

Super-Sized Synchro Network

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ABSTRACT

This paper focuses on the approach, lessons learned, and key issues related to the development of a large-scale traffic analysis network using the Synchro modeling software package developed by Trafficware Corporation (Ltd). The model was prepared for the Alaskan Way Viaduct and Seawall Replacement Project to investigate how construction closures of the Alaskan Way Viaduct may affect traffic on parallel routes and to assess strategies for minimizing traffic-related impacts.

The Alaskan Way Viaduct (Washington State Route 99) is a limited-access highway that carries up to 110,000 vehicles daily through downtown Seattle. The viaduct and adjacent seawall are aging and in need of near-term replacement. Alternatives for replacing these facilities would require partial to full closure of the highway during construction, displacing trips to parallel routes and other modes of travel.

To answer questions about what can be done to maintain traffic and transit operations on the adjacent local street system during construction, the project team developed a Synchro network of notable size (more than 400 intersections) to test traffic management strategies that could have the potential to effectively manage congestion, improve throughput, and help maintain transit reliability during construction. The process of developing the Synchro network and applying it to test a varied array of traffic management strategies is discussed in this paper. Additionally, the authors discuss the complexities of developing and maintaining such a large analysis network in the context of developing a plan for construction-related traffic management.

INTRODUCTION

The Alaskan Way Viaduct (AWV), or Washington State Route (SR) 99, is a limited-access highway that carries up to 110,000 vehicles per day through downtown Seattle. The viaduct and adjacent seawall are aging and are considered seismically vulnerable. Three agencies—the Washington State Department of Transportation (WSDOT), the City of Seattle, and the Federal Highway Administration (FHWA)—are leading an integrated team of agency and consultant staff to study replacement options for these facilities.

Alternatives for replacing the viaduct would require partial to full closure of the highway during construction, displacing trips to alternate routes and modes. To address potential construction impacts related to traffic capacity, circulation, and congestion, a large-scale traffic analysis model was developed to gauge traffic operating conditions on parallel arterial routes, identify the locations of capacity or operational deficiencies, and test a varied array of traffic management strategies. This paper discusses the development process for this model and highlights specific complexities related to building and maintaining such a large analysis network.

Analysis Purpose and Requirements

In 2006, the project team studied travel impacts associated with future construction activity and worked toward the development of a multimodal transportation management plan for the construction period. Because the different construction approaches under consideration would all involve significant displacement of traffic from SR 99, concerns were raised as to the potential impacts to other highways, local streets, and transit services. To answer questions about what can be done to maintain traffic and transit operations on the local street system during construction, the project team developed a Synchro

network of notable size (over 400 intersections) that encompassed the entire greater downtown Seattle and “South of Downtown” (SODO) areas. Development of such a broad network was deemed necessary because the construction is anticipated to cause far-reaching travel disruptions.

The specific required uses of the Synchro network were to:

- Gauge traffic conditions on parallel and nearby arterials and local streets, including the downtown Seattle street grid.
- Identify the specific locations and nature of capacity or operational deficiencies affecting general-purpose, freight, and transit vehicles.
- Test traffic management strategies that may help manage congestion, improve throughput, and help maintain transit reliability during construction.
- Compare the potential effectiveness of traffic management strategies by corridor (e.g., specific arterial) and type of users (e.g., general-purpose traffic, transit, freight).

Suitability of the Software Tool

The project team used several different analysis tools, of which Synchro was one. Synchro was specifically selected to gauge arterial traffic operations for an expanded study area for a number of reasons:

- Travel demand models do not provide sufficiently precise measures of operating conditions for the immediate study area, and they would have limited utility in identifying localized constraints or testing many of the operational mitigation strategies. The project’s travel demand model (EMME/2 platform) was instead used to develop travel forecasts and assess aggregated areawide measures.
- Developing a microsimulation model for such a large-scale network would have been problematic. Network development would have been time- and cost-prohibitive, and calibration may not have been achievable on such a large scale. Simulation modeling (CORSIM and VISSIM) was instead deemed better suited for more linear, corridor-specific applications.
- Synchro is well-suited for analyzing arterial street networks, with easily adjustable geometric inputs and robust signal timing/optimization capabilities. This allowed testing of alternate configurations and signal timing plans.
- Synchro is widely used in the region, allowing the project team to build off of existing assets. For example, the City of Seattle’s Traffic Management Center relies on Synchro for assessing and pursuing potential signal timing plan changes.
- Synchro’s graphic interface and data import/export capabilities were invaluable in managing such a large network with vast amounts of data. The model is also relatively user-friendly, allowing for efficient and effective application of network changes and data reporting.

SYNCHRO ANALYSIS APPROACH

The Synchro networks were developed using Trafficware's Synchro Version 5 (Build 323), in part because prior work prepared for the Draft Environmental Impact Statement (DEIS) used that version of Synchro. Additionally, some stakeholders were more comfortable with the results of this legacy version of the software (rather than more recent versions) because of their familiarity with and confidence in the calculation methods employed.

The sister program of Synchro, SimTraffic, which has traffic simulation capabilities, was primarily used to help check that inputs were coded correctly (e.g., lane geometries, signal phasing). In addition, Synchro's ability to import/export data was used with Microsoft Excel to allow automated mapping of data.

The team developed the Synchro networks by defining the study area and collaborating with multiple interested parties. The discussion that follows provides more detail on the approach to developing the networks and the results of the work.

Study Area

The study area consists of over 400 intersections from the street network extending from north of downtown Seattle in the Lake Union area to the south city limits (see Figure 1). The study area was identified using a screening process that considered the project limits, potential alternate travel routes, existing transit service, and freight operations. As a result, many strings or groupings of intersections that formed arterial segments were selected for analysis.

The SR 99 project limits extend from Roy Street in the north to the West Seattle Freeway/Spokane Street Viaduct in the south. These limits are shown on Figure 2. The arterial street grid and I-5 corridor provide potential alternate travel routes parallel to SR 99. The street grid paralleling SR 99 offers north-south arterials onto which traffic may shift during construction. The grid would also accommodate changes in east-west traffic patterns as more vehicles access I-5 instead of SR 99 during the construction period. Given these anticipated shifts, nearly the entire downtown street grid between the existing SR 99 facility and I-5 was included in the analysis network.

Within the study area, several transit operators provide daily service: King County Metro, Sound Transit, Community Transit, and Pierce Transit. Their routes were also used to screen and ultimately select corridors and study intersections of importance for detailed study. Similarly, major freight routes were also considered because of the importance of SR 99 as a freight haul corridor and the proximity of industrial land uses and Port of Seattle facilities south of downtown.

Collaboration with Public Agencies

The consultant team of PB and Parametrix worked as part of an integrated team with WSDOT and the Seattle Department of Transportation (SDOT) to develop the networks. Both agencies provided information from their databases of traffic counts, signal control data, and lane geometry data to aid the network development. Having an integrated team facilitated the flow of information needed for the Synchro network development.

The project team also initiated technical subcommittees consisting of staff from a broader range of agencies to help inform the model development process and evaluate analysis results. These stakeholders participated in the model development process by providing additional data; giving insight into transit, freight, and emergency responder operations; and reviewing analysis results. For example, King County

provided GIS and transit-related data, while the Port of Seattle and their consultants shared freight movement forecasts, routes, and information relating to typical operating procedures (e.g., time periods, priority rules). Participants in AWW transportation subcommittees included:

- The lead agencies – WSDOT, SDOT, and FHWA.
- Transit agencies – King County Metro, Sound Transit, Community Transit, Pierce Transit, and Washington State Ferries.
- The Port of Seattle.
- Emergency Services/First Responders – Seattle Police Department, Seattle Fire Department.
- The consultant team.

Analysis Scenarios

The team prepared Synchro networks for the weekday AM peak hour and weekday PM peak hour. The following scenarios were studied for those peak hours:

- Existing Year 2002 Conditions (for consistency with the DEIS)
- Future 2010 Baseline Conditions (included planned local improvements with funding)
- Future 2010 Closed Corridor (SR 99 completely closed) Unmitigated Conditions
- Future 2010 Closed Corridor Conditions with Tier 1 Management Strategies
- Future 2010 Closed Corridor Conditions with Tier 2 Management Strategies
- Future 2010 Closed Corridor Conditions with Tier 3 Management Strategies
- Future 2010 Closed Corridor Conditions with Draft Recommended Construction Transportation Management Plan

The Tier 1 management strategies represented those measures that were relatively inexpensive and easy to implement, while Tier 3 strategies included major capital improvements, and Tier 2 strategies were typically somewhere in between Tier 1 and Tier 3. Strategies reflected in the various tiers were evaluated and screened, and a draft recommended construction transportation management plan was prepared. The key elements of the transportation management plan were ultimately coded into the construction-period Synchro network.

Figure 1. Study Area Intersections

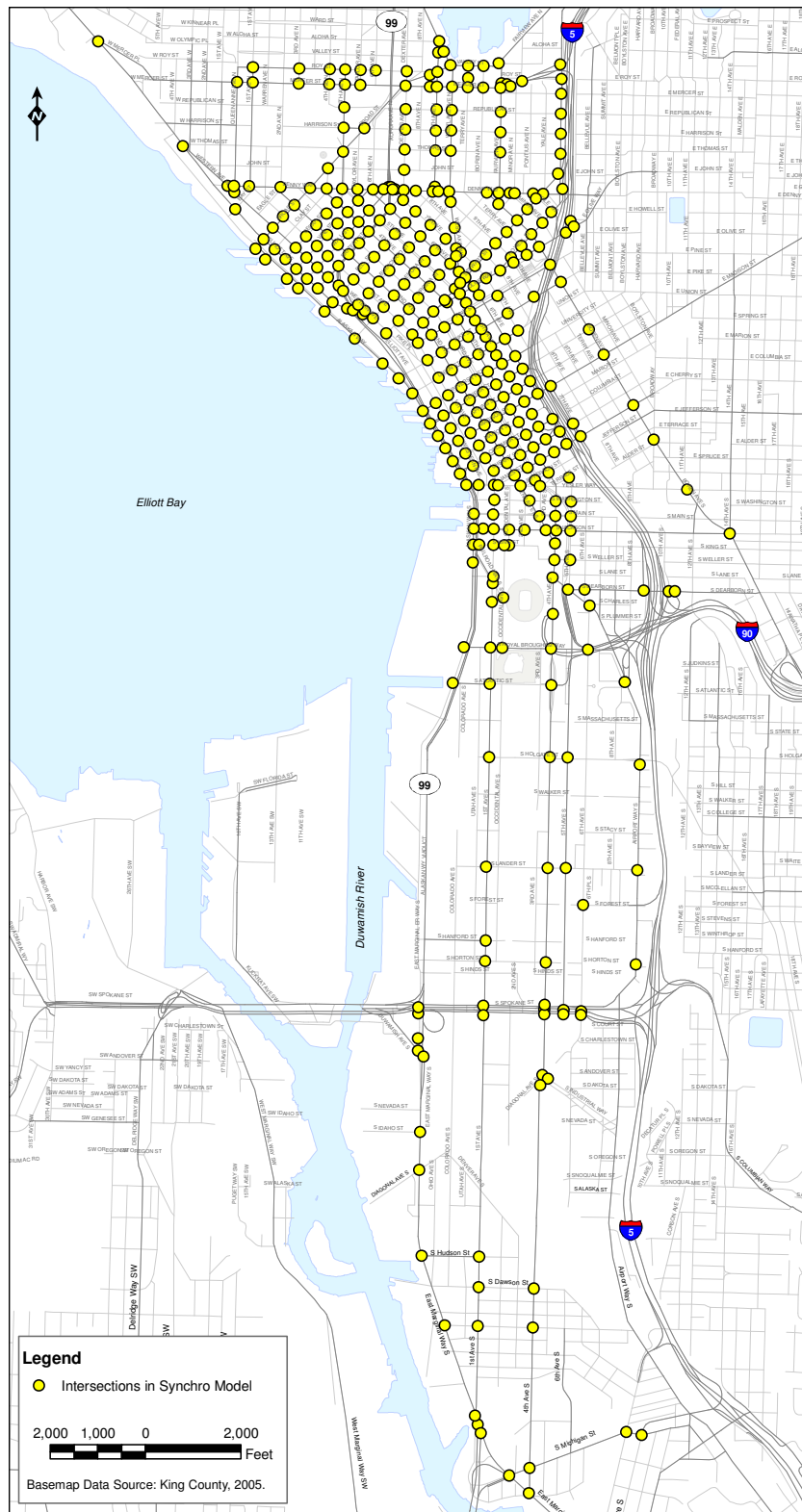
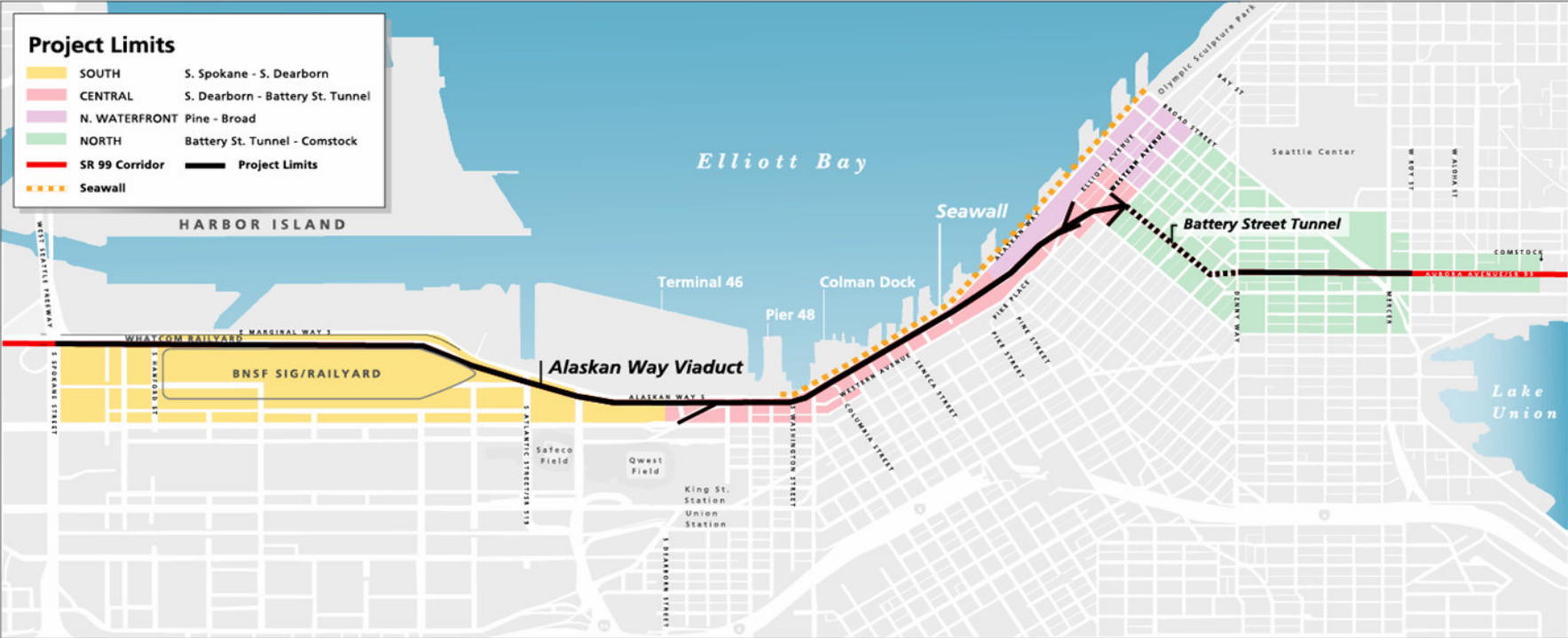


Figure 2. Project Limits



Source: AWW Supplemental DEIS (July 2006)

Application of the Model

Table 1 shows the various measures of effectiveness that Synchro provided for with the traffic assessment and screening process.

Table 1. Measures of Effectiveness in Synchro

Available Measures of Effectiveness	How Measures Were Used
Arterial Segment Level of Service	Directly, shown on maps and in tables.
Arterial Travel Times	Directly, shown on maps and in tables.
Arterial Speed	Directly, shown in tables and combined with travel times from other tools (CORSIM, EMME/2) to estimate point-to-point travel times.
Intersection Level of Service	Directly, shown on maps.
Intersection Delay	Indirectly, factored into arterial travel times at nodes.
Unserved Vehicles (number of vehicles in excess of capacity)	Summed up total unserved vehicles at intersections and shown on a map using graduated circle sizes.

Traffic operations results were largely reported on an arterial segment basis for select corridors and routes through the study area. This allowed for straight-forward comparison of travel conditions on primary alternate corridors, as well as transit and freight routes. Individual intersection results were evaluated as well, but primarily to identify specific movements that posed capacity constraints under the expected conditions. Both movement delay and entering volume of unserved vehicles at intersections were used to identify locations where significant impacts could be expected.

CHALLENGES AND LESSONS LEARNED

The project team learned a number of lessons from the process of developing and applying a large-scale macroscopic traffic operations model:

- Data management for more than 400 intersections is challenging considering that traffic volumes, intersection control data, topographic data, lane geometry data, etc. needed to be collected for the intersections studied. The user-friendly graphic interface and robust data management features of the Synchro model proved well-suited for this scale of application, particularly for static inputs. Synchro proved a very good database for maintaining geometric, signal control, and traffic data.
- Even more challenging was the process of managing dynamic data, such as forecast traffic volumes for different scenarios. These data had to be prepared manually for each scenario, because an automated means for translating travel forecasting information into intersection-specific turning movements was not available. In this case, a mesoscopic model such as INRO's Dynameq may have been better suited to manage such a large network under varying demand conditions.
- An advantage of a macroscopic analytical model such as Synchro over simulation models for such large networks is that perfect data coverage is not required. Minor intersections could easily be omitted without consequence, whereas a simulation network would generally need data for all roadway features and arterial crossing points for roadway segments in the study area.

- Bus and/or high-occupancy vehicle (HOV) lane treatments on arterials cannot be specifically modeled using Synchro. However, in many cases reasonable work-around methods can be employed to approximate travel conditions for these types of facilities. For example, the project team coded “dummy receiving links” connected to targeted intersections to account for shared transit/right-turn lanes. General-purpose vehicles are coded normally as right-turns, while transit vehicles were shown continuing to the “dummy links,” representing a receiving transit lane for through movements.

CONCLUSION

The project team found Synchro to be generally well-suited to analyze a large-scale street network. In particular, the network layout, signal timing/optimization, and data management features of the software package proved to be both efficient and effective for the purposes of the project. With respect to analysis reporting, the team found that aggregated results at the arterial segment level were generally more useful and appealing than results for individual intersections because it better communicates the driver experience and provides a more meaningful context. Translating travel forecasting information into the operations model environment proved to be challenging, but otherwise management of such a large volume of data was possible in this modeling environment.

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