) |
| | Traffic Impacts | - | Negative | Negative |
| | LOS Impacts | - | Negative | More Negative |
| USH 96 - STH 47 | * Road User Costs | 2,500,000 | 0 | 0 |
| | Pavement Structure Costs South of USH 41 | - | -40,000 | +60,000 |
| | Pavement Structure Cost USH 41 to JJ West | - | +50,000 | +90,000 |
| | ** Overlay Cost North 5 miles | - | +350,000 | +350,000 |
| | Construction Costs 41/A Intersection | 1,500,000 | 2,500,000 | 3,500,000 |
| | Accidents South of 41 20 years | - | -120 | -120 |
| | *** Safety Impact South of USH 41 | - | Very Positive | Somewhat Neg. |
| | Safety Impacts North of USH 41 | - | Negative | Negative |

* Road user costs are due to indirection and lower speed using CTH A and CTH OO to go south and west as compared to using USH 41.

** Overlay cost to compensate for added traffic on new pavement. Actual overlay would take place when conditions warrant.

*** For the partial interchange alternate, safety not only improved by reduction of traffic, but also substantial reduction of trucks in a school zone.

**ALTERNATE EVALUATION**
**Table 3**

| STH 47 | Impacts and Costs | No Interchange | Partial Interchange | Full Interchange |
|---|---|---|---|---|
| South of USH 41 | Average Daily Traffic 2000 (2020) 1000's | (28.4) | (28.0) | (21.0) |
| | Traffic Increase 2020 % | - | (-1) | -26 |
| | Urban Design Class | 5 | 5 | 4 |
| | Traffic Impact | - | Negligible | Very Positive |
| | LOS Impact | - | None | Positive |
| USH 41 to CTH JJ | Average Daily Traffic 2000 (2020) 1000's | 16.3(26.4) | 13.5(21.4) | 11.6(19.0) |
| | Traffic Increase 2000 (2020) % | - | -17 (-19) | -29(-28) |
| | Urban Design Class | 5 | 4 | 4 |
| | Traffic Impact | - | Positive | Very Positive |
| | LOS Impact | - | Positive | Positive |
| CTH JJ to CTH O | Average Daily Traffic 2000 (2020) 1000's | 9.2(13.5) | 8.2(12.0) | 7.6(11.2) |
| | Traffic Increase 2000 (2020) % | - | -11(-11) | -17(-17) |
| | LOS 2-lanes 2000 (2020) | D (D) | C(D) | C(D) |
| | Traffic Impact | - | Positive | Positive |
| | LOS Impact | - | Positive | Positive |
| CTH S to CTH A | Average Daily Traffic 2000 (2020) 1000's | 6.9(9.5) | 5.9(8.0) | 5.3(7.2) |
| | Traffic Increase 2000 (2020) % | - | -15(-16) | -23(224) |
| | LOS 2-lanes 2000 (2020) | C(D) | C (C) | B (C) |
| Capitol Dr to A | Traffic Impact | - | Positive | Positive |
| | LOS Impact | - | Positive | Positive |
| | STH 47 & A Intersection | - | No Impact | No Impact |
| | *Road User Costs | 7,000,000 | 0 | 0 |
| | ** Pavement Structure Costs | - | -180,000 | -340,000 |
| | Turning Lanes STH 47/41 Interchange (Cost) | - | -20,000 | -40,000 |
| | Accidents (20 years) | - | -50 | -50 |
| | Safety Impact | - | Positive | Positive |

* Road user costs are due to the 2-mile indirection of traffic from the north wishing to travel west on USH 41.

** Costs associated with the changes in design class are not included.

**ALTERNATE EVALUATION**
**Table 4**

| Capitol Drive | Impacts and Costs | No Interchange | Partial Interchange | Full Interchange |
|---|---|---|---|---|
| West of CTH A | Average Daily Traffic 2000 (2020) 1000's | 3.2(4.6) | 3.2(4.6) | 3.8(5.7) |
| | Traffic Increase 2000 (2020) % | - | 0 (0) | +19 (+24) |
| | Level of Service 2000 (2020) | A (B) | A (B) | B (B) |
| | Traffic Impact | - | None | Negative |
| | LOS Impact | - | None | Negative |
| East of CTH A | Average Daily Traffic 2000 (2020) 1000's | 4.3(6.0) | 4.3(6.0) | 3.7(5.6) |
| | Traffic Increase 2000 (2020) % | - | 0 (0) | -14 (-7) |
| | Level of Service 2000 (2020) | B (B) | B (B) | B (B) |
| | Traffic Impact | - | None | Positive |
| | LOS Impact | - | None | None |

**ALTERNATE EVALUATION**
**Table 5**

| CTH OO | Impacts and Costs | No Interchange | Partial Interchange | Full Interchange |
|---|---|---|---|---|
| West of CTH A | Average Daily Traffic 2000 (2020) 1000's | 27.6(36.8) | 23.4(31.4) | 23.1(31.2) |
| | Traffic Increase 2000 (2020) % | - | -15 (-15) | -16 (-15) |
| | Level of Service 2000 (2020) | B (C) | B (B) | B (B) |
| | Traffic Impact | - | Positive | Positive |
| | LOS Impact | - | Positive | Positive |
| East of CTH A | Average Daily Traffic 2000 (2020) 1000's | 27.3(36.4) | 27.4(36.5) | 23.9(32.0) |
| | Traffic Increase 2000 (2020) % | - | +1 (+1) | -12 (-12) |
| | Level of Service 2000 (2020) | B (C) | B (C) | B (B) |
| | Traffic Impact | - | Negligible | Positive |
| | LOS Impact | - | None | Positive |

## CONCLUSIONS

The partial and full interchange alternate eliminates indirection for traffic from the north of USH 41 that wants to travel to the south on USH 41 or to points west of USH 41. Without an interchange at CTH A, motorists will travel on the average 5,500 extra miles per day over the next 20 years. The interchange alternates would eliminate about $7,000,000 in user cost associated with the extra travel over the next 20 years. Based on state wide Crash Rate Tables the interchange alternates would also eliminate about 50 accidents associated with the extra 40 million miles traveled over the next 20 years.

Over the next 20 years an average of about 5,000 vehicles per day will use CTH A and CTH OO to reach USH 41 and points west if there is no interchange at CTH A and USH 41. This is a slower and longer route through a fully developed urban area as compared to the USH 41 route that would be available if there was access to USH 41 at CTH A. Access to USH 41 at CTH A would save about $2,500,000 in user costs over the next 20 years and eliminate about 120 traffic accidents over the same period of time. The interchange alternates would eliminate much of the truck traffic from the urban street system south of USH 41 that originates from the quarries located along CTH A north of USH 41. The origin destination study indicated that 25% of all heavy trucks on CTH A have an origin and destination beyond the Appleton Urbanized area west of USH 41 or south on USH 41. The interchange alternates would remove these trucks from the local street system south of USH 41. As can be seen in the Tables located in the summary, the interchange alternates would have a positive impact on STH 47 and its interchange with USH 41. They both would have a negative impact on CTH A north of USH 41. The partial interchange alternate would have a further negative impact on the intersections along CTH A due to the heavy left turn movements from the north created by traffic wishing to cut over to STH 47 in desire to travel east on USH 41. The left turn movements would be made with a greater opposing thru traffic. The partial interchange would have a very positive impact on CTH A south of USH 41 by postponing need for reconstruction beyond year 2020, whereas the full interchange alternate would require immediate action. The interchange alternates would have a positive or negligible effect on CTH OO and Capitol Drive. The interchange alternates would have a negative impact on particular movements in the STH 47 and CTH A intersection located 8 miles north of USH 41 but would have little or no impact on the overall level of service of the intersection.

Under the interchange alternates the traffic on USH 41 would increase west of CTH A and the addition of ramps would create points of friction for the USH 41 traffic. However, the amount of traffic on ramps at CTH A would be offset by an equal traffic reduction on ramps at STH 47 and STH 15 interchanges with USH 41. East of CTH A, USH 41 traffic would be reduced under the partial interchange alternate and increased under the full interchange alternate. The increase in USH 41 traffic at CTH A should not be such as to dictate the time when conversion of USH 41 from 4 lanes to 6 lanes is warranted. This timing would be dictated by a segment of USH 41 further to the east.

In general, the fact is that the CTH A/USH 41 intersection will be rebuilt within the next five years. The question is whether or not ramps should be part of the reconstruction to create a full or partial interchange at this location. Is an interchange feasible at this location? The answer is yes, provided that funding is available. The location is such that an interchange here would have no impact on adjacent interchanges other than to reduce the traffic on the adjacent interchange ramps. The traffic capacity manual indicates that interchanges would have to be spaced closer than a mile apart to have an adverse effect on each other. The closest interchange to CTH A is 1.5 miles. Right-of-way for an interchange at this location was acquired in approximately 1960. Very rough design of the ramps indicate that some additional right-of-way may be needed for ditching and that there may be proximity damages to the groups of farm buildings along the north ramps.

Will an interchange promote safety? Both, the partial and full interchange would eliminate about 170 accidents over the next 20 years and would reduce the quantity of truck traffic from local streets south of USH 41. The partial interchange alternate would significantly reduce all traffic in this area that contains two school zones.

Are the interchange alternates cost effective? Savings in road user costs and costs associated with the reduction of accidents more than offset the increased construction costs.

Will the interchange alternates promote development that is currently not planned? The area south of USH 41 is fully developed, an interchange would likely expedite the planned development to the north. Worst case scenario traffic projections indicated that unplanned development would have a large impact on CTH A and local streets but that the impact on USH 41 would be minor.

The questions remaining are financial. Who will assume the added construction costs of the interchange alternates? Who will assume the added costs to the local and county roads that would be generated by the interchange alternates?

**Appendix A**
**Traffic**
**Table of Contents**

## Appendix A
## Traffic

### A. USH 41

A major focus of the CTH A interchange study is to investigate the impacts of the three alternatives on USH 41 traffic. The traffic design parameters for the three alternates are shown on Exhibit E-1. The parameters are very close and only one set will be used to analyze existing and future levels of service (L.O.S.).

The level of service is based on the density of vehicles on a given section of road in terms of passenger cars per lane per mile. Exhibits F-1 thru F-3 show and discuss the various levels of service. It should be noted that the density allowed for levels of service B, C, and D in ramp-freeway junction areas is higher than that on a freeway segment alone.

HCS (Freeway Release 3.1) by McTrans software was used to analyze the capacity of the existing 4-lane section on USH 41 and a six-lane future section using the following parameters: peak hour factor – 0.9, terrain type-level, trucks and busses – 10 percent , truck and busses passenger car equivalency – 1.5, heavy vehicle adjustment – 0.9, driver population adjustment – 1.0, and a measured free-flow speed of 65 miles per hour.

A four-lane freeway is at a LOS "E" with a volume of 4,000 vehicles per hour (VPH) and at LOS "F" (over capacity) at 4,100 vehicles. For a six-lane freeway the corresponding volumes are 6,000 vehicles and 6,100 vehicles.

Using a peak hour factor (K 30) of 11 percent and a directional factor (D) of 55 percent, the capacity of USH 41 in terms of Average Daily Traffic (ADT) is 66,000 for four lanes and 99,000 for six lanes.

Using a straight-line interpolation, the current four lane section on USH 41 west of STH 47 would reach capacity in the year 2019. For the partial interchange alternate, four-lanes on USH 41 west of CTH A would reach capacity in year 2011. For the segment of USH 41 between STH 47 and CTH A, the 4 lanes would reach capacity in the year 2026. As compared to the no interchange alternate, four lanes on USH 41 west of CTH A would reach capacity 8 years sooner while east of CTH A the capacity would be reached 7 years later.

For the full interchange alternate, four lanes on USH 41 would reach capacity in year 2014 west of CTH A and year 2013 east of CTH A. In other words, USH 41 would warrant upgrading to a six-lane facility about 5 years earlier as compared to the no interchange alternate.

### B. CTH A NORTH OF USH 41

CTH A north of USH 41 is a two-lane rural highway. In around 1990, Outagamie County acquired enough right-of-way for a four-lane highway from USH 41 for a length of about 2.5 miles. At the time, this segment was graded for a four-lane typical section, but only the center two lanes were resurfaced over the preexisting pavement structure. The County has scheduled the reconstruction to a four-lane facility in the year 2003. This scheduled reconstruction is in anticipation that at least a partial interchange will be built at the USH 41 and CTH A intersection.

The signalized CTH A intersection with Capitol Drive was built in 1992. The intersection is located about one-fourth mile south of USH 41. Exhibit A-4 shows the lane configuration at the intersection. Using rough assumptions of traffic movements indicates that about 14,300 vehicles on CTH A should put the intersection at its capacity (Level of Service "F"). Using 14,300 vehicles per day as the capacity of CTH A south of USH 41, this segment of CTH A would reach capacity in the year 2001.

The overall capacity and level of service of a four-lane facility on CTH A north of USH 41 would be controlled by the capacity of the CTH A and CTH JJ intersection. Detailed traffic analysis would be needed to analyze the impact of the three alternates. However, using rough estimate of volumes and movements, the intersection would warrant signalization in the not too far future for any of the three alternates. The interchange alternates would increase the traffic on CTH A but should reduce the traffic on CTH JJ especially the north to east movement.

The north 5 miles of the 8 mile segment of CTH A, between USH 41 and STH 47, were reconstructed in 1996 to a rural two-lane section with 12-foot lanes and 10-foot shoulders. For this segment, the design ADT was 7,780 vehicles in year 1995 and 8,350 vehicles in year 2015.

## C. CTH A AND STH 47 INTERSECTION

Exhibits B-2 thru B-6 show the traffic projections for the CTH A and STH 47 intersection located 8 miles north of USH 41. Exhibit A-3 shows the roadway configuration at the junction of the two roadways. STH 47 runs in a north-south direction with CTH A abutting from the west to form a "T" intersection with a stop sign on CTH A. The traffic from the south to the north on CTH A makes a left turn at the "T" intersection while the traffic from the north to the south bypasses the intersection.

The total amount of traffic on CTH A and STH 47 is the same for all three alternates. For the no interchange alternate, 44% of the traffic is on CTH A and 56% is on STH 47. For the partial interchange the percentage of traffic on CTH A is 53% and 47% on STH 47. For the full interchange alternate, the percentage of traffic on CTH A increases to 57% leaving 43% of the traffic on STH 47.

For the interchange alternates, as the traffic is shifted from STH 47 to CTH A, the total traffic on the "T" intersection is reduced by one-half of the shifted traffic because the north to south traffic on CTH A bypasses the "T" intersection. For this reason, the level of service remains at LOS "D" for all three alternates. Based on the year 2020 traffic, the "T" intersection would be at capacity or LOS "F". In other words, capacity at the intersection would have to be increased by the year 2020 for all three alternates either by addition of lanes or signalization.

Field reports indicate that the intersection is already experiencing traffic congestion on weekends. This is because the traffic projections used in this report are based on weekday traffic counts and that STH 47 and CTH A are popular routes used by vacationers.

For proper analysis of the impacts for each alternate, additional traffic analysis would be warranted, including weekend counts and projections of turning movements.

The turning movements for computing of level of service in this report were assumed values with 10% trucks and a 50/50 peak hour distribution.

## D. RAMPS AT CTH A AND USH 41

Exhibit H-1 is an excerpt from the Highway Capacity Manual dealing with operational characteristics of ramps. Ramp spacing adversely affects the level of service if the merge or diverge influence areas (Figure 5-1, Exhibit H-1) overlap. Since the distance from the crossroad to the gore area is 900 to 1,200 feet for a typical diamond interchange design and with the 1,500 ft. influence area, the intersections with diamond interchanges would have to be spaced less than one mile for this to happen. Since CTH A is located one and a half miles from both STH 47 and STH 15 proximity to the ramps is not a factor in determining the level of service.

HCS-3 software for ramps and ramp junctions, Release 3.1, was used to compute the level of service at ramp junctions in both STH 47 and CTH A interchanges with USH 41 for both year 2000 and year 2020. Since none of the ramps analyzed are existing, we assume that all the ramps will conform to the design parameters established in Procedure 11-30-1 of the Facilities Development Manual (FDM). The typical ramp terminals are shown on Exhibits H-2 and H-3. For the analysis, the following parameters were used: peak hour factor – 0.9, passenger car equivalent of 1.5 for trucks and busses, driver population factor – 1.0, thirtieth highest traffic factor (K-30). Based on observations, free flow speed of 65 mph was used for USH 41 traffic and 50 mph for the ramp traffic. Traffic design parameters for USH 41 traffic were also used for the ramp traffic although a case could be made for using the cross road parameters, but cross road parameters are very close to those on USH 41.

## E. ORIGIN-DESTINATION STUDY

An extensive origin-destination study was conducted around the Appleton Urbanized Area in 1993 as one of the initial steps in developing a transportation plan for The Appleton Urban Area. Thirty two interview stations recorded the vehicle travel patterns over a six week period. The study found that for all the stations 83 percent were local trips and 17 were through trips. Ten percent of all the vehicles were medium and heavy duty trucks. For the truck traffic, 66 percent of the trips were local with 34 percent of the trips being through trips. A through trip is a trip whose origin and destination are located outside of the study area.

Two interview stations are of particular interest to this interchange study. One (#74) is located on STH 47, 0.8 miles north of Broadway and the other (#73) is located on CTH A, 1.2 miles south of CTH JJ. The total number of trips for the two locations is similar with 7,560 trips on CTH A and 7,237 trips on STH 47. However, the amount of thru traffic on CTH A was more than double that on STH 47. (1,355 on CTH A and 586 on STH 47).

The study found that the largest concentration of heavy trucks was on CTH A north (16.2), STH 55 south (14.7), STH 47 (14.3), USH 41 north (14.1) and USH 45 south (13.5).

Of the total 1,355 through trips on CTH A, 381 were heavy trucks. The vast majority (289) of the through trucks were headed towards or coming from USH 41 at Neenah while 25 trucks were headed or coming from points west of USH 41. These 314 trucks would have used the west ramps at USH 41 and CTH A intersection if the ramps had been available. This represents 26 percent of trucks on CTH A. Similarly 830 of the 970 through passenger cars including light weight trucks were headed south on USH 41 or west on various routes. The 830 represents 13 percent of total passenger vehicles and light trucks on CTH A.

Of the 586 through trips on STH 47, 143 are heavy trucks. Of these trucks, 90 percent were headed south on USH 41 or to the west of USH 41. Some of these 128 trucks might have used a southbound on ramp at CTH A if one had been available. The 128 trucks represent 12 percent of total truck traffic on STH 47. About 370 through passenger cars and light trucks on STH 47 were headed south on USH 41 or points west of USH 41 representing about 6 percent of all passenger cars and light trucks.

The data indicates that much of the through traffic, if familiar with the Appleton Urban Area avoids the indirection of the STH 47 route to head south on USH 41 or to points west of USH 41. This is particularly true of truck traffic, meaning that heavy trucks are using CTH A south of USH 41 and CTH OO that would be entering southbound USH 41 at CTH A if the west ramps were available.

**Appendix B**
**Economic Impacts**
**Table of Contents**

## Appendix B
## Economic Impacts

### A. CONSTRUCTION COSTS

The recently completed Meade Street project is very similar to the no interchange alternate. Meade Street crosses USH 41 two and one half miles east of CTH A. The work under this project consisted of removing an existing two lane structure and replacing it with a four lane structure. The work also involved the widening of embankments and the construction of a four lane urban section for both approaches to the bridge. The lanes on the Meade Street project were 11 foot wide and the anticipated lane width for CTH A is 12 feet. Adjusting the Meade Street project costs for inflation, wider lanes, and box culvert extension required at CTH A, the rough construction cost estimate to the no interchange alternate is $1,500,000.

The project at Ballard Road and USH 41 located 3.5 miles east of CTH A is similar to the full interchange alternate at CTH A. The construction costs of the Ballard Interchange was $2,300,000. Making allowances for differences in the two projects, the rough estimate of construction costs for a full interchange at CTH A is $3,500,000. About one third of this cost is for the construction of noise walls along the south ramps and the extension of a twin box culvert under the northeast and southwest ramps at CTH A. Making adjustments to the no interchange construction costs and the full interchange costs, the rough construction cost estimate for the partial interchange alternate is $2,500,000.

### B. ROAD USER COSTS

For the alternates to be economically equal, the additional construction costs of the full or partial interchange alternatives plus incurred costs to peripheral facilities caused by these alternates would have to be offset by savings in road user costs and savings in construction costs of peripheral traffic facilities. Peripheral facilities would include the CTH A/Capitol Drive intersection, USH 41/STH 47 interchange, USH 41, CTH A and the local street system in general.

Following tables show the values that WisDOT central office planners uses in computing road user costs. The costs of the alternates are normally compared over a 50 year period with money valued at 5%.

Vehicle Operating costs ($/vehicle mile)

| | |
|---|---|
| Auto | $0.17 |
| Single Unit Truck | $0.41 |
| Combination Truck | $0.74 |

Values of Travel Time ($/hour) 1998 dollars

| | | |
|---|---|---|
| Auto | $7.50 | (per person) |
| Single Unit Truck | $19.59 | (per vehicle) |
| Combination Truck | $22.25 | (per vehicle) |

In the year 2020, the north to west movement of the STH 47 interchange is 5,000 vehicles for the no interchange alternate and 2,400 vehicles for the partial interchange alternate. This means that 2,600 vehicles avoided the indirection of STH 47 by using the northwest ramp at CTH A. This also applies to the return trip. The total vehicles avoiding this indirection in year 2020 would be 5,200. See exhibits C-1 and C-2 for the projected traffic movements. Using the proportion of traffic decrease on STH 47 in the year 2020, the traffic avoiding the indirection in the year 2000 would be 3,500.

Since there is debate as to whether the travel time costs of persons in passenger cars are legitimate road user costs, these costs will not be included in the calculations. Road user costs will be computed for a 20 year period because that is the time when structures normally need maintenance work such as redecking and would be the logical time to add ramps not built at this time. The right-of-way for ramp construction is already available. For this reason the ramps could also be added at a later date such as adding ramps at time of conversion of USH 41 from four lanes to six lanes.

For the calculation of user costs, the average traffic design parameters were used for CTH A and STH 47 assuming 10% trucks of which 70% would be single unit trucks. Figures B-4 thru B-6 show the traffic volumes along CTH A and STH 47 north of USH 41. The amount of traffic at the merge of CTH A and STH 47 is 10,600 vehicles in the year 2000 and 15,700 vehicles in the year 2020. For the partial interchange alternate, 900 vehicles would be diverted from STH 47 to CTH A in year 2000 and 1,400 vehicles in the year 2020. This is the amount of traffic at the merger point that is avoiding the 2.1 mile extra travel distance along STH 47 route to head west and south on USH 41.

For the full interchange alternate the amount of traffic diverted onto CTH A is greater, however, this is traffic that would head east at USH 41 and there would be no indirection for this traffic and no savings in the user costs.

Most of the traffic diverted from the west ramps at STH 47 to the west ramps at CTH A would be generated in the area located between CTH A and STH 47 from USH 41 to the merge of CTH A and STH 47. The following computations assume the indirection of this traffic is one mile and two miles for traffic diverted at the merge.

**Road User Cost Computations**

CTH A route vs. STH 47 route

| **Vehicles** | | | | | **Extra Vehicle Miles** | |
|---|---|---|---|---|---|---|
| **Total Year** | **2000** | | **2020** | | | |
| | **At Merge** | **Rest** | **At Merge** | **Rest** | **2000** | **2020** |
| Total Vehicles | 900 | 2,600 | 1,400 | 3,800 | 4,400 | 6600 |
| Passenger Vehicle | 810 | 2,340 | 1,260 | 3,420 | 3,960 | 5,940 |
| Trucks | 90 | 260 | 140 | 380 | 440 | 660 |
| Single Unit Trucks | 60 | 180 | 100 | 260 | 300 | 460 |
| Combination Trucks | 30 | 80 | 40 | 120 | 140 | 200 |

Using a 1.5 percent inflation rate, the 1998 user costs would increase by a factor of 1.03 for year 2000 and 1.388 for year 2020. The average travel speed is assumed to be 55 mph.

| **Year** | **2000** | **2020** |
|---|---|---|
| Passenger Vehicle Operating Costs | $ 690 | $1,400 |
| Single Unit Truck Operating Costs | $ 130 | $ 260 |
| Combination Truck Operating Costs | $ 110 | $ 210 |
| Single Unit Time Costs | $ 110 | $ 230 |
| Combination Truck Time Cost | $ 60 | $ 110 |
| Total Cost Per Day | $ 1,100 | $2,210 |
| User Cost Per Year | $401,000 | $807,000 |

Following road user costs are incurred by the traveling public due to distance and inconvenience of travel from north of USH 41 via CTH A and CTH "OO". The extra distance traveled is 0.3 miles.

The north to west movement at CTH A for the full and partial interchange alternates is 5,500 vehicles in the year 2020. Subtracting the 2,600 vehicles reduction at STH 47 leaves 2,900 vehicles or a total of 5,800 vehicles in both directions are avoiding the inconvenience and indirection of getting to southbound USH 41 via CTH A and CTH OO. In the year 2000 this number would be 3,700 vehicles.

| | **Vehicles** | | **Extra Vehicle Miles** | |
|---|---|---|---|---|
| **Total Year** | **2000** | **2020** | **2000** | **2020** |
| All Vehicles | 3,700 | 5,800 | 1,110 | 1,740 |
| Passenger Vehicle | 3,330 | 5,200 | 1,000 | 1,560 |
| All Trucks | 370 | 600 | 110 | 180 |
| Single Unit Trucks | 260 | 420 | 80 | 130 |
| Combination Trucks | 110 | 180 | 30 | 50 |

The assumed average travel speed along USH 41 is 60 mph and the average speed along the CTH A and CTH OO route is 40 mph. To travel the CTH OO route would take 1.7/40 = .043 hours and 1.4/60 = .023 hours via USH 41 route, a difference of .02 hours per vehicle.

| **Year** | **2000** | **2020** |
|---|---|---|
| Passenger Vehicle Operating Costs | $ 180 | $ 370 |
| Single Unit Truck Operating Costs | $ 30 | $ 70 |
| Combination Truck Operating Costs | $ 20 | $ 50 |
| Single Unit Time Costs | $ 100 | $ 230 |
| Combination Truck Time Cost | $ 50 | $ 110 |
| Total Cost Per Day | $ 380 | $ 830 |
| User Cost Per Year | $139,000 | $303,000 |

Using present worth factors for a uniform series and gradient series, the present worth of road user costs is $9,500,000 with money valued at 5% over a 20 year period.

These same savings in road user costs would also apply when comparing the full interchange alternate to the no interchange alternate. The full interchange alternate eliminates the same indirection from the north as the partial interchange. The full interchange further eliminates some indirection and inconvenience to the traffic generated from south of USH 41. However these savings in user costs would be very minor when compared to the savings for the traffic from the north and will not be computed.

One of the major cost factors would be associated with the timing of improving USH 41 from four to six lanes. USH 41 is six lanes already from CTH "OO" to the south. The next logical segment to be converted to six lanes would include the area of CTH A and USH 41 intersection.
Exhibit B-4 shown the projected traffic for USH 41 in Outagamie County. The segment at CTH A has the least projected traffic when compared to the next three segments to the east. Therefore it would be one of these other segments that would dictate the time of conversion of USH 41 from four lanes to six lanes at CTH A.

Even though the traffic at CTH A on USH 41 will not govern the timing of the conversion of USH 41 from four lanes to six lanes, the costs associated with the timing of the conversion were computed for the alternates. The computations assume that the conversion will be warranted when the daily traffic on USH 41 reaches 66,000 at a cost of $800,000 for a 1½ mile segment in year 2000 dollars.

Another cost to be considered is the timing of when CTH A south of USH 41 will be converted from a rural 2 lane section to an urban four lane section. Using CTH OO (Richmond Street to Meade Street) as an example of such a conversion, the cost would be about $2,000,000 per mile in year 2000 dollars. This conversion was computed for the time when traffic on CTH A would reach 14,300 vehicles per day.

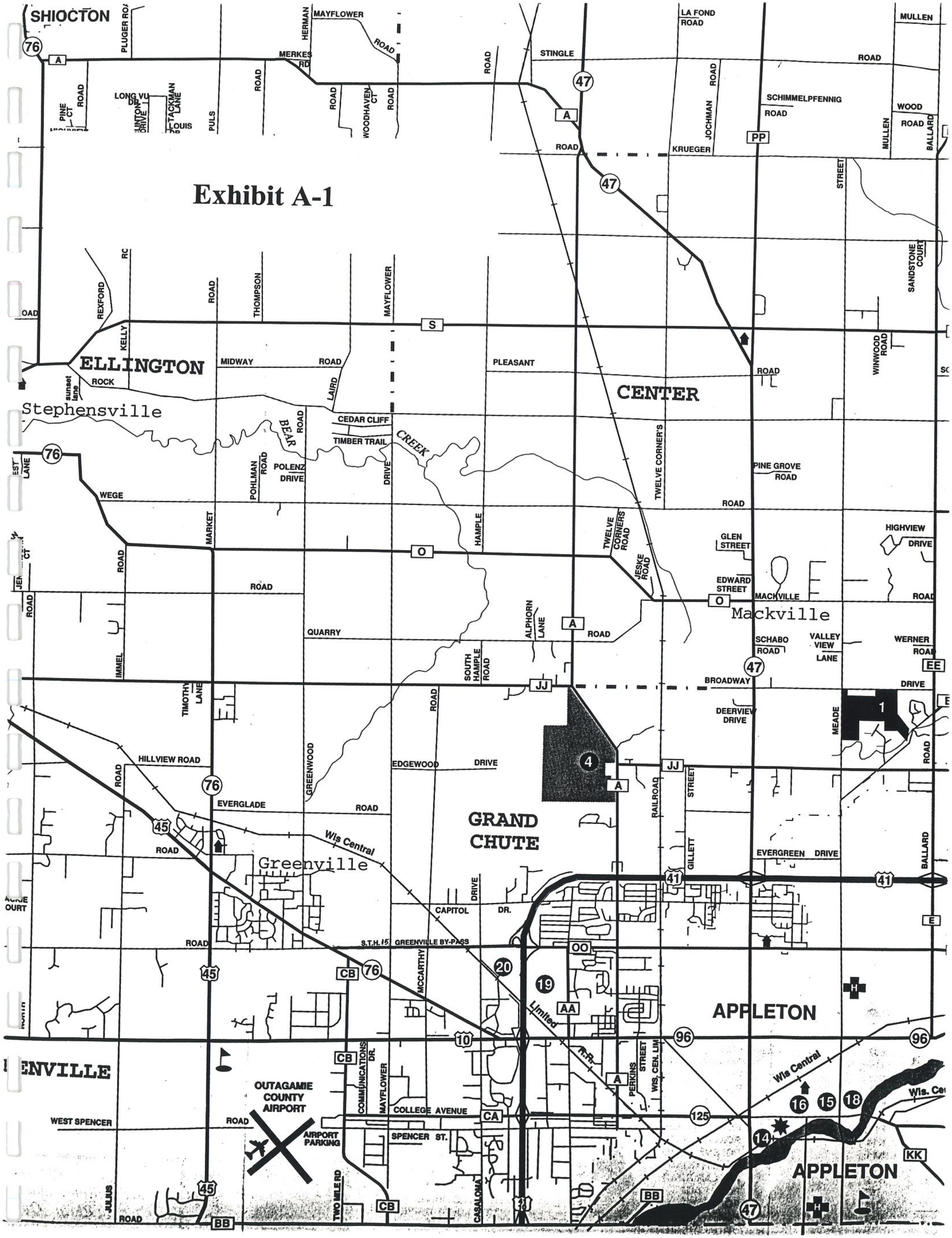
## C. Summary of Costs

Pavement structure is directly related to the amount and type of traffic on a given segment of highway. Removing traffic from STH 47 and putting it on CTH A means that the required pavement thickness would be reduced for the interchange alternates on STH 47 and increased on CTH A.

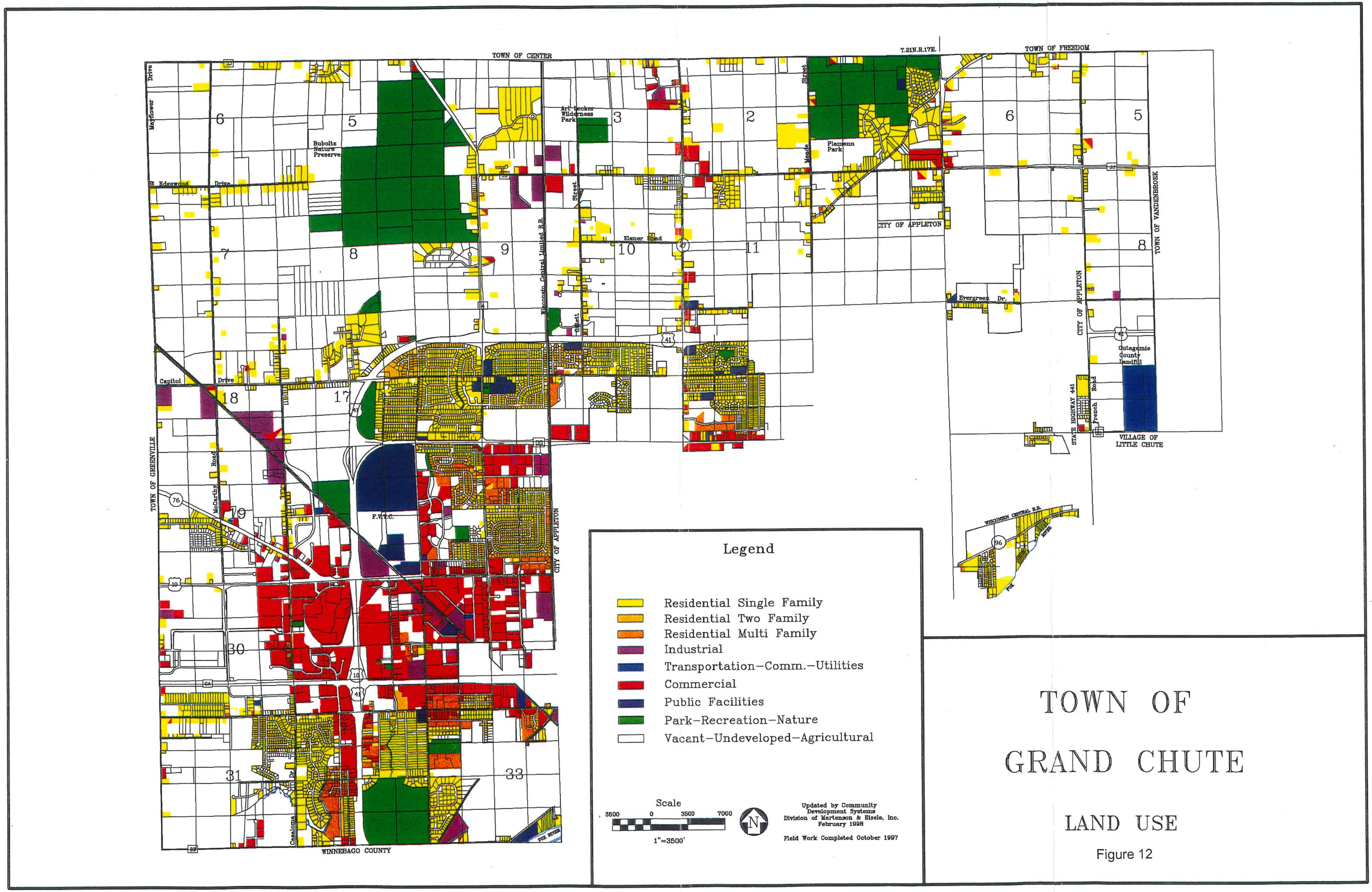
Using the traffic projections and design parameters contained in the report a structure number for flexible pavement was computed for segments of CTH A and STH 47 for all three alternates. The pavement design assumed uniform soils for the entire areas with a design group index of 12, soil support value of 4.2 and a frost Index of 12. The costs are based on an inch of asphalt representing 0.44 of the structure number and are based on $2.50 per square yard per inch of pavement area.

Costs associated with each of the alternatives for individual segments of roadways are shown in the tables located in the summary of the report.

# Exhibit A-1

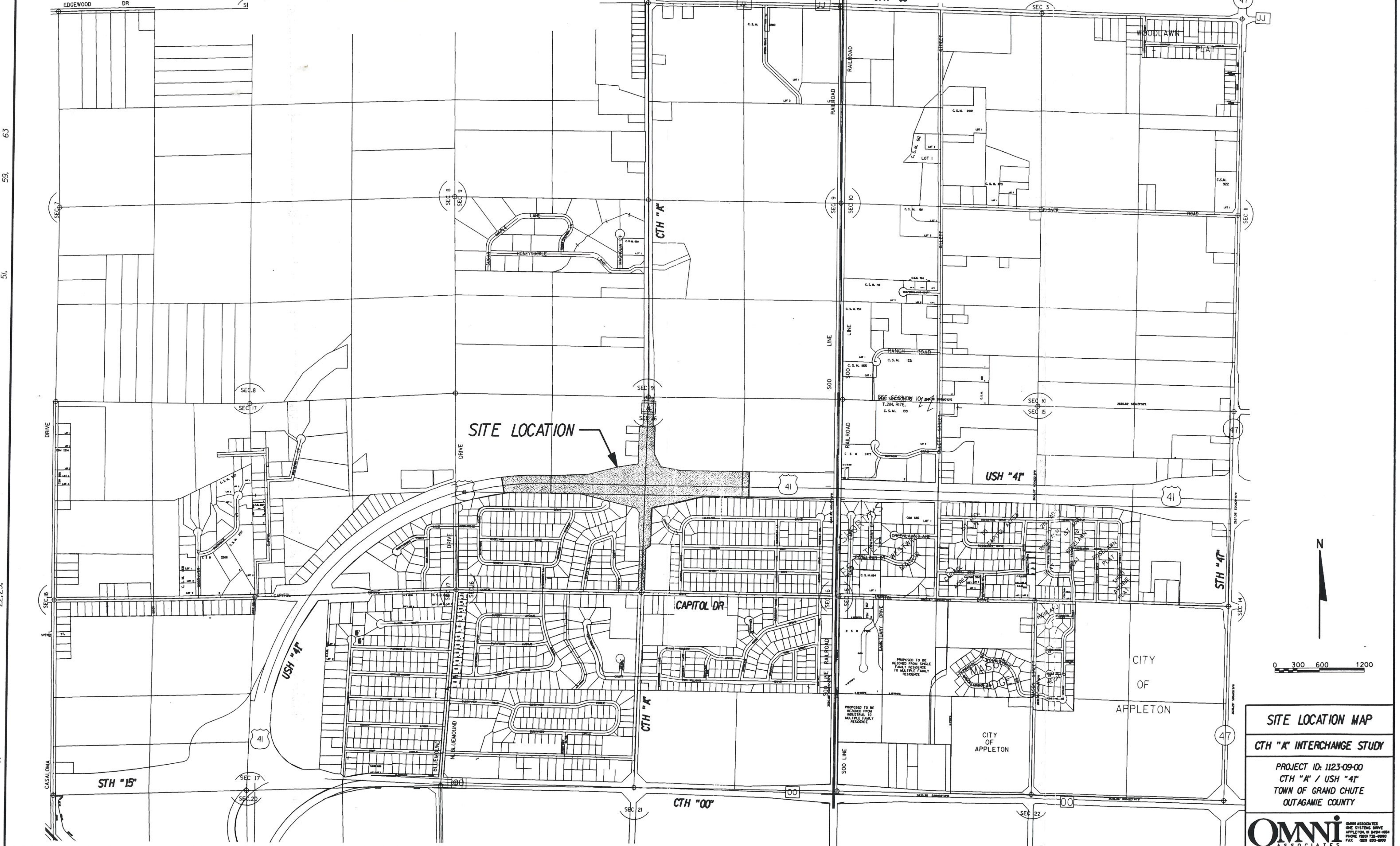

SHIOCTON
ELLINGTON
CENTER
Stephensville
Mackville
GRAND CHUTE
Greenville
APPLETON
OUTAGAMIE COUNTY AIRPORT
AIRPORT PARKING
MAYFLOWER ROAD
STINGLE ROAD
LA FOND ROAD
MULLEN
SCHIMMELPFENNIG ROAD
WOOD ROAD
KRUEGER
JOCHMAN ROAD
MERKES RD
HERMAN
WOODHAVEN CT
PULS ROAD
LONG VU DR
TACKMAN LANE
LOUIS DR
PINE CT
REXFORD
KELLY
THOMPSON
MIDWAY ROAD
ROCK
sunset lane
LAIRD
PLEASANT
CEDAR CLIFF
TIMBER TRAIL
BEAR CREEK
POHLMAN ROAD
POLENZ DRIVE
WEGE
TWELVE CORNER'S
PINE GROVE ROAD
WINWOOD ROAD
SANDSTONE COURT
HIGHVIEW DRIVE
GLEN STREET
EDWARD STREET
MACKVILLE
JESKE ROAD
TWELVE CORNERS ROAD
HAMPLE
MARKET
QUARRY
ALPHORN LANE
SOUTH HAMPLE ROAD
SCHABO ROAD
VALLEY VIEW LANE
WERNER ROAD
BROADWAY DRIVE
DEERVIEW DRIVE
MEADE
IMMEL
TIMOTHY LANE
HILLVIEW ROAD
EDGEWOOD DRIVE
GREENWOOD
EVERGLADE ROAD
RAILROAD
GILLETT
EVERGREEN DRIVE
BALLARD
Wis Central
CAPITOL DR.
S.T.H. 15 GREENVILLE BY-PASS
MCCARTHY
Limited R.R.
PERKINS STREET
WIS. CEN. LIM
COMMUNICATIONS DR.
COLLEGE AVENUE
SPENCER ST.
WEST SPENCER ROAD
TWO MILE RD
CASALOMA
JULIUS
ENVILLE
1
4
14
15
16
18
19
20

# Exhibit A-5



TOWN OF CENTER
TOWN OF FREEDOM
T.21N.R.17E.
Buboltz Nature Preserve
Art Lecker Wilderness Park
Plamann Park
CITY OF APPLETON
Elsner Road
Wisconsin Central Limited R.R.
TOWN OF VANDENBROEK
Evergreen Dr.
Outagamie County Landfill
STATE HIGHWAY 441
French Road
VILLAGE OF LITTLE CHUTE
WISCONSIN CENTRAL R.R.
FOX RIVER
TOWN OF GREENVILLE
Capitol Drive
McCarthy Road
F.V.T.C.
Casaloma Dr.
WINNEBAGO COUNTY
Legend
Residential Single Family
Residential Two Family
Residential Multi Family
Industrial
Transportation–Comm.–Utilities
Commercial
Public Facilities
Park–Recreation–Nature
Vacant–Undeveloped–Agricultural
Scale
3500 0 3500 7000
1"=3500'
N
Updated by Community Development Systems Division of Martenson & Eisele, Inc. February 1998
Field Work Completed October 1997
TOWN OF
GRAND CHUTE
LAND USE
Figure 12

# Exhibit A-2

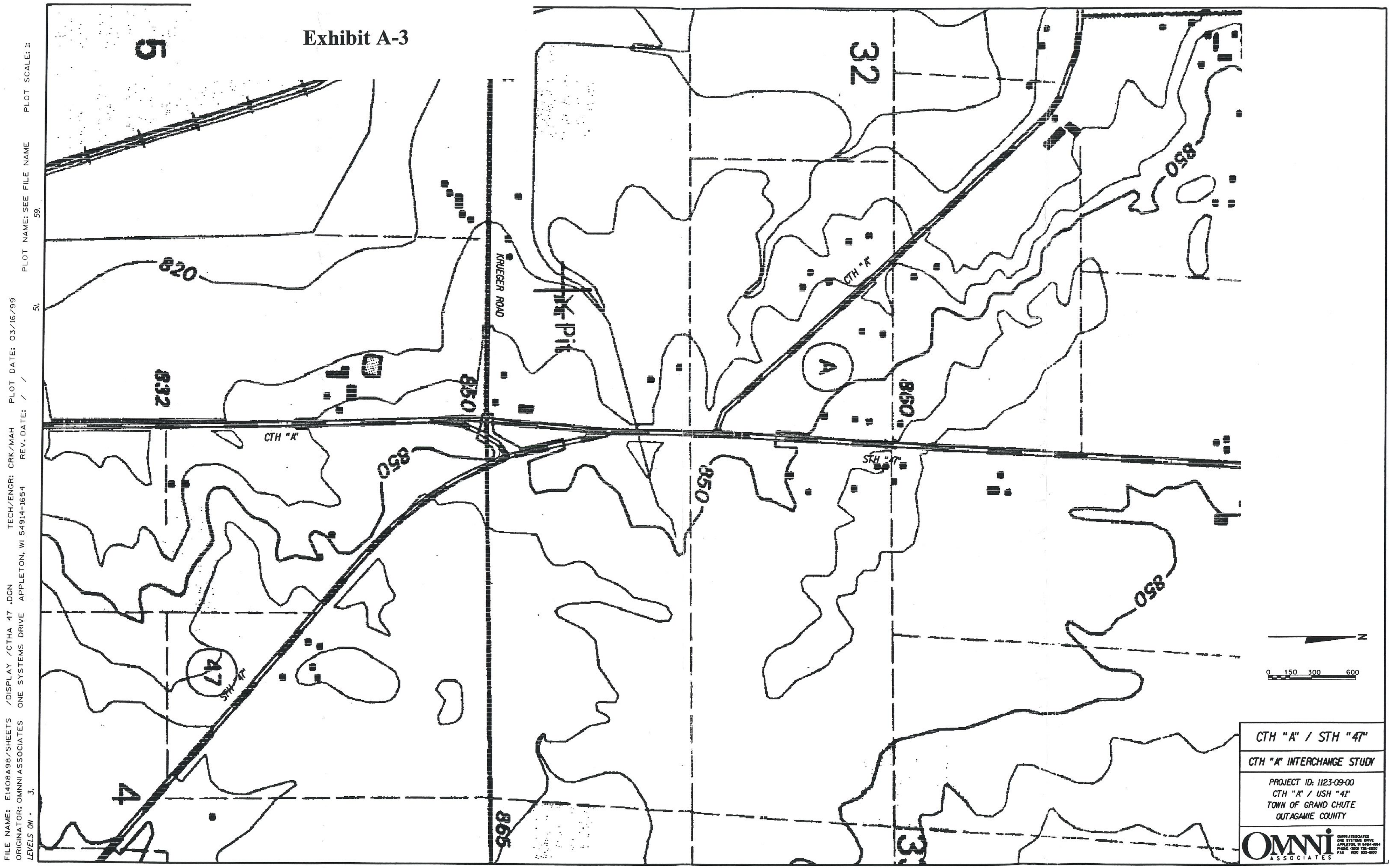



FILE NAME: E1408A98/SHEETS /DISPLAY /SITEPLAN.DGN TECH/ENGR: CRK/MAH PLOT DATE: 03/16/99 PLOT NAME: SEE FILE NAME PLOT SCALE: 1:

ORIGINATOR: OMNI ASSOCIATES ONE SYSTEMS DRIVE APPLETON, WI 54914-1654 REV. DATE: / /

LEVELS ON • 5, 22,23, 51, 59, 63

# Exhibit A-3



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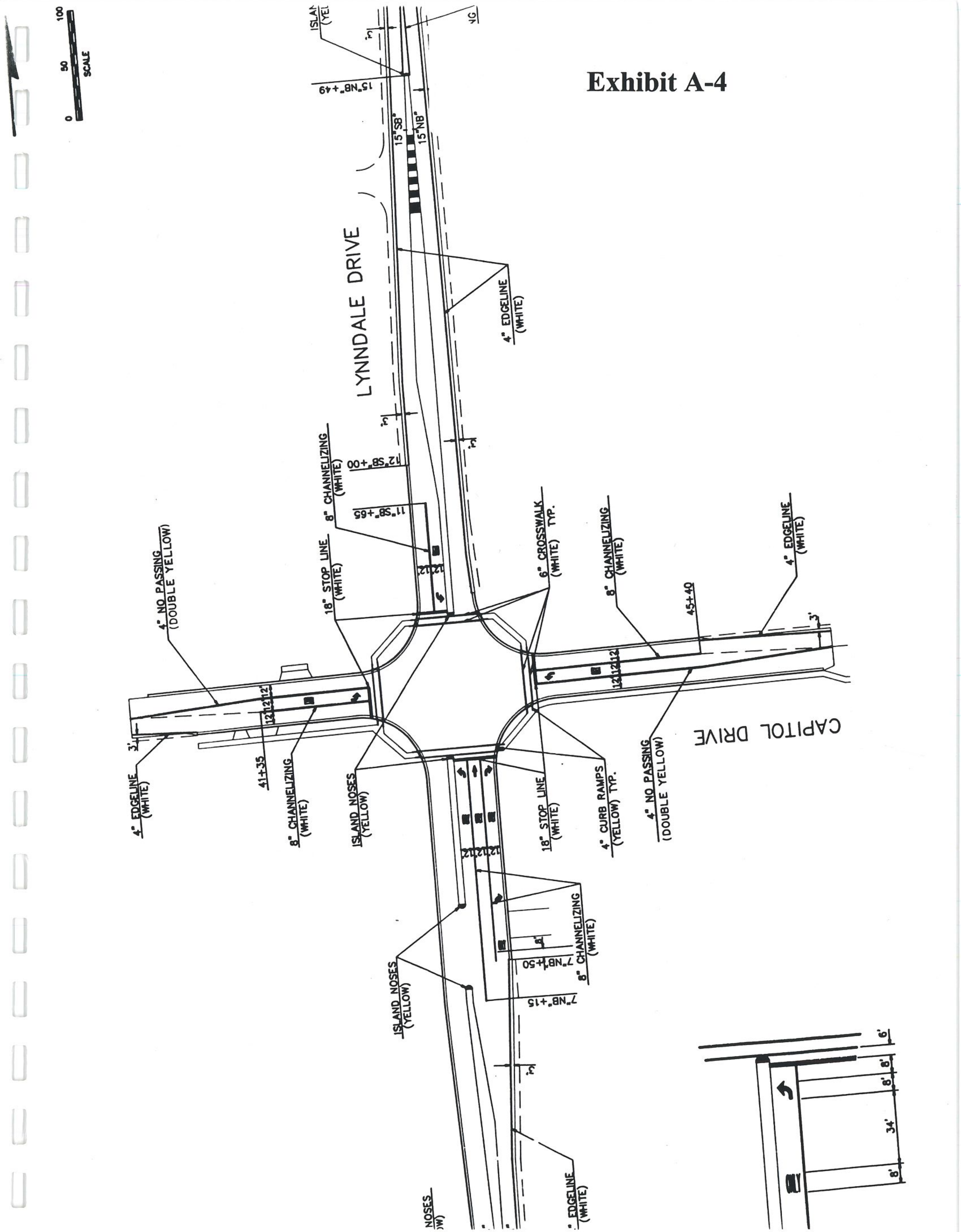
TECH/ENGR: CRK/MAH
PLOT DATE: 03/16/99
PLOT NAME: SEE FILE NAME
PLOT SCALE: 1:
ORIGINATOR: OMNI ASSOCIATES ONE SYSTEMS DRIVE APPLETON, WI 54914-1654
REV. DATE: / /
LEVELS ON - 3, 51, 59,
5
32
4
820
832
850
860
865
KRUEGER ROAD
Pit
CTH "A"
STH "47"
A
47
N
0 150 300 600
CTH "A" / STH "47"
CTH "A" INTERCHANGE STUDY
PROJECT ID: 1123-09-00
CTH "A" / USH "41"
TOWN OF GRAND CHUTE
OUTAGAMIE COUNTY
OMNNI ASSOCIATES

# Exhibit A-4



LYNNDALE DRIVE
CAPITOL DRIVE
SCALE
0
50
100
4" EDGELINE (WHITE)
15"NB"+49
15"SB"
15"NB"
12"SB"+00
11"SB"+65
8" CHANNELIZING (WHITE)
18" STOP LINE (WHITE)
4" NO PASSING (DOUBLE YELLOW)
6" CROSSWALK (WHITE) TYP.
45+40
41+35
ISLAND NOSES (YELLOW)
4" CURB RAMPS (YELLOW) TYP.
7"NB"+50
7"NB"+15
3'
6'
8'
34'

## Exhibit A-5

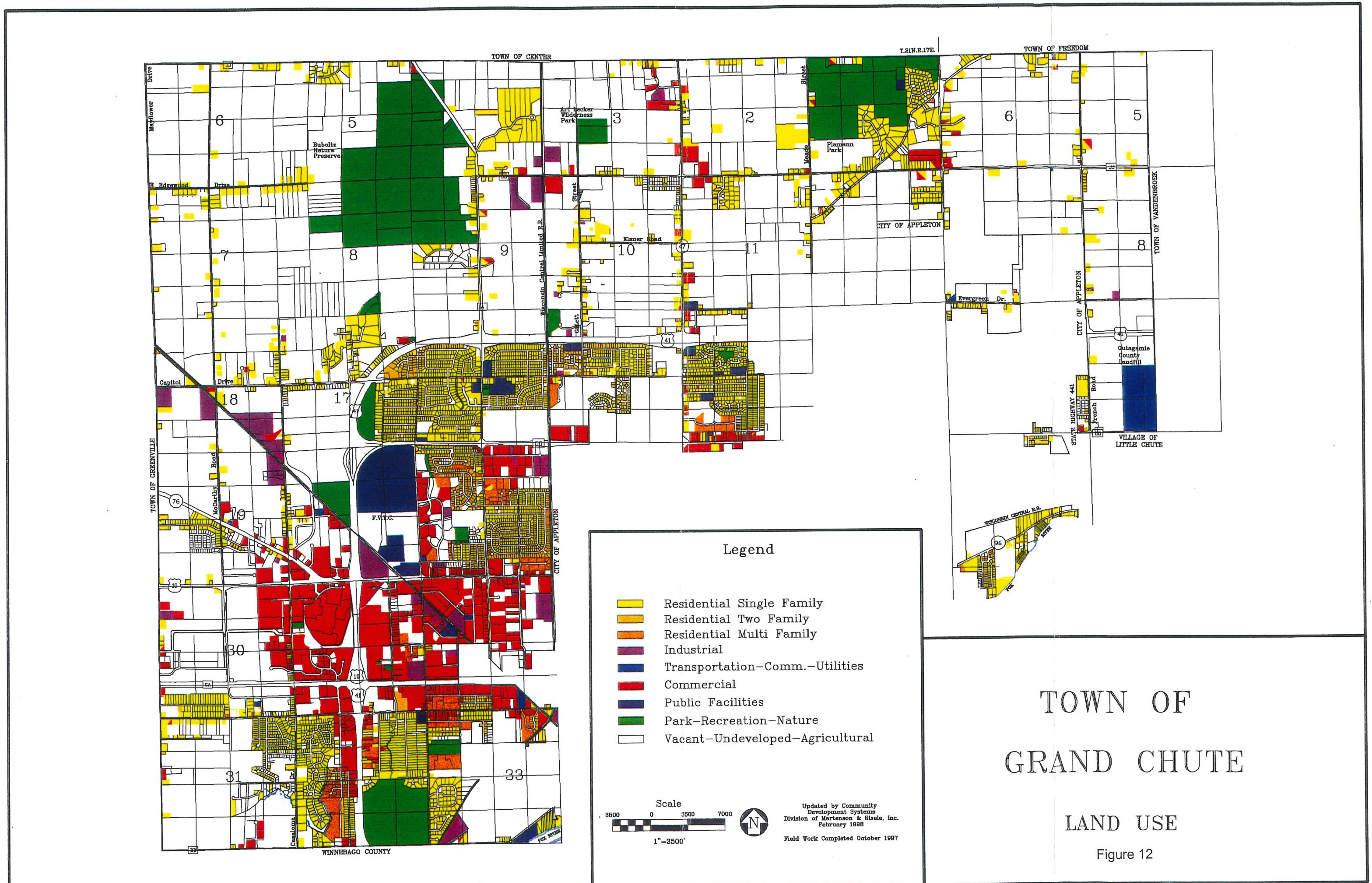
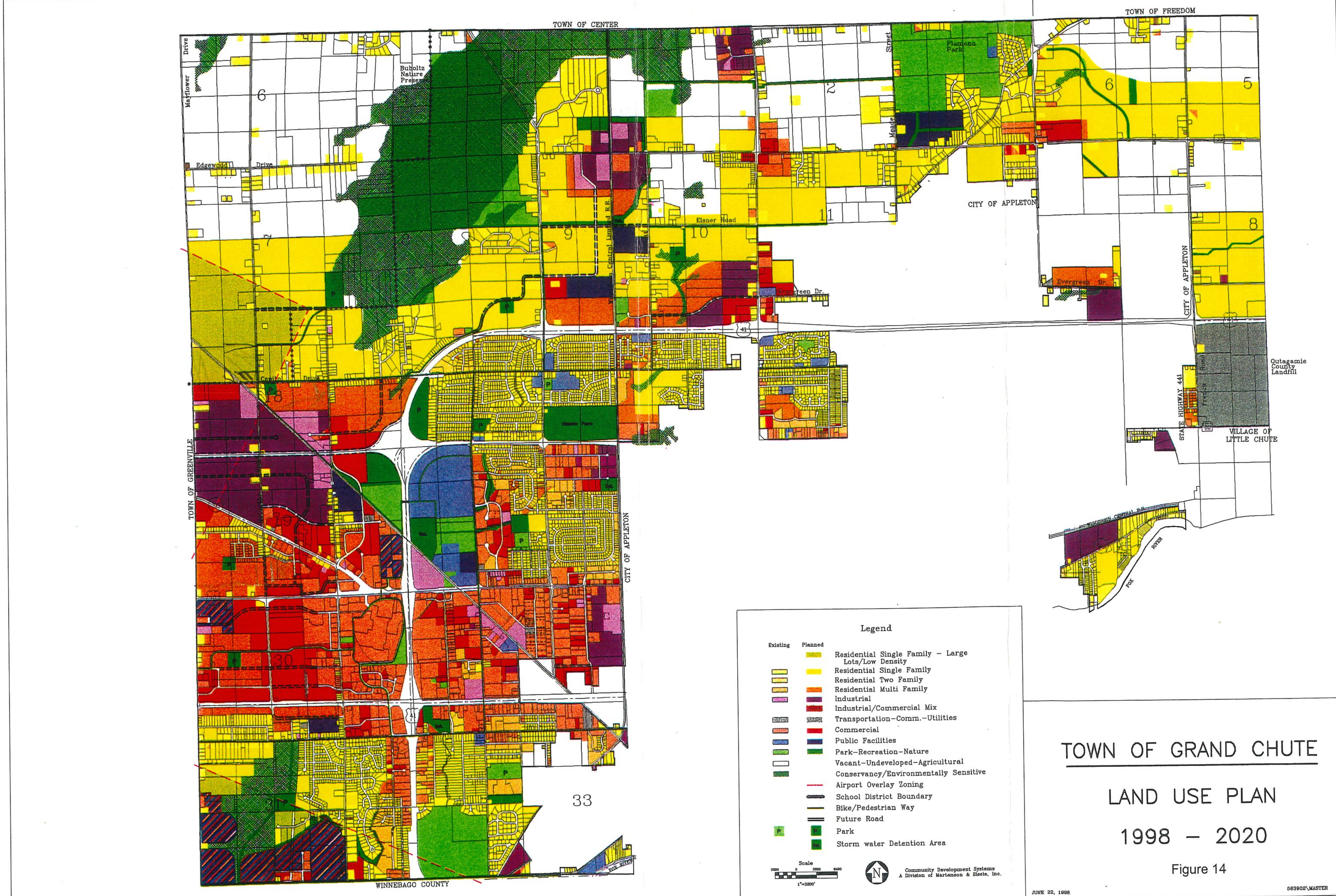


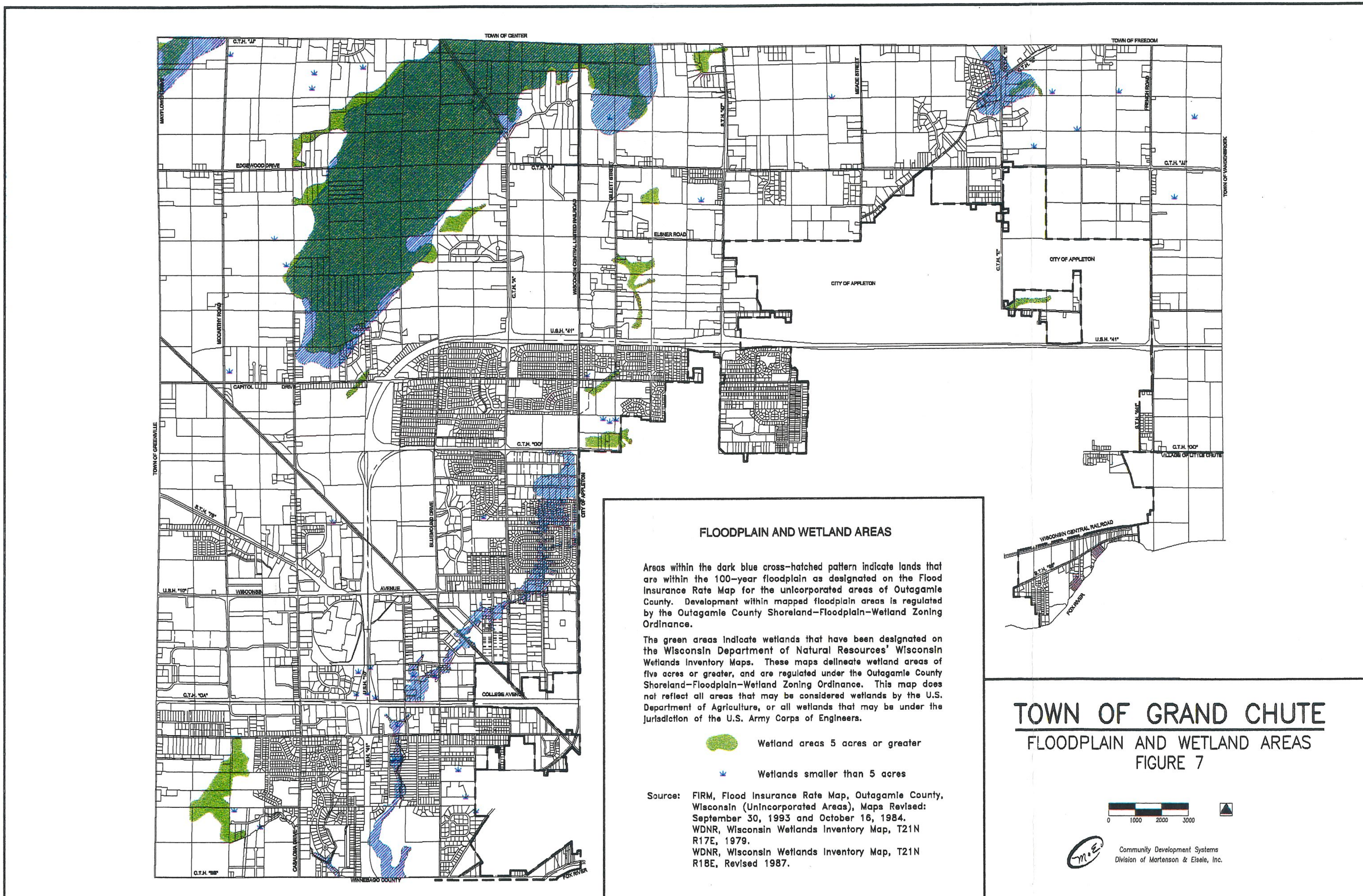

Figure 12

# Exhibit A-6

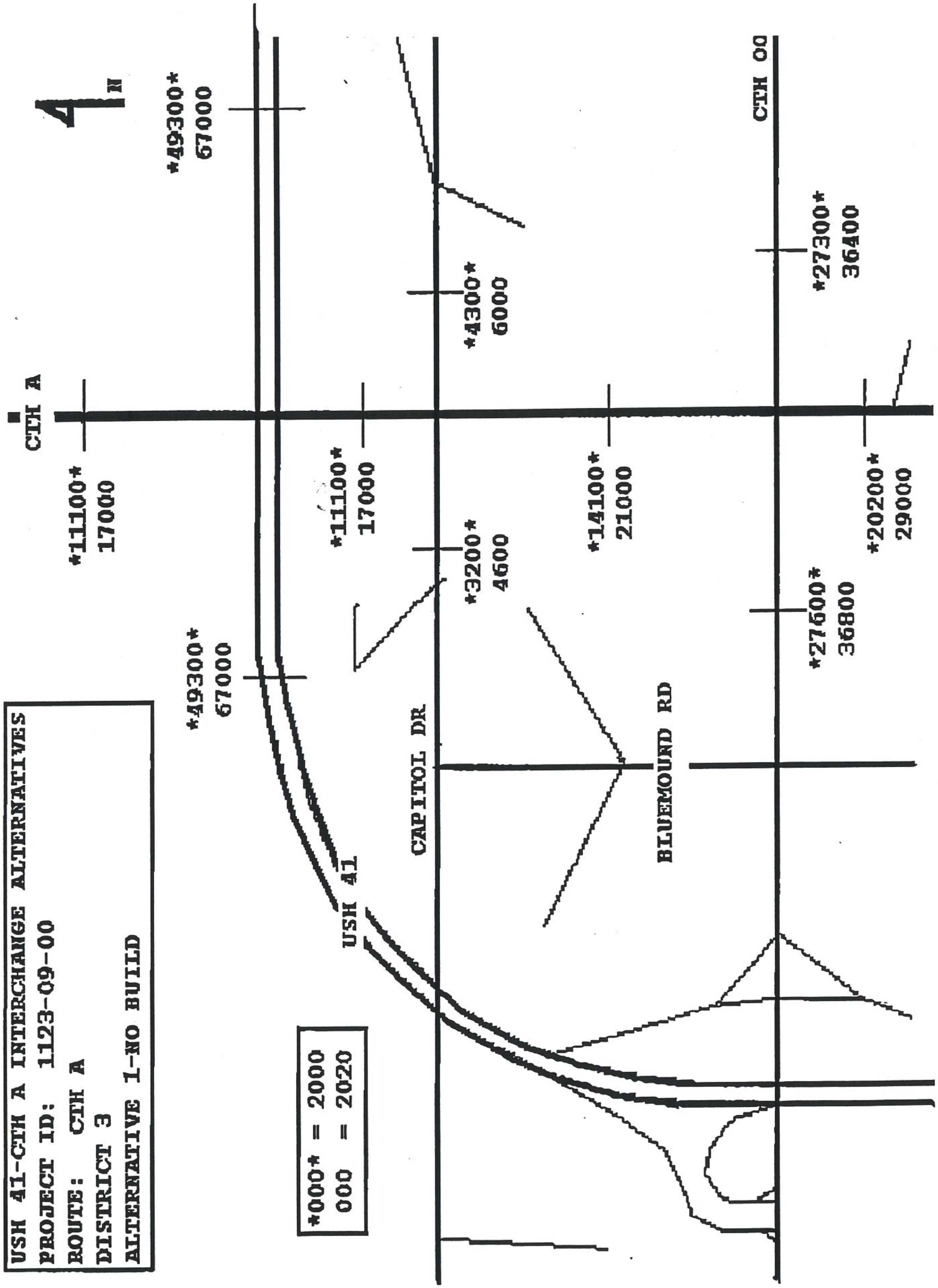


TOWN OF CENTER
TOWN OF FREEDOM
TOWN OF GREENVILLE
CITY OF APPLETON
VILLAGE OF LITTLE CHUTE
WINNEBAGO COUNTY
Outagamie County Landfill
Mayflower Drive
Edgewood Drive
Buboltz Nature Preserve
Plamann Park
Meade Street
Elsner Road
Evergreen Dr.
Central Wisconsin RR
STATE HIGHWAY 441
French Road
FOX RIVER
Legend
Existing
Planned
Residential Single Family – Large Lots/Low Density
Residential Single Family
Residential Two Family
Residential Multi Family
Industrial
Industrial/Commercial Mix
Transportation-Comm.-Utilities
Commercial
Public Facilities
Park-Recreation-Nature
Vacant-Undeveloped-Agricultural
Conservancy/Environmentally Sensitive
Airport Overlay Zoning
School District Boundary
Bike/Pedestrian Way
Future Road
Park
Storm water Detention Area
Scale
1"=3200'
Community Development Systems
A Division of Martenson & Eisele, Inc.
TOWN OF GRAND CHUTE
LAND USE PLAN
1998 – 2020
Figure 14
JUNE 22, 1998
563902\MASTER

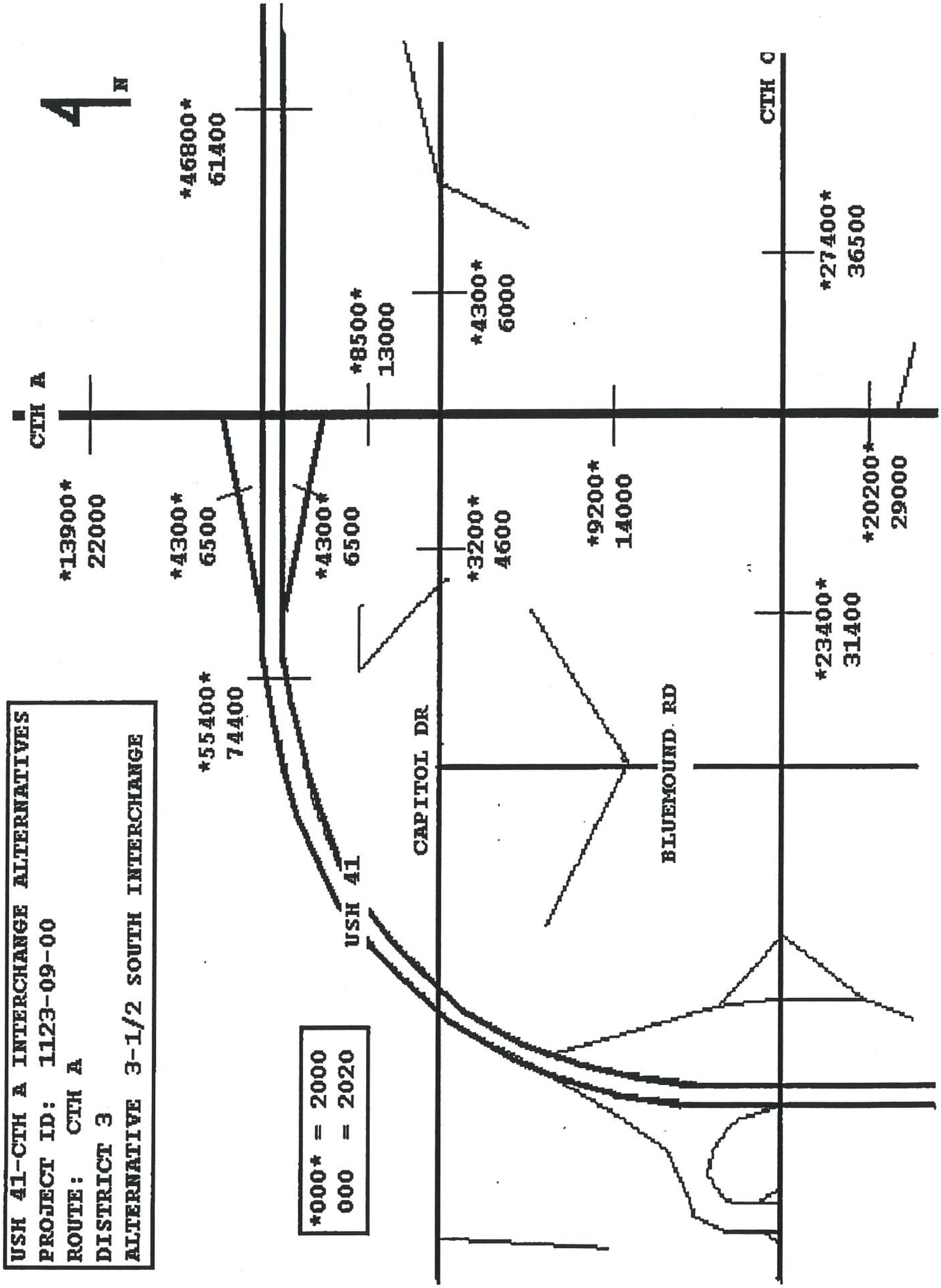
## Exhibit A-7


TOWN OF CENTER
TOWN OF FREEDOM
TOWN OF GREENVILLE
TOWN OF VANDENBROEK
CITY OF APPLETON
WINNEBAGO COUNTY
FOX RIVER
EDGEWOOD DRIVE
CAPITOL DRIVE
ELSNER ROAD
MEADE STREET
FRENCH ROAD
MCCARTHY ROAD
BLUEMOUND DRIVE
GILLETT STREET
COLLEGE AVENUE
WISCONSIN CENTRAL RAILROAD
U.S.H. "41"
FLOODPLAIN AND WETLAND AREAS
Areas within the dark blue cross-hatched pattern indicate lands that are within the 100-year floodplain as designated on the Flood Insurance Rate Map for the unincorporated areas of Outagamie County. Development within mapped floodplain areas is regulated by the Outagamie County Shoreland-Floodplain-Wetland Zoning Ordinance.
The green areas indicate wetlands that have been designated on the Wisconsin Department of Natural Resources' Wisconsin Wetlands Inventory Maps. These maps delineate wetland areas of five acres or greater, and are regulated under the Outagamie County Shoreland-Floodplain-Wetland Zoning Ordinance. This map does not reflect all areas that may be considered wetlands by the U.S. Department of Agriculture, or all wetlands that may be under the jurisdiction of the U.S. Army Corps of Engineers.
Wetland areas 5 acres or greater
Wetlands smaller than 5 acres
Source: FIRM, Flood Insurance Rate Map, Outagamie County, Wisconsin (Unincorporated Areas), Maps Revised: September 30, 1993 and October 16, 1984.
WDNR, Wisconsin Wetlands Inventory Map, T21N R17E, 1979.
WDNR, Wisconsin Wetlands Inventory Map, T21N R18E, Revised 1987.
TOWN OF GRAND CHUTE
FLOODPLAIN AND WETLAND AREAS
FIGURE 7
0 1000 2000 3000
Community Development Systems
Division of Martenson & Eisele, Inc.

# Exhibit B-1


USH 41-CTH A INTERCHANGE ALTERNATIVES
PROJECT ID: 1123-09-00
ROUTE: CTH A
DISTRICT 3
ALTERNATIVE 1-NO BUILD
*000* = 2000
000 = 2020
N
CTH A
CTH OO
USH 41
CAPITOL DR
BLUEMOUND RD
*49300*
67000
*11100*
17000
*4300*
6000
*27300*
36400
*14100*
21000
*20200*
29000
*3200*
4600
*27600*
36800

# Exhibit B-2


USH 41-CTH A INTERCHANGE ALTERNATIVES
PROJECT ID: 1123-09-00
ROUTE: CTH A
DISTRICT 3
ALTERNATIVE 3-1/2 SOUTH INTERCHANGE
*000* = 2000
000 = 2020
N
CTH A
CTH Q
USH 41
CAPITOL DR
BLUEMOUND RD
*46800*
61400
*8500*
13000
*4300*
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6500
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74400
*23400*
31400

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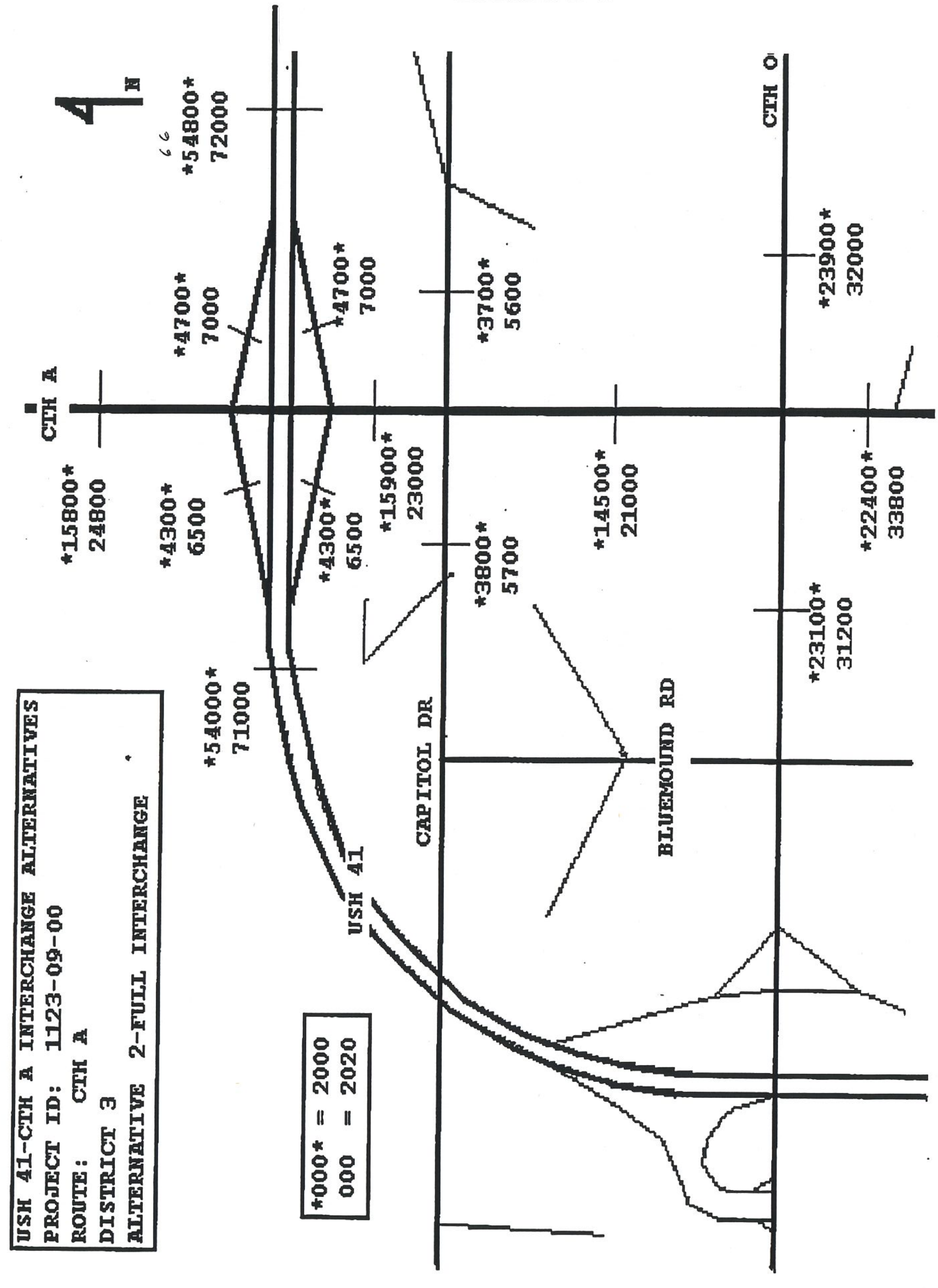
USH 41-CTH A INTERCHANGE ALTERNATIVES
PROJECT ID: 1123-09-00
ROUTE: CTH A
DISTRICT 3
ALTERNATIVE 2-FULL INTERCHANGE
*000* = 2000
000 = 2020
N
CTH A
CTH O
CAPITOL DR
BLUEMOUND RD
USH 41
*54800*
72000
*4700*
7000
*4700*
7000
*3700*
5600
*23900*
32000
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6500
*15900*
23000
*14500*
21000
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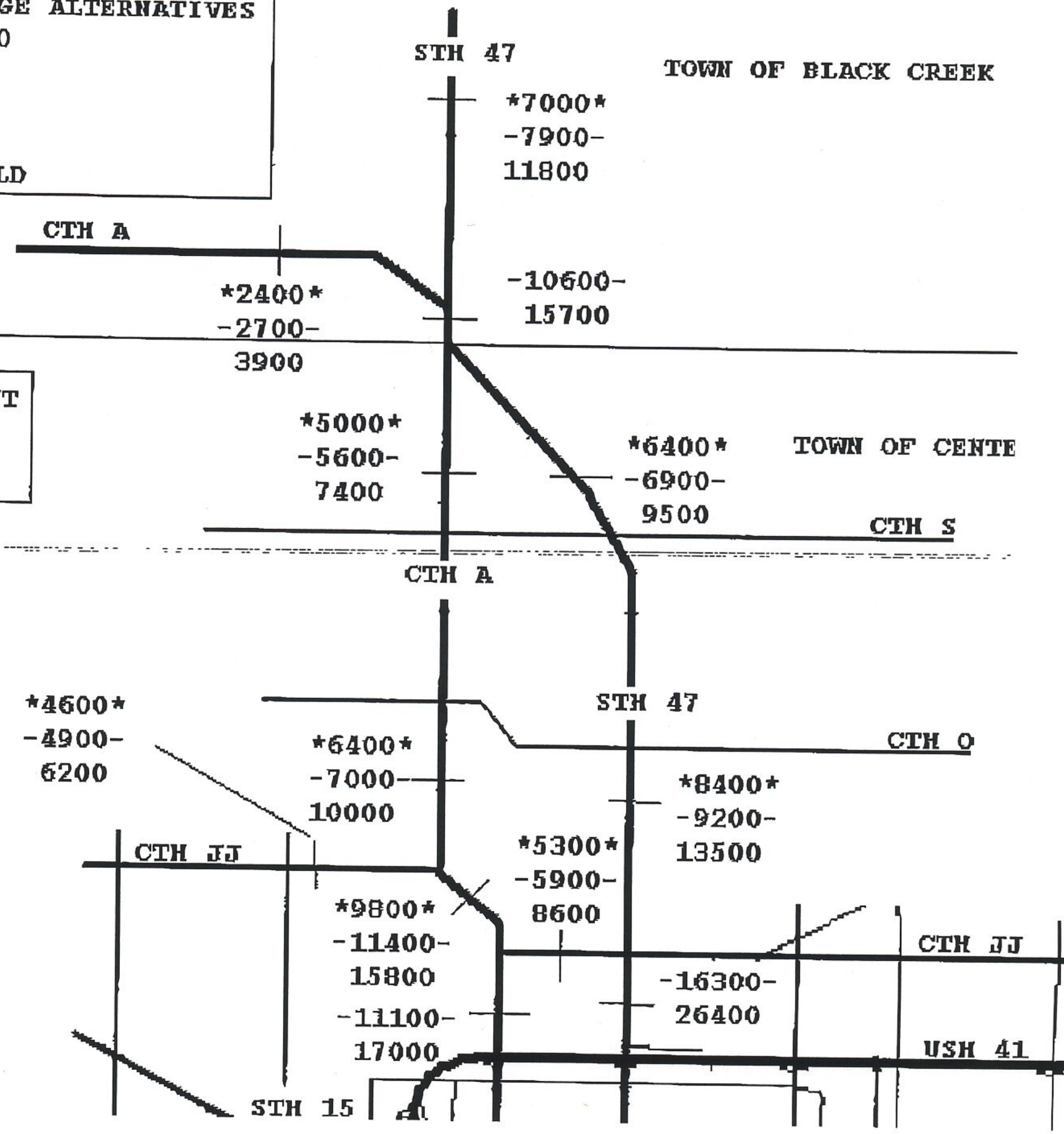
33800
*3800*
5700
*23100*
31200
*54000*
71000

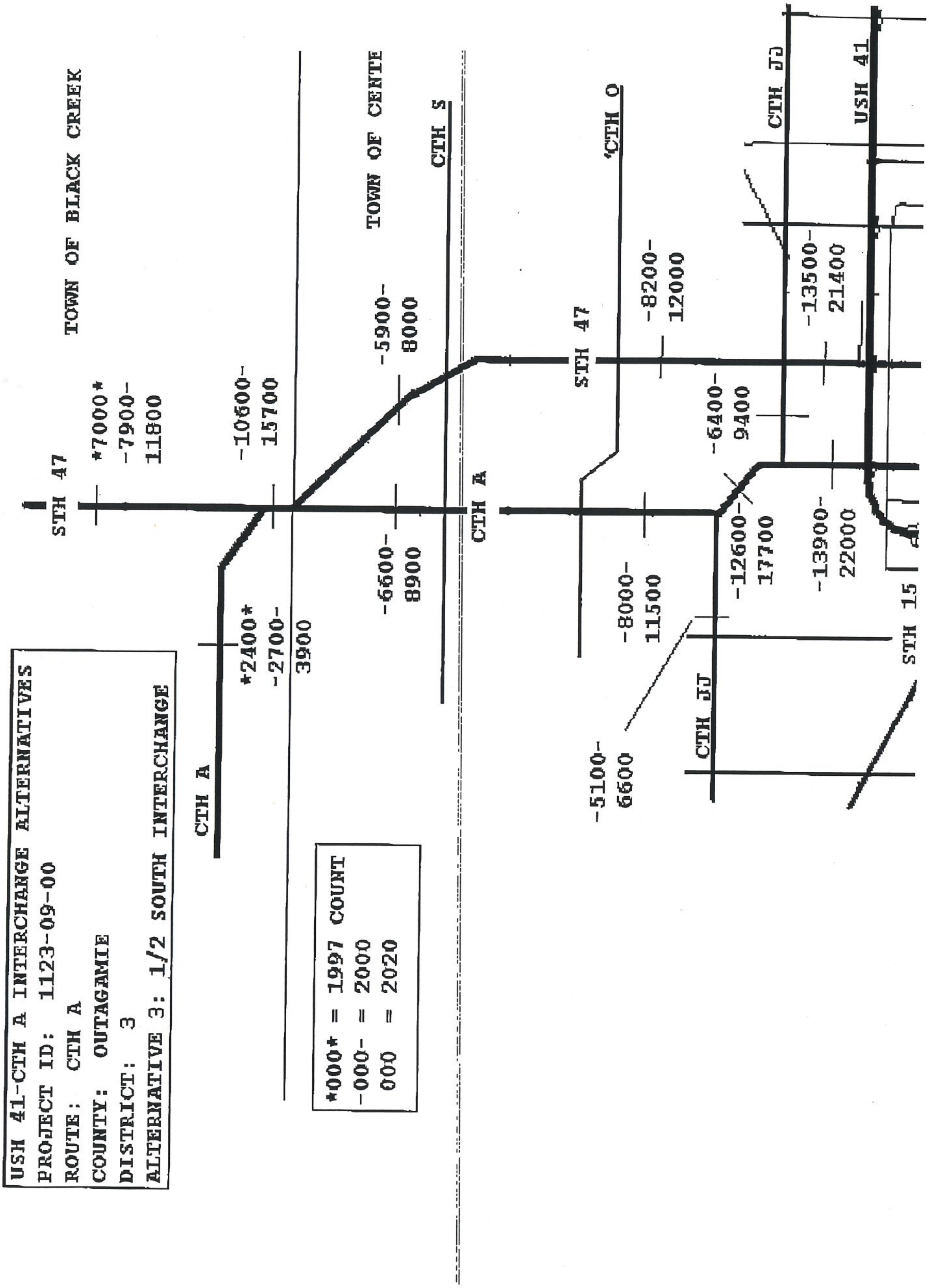
# Exhibit B-4

USH 41-CTH A INTERCHANGE ALTERNATIVES
PROJECT ID: 1123-09-00
ROUTE: CTH A
COUNTY: OUTAGAMIE
DISTRICT: 3
ALTERNATIVE 1: NO BUILD

*000* = 1997 COUNT
-000- = 2000
000 = 2020



# Exhibit B-5


USH 41-CTH A INTERCHANGE ALTERNATIVES
PROJECT ID: 1123-09-00
ROUTE: CTH A
COUNTY: OUTAGAMIE
DISTRICT: 3
ALTERNATIVE 3: 1/2 SOUTH INTERCHANGE
*000* = 1997 COUNT
-000- = 2000
000 = 2020
TOWN OF BLACK CREEK
TOWN OF CENTE
CTH S
CTH O
CTH JJ
USH 41
STH 47
CTH A
STH 15
*7000*
-7900-
11800
-10600-
15700
-5900-
8000
-8200-
12000
-13500-
21400
*2400*
-2700-
3900
-6600-
8900
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11500
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9400
-12600-
17700
-13900-
22000
-5100-
6600

# Exhibit B-6

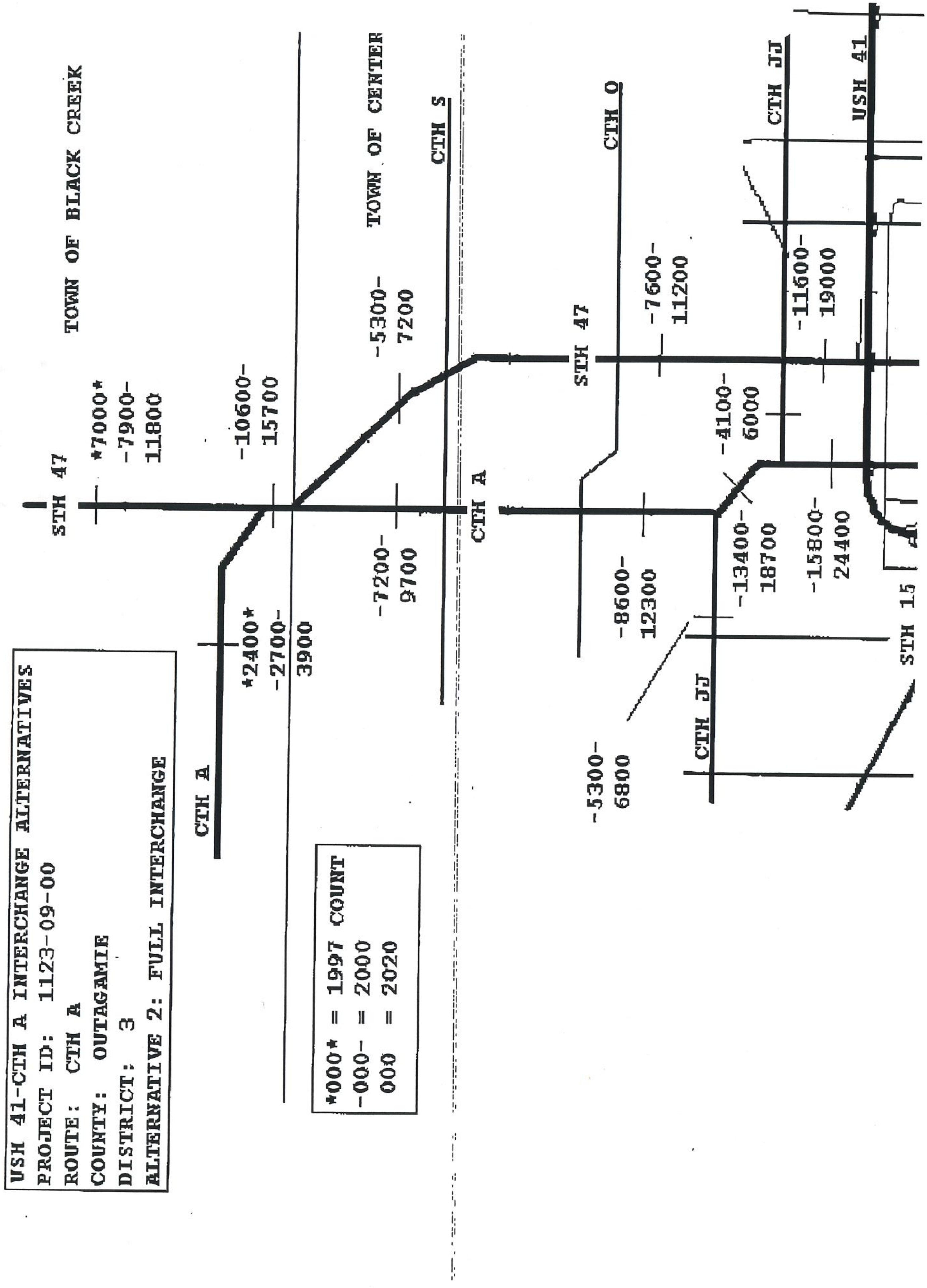
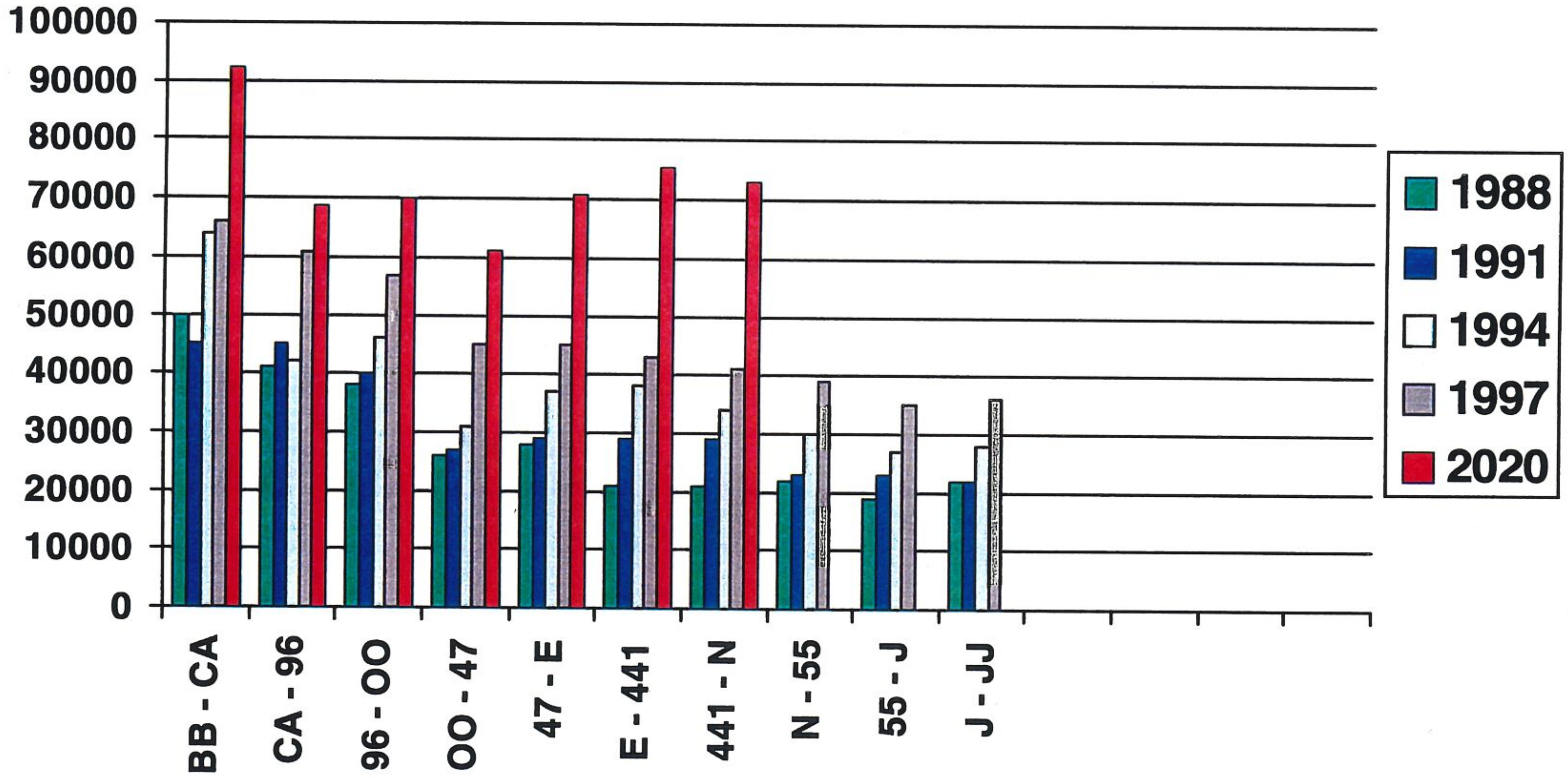

USH 41-CTH A INTERCHANGE ALTERNATIVES
PROJECT ID: 1123-09-00
ROUTE: CTH A
COUNTY: OUTAGAMIE
DISTRICT: 3
ALTERNATIVE 2: FULL INTERCHANGE
*000* = 1997 COUNT
-000- = 2000
000 = 2020
TOWN OF BLACK CREEK
TOWN OF CENTER
STH 47
CTH A
CTH S
CTH O
CTH JJ
USH 41
STH 15
*7000*
-7900-
11800
-10600-
15700
-5300-
7200
-7600-
11200
-11600-
19000
-4100-
6000
*2400*
-2700-
3900
-7200-
9700
-8600-
12300
-13400-
18700
-15800-
24400
-5300-
6800

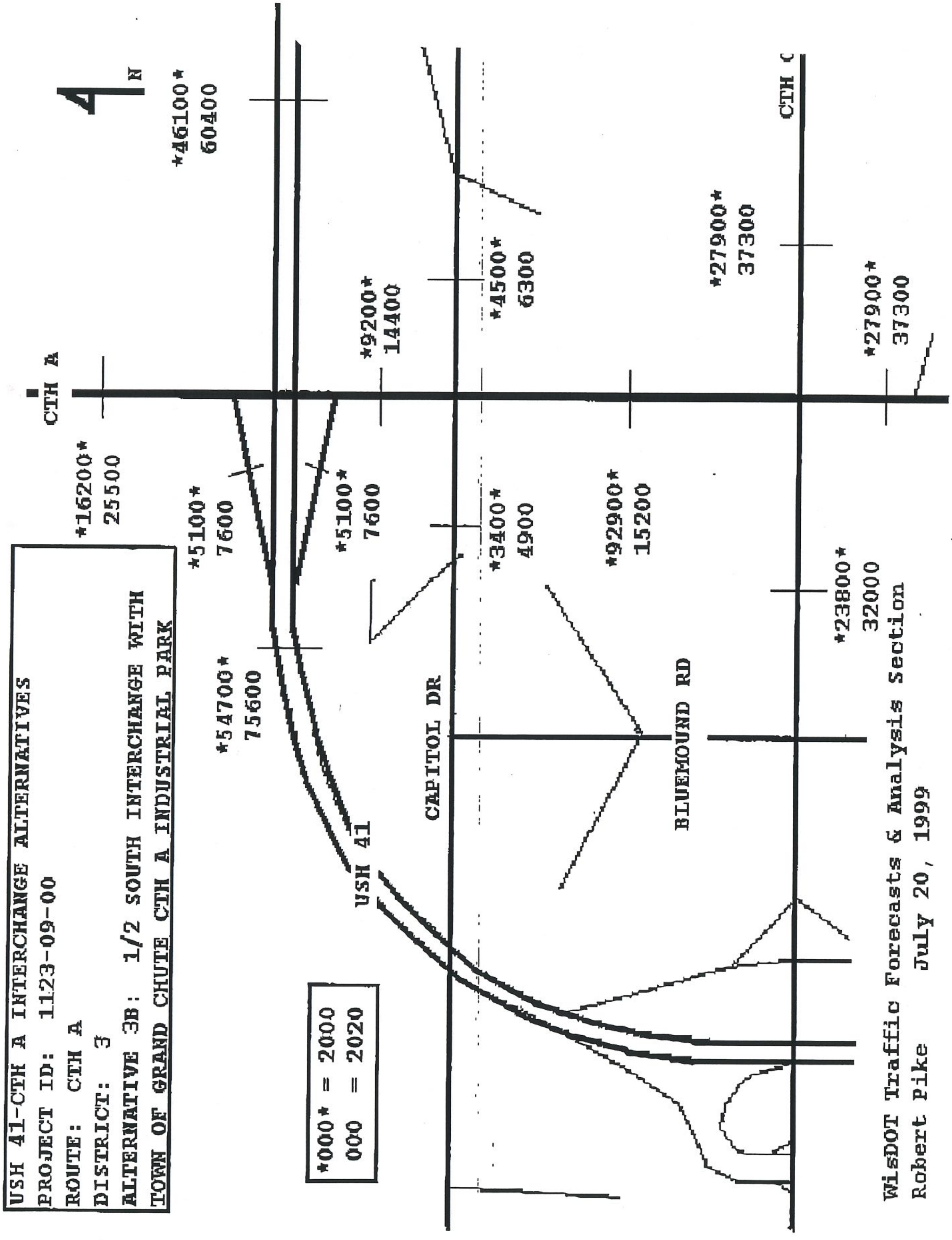
Exhibit B-7

# USH 41 OUTAGAMIE COUNTY
# 1988 - 1997

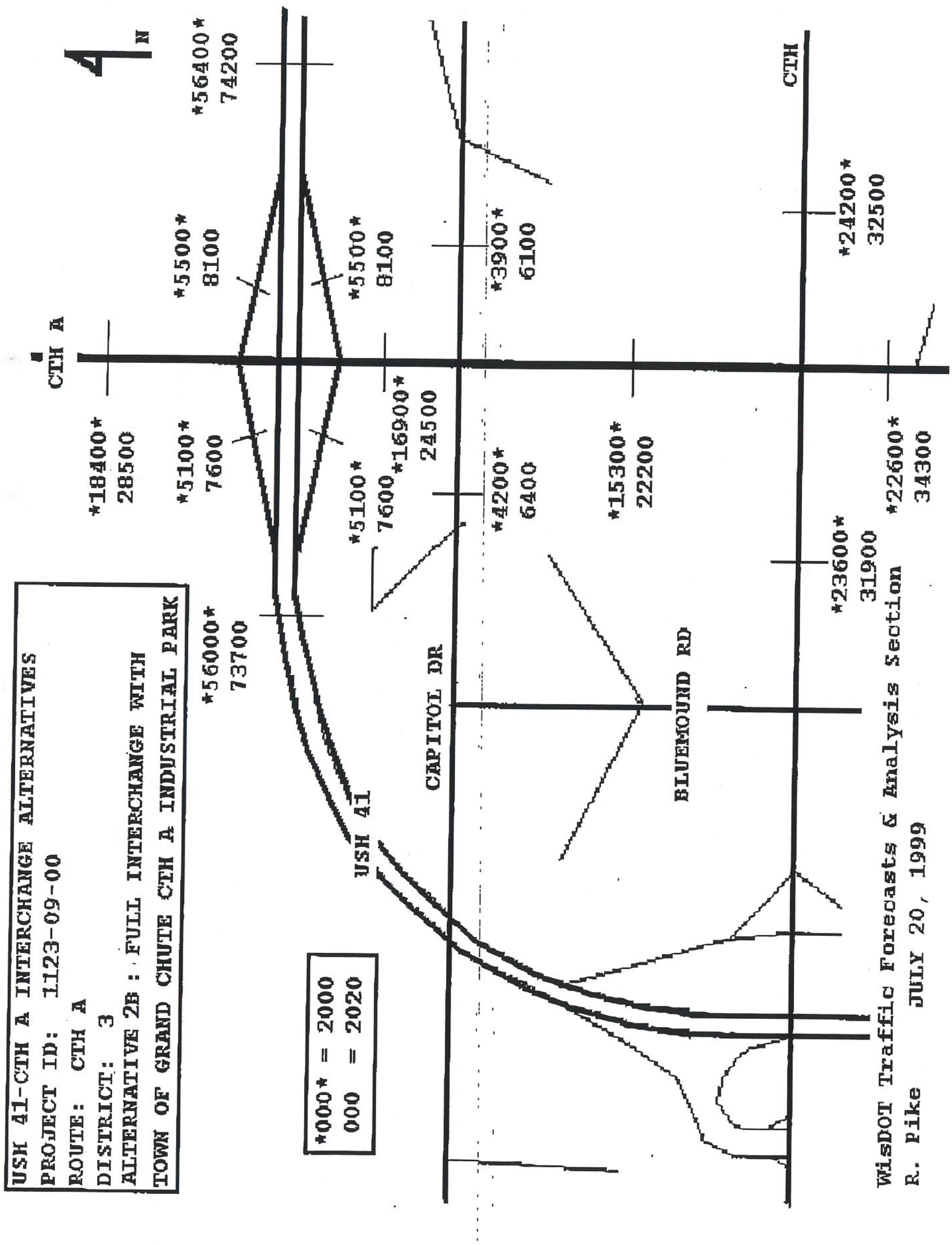



6 Lanes open from SCL - OO in 1992.

# Exhibit B-9


USH 41-CTH A INTERCHANGE ALTERNATIVES
PROJECT ID: 1123-09-00
ROUTE: CTH A
DISTRICT: 3
ALTERNATIVE 3B: 1/2 SOUTH INTERCHANGE WITH
TOWN OF GRAND CHUTE CTH A INDUSTRIAL PARK
N
*46100*
60400
*16200*
25500
CTH A
*5100*
7600
*5100*
7600
*9200*
14400
*4500*
6300
*3400*
4900
*54700*
75600
*92900*
15200
*27900*
37300
*27900*
37300
*23800*
32000
CAPITOL DR
BLUEMOUND RD
USH 41
CTH
*000* = 2000
000 = 2020
WisDOT Traffic Forecasts & Analysis Section
Robert Pike July 20, 1999

# Exhibit B-10


USH 41-CTH A INTERCHANGE ALTERNATIVES
PROJECT ID: 1123-09-00
ROUTE: CTH A
DISTRICT: 3
ALTERNATIVE 2B : FULL INTERCHANGE WITH
TOWN OF GRAND CHUTE CTH A INDUSTRIAL PARK
000* = 2000
000 = 2020
N
CTH A
CTH
USH 41
CAPITOL DR
BLUEMOUND RD
*56400*
74200
*5500*
8100
*5500*
8100
*3900*
6100
*24200*
32500
*18400*
28500
*5100*
7600
*5100*
7600
*16900*
24500
*4200*
6400
*15300*
22200
*22600*
34300
*23600*
31900
*56000*
73700
WisDOT Traffic Forecasts & Analysis Section
R. Pike JULY 20, 1999

# Exhibit C-1

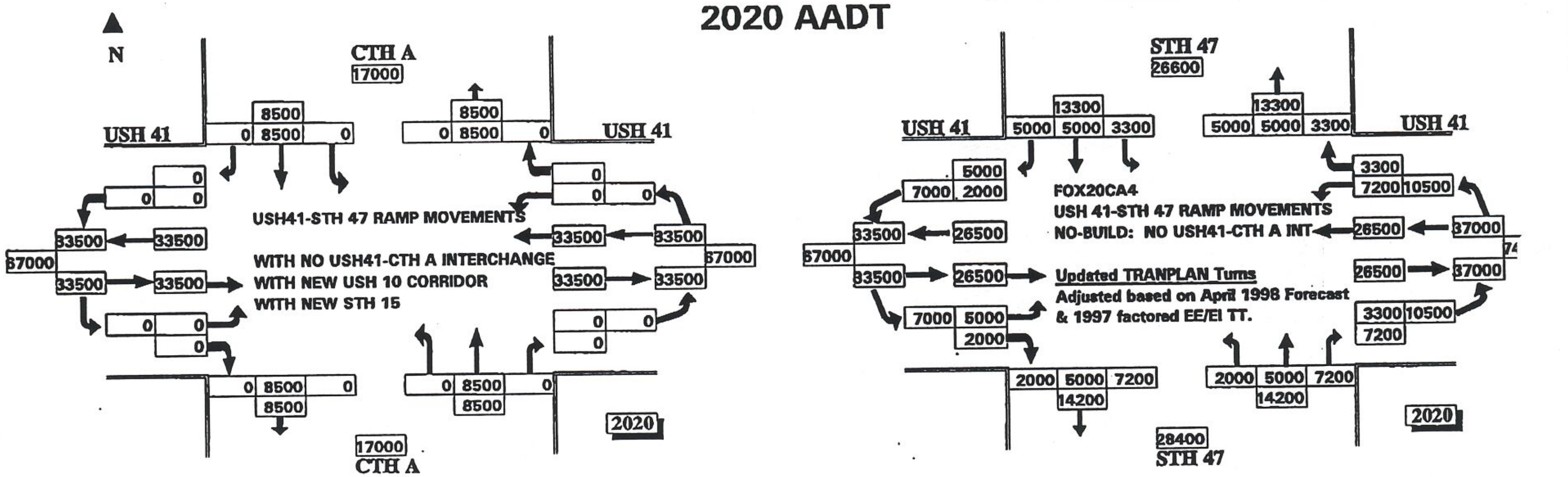
File Ref: U:\LOTUS\I41AA120.WK1

PROJECT ID: 1123-09-00
2020 USH 41- CTH A Interchange Alternatives
ALTERNATIVE 1: NO BUILD
2020 RAMP MOVEMENTS

## INTERCHANGE FORECAST

## ALTERNATIVE 1: NO BUILD USH 41-CTH A INTERCHANGE

## 2020 AADT



# Exhibit C-2

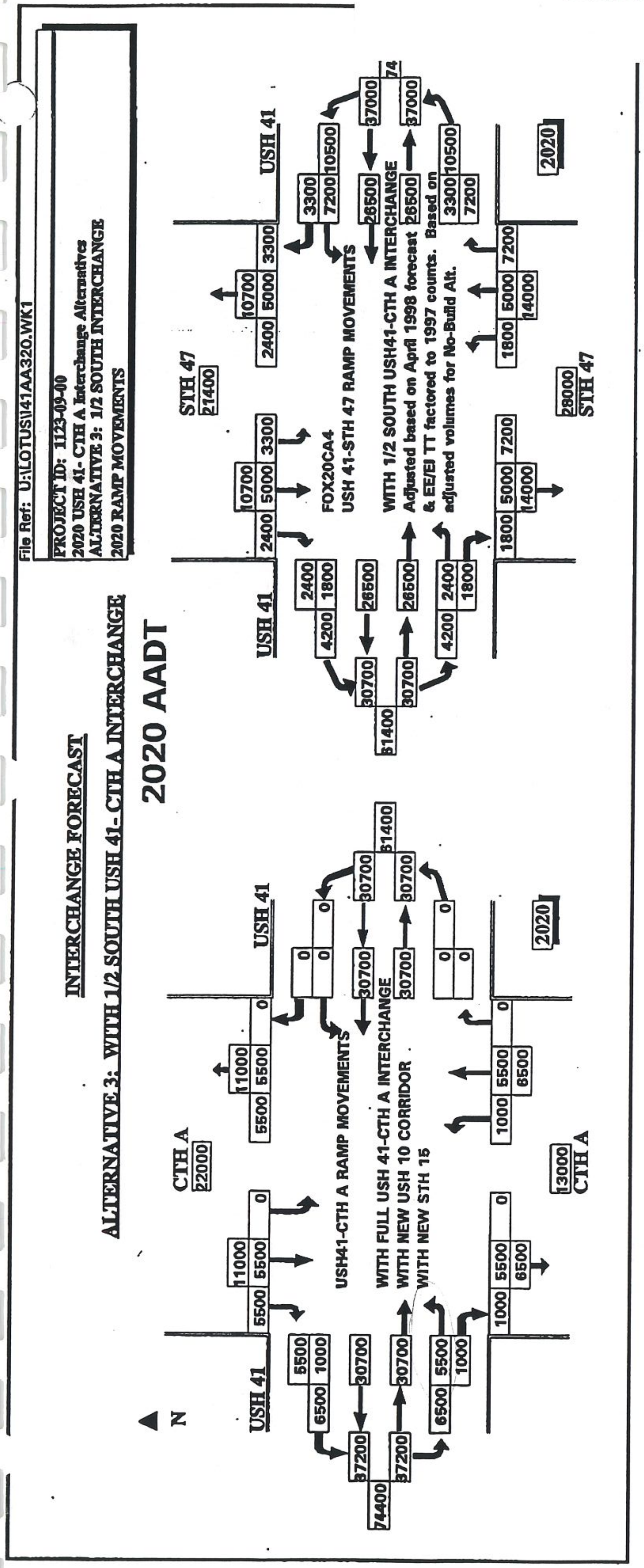

File Ref: U:\LOTUS\41AA320.WK1
PROJECT ID: 1123-09-00
2020 USH 41- CTH A Interchange Alternatives
ALTERNATIVE 3: 1/2 SOUTH INTERCHANGE
2020 RAMP MOVEMENTS
INTERCHANGE FORECAST
ALTERNATIVE 3: WITH 1/2 SOUTH USH 41- CTH A INTERCHANGE
2020 AADT
N
USH 41
CTH A
22000
13000
USH41-CTH A RAMP MOVEMENTS
WITH FULL USH 41-CTH A INTERCHANGE
WITH NEW USH 10 CORRIDOR
WITH NEW STH 15
74400
37200
30700
61400
5500
6500
1000
11000
0
2020
STH 47
21400
28000
FOX20CA4
USH 41-STH 47 RAMP MOVEMENTS
WITH 1/2 SOUTH USH41-CTH A INTERCHANGE
Adjusted based on April 1998 forecast
& EE/EI TT factored to 1997 counts. Based on
adjusted volumes for No-Build Alt.
26500
4200
2400
1800
10700
5000
3300
7200
14000
10500
37000
74

Exhibit C-3

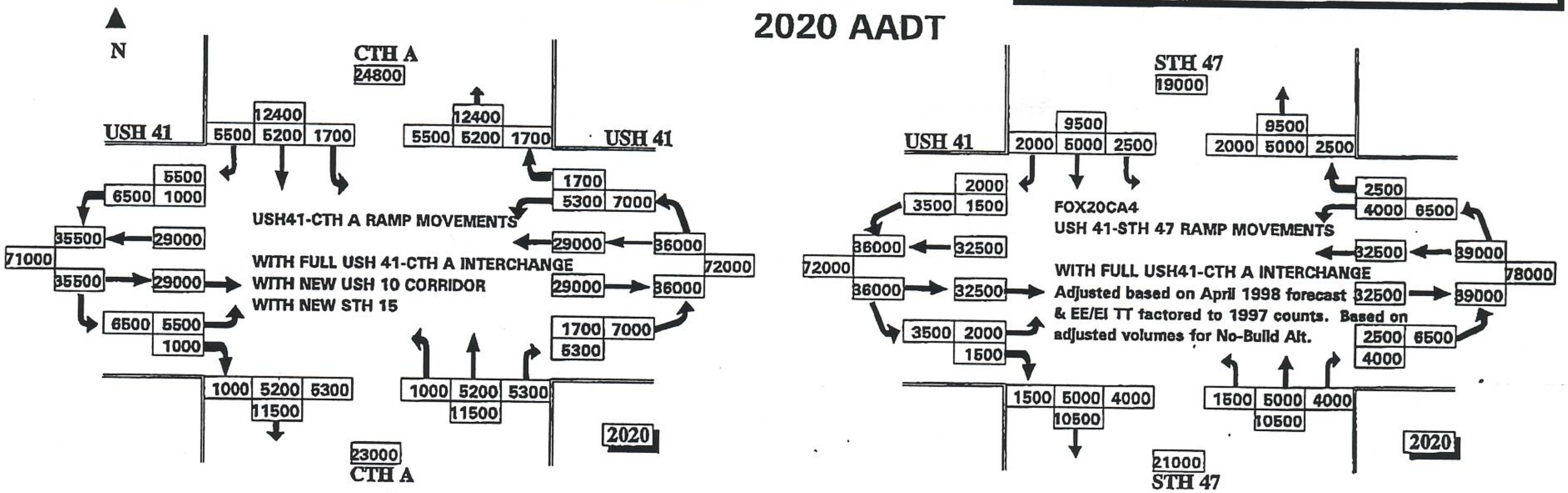
File Ref: U:\LOTUS\I41AA220.WK1

PROJECT ID: 1123-09-00
2020 USH 41- CTH A Interchange Alternatives
ALTERNATIVE 2: FULL INTERCHANGE
2020 RAMP MOVEMENTS

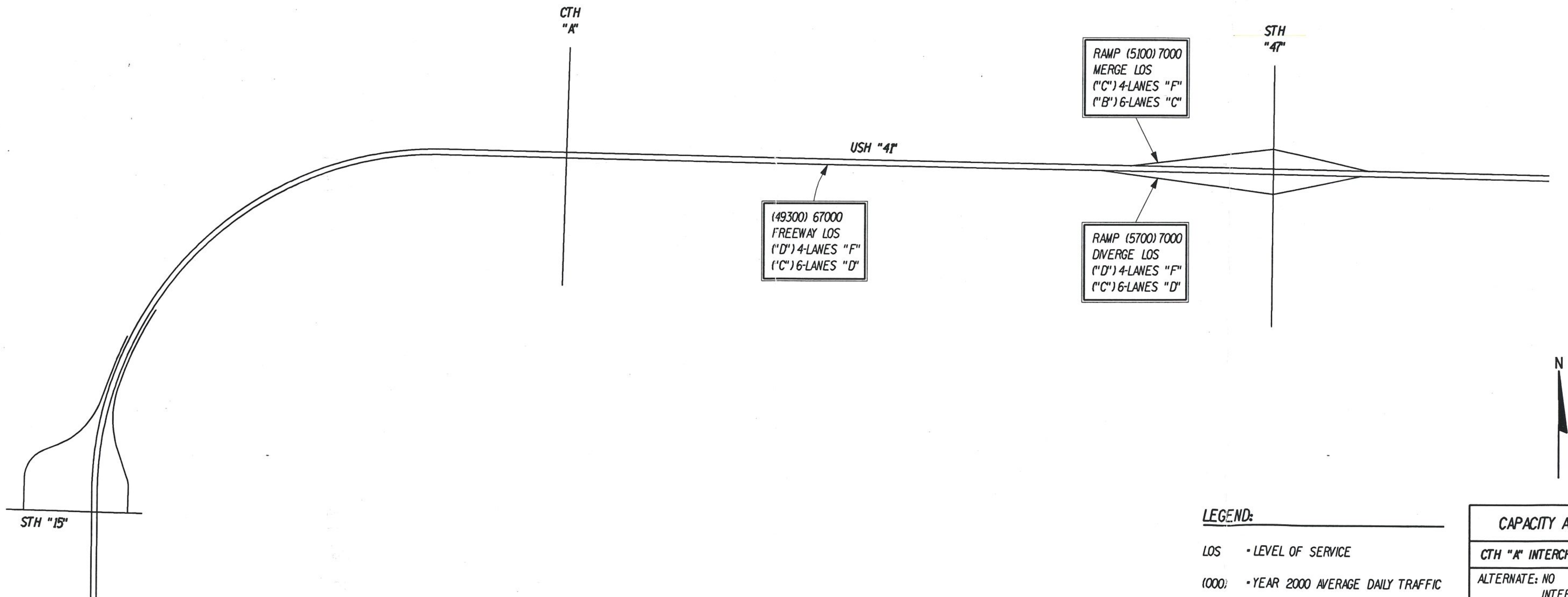
## INTERCHANGE FORECAST

## ALTERNATIVE 2: WITH FULL USH 41-CTH A INTERCHANGE

## 2020 AADT



# Exhibit D-1




LEGEND:

LOS - LEVEL OF SERVICE

(000) - YEAR 2000 AVERAGE DAILY TRAFFIC

000 - YEAR 2020 AVERAGE DAILY TRAFFIC

("X") - YEAR 2000 LOS

"X" - YEAR 2020 LOS

CAPACITY ANALYSIS

CTH "A" INTERCHANGE STUDY

ALTERNATE: NO INTERCHANGE

PROJECT ID: 1123-09-00
CTH "A" / USH "41"
TOWN OF GRAND CHUTE
OUTAGAMIE COUNTY

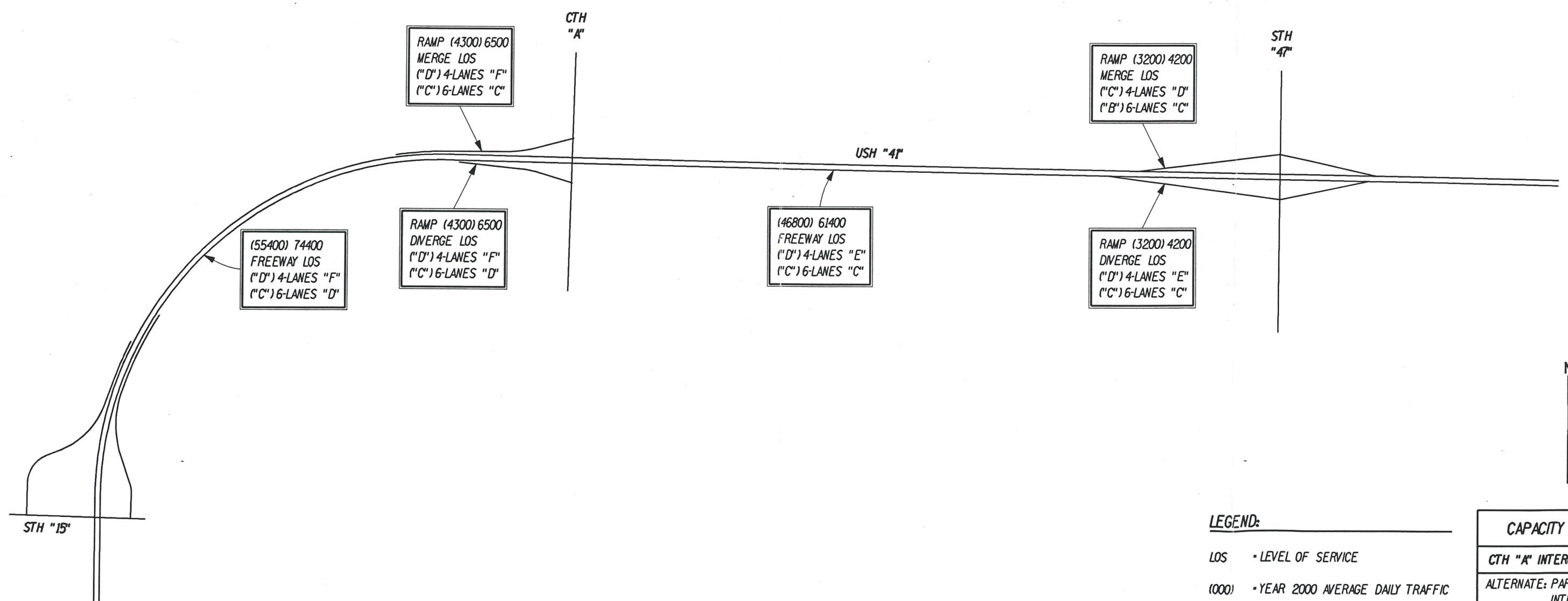
OMNI ASSOCIATES

FILE NAME: E1408A98/SHEETS /DISPLAY /NONE20XX.DGN TECH/ENGR: CRK/MAH PLOT DATE: 03/25/99 PLOT NAME: SEE FILE NAME PLOT SCALE: 1:

ORIGINATOR: OMNI ASSOCIATES ONE SYSTEMS DRIVE APPLETON, WI 54914-1654 REV. DATE: / /

LEVELS ON - 51, 53, 58, 59, 63

# Exhibit D-2




LEGEND:

| | |
|---|---|
| LOS | = LEVEL OF SERVICE |
| (000) | = YEAR 2000 AVERAGE DAILY TRAFFIC |
| 000 | = YEAR 2020 AVERAGE DAILY TRAFFIC |
| ("X") | = YEAR 2000 LOS |
| "X" | = YEAR 2020 LOS |

CAPACITY ANALYSIS

CTH "A" INTERCHANGE STUDY

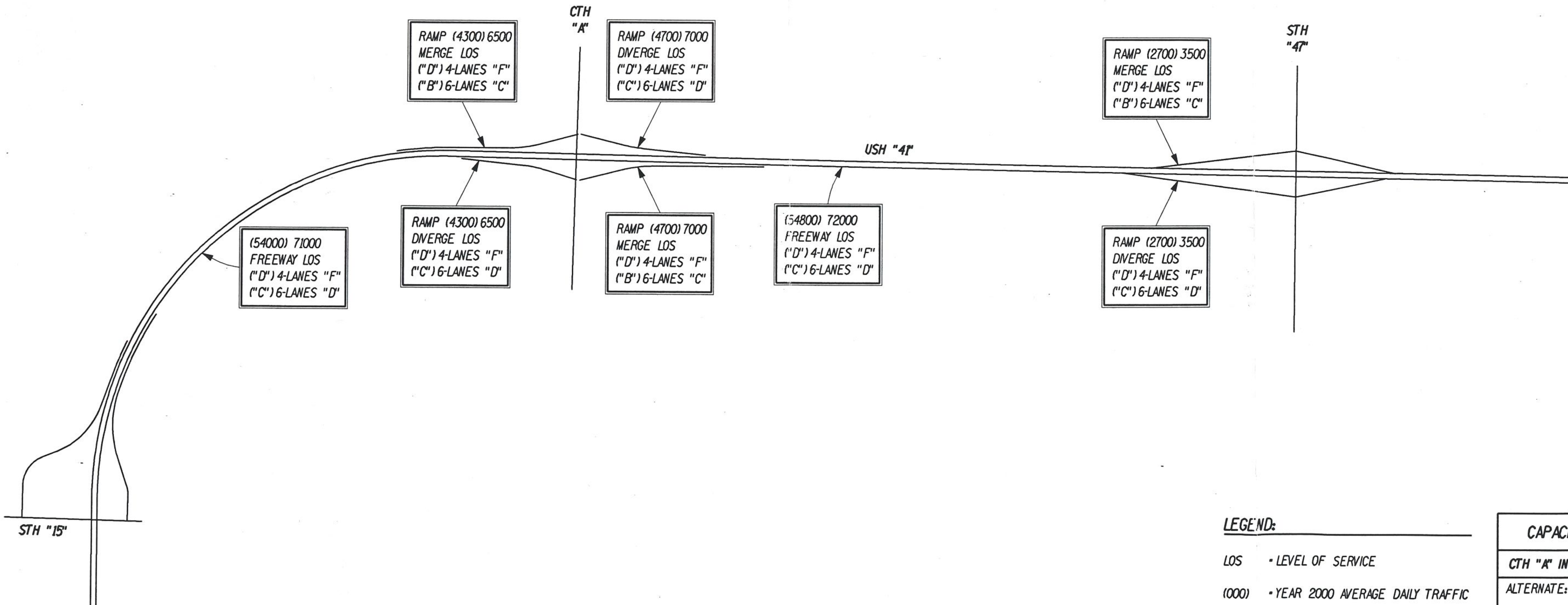
ALTERNATE: PARTIAL INTERCHANGE

PROJECT ID: 1123-09-00
CTH "A" / USH "41"
TOWN OF GRAND CHUTE
OUTAGAMIE COUNTY

OMNI ASSOCIATES

FILE NAME: E1408A98/SHEETS /DISPLAY /PART20XX.DGN TECH/ENGR: CRK/MAH PLOT DATE: 03/25/99 PLOT NAME: SEE FILE NAME PLOT SCALE: 1:
ORIGINATOR: OMNI ASSOCIATES ONE SYSTEMS DRIVE APPLETON, WI 54914-1654 REV. DATE: / /
LEVELS ON = 51, 53, 58, 59, 63

# Exhibit D-3




**LEGEND:**

LOS - LEVEL OF SERVICE

(000) - YEAR 2000 AVERAGE DAILY TRAFFIC

000 - YEAR 2020 AVERAGE DAILY TRAFFIC

("X") - YEAR 2000 LOS

"X" - YEAR 2020 LOS

CAPACITY ANALYSIS

CTH "A" INTERCHANGE STUDY

ALTERNATE: FULL INTERCHANGE

PROJECT ID: 1123-09-00
CTH "A" / USH "41"
TOWN OF GRAND CHUTE
OUTAGAMIE COUNTY

OMNI ASSOCIATES

FILE NAME: E1408A98/SHEETS /DISPLAY /FULL20XX.DGN TECH/ENGR: CRK/MAH PLOT DATE: 03/25/99 PLOT NAME: SEE FILE NAME PLOT SCALE: 1:
ORIGINATOR: OMNI ASSOCIATES ONE SYSTEMS DRIVE APPLETON, WI 54914-1654 REV. DATE: / / 50,51,52,53, 58,59, 63
LEVELS ON -

**PROJECT ID: 62**
**ROUTE: STH 47**
**LOCATION: USI**
**2002, 2012 & 2022**

# Exhibit E-2

## Truck Classification/Design Parameters

### Truck Classification

| Truck Type | %AADT |
|---|---|
| 2D | 2.6 |
| 3AXSU+ | 1.9 |
| 2S1+2S2 | 1.3 |
| 3S2+ | 1.2 |
| DBL BTM | 0.2 |
| TOTAL | 7.2 |

### Design Parameters

| Factor | %AADT |
|---|---|
| P(K1) | 11.9 |
| K30 | 10.6 |
| K50 | 10.4 |
| K100 | 9.9 |
| T(DHV) | 5.8 |
| T(PHV) | 5.4 |
| D | 55/45 |

The following major assumptions are reflected in the 2002, 2012 & 2022 AADT Forecast for the USH 41-CTH OO segment of Project ID: 6240-05-00:

1. The forecast volumes are based on an analysis of historic traffic volumes and the 2020 travel demand model for the Fox Cities area. Year 2020 Socio-Economic forecasts developed by the ECWRPC for the Fox Cities Area Long Range Transportation Plan adopted in July, 1997 are incorporated into the travel model. This land use plan reflects major residential development along the STH 47 corridor between CTH JJ and Evergreen Drive North of the project area. Continued moderate expansion of residential development is identified for the Richmond Street corridor South of USH 41 and the Capitol Drive corridor East and West of STH 47/Richmond Street.
2. The estimated turning movements are based on a review of previous turning movement projections at the Richmond-Capitol intersection (1988) and the 1994 and 2020 turning movements generated in the Fox Cities travel model.
3. Truck classification data was obtained from site ID 441157 - STH 47/Richmond North of CTH OO/Northland Av..
4. Design parameters are based on the functional classification of this segment of STH 47 as an urban principal arterial in Factor Group 2.

WisDOT Traffic Forecasts & Analysis Section
Robert Pike April 28,1998

**PROJECT ID: 11**
**ROUTE: CTH A**
**LOCATION: USl**
**2000, & 2020 AADT FORECAST**

# Exhibit E-3

**Truck Classification/Design Parameters**

## ALTERNATIVE 1: NO BUILD

**Truck Classification**

| Truck Type | %AADT |
|---|---|
| 2D | 3.2 |
| 3AXSU+ | 3.5 |
| 2S1+2S2 | 1.9 |
| 3S2+ | 0.8 |
| DBL BTM | 0.2 |
| TOTAL | 9.6 |

**Design Parameters**

| Factor | %AADT |
|---|---|
| P(K1) | 13.1 |
| K30 | 11.2 |
| K50 | 11.0 |
| K100 | 10.4 |
| T(DHV) | 7.7 |
| T(PHV) | 5.8 |
| D | 55/45 |

## ALTERNATIVE 2: FULL INTERCHANGE

**Truck Classification**

| Truck Type | %AADT |
|---|---|
| 2D | 3.2 |
| 3AXSU+ | 3.5 |
| 2S1+2S2 | 4.2 |
| 3S2+ | 1.4 |
| DBL BTM | 0.2 |
| TOTAL | 12.5 |

**Design Parameters**

| Factor | %AADT |
|---|---|
| P(K1) | 12.1 |
| K30 | 10.7 |
| K50 | 10.5 |
| K100 | 10.0 |
| T(DHV) | 10.0 |
| T(PHV) | 7.5 |
| D | 55/45 |

## ALTERNATIVE 3: ½ HALF SOUTH INTERCHANGE

**Truck Classification**

| Truck Type | %AADT |
|---|---|
| 2D | 3.2 |
| 3AXSU+ | 3.5 |
| 2S1+2S2 | 3.1 |
| 3S2+ | 1.1 |
| DBL BTM | 0.2 |
| TOTAL | 11.1 |

**Design Parameters**

| Factor | %AADT |
|---|---|
| P(K1) | 12.4 |
| K30 | 10.9 |
| K50 | 10.6 |
| K100 | 10.1 |
| T(DHV) | 8.9 |
| T(PHV) | 6.7 |
| D | 55/45 |

The following major assumptions are reflected in the Truck Classification and Design Parameters for Project ID: 1123-09-00:

1. Truck classification data is based-on Vehicle Classification data collected in 1996 on CTH A North of Capitol Dr. (Site ID: 441216) and in 1993 on CTH A North of CTH JJ (Site ID: 440073). Alternative 1: No Build is based on the site North of Capitol Dr. With the changes in access to USH 41 under Alternatives 2 & 3, the truck classification data is adjusted based on the site North of CTH JJ. This reflects the basic assumption that under the existing no access conditions at USH 41-CTH A, significant numbers of trucks on CTH A North of CTH JJ are using a CTH A to CTH JJ to STH 47 route to access USH 41. Alternatives 2 & 3 provide different levels of access at USH 41-CTH A.
2. Design parameters are a composite of Factor Group 2, Urban Other and Factor Group 4, Rural Other values reflecting the existing rural character evolving to a more urban character over the forecast period.

WisDOT Traffic Forecasts & Analysis Section
Robert Pike Dec 16,1998

# Exhibit F-1



| *Level of Se*... | |
|---|---|
| A | 0–10.0 |
| B | 10.1–16.0 |
| C | 16.1–24.0 |
| D | 24.1–32.0 |
| E | 32.1–45.0 |
| F | > 45.0 |

For any given level of service, the maximum allowable density is somewhat lower than that for the corresponding level of service on multilane highways. This reflects the higher service quality drivers expect when using freeways as compared with surface multilane facilities. This *does not* imply that under similar conditions an at-grade multilane highway will perform better than a freeway with the same number of lanes. For any given density, a freeway will carry higher flow rates at higher speeds than will a comparable multilane highway.

Although the specification of maximum densities for LOS A through D is based on the collective professional judgment of the members of the Committee on Highway Capacity and Quality of Service, the upper value shown for LOS E (45 pc/mi/ln) is not. That value is the density at which capacity occurs for different free-flow speeds; it is the maximum density at which sustained flows at capacity are expected to occur.

LOS criteria for basic freeway sections are provided in Table 3-1 for free-flow speeds of 75, 70, 65, 60, and 55 mph. To be within a given level of service, the *density* criterion must be met. In effect, under ideal conditions, these are the speeds and flow rates *expected* to occur at the designated densities. Local variations in driving behavior, however, may cause some variance from these expectations.

It should be noted that the LOS F operations observed within a queue are the result of a breakdown or bottleneck at a downstream point. LOS F is also used to describe conditions at the upstream point of the breakdown or bottleneck as well as the operations within the queue that forms behind it.

Failure, breakdown, congestion, and LOS F occur when queues begin to form on the freeway. Density tends to increase sharply within the queue and may be expected to be considerably higher than the maximum value of 45 pc/mi/ln for LOS E.

Figure 3-4 shows the relationship among speed, flow, and density for basic freeway sections. It also shows the definition of the various levels of service using density boundary values.

Operational characteristics for the six levels of service are shown in Illustrations 3-5 through 3-10. The levels of service were defined to represent reasonable ranges in the three critical flow variables: speed, density, and flow rate.

*LOS A* describes free-flow operations. Free-flow speeds prevail. Vehicles are almost completely unimpeded in their ability to maneuver within the traffic stream. Even at the maximum density for LOS A, the average spacing between vehicles is about 530 ft, or 26 car lengths, which affords the motorist a high level of physical and psychological comfort. The effects of incidents or point breakdowns are easily absorbed at this level.

*LOS B* represents reasonably free flow, and free-flow speeds are maintained. The lowest average spacing between vehicles is about 330 ft, or 17 car lengths. The ability to maneuver within the traffic stream is only slightly restricted, and the general level of physical and psychological comfort provided to drivers is still high. The effects of minor incidents and point breakdowns are still easily absorbed.

*LOS C* provides for flow with speeds at or near the free-flow speed of the freeway. Freedom to maneuver within the traffic stream is noticeably restricted at LOS C, and lane changes require more care and vigilance on the part of the driver. Minimum average spacings are in the range of 220 ft, or 11 car lengths. Minor incidents may still be absorbed, but the local deterioration in service will be substantial. Queues may be expected to form behind any significant blockage.

*LOS D* is the level at which speeds begin to decline slightly with increasing flows. In this range, density begins to increase somewhat more quickly with increasing flow. Freedom to maneuver within the traffic stream is more noticeably limited, and the

# Exhibit F-2



TABLE

| Level of Service | Maximum Density (pc/mi/ln) | Minimum Speed (mph) | Maximum Service Flow Rate (pcphpl) | Maximum v/c Ratio |
|---|---|---|---|---|
| | | Free-Flow Speed = 75 mph | | |
| A | 10.0 | 75.0 | 750 | 0.31 |
| B | 16.0 | 75.0 | 1,200 | 0.50 |
| C | 24.0 | 71.0 | 1,704 | 0.71 |
| D | 32.0 | 65.0 | 2,080 | 0.87 |
| E | 45.0 | 53.0 | 2,400 | 1.00 |
| F | >45.0 | <53.0 | <2,400 | <1.00 |
| | | Free-Flow Speed = 70 mph | | |
| A | 10.0 | 70.0 | 700 | 0.29 |
| B | 16.0 | 70.0 | 1,120 | 0.47 |
| C | 24.0 | 68.0 | 1,632 | 0.68 |
| D | 32.0 | 64.0 | 2,048 | 0.85 |
| E | 45.0 | 53.0 | 2,400 | 1.00 |
| F | var | var | var | var |
| | | Free-Flow Speed = 65 mph | | |
| A | 10.0 | 65.0 | 650 | 0.28 |
| B | 16.0 | 65.0 | 1,040 | 0.44 |
| C | 24.0 | 64.5 | 1,548 | 0.66 |
| D | 32.0 | 62.0 | 1,984 | 0.84 |
| E | 45.0 | 52.0 | 2,350 | 1.00 |
| F | var | var | var | var |
| | | Free-Flow Speed = 60 mph | | |
| A | 10.0 | 60.0 | 600 | 0.26 |
| B | 16.0 | 60.0 | 960 | 0.42 |
| C | 24.0 | 60.0 | 1,440 | 0.63 |
| D | 32.0 | 58.0 | 1,856 | 0.81 |
| E | 45.0 | 51.0 | 2,300 | 1.00 |
| F | var | var | var | var |
| | | Free-Flow Speed = 55 mph | | |
| A | 10.0 | 55.0 | 550 | 0.24 |
| B | 16.0 | 55.0 | 880 | 0.39 |
| C | 24.0 | 55.0 | 1,320 | 0.59 |
| D | 32.0 | 54.5 | 1,744 | 0.78 |
| E | 45.0 | 50.0 | 2,250 | 1.00 |
| F | var | var | var | var |

capacity, and downstream operations improve (assuming that there are no additional downstream bottlenecks) as discharging vehicles move away from the bottleneck.

It should be noted that LOS F operations within a queue are the result of a breakdown or bottleneck at a downstream point. LOS F is also used to describe both conditions at the point of the breakdown or bottleneck and the operations within the queue that forms upstream.

Whenever LOS F conditions exist, there is the potential for these conditions to extend upstream for significant distances. A prerequisite for valid analyses using these procedures is the assumption that the section under consideration is free from downstream effects that promulgate upstream. In such cases, upstream operations will reflect the effect of the downstream bottleneck and will not be as indicated by the procedures of this chapter.

| FREEWAY FREE-FLOW SPEED (MPH) | MAXIMUM UPSTREAM ($V_F$) OR DOWNSTREAM ($V_{FO}$) FREEWAY FLOW (PCPH) BY NO. OF LANES IN ONE DIRECTION | | | | MAX FLOW ENTERING MERGE INFLUENCE AREA ($V_{R12}$) (PCPH) | MAX FLOW ENTERING DIVERGE INFLUENCE AREA ($V_{12}$) (PCPH) |
|---|---|---|---|---|---|---|
| | 2 | 3 | 4 | >4 | | |
| 70 | 4,800 | 7,200 | 9,600 | 2,400/ln | 4,600 | 4,400 |
| 65 | 4,700 | 7,050 | 9,400 | 2,350/ln | 4,600 | 4,400 |
| 60 | 4,600 | 6,900 | 9,200 | 2,300/ln | 4,600 | 4,400 |
| 55 | 4,500 | 6,750 | 9,000 | 2,250/ln | 4,600 | 4,400 |

NOTE: For capacity of ramp roadways, see Table 5-6.

It is possible, however, to experience congestion in the merge influence area even if the capacity of the downstream freeway segment is adequate. Studies (2) have shown that there is a practical maximum flow that may enter the merge influence area and still maintain stable operations. In a ramp merge junction, both the flow in Lanes 1 and 2 and the flow in the on-ramp enter the merge influence area. Thus,

$$V_{R12} = V_R + V_{12}$$

Table 5-1 shows capacity values for the downstream freeway flow ($V_{FO}$) and the merge influence area ($V_{R12}$). If the demand expected at either point exceeds the capacity values shown, failure, or LOS F, is expected to exist. When this is the case, the analysis ends, and solutions are sought to alleviate the problem. Where stable operations are expected (i.e., demand does not exceed capacity at either point), the next step of the analysis—estimation of density in the merge influence area—is implemented to find the level of service.

### Diverge Areas

Three capacity values should be checked in a diverge area: (*a*) the total flow that may leave the diverge area, (*b*) the maximum flow that may enter Lanes 1 and 2 immediately before the deceleration lane, and (*c*) the capacity of each of the exiting legs of the freeway.

The total flow that can leave the diverge area is generally limited by the capacity of the freeway lanes approaching the diverge junction. In all appropriate diverge designs, the number of lanes leaving the diverge area is either equal to or one greater than the number entering. This departing flow is designated $V_{FO}$.

The flow entering Lanes 1 and 2 just upstream of the deceleration lane is simply the flow in Lanes 1 and 2 ($V_{12}$). This flow *includes* the off-ramp flow. Table 5-1 gives capacity values for the first two capacity checks.

The third limit is most important because it is the primary reason for failure of diverge areas. Failure at a diverge is most often related to the capacity of one of the exit legs, usually the ramp. The capacity of each exit leg must be checked against the expected demand. For a downstream freeway leg (at a major diverge area there may be two), capacity values may be drawn from Table 5-1 for the appropriate number of freeway lanes. The capacity of ramp roadways is discussed later in the chapter.

The failure of any of these capacity checks, that is, an expected demand that exceeds the capacities given, indicates that the merge area will fail. In such cases, breakdown and formation of queues are expected to occur. Where an off-ramp terminates at an at-grade intersection (either signalized or unsignalized), the capacity of the ramp-street junction should also be checked using the procedures for signalized intersections (Chapter 9) or those for unsignalized intersections (Chapter 10) to ensure that queues will not form and spread upstream on the ramp, affecting traffic operations on the diverge area.

## LEVEL-OF-SERVICE CRITERIA

LOS A through E for ramp-freeway terminals are based on the density in the influence area of the ramp and the expectation that no breakdown will occur. LOS F signifies that a breakdown condition exists or is expected to exist. LOS F occurs whenever demand exceeds the limits indicated in Table 5-1. When none of these limits is exceeded, no breakdown is expected, and the level of service is based on density, as indicated in Table 5-2. Table 5-2 also gives average speed of vehicles in the ramp influence area as a secondary LOS parameter. This is particularly useful in comparing these criteria with field data, since density is rarely measured directly.

The density values shown for LOS A through E assume stable, nonbreakdown operations. Studies (2) have shown that there is an overlap in the density range such that some breakdown operations may actually have lower densities than those achieved under stable operation. This is due to the wavelike movement of vehicles in a queue and the rather short length of the defined ramp influence area. The model first calls for determination of whether LOS F exists using the maximum flow levels of Table 5-1. Then density is estimated and the level of service assigned if flow is stable.

Except for LOS A, each of the density boundaries is higher than that of a similar basic freeway section (Chapter 3). This is because (*a*) drivers expect increased turbulence and greater proximity of other vehicles in a merge or diverge area and (*b*) drivers are generally traveling at somewhat lower speeds at any given per-lane flow rate in the merge or diverge area than on open freeway.

TABLE 5-2. LEVEL-OF-SERVICE CRITERIA FOR RAMP-FREEWAY JUNCTION AREAS OF INFLUENCE

| LEVEL OF SERVICE | MAXIMUM DENSITY (PRIMARY MEASURE) (PC/MI/LN) | MINIMUM SPEED (SECONDARY MEASURE) (MPH) |
|---|---|---|
| A | 10 | 58 |
| B | 20 | 56 |
| C | 28 | 52 |
| D | 35 | 46 |
| E | >35 | 42 |
| F | [a] | [a] |

[a] Demand flows exceed limits of Table 5-1.

# Exhibit H-1

Chapter 9, Signalized Intersections, or Chapter 10, Unsignalized Intersections, should be applied.

### RAMP COMPONENTS

A ramp may consist of up to three geometric elements of interest:

1. The ramp-freeway junction,
2. The ramp roadway, and
3. The ramp-street junction.

A ramp-freeway junction is generally designed to permit high-speed merging or diverging to take place with a minimum of disruption to the adjacent freeway traffic stream. The geometric characteristics of ramp-freeway junctions vary. Elements such as the length and type (taper, parallel) of acceleration or deceleration lane, free-flow speed of the ramp in the immediate vicinity of the junction, and sight distances may all influence ramp operations. The procedures in this chapter are primarily applicable to high-type designs. Nevertheless, some of the models used account explicitly for the effect of acceleration or deceleration lane length and the free-flow speed of the ramp and can therefore be applied to a range of geometric designs, including some that might be considered substandard. Geometric design standards for ramps and ramp junctions are given by AASHTO (*1*).

Geometric characteristics of ramp roadways also vary from location to location. Ramps may vary in terms of number of lanes (usually one or two), design speed, grade, and horizontal curvature. The design of a ramp roadway is seldom a source of operational difficulty unless a traffic incident causes disruption along its length. Ramp-street terminal problems can cause queueing along the length of a ramp, but this queueing is generally not related to the design of the ramp roadway.

Freeway-to-freeway ramps have two ramp-freeway terminals and do not have a ramp-street terminal. Many ramps, however, connect limited-access facilities to local arterials and collectors. For such ramps, the ramp-street terminal is often a critical element in the overall design. Ramp-street junctions can permit uncontrolled merging and diverging movements or take the form of an at-grade intersection.

Procedures in this chapter allow for the identification of likely breakdowns at ramp-freeway terminals [Level-of-Service (LOS) F] and for the analysis of operations at ramp-freeway junctions and on ramp roadways at LOS A through E. For analysis of ramp-street junctions involving an at-grade intersection, consult Chapter 9, Signalized Intersections, or Chapter 10, Unsignalized Intersections.

Sections addressing special applications, including metered ramps, ramps on five-lane (one-direction) freeway sections, two-lane ramps, major merge areas, and major diverge areas, are contained in this chapter.

### OPERATIONAL CHARACTERISTICS

A ramp-freeway junction is an area of competing traffic demands for space. Upstream freeway traffic competes for space with entering on-ramp vehicles in merge areas. On-ramp demand is usually generated locally, although arterials and collectors may bring some drivers to the ramp from more distant origins. The ups... posite of upstream trip generation patterns from a variety of sources.

In the merge area, individual on-ramp vehicles attempt to find gaps in the traffic stream of the adjacent freeway lane. Since most ramps are on the right side of the freeway, the freeway lane in which on-ramp vehicles seek gaps is the shoulder lane, designated herein as Lane 1. In this chapter, lanes are numbered 1 to *N* from the shoulder to the median.

The action of individual merging vehicles entering the Lane 1 traffic stream creates turbulence in the traffic stream in the vicinity of the ramp. Approaching freeway vehicles move toward the left to avoid this turbulence. Recent studies (*2*) have shown that the operational effect of merging vehicles is heaviest in freeway Lanes 1 and 2 and the acceleration lane for a distance extending from the physical merge point to 1,500 ft downstream. Figure 5-1 shows the "influence area" for on-ramp junctions. Models presented in this chapter focus on operational characteristics within this defined influence area.

Interactions are dynamic. Approaching freeway vehicles will move left as long as there is capacity to do so. Whereas the intensity of ramp flow generally influences the behavior of freeway vehicles, general freeway congestion can also limit ramp flow, causing diversion to other interchanges or routes.

At off-ramps the basic maneuver is a diverge, that is, a single traffic stream separating into two separate streams. Exiting vehicles *must* occupy the lane adjacent to the off-ramp, Lane 1 for a right-hand off-ramp. Thus, as the off-ramp is approached, exiting vehicles move right. This movement brings about a redistribution of other freeway vehicles, which move left to avoid the turbulence of the immediate diverge area. Again, recent studies (*2*) show that the area of most intense turbulence is the deceleration lane plus Lanes 1 and 2 over 1,500 ft extending upstream from the physical diverge point (Figure 5-1).

Procedures in this chapter treat both ramp and freeway flow rates as inputs to an operational analysis of the merge or diverge influence area. Thus, design and planning applications become trial-and-error computations using the operational analysis techniques as specified. This procedure is logical, because the ramp is a point location on an overall facility for which flows are either known or specified.

The procedures in this chapter assume that the behavior of merging or diverging vehicles is unaffected by downstream or upstream constrictions or disruptions. Downstream problems, for example, can easily propagate upstream through a merge or diverge area. In such cases operations reflect the characteristics of the downstream

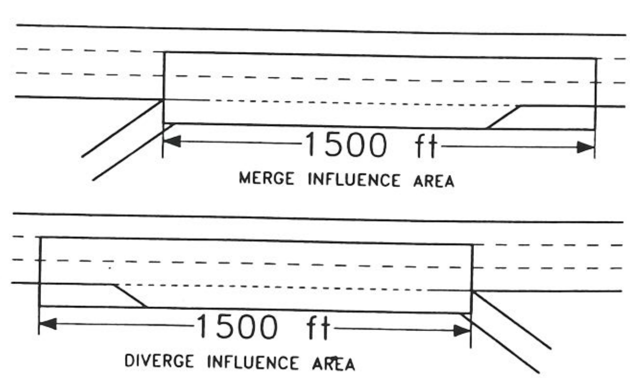
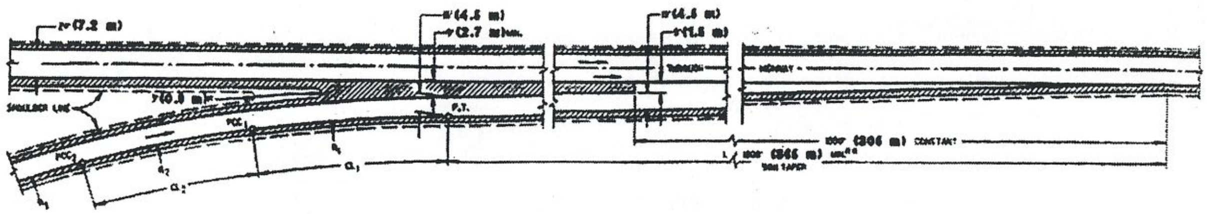



*Figure 5-1. On- and off-ramp influence areas.*

# Exhibit H-2



SINGLE LANE ENTRANCE TERMINAL

LEGEND

PAVED SHOULDER.

$R_3$ - RADIUS OF THE MAJOR INTERNAL SEGMENT OF A LOOP.

| Ramp Design Speed $PCC_2$ | | Radius | | | Curve Length | |
|---|---|---|---|---|---|---|
| (mph) | (km/h) | $R_3$ | $R_2$ | $R_1$ | $CL_2$ | $CL_1$ |
| 55 | 90 | TANGENT ALIGNMENT | | [redacted] | | MIN.200 (60 m) |
| 50 | 80 | | | [redacted] | | MIN.200 (60 m) |
| 45 | 70 | [redacted] | | [redacted] | | 150' (45 m) |
| 40 | 60 | [redacted] | | [redacted] | | 150' (45 m) |
| 35 | 60 | [redacted] | [redacted] | [redacted] | 150 (45 m) | 150' (45 m) |
| 30 | 50 | [redacted] | [redacted] | [redacted] | 150 (45 m) | 150' (45 m) |
| | | [redacted] | * Minimum Desirable | | | |

Minimum Shoulder Treatments

Mainline

Left - 6'(1.8 m) total / 3'(0.9 m) paved [4'(1.2 m) for interstate]

Right - 10'(3.0 m) total / 8'(2.4 m) paved

Ramps

Left - 4'(1.2 m) total / 3'(0.9 m) paved

Right - 8'(2.4 m) total / 5'(1.5 m) paved

NOTES:

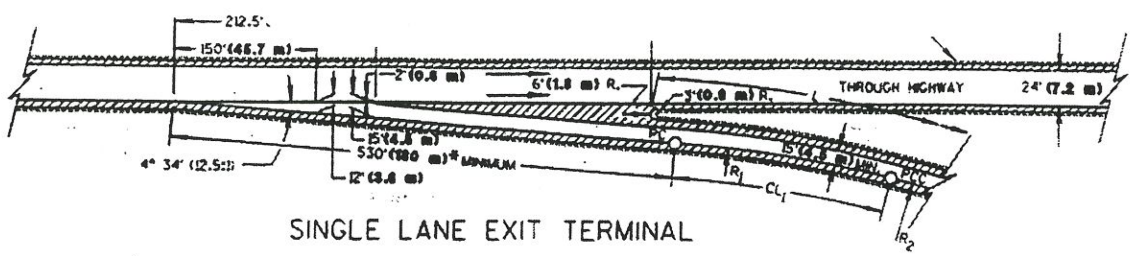
Ramp design speeds at $PCC_2$ are based on governing radii $R_3$ or $R_1$. Assuming SE = [redacted] refer to Table III-6, page 154, GDHS.

Minimum acceleration lane, taper length (L), based on Table X-4, page 986, GDHS.

For acceleration lanes having grades in excess of ±2% refer to Table X-5, page 990, GDHS, for length adjustment.

**When design speed at $PCC_2$ is 40 MPH (60 km/h) or less, adjust acceleration length (L) as follows: 1250' (380 m) (40 MPH) (60 km/h), 1300' (395 m) (35 MPH) (60 km/h), and 1400' (425 m) (30 MPH) (50 km/h).

Ramp geometrics are adequate for mainline design speeds through 65 MPH. (110 km/h).




SINGLE LANE EXIT TERMINAL

| Ramp Design Speed PC | Radius $R_1$ | Radius $R_2$ | Ramp Design Speed PCC | Curve Length $CL_1$ |
|---|---|---|---|---|
| 55 mph (90 km/h) | Tangent Alignment | | | |
| 50 mph (80 km/h) | [redacted] | [redacted] | 40 mph (60 km/h) | 150' (50 m) |
| 45 mph (70 km/h) | [redacted] | [redacted] | 35 mph (60 km/h) | 150' (50 m) |
| 40 mph (60 km/h) | [redacted] | [redacted] | 30 mph (50 km/h) | 150' (50 m) |

L = 900' (280 m)

LEGEND

(hatched box) Paved Shoulder

L — Minimum ramp distance from gore to the intersection of the ramp with the crossroad.

$R_2$ — Radius of the major internal segment of the loop.

NOTES:

The length of the deceleration lane is based on ramp grades of 0 to 2%. Refer to table X-6, page 991, GDHS, for length adjustment factors to be used when ramp grades exceed ± 2%.

If the ramp speed and radii relationships listed in the table cannot be attained due to area R/W restrictions, consideration should be given to collector-distributor roads. This permits further speed reductions before entering the ramp loop.

The radii of the horizontal curves are rounded and based on a maximum superelevation rate of [redacted] and the speeds shown.

Ramp geometrics are adequate for mainline design speeds through 65 MPH.

* This metric length is based on a mainline design speed of 68 MPH (110 km/h) and a minimum ramp design speed at PC of 37 mph (60 km/h)

Minimum Shoulder Treatments

Mainline

- Left - 6'(1.8 m) total / 3'(0.9m) paved [4'(1.2 m) for interstate]
- Right- 10'(3.0 m) total / 8'(2.4 m) paved

Ramps

- Left - 4'(1.2 m) total / 3'(0.9 m) paved
- Right - 8'(2.4 m) total / 5'(1.5 m) paved

**PROJECT ID: 1123-09-00**
**ROUTE: CTH A**
**LOCATION: USH 41-CTH A INT**
**2000, & 2020 AADT FORECAST**

# Exhibit E-1

**Truck Classification/Design Parameters for USH 41 Between STH 47 and the Proposed CTH A Interchanges**

## ALTERNATIVE 1: NO BUILD

| Truck Type | %AADT | Factor | %AADT |
|---|---|---|---|
| 2D | 3.7 | P(K1) | 13.6 |
| 3AXSU+ | 1.7 | K30 | 11.1 |
| 2S1+2S2 | 0.7 | K50 | 10.8 |
| 3S2+ | 6.7 | K100 | 10.2 |
| DBL BTM | 0.2 | T(DHV) | 10.5 |
| TOTAL | 13.0 | T(PHV) | 7.9 |
| | | D | 55/45 |

(Truck Classification: Truck Type, %AADT; Design Parameters: Factor, %AADT)

## ALTERNATIVE 2: FULL INTERCHANGE

| Truck Type | %AADT | Factor | %AADT |
|---|---|---|---|
| 2D | 3.7 | P(K1) | 13.4 |
| 3AXSU+ | 1.7 | K30 | 10.9 |
| 2S1+2S2 | 1.0 | K50 | 10.6 |
| 3S2+ | 6.8 | K100 | 10.0 |
| DBL BTM | 0.2 | T(DHV) | 10.7 |
| TOTAL | 13.4 | T(PHV) | 8.1 |
| | | D | 55/45 |

(Truck Classification: Truck Type, %AADT; Design Parameters: Factor, %AADT)

## ALTERNATIVE 3: ½ HALF SOUTH INTERCHANGE

| Truck Type | %AADT | Factor | %AADT |
|---|---|---|---|
| 2D | 3.7 | P(K1) | 13.6 |
| 3AXSU+ | 1.7 | K30 | 11.1 |
| 2S1+2S2 | 0.7 | K50 | 10.8 |
| 3S2+ | 6.7 | K100 | 10.2 |
| DBL BTM | 0.2 | T(DHV) | 10.5 |
| TOTAL | 13.0 | T(PHV) | 7.9 |
| | | D | 55/45 |

(Truck Classification: Truck Type, %AADT; Design Parameters: Factor, %AADT)

The following major assumptions are reflected in the USH 41Truck Classification and Design Parameters for Project ID: 1123-09-00:

1. Truck classification data is based on Vehicle Classification data collected in 1996 on USH 41 North of USH 10/Wisconsin Av. (Site ID: 440165/WIM Site 14C06). With the changes in access to USH 41 under Alternatives 2 & 3, the truck classification data is adjusted based on the site North of USH 10. This reflects the basic assumption that under the existing no access conditions at USH 41-CTH A, significant numbers of trucks on CTH A North of CTH JJ are using a CTH A to CTH JJ to STH 47 route to access USH 41. Alternatives 2 & 3 provide different levels of access at USH 41-CTH A.
2. Design parameters are based on ATR STA. 5-0001, 1.5 Mi. N. of Outagamie-Brown Co. line as well as Factor Group 1- Urban Interstate values.

WisDOT Traffic Forecasts & Analysis Section
Robert Pike Feb 14, 1999

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