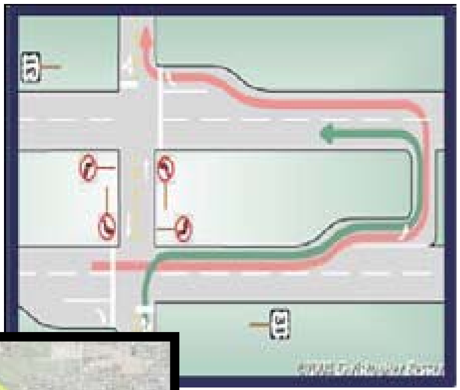
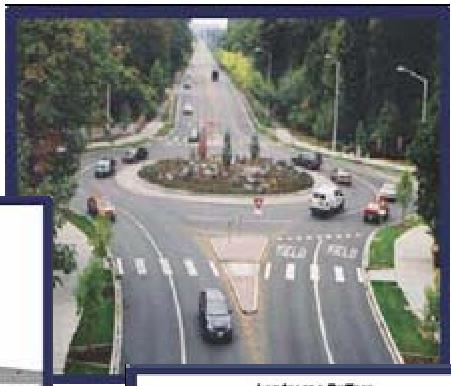
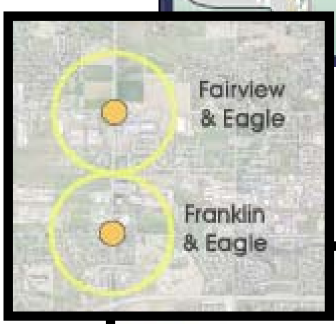
High Volume Intersection Study, Vol. III

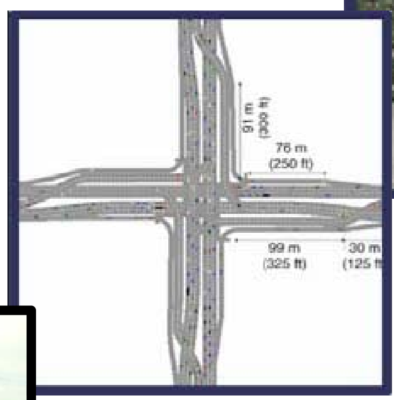
Additional Materials

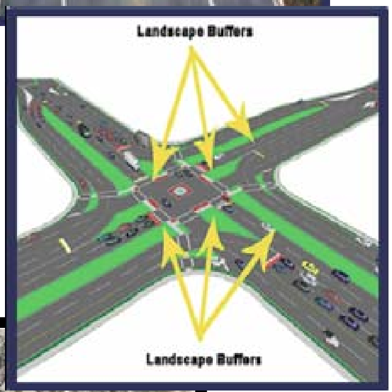
COMPASS
COMMUNITY PLANNING ASSOCIATION
of Southwest Idaho

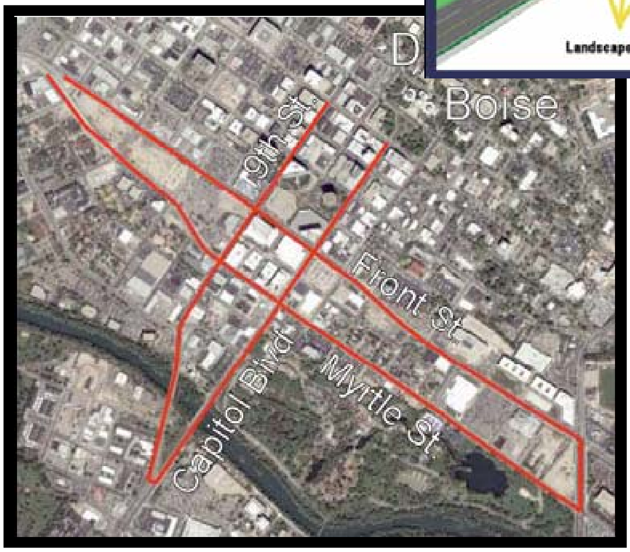












May, 2008

The *High Volume Intersection Study* (HVIS) consists of three volumes:

Vol. I Innovative Intersections: Overview and Implementation Guidelines, broadly outlines information about a variety of innovative intersection concepts and provides more specific implementation guidelines for intersection types that appear to be most applicable to southwest Idaho.

Vol. II Intersection Concept Layout Report, features spotlighted high volume intersection concepts at nine different intersections in Ada County.

Vol. III Additional Materials, includes a compatibility matrix between intersection types and urban forms and street functional classifications.

The Community Planning Association of Southwest Idaho (COMPASS) contracted with Wilbur Smith Associates for this study, with additional contributions by Thompson Transportation, HDR, and Joseph E. Hummer, Ph.D., P.E.

Table of Contents

Source: Wilbur Smith Associates
See Vol. I, Innovative Intersections, page 2-21.

"Intersection Toolbox": Generalized capacity, geometry, and cost by intersection type. Left to right by increasing capacity.

Scenario	"Double-left", 4-approaches (base case)	Roundabout, 2-entering lanes all approaches	"Triple-left" Intersection	Bowtie / Median U	Rerouting lefts on single quadrant	CFI/PFI, four approaches	Town Center oneways, four approaches	Rerouting lefts using four quadrants	Tight diamond Interchange
Signal phases at main intersection	4	All yield	4	2	2	2	2	2	3
Additional intersections / signals created by design	None	None	None	0, 2*	2 T's	4 mid-block	4 total	8 T's**	2 at ramps
Hourly System Capacity (LOS E - approx 60 sec delay/veh)	7,000	4,500	8,500	10,500	10,500	12,000	13,000	13,000	14,500
Percent change over base	-	*-36%*	*21%*	*50%*	*50%*	*71%*	*86%*	*86%*	*107%*
Major arterial daily volume supported (if peak hour is 8% of daily)	45,000	30,000	55,000	80,000	80,000	75,000	90,000	90,000	120,000
Minor arterial daily volume supported	40,000	25,000	50,000	50,000	50,000	70,000	75,000	75,000	55,000
Corresponding intersection AADT (Daily sum of all 4 approaches)	85,000	55,000	105,000	130,000	130,000	145,000	165,000	165,000	175,000
Corresponding peak hour, peak dir. approach volume (Major street)	1,900	1,300	2,200	3,200	3,200	3,100	3,500	3,500	4,850
Total approach lanes (left pockets + thru lanes + right pockets)	6 (2+3+1)	3 (0+2+1)	7 (3+3+1)	4 (0+3+1)	4 (0+3+1)	6 (2+3+1)	5 (1+3+1)	4 (0+3+1)	5(2+2+1+shldr)
Capacity per hour per approach lane at LOS E (Major street only)	320	430	310	800	800	510	700	700	970
Capacity per hour per thru lane (for travel demand models)	630	430	730	1,070	1,070	1,030	1,170	1,170	2,200
Percent change over base	-	*-32%*	*16%*	*70%*	*70%*	*63%*	*86%*	*86%*	*249%*
Typical intersection right-of-way on major street (feet)	128-132	84-110	150-160	84-110	84-110	140-160	80-84	84-110	170-200
Typical between intersection right-of-way on major street (feet)	106-120	80-100	120-130	84-110	84-110	106-120	66-80	84-110	120-150
Ideal limited access length (driveway and center island restrictions)	50-200	50-200	100-300	300-600	100-200	300-600	50-100	100-200	1000-5280
Bike / Ped / Mixed-Use friendly? (Great, Good, Ok, Poor)	Ok	Good	Poor	Good	Ok-Good	Ok-Poor	Great	Good	Poor
Signal coordination (Great, Good, Ok, Poor)	Ok	N/A	Poor	Ok-Good	Ok	Ok	Great	Ok-Good	No signals
Driver Expectations (Perfect, Good, Unusual)	Perfect	Perfect	Perfect	Unusual	Unusual	Good	Good-Perfect	Good	Ok
Other key features	Low cost, very common	Good aesthetics	May be only option	Good aesthetics	Often near-zero cost	Easy to grade separate	Redevelop-ment tool	Direct paths	One movement is free-flow
Other key detractants	Inefficient, high delay	Poor choice for major arterials	Inefficient, high delay	Weaves could be an issue	Circuitous	Large footprint	Greyfield high impacts	Usually has impacts	Most mvmnts. mediocre
Planning-level cost (Low = few conflicts, high = many)	Default	$1-3 M	$2-4 M	$1-$5 M	$0.3-$1 M	$4-12 M	$4-15 M	$2-10 M	$15-25 M
Relative Cost	Default	Low	Low-Medium	Low-Medium	Very Low	Medium	Medium-High	Low-Medium	Very High

Lower Capacity	Up to 35% better	Up to 70% better	70% better or more

1. All scenarios but Roundabout were measured with Synchro. Volumes were selected such that the average delay per vehicle is about 60 seconds (LOS E). Roundabouts are based on experience.

* Median requires signal to make U, Bowtie has wrap-around lane that does not require signal.

** A quadrant creates 2-T's, so 4 creates 8. They can be coordinated, and 4 of 8 can be Green-Ts.

Note: Planning-level Synchro estimates. Sites should be independently varified using expected volumes, and/or Vissim-type analysis

Source: COMPASS and Wilbur Smith Associates

Intersection Compatibility and Land Development

Intersection Type	Bowtie / Median U-turn	Route lefts on Single Quadrant	CFI/PFI 4 approaches	Town Center one-ways 4 approaches	Route lefts using Four Quadrants	Tight Diamond Interchange
Selection Criteria *(satisfies need of highest concern)*						
Capacity/Delay	yes	yes	yes	yes	yes	yes
Pedestrian Crossings	yes	yes	no	yes	yes	no
Available ROW	yes	yes	yes	no	yes	yes
Access	yes	yes	no	yes	yes	no
Construction Cost	yes	yes	yes	yes	yes	no
General Compatibility with Functional Classification *(major street - poor/ok/good/great)*						
Expressway *(restricted access, high speed/high volume)*	poor**	ok	good	good	good	great
Principal Arterial *(limited access, high volume)*	poor**	ok	great	great	great	good
Minor Arterial *(access to non-residential available)*	good	great	good	great	great	good
Major Collector *(access to local streets, parcels)*	great	great	good	great	great	ok
Transit Route (*fixed guideway/HOV lane can be accommodated)*	y - Lturn*	y - Lturn*	yes	yes	yes	yes
Center or outside lane preferred?	either	either	either	outside	either	either

**special design/consideration needed for transit vehicles making left turns*
***high speeds and weaving volumes make application of MUTs and Bowties challenging on this type of roadway*

General Compatibility with Urban Form *(poor/ok/good)**	Bowtie / Median U-turn	Route lefts on Single Quadrant	CFI/PFI 4 approaches	Town Center one-ways 4 approaches	Route lefts using Four Quadrants	Tight Diamond Interchange
Downtown / Urban Core (uniform blocks)	poor-ok	good	poor	good	good	poor
Urban Neighborhood (mixture of street/block types)	good	good	ok	good	good	ok-poor
Mature Suburb (section line grid, strip malls)	good	ok	ok-good	poor-ok	poor-ok	ok-good
Rural Townsite/Agriculture (small towns, farms)**	good	good	poor-ok	ok-good	ok-good	poor-ok
New Suburb/Greenfield (newly developed or developing)	good	good	good	good	good	ok

**compatibility with urban form is noted with only three strata instead of four - it differs from the functional classification topics above, in that there is greater variability/range in the context of urban form and within each category*
***this assumes that rural townsites will not stay rural in the long term - compatibility includes community character*

Land Division / Access	Bowtie / Median U-turn	Route lefts on Single Quadrant	CFI/PFI 4 approaches	Town Center one-ways 4 approaches	Route lefts using Four Quadrants	Tight Diamond Interchange
Observed* Lot/Frontage Width *(minimum range)*	n/a	150-180	350**	150-170	n/a	none
Observed* Intersection Envelope *(1 leg, length from center point)*	450-1000	450-1600	650-1100	900-1500	500-1000	n/a
Ideal Access Within Envelope - If Allowed *(none/restricted movement/consolidated)*	restricted	restricted (quadr consol)	none or restricted	consolidated (and restr)	restricted	none or restricted

**from intersection locations in CA, LA, MD, MI, MO, NJ, NY, TX, UT, VA and from spotlighted intersections in the HVIS*
***most existing CFIs in the US are on limited access roadways with no front access*

Note: It is not anticipated that any change would be necessary to current building setbacks or streetscape standards (incl. signs, landscaping, etc.).

This table is a compilation of recommendations from the consultant and observations of existing conditions. The final design selection process would include additional characteristics and forecasts unique to each site.

Overview of Unconventional Intersection Forms

Source: Dr. Joseph E. Hummer, Ph.D., P.E., North Carolina State University

Workshop presented to COMPASS Board of Directors August 20, 2007

Overview of Unconventional Intersection Forms

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For COMPASS, August 20, 2007

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Objectives

- Provide you a glimpse of part of the "menu" of unconventional intersection designs
- Inspire you to strongly consider these in your study of intersection alternatives
- Practice selecting the best form of intersection for a particular location

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Problem

- Growing demand
- Close to 50/50 directional split
- Conventional solutions exhausted
- Too expensive to widen
- Structures expensive and unpopular
- ITS, transit, demand management, etc. not helpful

Potential Solution: Unconventional Designs

- 15 designs on current intersection "menu"
  - Most published
  - Most in use in U.S.
- This presentation highlights those with potential in Idaho

Major Principles

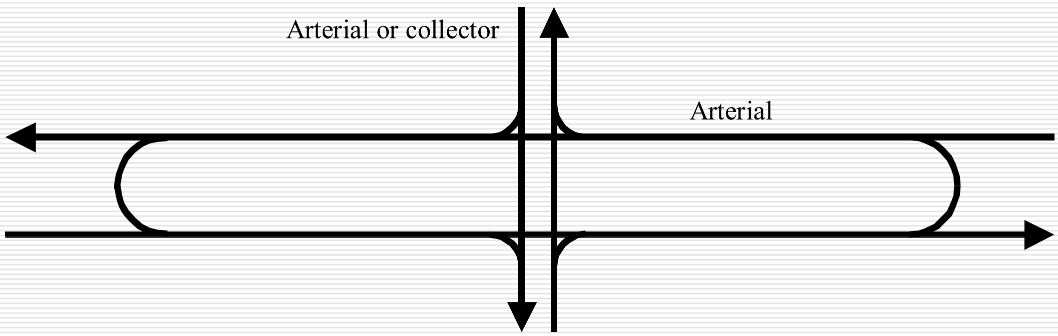
- Reduce delay to through vehicles
- Reduce number of conflict points at intersections
  - Separate remaining conflict points
  - Reduce signal phases

- Accomplished mostly by rerouting left turns

Driver Confusion?

- Potential is there; however...
- Most in place somewhere for years
- Precedent in other new designs
  - Roundabout, single point diamond, etc.
- Traffic control devices helpful
- Design whole corridor

Median U-Turn



Median U-Turn Capacity

		Critical V/C, 30,000 ADT	
Minor ADT	% turns	Med. U-turn	Conventional
15,000	20	0.74	0.86
	40	0.88	0.90
25,000	20	0.90	1.04
	40	1.11	1.14

Median U-Turn Collision Rates (per 100 mil. veh-miles)

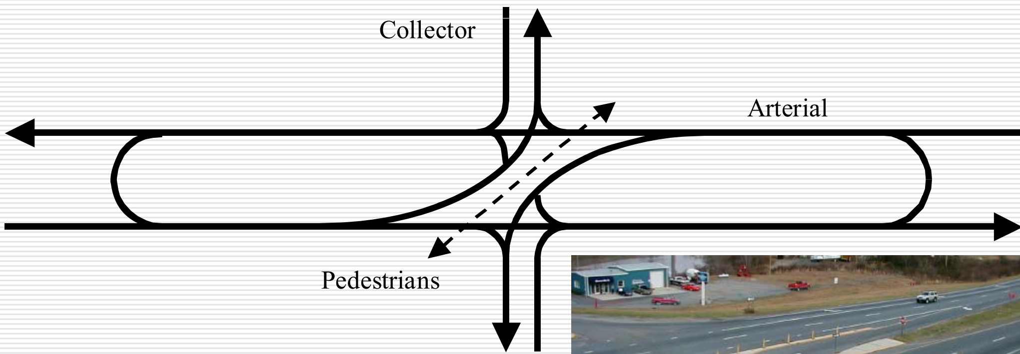
Road	Rate
TWLTL	1220
Conventional with median	750
Median u-turn	600

Also better for pedestrians!

Median U-Turn Disadvantages

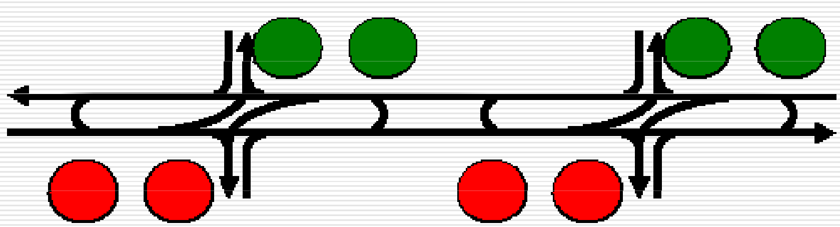
- Left turns penalized
- Wider right-of-way
- Higher minimum green time
- Indirect left turns into businesses
- Wide median means less business visibility

Superstreet



Superstreet Advantages

- Perfect two-way progression at any speed with any signal spacing!
  - Install signals anywhere
  - You set progression speed



- Safer
- All pedestrian crossing controlled

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Superstreet Travel Time

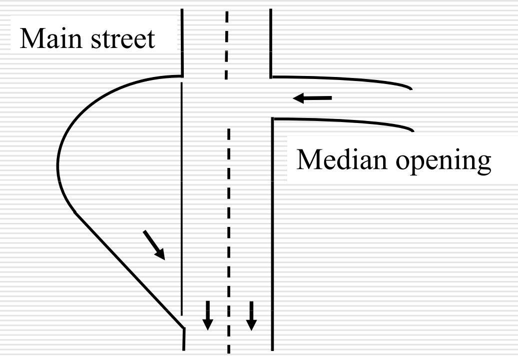
MOE	TWLTL	Median U-Turn	Superstreet
Travel time, veh-hours	403	280	314
Stops per vehicle	2.08	2.19	2.59

Superstreet Disadvantages

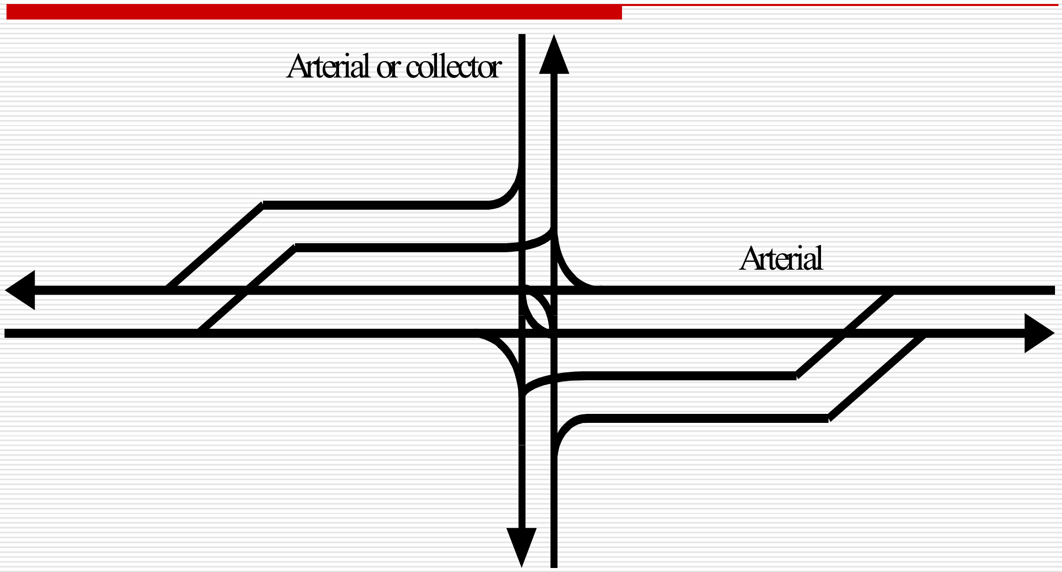
- Same as median u-turn plus…
- Less efficient with heavy minor street volumes

Mitigating Superstreet Disadvantages

- High side street through volumes—use median u-turn or bowtie
- Wide right-of-way—use bulb-outs
- Effects on businesses—use slower speeds, more signals, and openings tailored to driveway locations



Continuous Flow Intersection



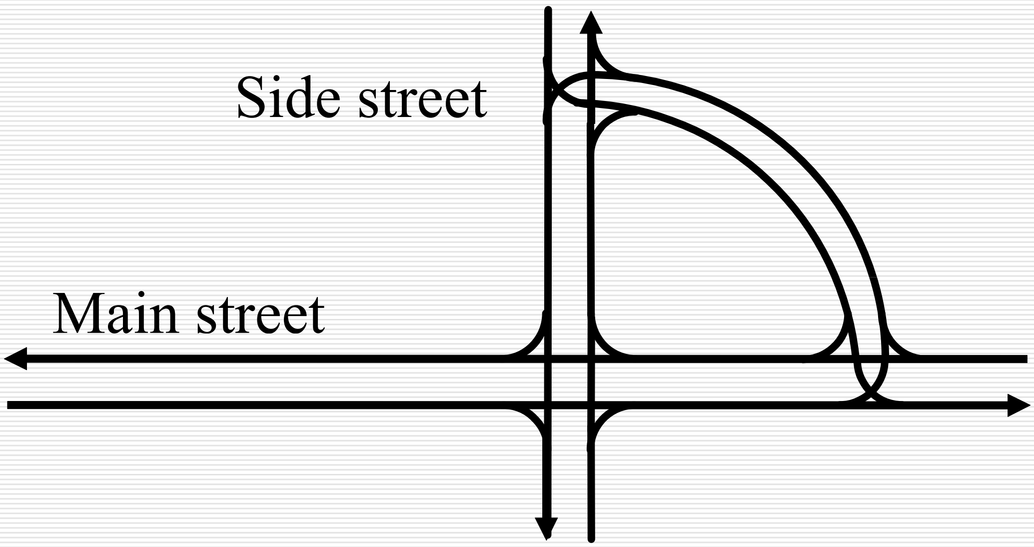
Continuous Flow Intersection Advantages

- Reduced travel time with high volumes
- Keeps traffic moving
- Enhanced progression
- Narrower major street ROW
- Fewer conflict points

Continuous Flow Intersection Disadvantages

- No u-turns at intersection
- Pedestrians must cross ramps
- Access difficult for parcels next to ramps

Quadrant Roadway



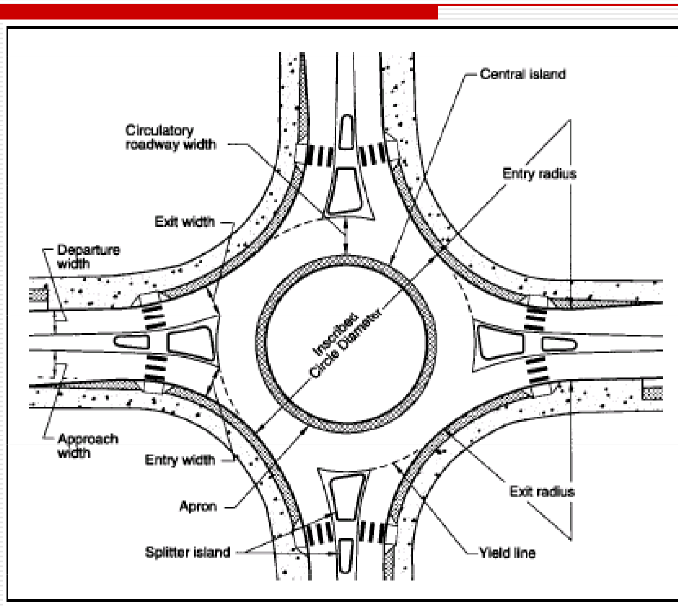
Single Quadrant Advantages

- Typically vies with median u-turn as most efficient unconventional design
- Major and minor streets can have narrow rights-of-way
- Connector road provides development opportunity
- Some pedestrians have shorter, simpler crossing

Single Quadrant Disadvantages

- Some left turns have more travel time, distance, stops
- ROW for connector road
- No u-turns at main intersection
- No driveways opposite ends of connector road
- Some pedestrians must cross connector road too

Roundabouts



Roundabout Features

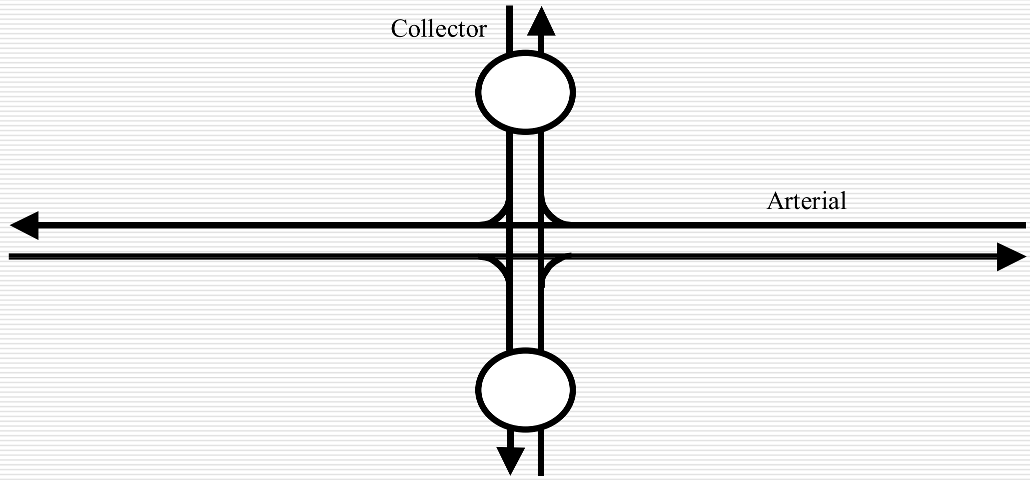
For one-lane design

- If roundabout stays below capacity, delay savings above 50% possible
- Credible studies show 20-40% collision and injury reductions
- Not too large
- Aesthetics
- Calming, gateway function

Roundabout Niche

- Two two-lane roads
- ADTs 5,000-15,000 for each
- Competes with all-way stop control
- Too much traffic for two-way stop control
- Not enough traffic for signal

Bowtie



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Bowtie Advantages

- Narrow major street right-of-way
- Short, simple pedestrian crossing
- Enhanced major street progression
- Aesthetics
- Developments can tie into roundabouts

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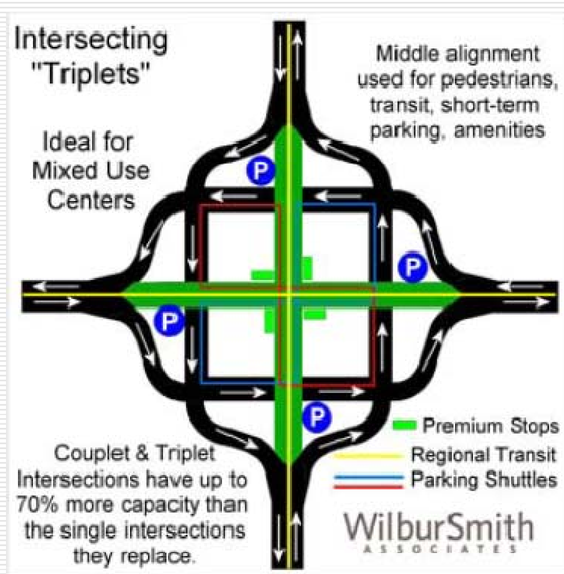
Bowtie Disadvantages

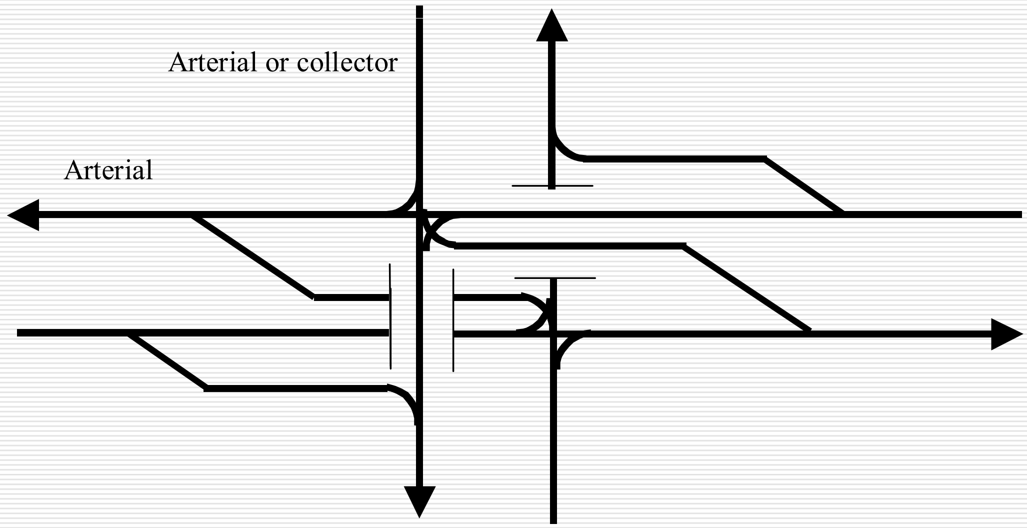
- Low minor street capacity
- Left turn delay
- Left turn travel distance
- Left turn stops
- Difficult arterial u-turn

Town Center Intersection

- High capacity, low delay
- Good for pedestrians
- Frees quality space in middle
- Need new ROW



Echelon Interchange



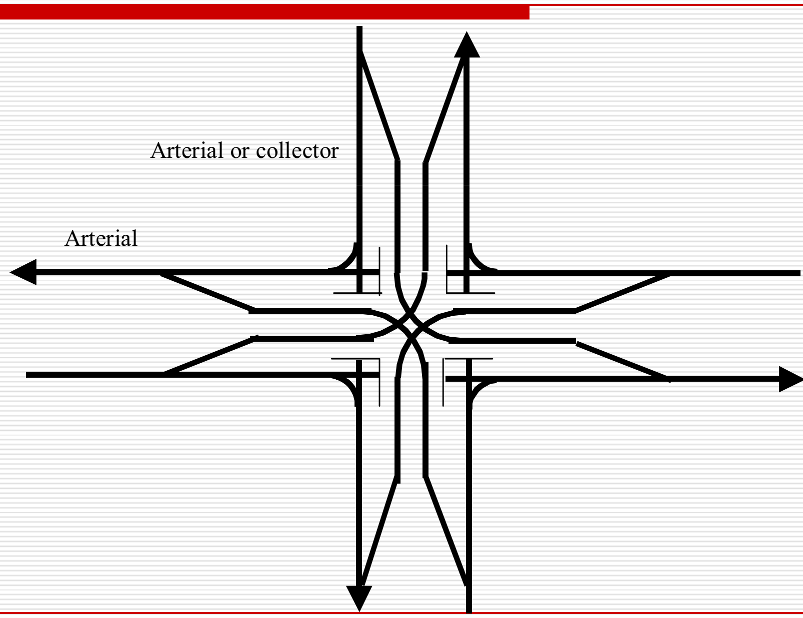
Echelon Interchange Advantages

- Much higher capacity than at-grade intersections
- Much lower travel time than at-grade intersections
- Enhanced progression for both streets
- Meters traffic to help downstream signals

Echelon Interchange Disadvantages

- High structure cost
- Access impaired to 3 quadrants
- No u-turns at or near interchange
- Pedestrians must climb grades or cross streets unprotected by signals

Center Turn Overpass



Center Turn Overpass Advantages

- Same as echelon plus…
- Direct pedestrian crossing
- Good access to roadside businesses

Typical critical volume/capacity ratios

Intersection volume, veh/day	Median u-turn	Echelon interchange	Center turn overpass
60,000	0.89	0.75	0.80
70,000	1.03	0.86	0.93
80,000	1.19	0.99	1.06

Center Turn Overpass Disadvantages

- High structure cost
- Difficult to design if streets are not perpendicular
- Visibility to businesses blocked by structure
- Cost to obtain rights to design

A Review of the Menu

- Median u-turn
- Superstreet
- Continuous flow intersection
- Single quadrant
- Bowtie
- Town center
- Echelon
- Center turn overpass

Plus 7 others:

- Jughandle
- Continuous green T
- Double wide
- Synchronized split phasing
- Paired intersections
- Hamburger
- Two-level signalized

References

- Jonathan Reid, "Unconventional Arterial Intersection Design, Management and Operations Strategies," Sept. 2003, at www.pbworld.com/library/fellowship/reid
- FHWA, "Signalized Intersections: Informational Guide," August 2004, at www.tfhrc.gov/safety/pubs/04091
- "Impacts of Access Management Techniques," NCHRP Report 420, 1999, at www.cutr.usf.edu/ research/access_m/ada70/420NCHRP.pdf

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Selection Criteria

- Capacity and delay
  - Critical lane volume technique
  - Best designs: grade separated, median u-turn, quadrant, continuous flow, town center
- Pedestrian crossing
  - Best designs: bowtie, median u-turn, superstreet, center turn, single quadrant, town center

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More Selection Criteria

- Available right of way
  - Best designs: grade separated, bowtie, single quadrant, continuous flow
- Providing access to nearby parcels
  - Best designs: single quadrant, town center, median u-turn, superstreet, bowtie, center turn
- Construction cost
  - Best designs: at-grade

HVIS Technical Memo 4: Future Alternative Concept Development and Evaluation

Source: Wilbur Smith Associates and Thompson Transportation

Memorandum

To: COMPASS

From: Wilbur Smith Associates & Thompson Transportation

Date: December 13, 2007

Subject: Future Alternative Concept Development and Evaluation

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Introduction

In our effort to identify promising improvements at the ten study intersections, shown in **Figure 1**, the consultant team has:

- Developed future year traffic volume projections;
- Analyzed a future baseline scenario;
- Creatively developed and preliminarily screened intersection alternative concepts; and
- Identified recommended alternatives to further evaluate.

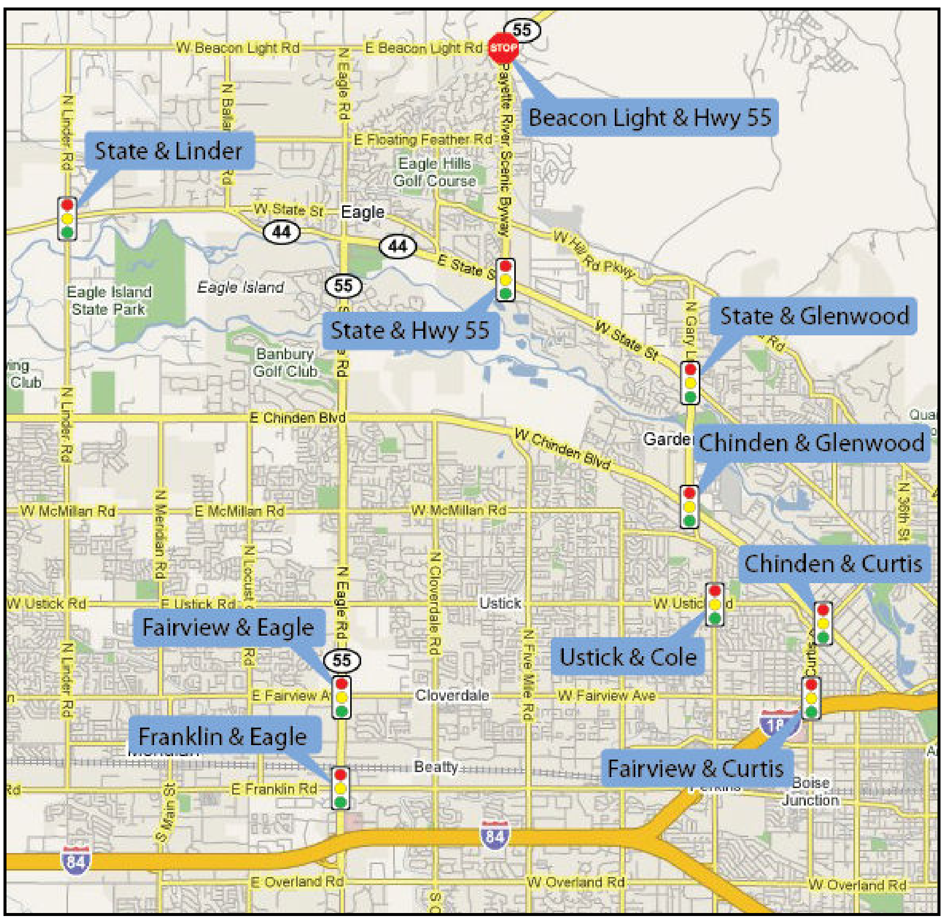


Figure 1: Study Intersection Location Map

ITD and ACHD have plans to upgrade most of the study intersections over the next 25 years or so. In the meantime, traditional intersection upgrades will likely provide an acceptable level of service at many intersections. These typical designs and associated costs are well understood and already planned for implementation in the future.

For this study, we want to identify some innovative and less conventional intersection improvement concepts to consider at the busy study intersections. These intersection treatments have the potential to provide longer life and improved operations over the traditional approach to widening and adding lanes at congested intersections. Based on this approach, this memo provides an overview of the process and:

- Documents the development of future traffic volumes and a baseline scenario for the study intersections;
- Documents the consultant team's process of developing future alternatives (brainstorming);
- Provides an overview of the preliminary screening process used to identify the future alternatives recommended for further evaluation;
- Lists the recommended intersection alternative concepts; and
- Identifies the next steps to finalize the alternative concept selection.

For the intersection specific details, we provided supplement pages to this memo containing more detailed information about each intersection and the selection process. The information provided in the supplement:

- Compares existing and future baseline conditions at each study intersection;
- Presents our screening analysis of the future alternative concepts; and
- Provides pros and cons for the promising intersection concepts.

Future Baseline Conditions

Future Volume Forecasting

A thorough future traffic volume forecast effort was made to develop traffic volumes that would help us best develop solutions that would accommodate traffic growth through 2030 and beyond in some instances. In support of this effort, COMPASS provided projected traffic volumes from several of their travel demand models including:

- 2002 calibrated model
- 2007 current conditions model
- 2030 Community Choices model
- 2030 Trend model
- 2030 Constrained model
- Preservation model (post 2030)

While our approach to forecasting future traffic volumes centers on the 2030 Community Choices model volume outputs (as directed by COMPASS), we also adjusted for significant differences observed between the various 2030 modeled volumes where we, as the study team, felt some instances may be under-forecasting and others over-forecasting future growth. We also made efforts to adjust the forecasted volumes with respect to actual counts collected as part of this study. The following are the steps we took to identify the future traffic volumes to be used with this study.

1. We determined the difference between the 2007 model volumes and the 2030 Community Choices volumes to determine a model based growth.
2. The difference in the models was added to the 2007 count data to create the initial future volumes.

3. Manual adjustments were made at some intersections to account for perceived deficiencies in the 2030 Community Choices model outputs, particularly where other future models differed substantially from the Community Choices model.
4. As a final adjustment, the developed approach volumes were compared against the 2030 Community Choices approach volumes. On approaches where the study volumes were less than the 2030 Community Choices volumes, the difference in volume was added to the through movement on that approach.

Because of the relatively low volumes occurring at Beacon Light & SH55 North in the 2030 Community Choices model and the very large volumes occurring in the Preservation model, we determined that the volumes at this location should be calculated differently than at the other study intersections. For this intersection only, we used future volumes based on those obtained from the Preservation model. Our goal with this study is to identify cost effective intersection concepts that will operate well at varying traffic volume levels but are also easily upgradable should larger growth occur beyond that forecasted by the Community Choices model.

Identify Future Geometry

To define what the future baseline conditions should be, we consulted a number of sources to develop appropriate intersection and roadway geometries for the future baseline conditions. These sources included:

- A revised "2030 Community Choices" travel demand model run by COMPASS on August 31, 2007 that accounts for recent amendments to their plan.
- The ACHD Five-Year Work Program, dated February 28, 2007.
- "Idaho Horizons," ITD's FY 2007 Long Range Capital Improvement and Preservation Program, dated September 2006.
- The ACHD Capital Improvements Plan, dated July 26, 2006.

We reviewed these documents and identified projects impacting the geometry of the study intersections and the roadways leading to them. Based on the planned improvements identified in these plans, we developed the future geometries. These are identified and shown next to the existing intersection geometries in the supplement pages to this memo. Where clarifications were required, we made contact with staff from COMPASS and the highway agencies (ITD and ACHD).

Future Baseline Operations Analysis

Having identified future volumes and geometries at the study intersections, we developed Synchro models representing future baseline conditions. These operation models were developed from the calibrated existing conditions models previously developed. We also made reasonable signal timing adjustments that would occur to accommodate the changing volumes as the intersections.

The existing and future baseline volumes, geometries, and traffic conditions are summarized in the Supplement to this memo.

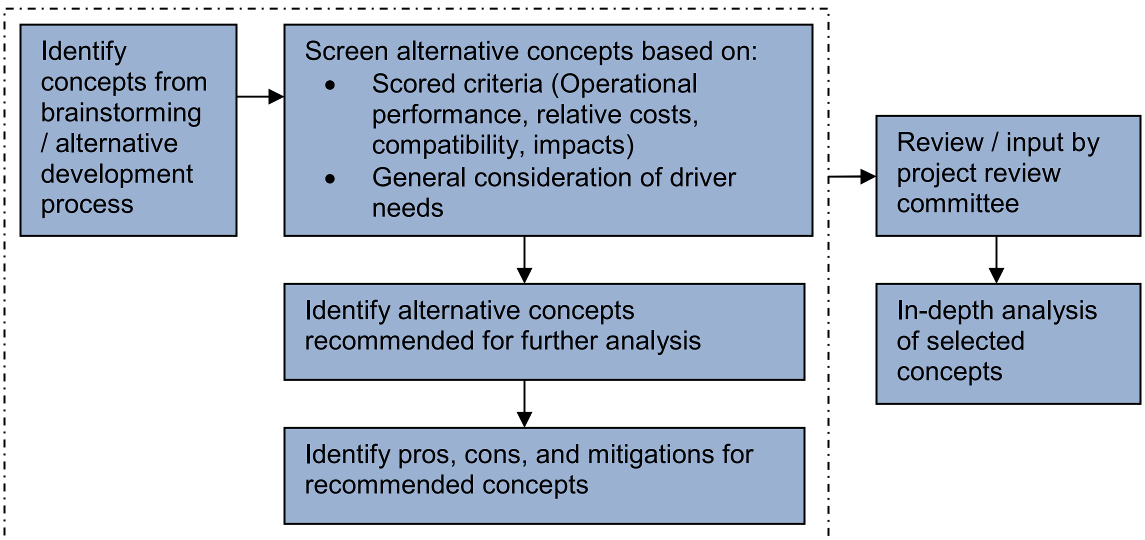
Brainstorming / Alternative Development Process

We conducted the brainstorming / alternative development process with openness to the entire universe of concepts available, including but not limited to those that were discussed in Chapter 2 of the Draft Intersection Guidelines Report. At-grade concepts in that report include the continuous flow intersection, parallel flow intersection, town center intersection, median U-turn, superstreet, quadrant roadway, and multi-lane roundabout. Because of strong local preferences and cost concerns, we focused primarily on developing innovative, well-tailored at-grade concepts for the study intersections. We only roughly developed the grade separation concepts at pertinent locations to provide a comparison for the at-grade concepts.

Using a creative engineering approach and considering a variety of location-specific information (such as aerial photographs of the intersection locations, right of way boundaries, and current and expected future volumes), we developed a number of concepts at each of the ten study intersections. Concepts were developed in sufficient detail that they could be preliminarily evaluated with Synchro.

Overview of Alternative Selection Process

The flow chart below provides an overview of the process that we followed to identify alternative concepts to be further evaluated in the final stages of the project. Upon approval from the project review committee, the selected alternative concepts will be further evaluated in greater detail.



With feedback from COMPASS, the consultant team developed four scoring criteria to evaluate the various concepts quantitatively. The criteria shown in **Table 1** give a good feel for how well the solution would work and fit the local situation. For each alternative concept, each of the scored criteria was assigned a point value from 1 (poor) to 5 (excellent), from which a weighted composite score was calculated. The concepts at each study intersection were then ranked based on the composite score.

Table 1: Scored Criteria for Alternative Screening		
Criteria	**Definition**	**Assigned Weighting**
Operational Performance	Operational performance of intersection with future volumes	40%
Relative Costs	Order of magnitude costs of each alternative relative to others considered at the intersection	30%
Compatibility	Fit within intersection geometry and within the broader geographical context of the area – out of direction travel was also considered here	20%
Impacts	ROW impacts; utility impacts; access impacts; aesthetics; environmental impacts	10%

At this level of evaluation, detailed cost estimates were not developed; rather, application of engineering experience provided good relative order of magnitude costs. Also, refer to the supplement pages to this memo for discussion of the operational analysis effort conducted in support of assigning values for the operational performance criterion. In addition to these scored criteria, the consultant team considered the needs of drivers. Innovative intersections by nature require at least some drivers to do things not typical at conventional intersections. However, the driver-friendliness of the concepts was heavily considered as we reviewed the results of scoring the criteria and influenced our recommendations.

Based on the results of the preliminary screening process, the consultant team developed a list of recommended concepts to further evaluate in the next steps of this study.

Future Alternative Concepts Recommendations for Further Evaluation

The details of our screening analysis are presented in the Supplement to this memo. Table 2 summarizes the concepts that we recommend for further evaluation at the study intersections.

Table 2: Future Alternative Concept Recommendations	
Intersection Location	**Future Alternative Concepts**
1 – Beacon Light & SH55 North	1. TSM improvements – adding a NB and SB lane 2. Continuous Green T
2 – State & Linder	1. Continuous flow intersection – 2 approaches 2. Median U-turn
3 – State & SH55 North	1. Continuous flow intersection – 4 approaches 2. Continuous flow intersection – 2 approaches
4 – State & Glenwood	1. Median U-turn 2. Quadrant Roadway – 2 Quadrants
5 – Chinden & Glenwood	1. Quadrant Roadway – Northeast Quadrant 2. Median U-turn / Continuous flow intersection (tie)
6 – Ustick & Cole	1. Bowtie – Ustick 2. Continuous flow intersection
7 – Chinden & Curtis	1. Median U-turn 2. Quadrant Roadway – Southwest Quadrant
8 – Fairview & Curtis	1. Realign Opohonga & Quadrant 2. Quadrant Roadway – Northeast Quadrant
9 – Fairview & Eagle	1. Quadrant Roadway 2. Continuous flow intersection
10 – Franklin & Eagle	1. Quadrant Roadway – Northeast Quadrant 2. Continuous flow intersection

In the attached supplement, there are details of the various alternatives above along with some discussion of other concepts that could emerge as the best option upon more study, changing conditions, or depending upon what stakeholders value the most. We include them in part because the concepts themselves are solid and would potentially provide great benefit but would also require significant political support to implement.

Next Steps

Having presented this information (and the details of the Alternative Screening Analysis in the Supplement to this memo) to the Project Review Committee, we desire the committee's input on our findings and recommendations. Upon approval or modification of our recommendations, a more detailed evaluation of the approved alternative concepts will begin. Results from this analysis will be included in the Draft Intersection Concept Layout Report. The evaluation will include a refined operational analysis along with preliminary cost estimates for the concepts in order to identify the cost/benefit of the concepts.

Supplement to Technical Memo 4: Screening Analysis Details and Future Baseline Conditions

Source: Wilbur Smith Associates and Thompson Transportation

Supplement to Technical Memo 4 - Screening Analysis Details and Future Baseline Conditions

Introduction
This supplement provides details about:
- The operational analysis of alternative concepts;
- The role of driver expectancy in concept evaluation;
- Typical advantages and disadvantages of various intersection types; and
- For each study intersection:
  - Summary of the existing and future baseline conditions analyses
  - Alternative concept screening analysis, including:
    - Concept scores and rankings;
    - Pros, cons and mitigations for recommended concepts; and
    - An explanation of why other concepts were not recommended

Operational Analysis of Alternative Concepts

Overview
We approached the operational analysis of alternative concepts in as comprehensive a manner as feasible given budget and time constraints, yet also with an eye toward efficiency and being mindful of the "high-level" / planning nature of this project. This approach manifested itself in a number of ways, for instance:
- We limited our analysis to Synchro. Thus, we assessed concept performance based on Synchro outputs (level of service and delay), not SimTraffic. Synchro outputs, while useful, do not provide the full picture, particularly in cases where an intersection does not have sufficient capacity to meet demand on all movements. Nevertheless, the Synchro results were sufficiently clear to assign points satisfactorily to each analyzed concept under the "Operational Performance" criterion.
- We did not perform an operational analysis every concept that we brainstormed. Several intersection types did not require modeling at all because of limited application potential (multi-lane roundabouts, superstreet, town center intersection).
- We used some analyses as surrogates for other analyses, both within intersection types (especially quadrant roadways) and between types (parallel flow intersections), basing the "Operational Performance" points assignment for un-analyzed concepts on that for similar concepts.
- For several intersection types (continuous flow intersections, median U-turns, bowties), we made blanket assumptions about the spacing of elements.

These and other details, grouped by intersection type, are discussed in the next section.

Notes on Analysis and Scoring of Specific Intersection Types
<u>Continuous flow intersection</u>
- Default geometric assumption is CFI treatment on all 4 legs
  - CFI treatment on all 4 legs was not feasible at some intersections
- Typically analyzed 4 leg treatment but did not analyze 2 leg treatment directly, assuming a 1 point decrease in operational performance score
- Assumed all left turn crossovers at 500 ft in advance of main intersection
- Coded new intersections at left turn crossovers and modified volumes and geometry at main intersection

<u>Parallel flow intersection</u>

- Not analyzed directly
- Operational performance considered identical to that of the CFI

Quadrant roadway
- The default geometric assumption is only one quadrant roadway.
- If multiple quadrants would allow a quadrant roadway, we analyzed only the option with the highest system-level volume. The operational performance of options with lower volumes was assumed identical since system volumes typically don't vary significantly.
- Concepts that would involve two quadrant roadways were not modeled directly but were given a 1 point increase in the operational performance score. Four-quadrant-roadway scenarios were given a 2 point increase.
- Quadrant roadways were positioned as seemed reasonable given existing roadways and / or logical new roadway paths.

Median U-turn
- Analyzed directly
- U-turns were assumed to be 500 ft away from the main intersection

Bowtie
- Analyzed directly
- Roundabouts were assumed to be 500 ft away from the main intersection

Superstreet
- Not analyzed; very limited application potential for the study intersections

Town center intersection
- Not analyzed directly; operational performance is typically very good.
- Potential applications at study intersections appear very limited.

Multi-lane roundabout
- Not analyzed; all study intersections appear to have future demand forecasts well beyond the range in which a multi-lane roundabout would operate well. There may be some locations where it could operate for a while (as an interim solution).

TSM improvements
- We limited our consideration of TSM improvements to just two intersections. Other intersections may benefit at least temporarily from such improvements.

The Role of Driver Expectancy in Concept Evaluation

Driver expectancy was considered in ranking concepts. Definitions of driver expectancy are below:

Degrees of driver expectancy for making a left turn on an arterial
Perfect expectancy: Driver gets into left lane just ahead of the intersection. Intersection geometry is typical of others in the region. Typical double-lefts and perhaps roundabouts fit this, but neither can handle high volumes.

Good expectancy: Driver gets into left lane ahead of the intersection, but paths to complete left are not typical. CFI, PFI, Town Center one-ways, and 4-quadrant roadways all fit this definition.

Unusual expectancy: Making a left ahead of the intersection is not possible. With Median U-turns, Bowties, and when there are just one or two quadrant roadways, drivers on some approaches must travel through, then make a U-turn and a right. In opposite approaches they must first turn right, then make a U-turn and travel trough. In the case of a single quadrant, one movement has good expectancy (left occurs ahead of the intersection). The next two movements are “through-U-right”, and “right-U-through”, and the last left equates to “three rights makes a left”. Grade separated intersections also are “unusual” in a non-freeway context, because they require an exit from the right lane to make a left.

Unusual driver expectancy should not automatically disqualify a concept from consideration unless for some reason it creates an unsafe situation. These options are often far less money to implement relative to other choices, and in some cases require only changing signs, striping, and signal timing. Perfect driver expectancy also comes with high congestion at high volumes. Most drivers would prefer to get used to a new expectancy if it means they’ll save a lot of time.

General Advantages and Disadvantages of Various Intersection Types

This describes the general advantages and disadvantages of various intersection types relative to a typical baseline that has dual lefts on all approaches (an inefficient, 4-phase signal).

General Advantages of CFI’s/PFI’s

- 2-legs always achieve 3-phases, increasing capacity considerably.
- 4-legs always achieve 2-phases, increasing capacity even more.
- Good driver expectancy
- Operationally, CFI’s and PFI’s are very similar, but one or the other may be easier to build within existing constraints.

General Disadvantages of CFI’s/PFI’s

- Require a considerably large footprint. This can be an advantage in situations where future grade separation is considered.
- Safe for pedestrians, but can be intimidating and would not be considered “pedestrian friendly”.
- Can be expensive if acquiring buildings, parking, or removing accesses is required.

General Advantages of Town Center Intersections

- Two legs creates two 3-phase intersections, each more efficient than a single 4-phase.
- Four legs creates four 2-phase signals, where the four together can handle much more volume than a single intersection.
- The most pedestrian-oriented of all high-volume systems.
- Design lends itself well to defining a higher-density, mixed-use “Place”. Very low cost when designed on open ground as part of a master-planned area.
- More signals, but they’re easily coordinated

General Disadvantages of Town Center Intersections

- The sum of the right-of-way is higher, due mostly to more sidewalk area.
- Numerous impacts and very expensive in developed settings. Cost is largely mitigated if private funds can be attracted as part of a general redevelopment strategy, or if tax-increment financing is used for the same purpose.

General Advantages of a Single Quadrant Roadway

- Makes it possible to achieve high-efficiency 2-phase signal
- Candidate roadway often already exists. Hence implementation is extremely low cost.

- Result is less intimidating for pedestrians than Baseline.

General Disadvantages of a Single Quadrant Roadway

- Creates unusual driver expectancy. However the public may prefer to get used to awkward paths if it means they'll save a lot of time and the implementation cost is low.
- The quadrant roadway will itself become very busy, as it is functioning for 4-left movements.
- 3 of 4 left paths still require drivers to traverse the main intersection – sometimes twice. Thus lefts are eliminated, but there are more rights and throughs. The former left-turn lanes may be used as through lanes to handle higher through volume.

General Advantages of Multiple Quadrant Roadway

- Makes it possible to achieve high-efficiency 2-phase signal
- May require construction to develop roads on more quadrants
- Each quadrant handles less volume.
- With 4-quadrants, there is very good driver expectancy (all approaches can turn left ahead of intersection. No circuitous paths)
- With 4-quadrants, lefts never enter the main intersection – making 4 quadrants among the highest overall capacity of all.

General Disadvantages of Multiple Quadrant Roadways

- Can be expensive to develop more quadrants.
- Introduces T-intersections
- Mitigate by making Continuous Green-Ts.

Note: The bowtie is essentially the same as median U-turn, but utilizes a bulb-out/roundabout to create a wrap-around lane that need not conflict with oncoming traffic, as a median U-turn typically would. Thus it is operationally superior and aesthetically more pleasing but also requires more space.

General Advantages of Median U-Turns / Bowties

- Reduces 4-phase signal to 2-phase signal
- Impacts typically limited just to the location of the U-turn or bulb out.
- Can be very low cost, depending on adjacent development

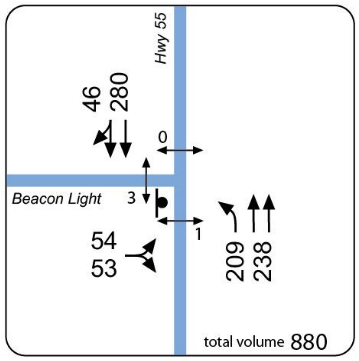
General Disadvantages of Median U-Turns / Bowties

- Results in unusual driver expectancy
- Vehicles still traverse intersection at least once, sometimes twice. Can be mitigated by converting former left pockets to through lanes.

Intersection 1 – Beacon Light & SH55 North

Summary of the Existing and Future Baseline Conditions Analyses

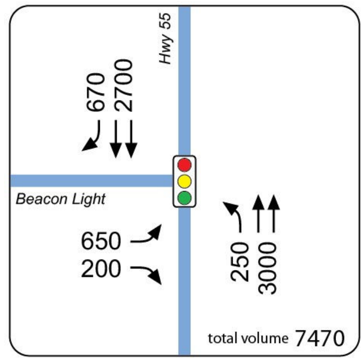
Existing Conditions



Beacon Light & Hwy 55 2007 PM Peak Hour

LOS A - Average delay 9 sec

Future Baseline Conditions



Beacon Light & Hwy 55 Future PM Peak Hour

LOS F - Average delay >100 sec

Alternative Concept Screening Analysis and Recommendations

Table 1: Future Design Alternatives at Beacon Light & SH 55 North

Design Alternative	Specific Details	Operational Performance (Weight 40%)	Relative Costs (Weight 30%)	Compatibility (Weight 20%)	Impacts (Weight 10%)	Composite Score (100%)	Rank
At-Grade Alternatives							
No build	Add right turn bays on eastbound and southbound approaches	1	5	5	5	3.4	4
TSM improvements	Add through lanes northbound and southbound	4	4	4	4	4.0	1
Realign west leg	Realign west leg of roadway to the north; relocate accesses					0.0	9
Relocate access	Relocate Horseshoe Bend Rd access					0.0	9
Continuous flow intersection	Apply to south leg	3	4	3	4	3.4	3
Continuous flow intersection	Apply to west leg	3	4	3	3	3.3	5
Parallel flow intersection	See CFI analysis					0.0	9
Quadrant roadway	Northwest Quadrant	3	2	4	3	2.9	7
Median U-turn	Apply to south and north legs	2	4	1	4	2.6	8
Continuous green T	Provide acceleration lanes	2	4	5	5	3.5	2
Grade-Separated Alternatives							
Grade-separated	Grade separate northbound left turns and southbound throughs	5	1	3	2	3.1	6

Beacon Light / 55, General Analysis

Baseline is a 3-phase signal that stops NB and SB both. Baseline has 2 lanes both NB and SB. The result is an extremely long queue long queue.

TSM (3 NB and SB through lanes on 55)
Advantages:
- Reduces delay considerably – 55 could use three lanes each direction if both NB and SB are stopped for a 3-phase signal.

Disadvantages:
- NB need not stop in other designs
- Does not solve poor connections of nearby streets
- Other designs can attain two-phase signal

Continuous Green T
Advantages:
- Channelization allows northbound to never stop
- Right of way and access control are not a problem
- Cost is very low
- Very traditional – no driver expectancy problems

Disadvantages:
- Requires SB to stop at three-phase signal
- Does not resolve poor roadway connections to 55 and Beacon

CFI (either on west leg or south leg, not both. South leg easier to fit)
Advantages:
- Allows EB to NB left and NB to WB left to occur at same time (2-phase signal)
- Does not require new alignments
- Fairly low cost if right-of-way is preserved

Disadvantages:
- Could make property access more difficult
- Does not resolve poor roadway connections to 55 and Beacon

Single Quadrant in the NW
Advantages:
- Allows EB to NB left and NB to WB left to occur at same time (2-phase signal)
- Eliminates poor access to 55, and poor access to Beacon becomes less significant.
- Easily combined with Green-T
- Very conventional – nothing unusual
- Avoids property access problems of CFI

Disadvantages:
- Requires constructing .2 miles of a local street, making it potentially more expensive than CFI.

Recommendations for further study
- Definitely do Green-T. It is compatible with any solution.
- Three lanes on SB or NB 55 are not necessary if 2-phase signal is achieved.
- If the quadrant roadway can be shown on local plans and constructed when the area develops, this becomes the lowest cost solution with the most advantages.
- If agencies must bear cost of quadrant, CFI may end up lower cost.

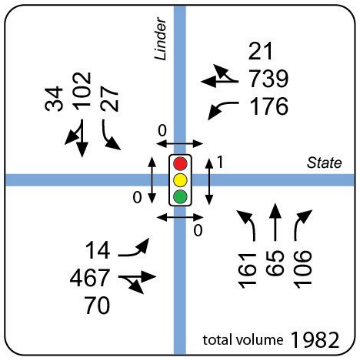
Other concepts reviewed and dropped
Grade separated: Would perform best of all and would easily fit if ROW is preserved. The required bridge would be lower cost as far as bridges go, but other solutions are far lower cost and get very good performance.

Median U-Turn: Requires a weave with significant differentials in speeds. Very unsafe, and poor driver expectation (right to make a left).

Intersection 2 – State & Linder

Summary of the Existing and Future Baseline Conditions Analyses

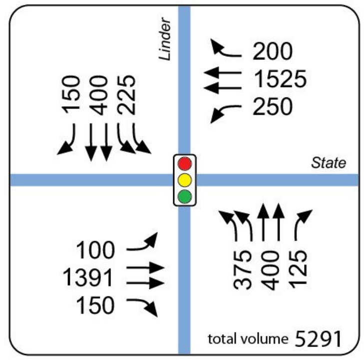
Existing Conditions



State & Linder 2007 PM Peak Hour

LOS D - Average delay 51 sec

Future Baseline Conditions



State & Linder Future PM Peak Hour

LOS F - Average delay >100 sec

Alternative Concept Screening Analysis and Recommendations

Table 2: Future Design Alternatives at State & Linder							
		Weight 40%	30%	20%	10%	100%	
Design Alternative	**Specific Details**	**Operational Performance**	**Relative Costs**	**Compatibility**	**Impacts**	**Composite Score**	**Rank**
At-Grade Alternatives							
No build	Upgrade all four approaches - additional through and turn lanes	2	5	5	5	3.8	1
Continuous flow intersection	Apply to west and east legs	3	4	4	4	3.6	2
Continuous flow intersection	Apply to all four legs	4	3	3	3	3.4	4
Parallel flow intersection	See CFI analysis					0.0	8
Quadrant roadway	Northwest Quadrant	3	3	2	2	2.7	7
Median U-turn	Apply to west and east legs	4	4	2	4	3.6	3
Bowtie	Apply to north and south legs	4	2	3	3	3.1	6
Grade-Separated Alternatives							
Grade separated	Stop or signal control on Linder; State St would have free movement	5	1	4	2	3.3	5
Screened Out for 2030; May Be Good Interim Solution							
Superstreet	Close off northbound and southbound throughs; provide median U-turn on east and west legs	2	4	3	4	3.0	

State / Linder, General Analysis

Baseline assumes 2 throughs and double lefts on all approaches. Long-range volumes fail the intersection, but not as bad as at other locations. This is a reasonable configuration perhaps for the next 15-years, but given the nature of State and the vast developable land, this is a poor long-term choice.

The model shows lower volumes on Linder, but this could change given that Linder is one of few river crossings. Linder may also become a retail corridor as is typical of streets like this, which may not be reflected in today's model. We recommend preserving space for a high-capacity option, along with lower-cost, short-term improvements.

2 or 4-leg CFI/PFI on State
Advantages:

- General advantages apply
- Could be low additional cost, if included as part of larger right of way on State.
- Fits with potential vision to grade-separate for State.

Disadvantages:

- General disadvantages apply
- Could be challenging with existing development, canal, etc.

Median U-Turn on State
Advantages:

- General advantages apply
- Performs very well in early tests
- Very low cost – especially if State expands right-of-way to 200 ft as may occur
- Consistent with longer vision for State.

Disadvantages:

- General disadvantages apply
- Potential high-speed weave

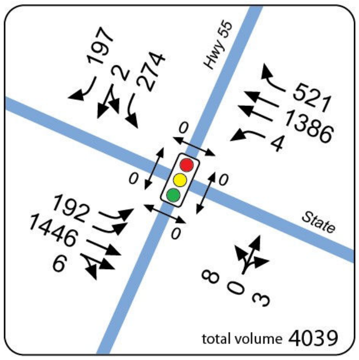
Points of Merit on others considered

Bulb-out bowtie/roundabouts on Linder may be very aesthetic and would improve function considerably. We don't plan to investigate this further, but future studies may want to consider this.

Intersection 3 – State & SH55 North

Summary of the Existing and Future Baseline Conditions Analyses

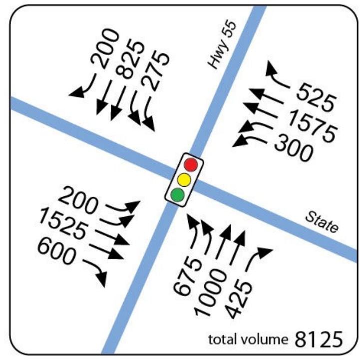
Existing Conditions



State & Hwy 55 2007 PM Peak Hour

LOS C - Average delay 27 sec

Future Baseline Conditions



State & Hwy 55 Future PM Peak Hour

LOS F - Average delay >100 sec

Alternative Concept Screening Analysis and Recommendations

Table 3: Future Design Alternatives at State & SH55 North

Design Alternative	Specific Details	Weight 40% Operational Performance	30% Relative Costs	20% Compatibility	10% Impacts	100% Composite Score	Rank
At-Grade Alternatives							
No build	Expand south leg; all approaches to be upgraded to dual left turns, two through lanes, and right turn bay	1	5	5	5	3.4	4
Continuous flow intersection	Apply to west and east legs	3	4	4	4	3.6	2
Continuous flow intersection	Apply to all 4 legs	4	3	4	4	3.7	1
Parallel flow intersection	See CFI analysis					0.0	7
Quadrant roadway	Southwest Quadrant	3	3	2	3	2.8	6
Median U-turn	Apply to west and east legs	3	4	3	4	3.4	3
Grade-Separated Alternatives							
Grade separated	Stop or signal control on SH55 North; State St would have free movement	5	1	4	2	3.3	5

State / Hwy 55, General Analysis

Baseline is a complete failure.

2 or 4-leg CFI/PFI on State
Advantages:
- General advantages apply
- Both 2 and 4-leg options are easily implemented, due to existing restricted access, ample space.
- Easily upgradable to grade-separated, which may be worth protecting on State
- Pedestrian issues less significant, as this location has few pedestrians

Disadvantages:
General disadvantages apply

Single Quadrant, SW corner
Advantages:
- General advantages apply
- Low cost relative to CFI.
- Could be coordinated with development

Disadvantages:
- General disadvantages apply
- Considerably less attractive than CFIs, but lower cost

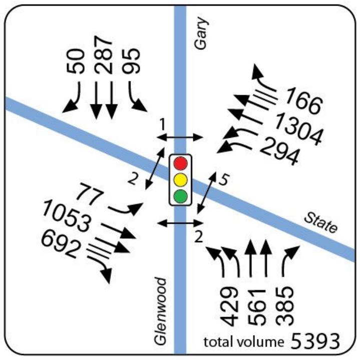
Points of Merit on others considered

Grade separation seems fairly compatible with the context. Cost is the only reason this is not attractive.

Intersection 4 – State & Glenwood

Summary of the Existing and Future Baseline Conditions Analyses

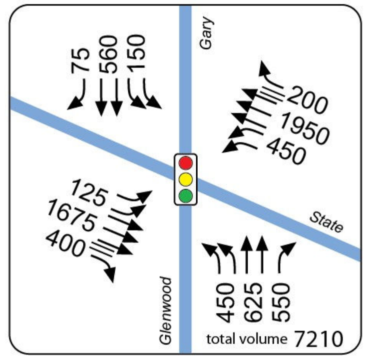
Existing Conditions



State & Glenwood 2007 PM Peak Hour

LOS D - Average delay 48 sec

Future Baseline Conditions



State & Glenwood Future PM Peak Hour

LOS F - Average delay 99 sec

Alternative Concept Screening Analysis and Recommendations

Table 4: Future Design Alternatives at State & Glenwood

Design Alternative	**Specific Details**	**Operational Performance** (Weight 40%)	**Relative Costs** (30%)	**Compatibility** (20%)	**Impacts** (10%)	**Composite Score** (100%)	**Rank**
At-Grade Alternatives							
No build	Eastbound and westbound approaches to have three through lanes; all approaches to have dual left turns	2	5	5	5	3.8	4
Continuous flow intersection	Apply to west and east legs	3	3	3	3	3.0	7
Continuous flow intersection	Apply to all 4 legs	4	2	2	2	2.8	8
Parallel flow intersection	See CFI analysis					0.0	10
Quadrant roadway	Northwest Quadrant	3	5	3	5	3.8	3
Quadrant roadway	Use 2 Quadrants	4	4	4	4	4.0	2
Quadrant roadway	Use 4 Quadrants	4	3	5	3	3.8	4
Median U-turn	Apply to west and east legs	5	4	4	4	4.4	1
Bowtie	Apply to south and north legs	4	3	4	3	3.6	6
Grade-Separated Alternatives							
Grade separated	Stop or signal control on Glenwood; State St would have free movement	4	1	1	1	2.2	9

State / Glenwood, General Analysis

Baseline is a complete failure. Something should be done.

Median U-Turns on State

Advantages:

- General advantages apply
- Fairly easy to implement with existing conditions.
- Tests suggest performance would improve significantly

Disadvantages:

General disadvantages apply

Single Quadrant Roadway

Advantages:

- General advantages apply
- Northwest quad already exists

Disadvantages:

- General disadvantages apply
- Other quadrants are possible but difficult

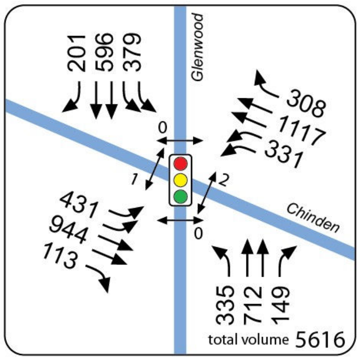
Points of Merit on others considered

Nothing else is very attractive. Bowtie is generally an enhancement of the Median U-Turn, and would work here, but requires more space and would conflict with existing parking lots.

Intersection 5 – Chinden & Glenwood

Summary of the Existing and Future Baseline Conditions Analyses

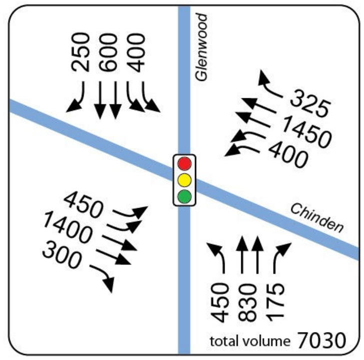
Existing Conditions



Chinden & Glenwood 2007 PM Peak Hour

LOS F - Average delay 96 sec

Future Baseline Conditions



Chinden & Glenwood Future PM Peak Hour

LOS F - Average delay >100 sec

Alternative Concept Screening Analysis and Recommendations

Table 5: Future Design Alternatives at Chinden & Glenwood

Design Alternative	Specific Details	Operational Performance (Weight 40%)	Relative Costs (30%)	Compatibility (20%)	Impacts (10%)	Composite Score (100%)	Rank
At-Grade Alternatives							
No build	No planned change from existing geometry	1	5	5	5	3.4	5
Continuous flow intersection	Apply to west and east legs	4	3	4	3	3.6	3
Parallel flow intersection	See CFI analysis					0.0	8
Quadrant roadway	Northeast Quadrant	3	5	4	5	4.0	1
Quadrant roadway	Northeast & Southwest Quadrants	4	3	3	3	3.4	4
Median U-turn	Apply to west and east legs	3	4	4	4	3.6	2
Grade-Separated Alternatives							
Grade separated	Traditional Interchange	4	1	1	1	2.2	7
Grade separated	Chinden access via Quadrant	5	1	3	2	3.1	6

Chinden / Glenwood, General Analysis

Baseline is a complete failure. Something should be done.

Median U-Turns on State

Advantages:

- General advantages apply
- Fairly easy to implement with existing conditions.
- Tests suggest performance would improve significantly

Disadvantages:

- General disadvantages apply

Single Quadrant Roadway

Advantages:

- General advantages apply
- Northeast quad already exists

Disadvantages:

- General disadvantages apply
- Other quadrants are possible. SW quad exists, but resident anxiety is likely.

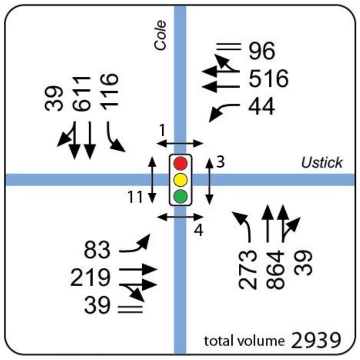
Points of Merit on others considered

Nothing else is very attractive. Bowtie is generally an enhancement of the Median U-Turn, and would work here, but requires more space and would conflict with existing parking lots.

Intersection 6 – Ustick & Cole

Summary of the Existing and Future Baseline Conditions Analyses

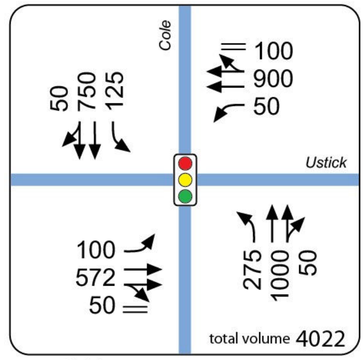
Existing Conditions



Ustick & Cole 2007 PM Peak Hour

LOS C - Average delay 29 sec

Future Baseline Conditions



Ustick & Cole Future PM Peak Hour

LOS F - Average delay 81 sec

Alternative Concept Screening Analysis and Recommendations

Table 6: Future Design Alternatives at Ustick & Cole							
		Weight					
		40%	30%	20%	10%	100%	
Design Alternative	**Specific Details**	**Operational Performance**	**Relative Costs**	**Compatibility**	**Impacts**	**Composite Score**	**Rank**
At-Grade Alternatives							
No build	No planned change from existing geometry	1	5	5	5	3.4	3
Continuous flow intersection	Apply to west and east legs	4	3	3	3	3.4	2
Continuous flow intersection	Apply to all 4 legs	5	2	2	2	3.2	5
Parallel flow intersection	See CFI analysis					0.0	8
Quadrant roadway	Southwest Quadrant	4	2	3	3	3.1	6
Jug-handle	One way right turn only in 4 quadrants	4	3	3	2	3.3	4
Median U-turn	Apply to west and east legs	3	3	3	4	3.1	7
Bowtie	Apply to west and east legs	4	3	4	3	3.6	1
Grade-Separated Alternatives							
None							

Ustick / Cole, General Analysis

Baseline assumes some widening, but it is still likely to fail, though not as badly as at some locations.

Many options can likely improve flow without a general widening, which may cost less than the baseline and help maintain the character of the area.

Bowtie (either Cole or Ustick –TBD)
Advantages:

- General advantages apply
- Very aesthetically appealing

Disadvantages:

- General disadvantages apply
- Will conflict with existing parking somewhat, and may require a home or two

CFI or PFI
Advantages:

- General advantages apply
- Performance indications are very good.
- May be possible to create a "tight design" that would not impact businesses

Disadvantages:

- General disadvantages apply
- High potential of conflicting with development

Points of Merit on others considered

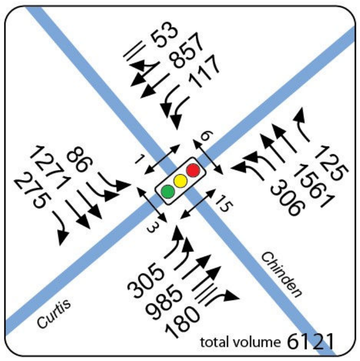
Jughandle Quadrants
Note: It appears possible to develop four very tight jughandles encircling the first businesses on the corners. This would achieve two-phase signals and clear congestion from the intersection. Some could be two-way, allowing access to parking lots as occurs today. The one by the gas station could be one-way to make it narrower, and avoid taking homes behind the station.

This could be a very good option, that should be considered further, even if resources in this study don't allow much more.

Intersection 7 – Chinden & Curtis

Summary of the Existing and Future Baseline Conditions Analyses

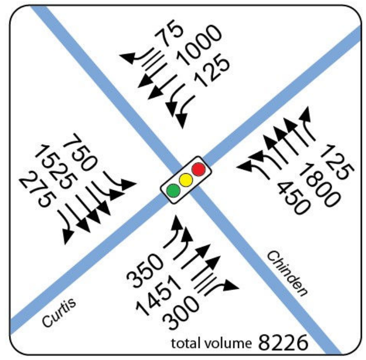
Existing Conditions



Chinden & Curtis 2007 PM Peak Hour

LOS F - Average delay >100 sec

Future Baseline Conditions



Chinden & Curtis Future PM Peak Hour

LOS F - Average delay >100 sec

Alternative Concept Screening Analysis and Recommendations

Table 7: Future Design Alternatives at Chinden & Curtis

Design Alternative	**Specific Details**	Weight 40% **Operational Performance**	30% **Relative Costs**	20% **Compatibility**	10% **Impacts**	100% **Composite Score**	**Rank**
At-Grade Alternatives							
No build	Eastbound and westbound approaches to have three through lanes; add right turn bay to southbound approach	1	5	5	5	3.4	3
Quadrant roadway	Southwest quadrant	2	5	4	5	3.6	2
Quadrant roadway	2 quadrants	3	3	4	3	3.2	4
Quadrant roadway	4 quadrants	4	2	4	1	3.1	5
Jughandle / cloverleaf	Right turn only one-way treatments to each quadrant	2	4	4	3	3.1	6
Median U-turn	Apply to west and east legs	3	4	4	4	3.6	1
Town center intersection	One variation: sections of Chinden and Curtis become pedestrian-friendly greenways. The traffic would be re-routed onto one-way roadways running parallel with the current roadways.					0.0	8
Grade-Separated Alternatives							
Grade separated	Stop or signal control on Chinden; Curtis would have free movement	5	1	1	2	2.7	7

Chinden / Curtis, General Analysis

Baseline assumes some widening, but there is still extreme failure in spite of widening Chinden.

Many options can likely improve flow to acceptable levels, and not require a general widening of Chinden.

Median U-Turns, either Chinden or Curtis
Advantages:

- General advantages apply
- Among the easiest of all options to implement at this site.

Disadvantages:

- General disadvantages apply
- Will have some impacts, but far less than most other options.
- Performance would be much better, but there are other options that would perform even better, though at a higher cost.

Single Quadrant, SW corner
Advantages:

- General advantages apply
- Very low cost to implement

Disadvantages:

- General disadvantages apply

Points of Merit on others considered

Jughandle Quadrants
Note: As at Ustick/Cole, it similarly appears possible to develop four very tight jughandles encircling the first businesses on the corners. This would achieve two-phase signals and likely clear congestion from the intersection.

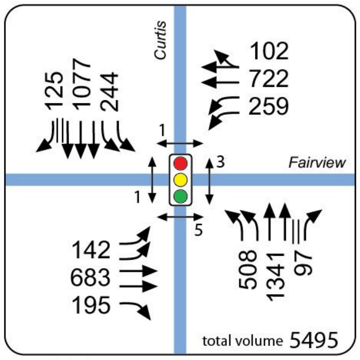
These jughandles would be designed as free rights, and they likely need their own through lanes in the main intersection.

This could be a very good option that should be considered further, even if resources in this study don't allow much more.

Intersection 8 – Fairview & Curtis

Summary of the Existing and Future Baseline Conditions Analyses

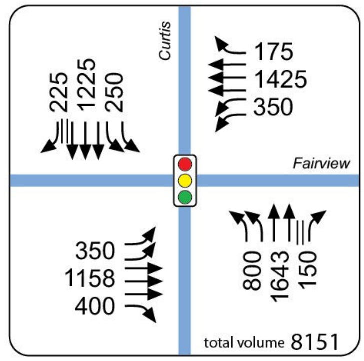
Existing Conditions



Fairview & Curtis 2007 PM Peak Hour

LOS D - Average delay 54 sec

Future Baseline Conditions



Fairview & Curtis Future PM Peak Hour

LOS F - Average delay >100 sec

Alternative Concept Screening Analysis and Recommendations

Table 8: Future Design Alternatives at Fairview & Curtis

Design Alternative	Specific Details	Weight 40% Operational Performance	30% Relative Costs	20% Compatibility	10% Impacts	100% Composite Score	Rank
At-Grade Alternatives							
No build	Eastbound and westbound approaches to have three through lanes; add right turn bay to westbound approach	1	5	5	5	3.4	3
TSM improvements	Triple northbound left turns 3 northbound through lanes	2	4	4	4	3.2	4
Continuous flow intersection	Apply to west and east legs	3	3	3	2	2.9	6
Parallel flow intersection	See CFI analysis					0.0	8
Quadrant roadway	Northeast Quadrant	3	4	4	4	3.6	2
Median U-turn	Apply to west and east legs	3	3	3	3	3.0	5
Realign Opohonga St / Quadrant roadway	Realign Opohonga St to the I-184 WB ramp intersection and provide northeast quadrant treatment.	5	2	4	3	3.7	1
Grade-Separated Alternatives							
Grade separated	Stop or signal control on Fairview; Curtis would have free movement	4	1	1	1	2.2	7

Fairview / Curtis, General Analysis
Baseline and conventional options simply won't work in this setting.

Realign Opohonga to meet with off-ramp
Advantages:

- Creates a quadrant road in SW
- Allows I-84 to WB Fairview volume to completely avoid intersection

Disadvantages:

- May be tricky to design

Single Quadrant, NE corner
Advantages:

- General advantages apply
- Very low cost to implement
- Good combination with Opohonga realignment

Disadvantages:

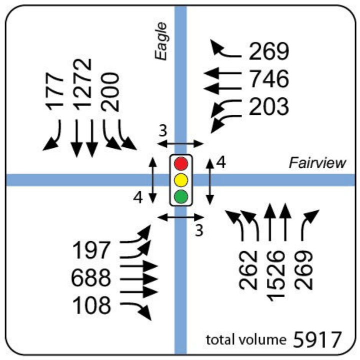
- General disadvantages apply

These options combined, or a variation, appears to be by far the most attractive

Intersection 9 – Fairview & Eagle

Summary of the Existing and Future Baseline Conditions Analyses

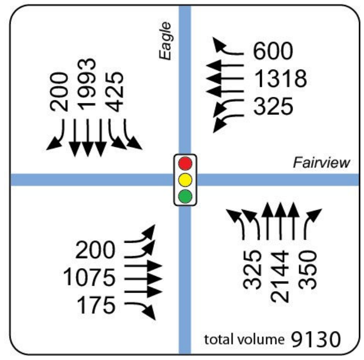
Existing Conditions



Fairview & Eagle 2007 PM Peak Hour

LOS F - Average delay 93 sec

Future Baseline Conditions



Fairview & Eagle Future PM Peak Hour

LOS F - Average delay >100 sec

Alternative Concept Screening Analysis and Recommendations

Table 9: Future Design Alternatives at Fairview & Eagle

Design Alternative	Specific Details	Operational Performance (Weight 40%)	Relative Costs (30%)	Compatibility (20%)	Impacts (10%)	Composite Score (100%)	Rank
At-Grade Alternatives							
No build	All approaches to have three through lanes	1	5	5	5	3.4	5
Continuous flow intersection	Apply to all 4 legs	4	3	4	3	3.6	2
Parallel flow intersection	See CFI analysis					0.0	7
Quadrant roadway - 1	Northeast Quadrant	3	4	4	4	3.6	1
Quadrant roadway - 2	Northeast and Southwest Quadrant	4	3	4	3	3.6	2
Median U-turn	Apply to west and east legs	3	4	4	3	3.5	4
Grade-Separated Alternatives							
Grade separated	Stop or signal control on Fairview; Eagle would have free movement	5	1	1	1	2.6	6

Fairview / Eagle, General Analysis

Baseline and conventional options simply won't work in this setting.

CFI

Advantages:

- General advantages apply
- Very compatible with existing conditions.

Disadvantages:

- General disadvantages apply

Single Quadrant, NW or NE corner

Advantages:

- General advantages apply
- Can be built as the corner develops
- More pedestrian friendly than CFI

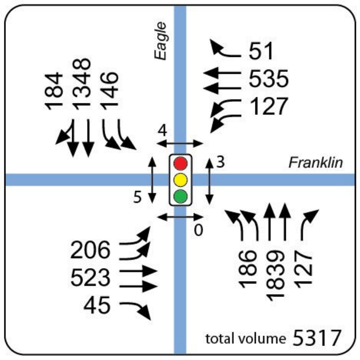
Disadvantages:

- General disadvantages apply

Intersection 10 – Franklin & Eagle

Summary of the Existing and Future Baseline Conditions Analyses

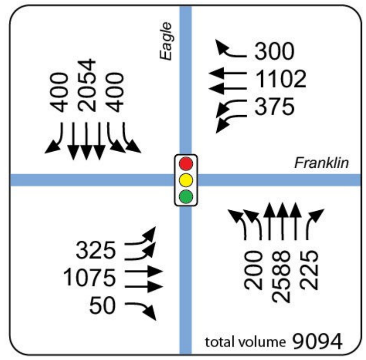
Existing Conditions



Franklin & Eagle 2007 PM Peak Hour

LOS E - Average delay 70 sec

Future Baseline Conditions



Franklin & Eagle Future PM Peak Hour

LOS F - Average delay >100 sec

Alternative Concept Screening Analysis and Recommendations

Table 10: Future Design Alternatives at Franklin & Eagle

Design Alternative	Specific Details	Operational Performance	Relative Costs	Compatibility	Impacts	Composite Score	Rank
		Weight 40%	30%	20%	10%	100%	
At-Grade Alternatives							
No build	Northbound and southbound approaches to have three through lanes; add right turn bay to southbound approach	1	5	5	5	3.4	2
Continuous flow intersection	Apply to south and north legs	3	3	4	4	3.3	3
Continuous flow intersection	Apply to all 4 legs	4	2	3	3	3.1	4
Parallel flow intersection	See CFI analysis					0.0	7
Quadrant roadway	Northeast Quadrant	4	5	4	5	4.4	1
Median U-turn	Apply to west and east legs	2	3	3	4	2.7	5
Grade-Separated Alternatives							
Grade separated	Stop or signal control on Franklin; Eagle would have free movement	5	1	1	1	2.6	6

Franklin / Eagle, General Analysis

Baseline and conventional options simply won't work in this setting.

CFI

Advantages:

- General advantages apply
- Very compatible with existing conditions.

Disadvantages:

- General disadvantages apply

Single Quadrant, NE corner

Advantages:

- General advantages apply
- NE quad already exists
- More pedestrian friendly than CFI

Disadvantages:

- General disadvantages apply