Highway Configuration and Implementation Issues

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NASHC Workshop #3

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(slides: 12-1 to 12-14)

Contents

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Configuration Alternatives for Dedicated AHS Operation

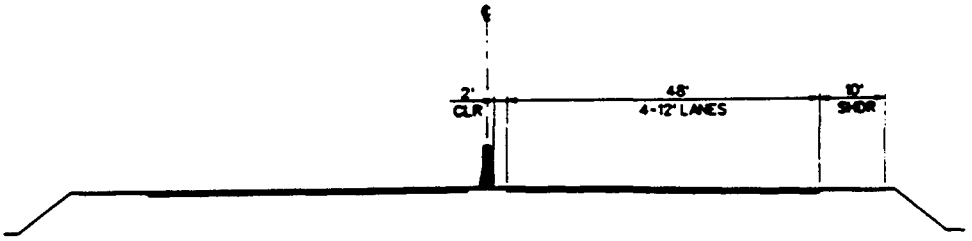
- **Share common ROW with existing freeway at same grade:**
  - *use common ramps and transition lane*
  - *use dedicated ramps and interchanges*
- **Share common ROW with existing freeway but at a different elevation**
- **Build a separate facility on exclusive ROW, dedicated to AHS only**
- **Options for specific application environment**

12-3

Factors Influencing AHS Highway Configuration and Design

- **Automation Technology**
- **Driver Involvement**
- **Throughput**
- **Safety**
- **Liability**
- **Cost**
- **Environmental Mitigation**
- **Application Environment**
- **Local Conditions & Requirements**

12-4



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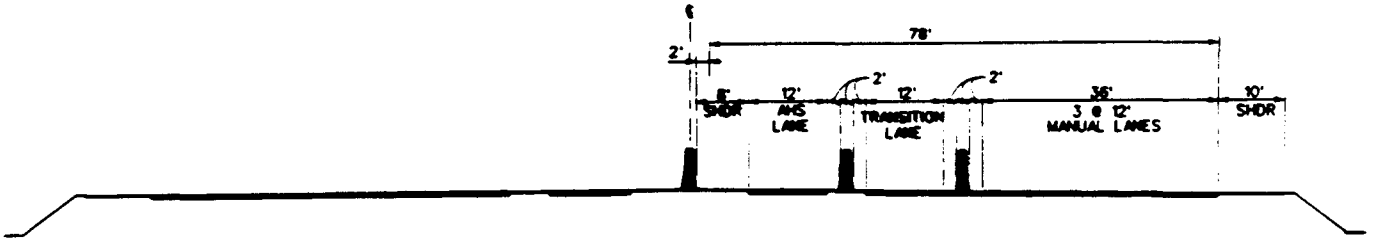

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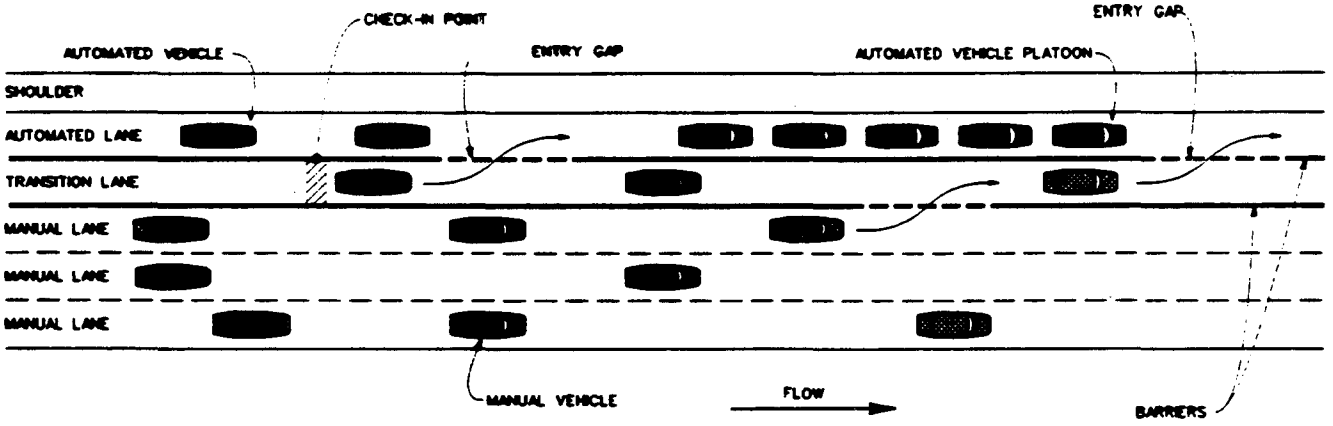
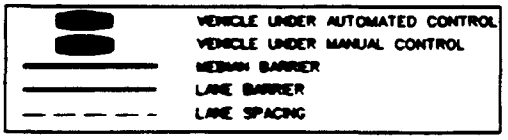
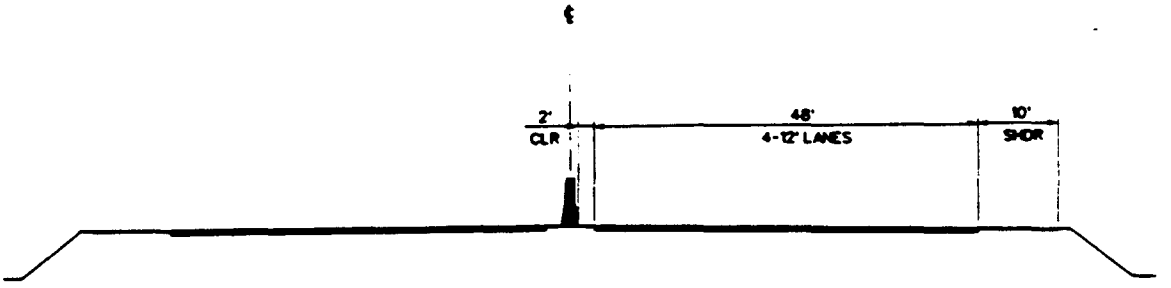
DEDICATED LANE WITH TRANSITION LANE
COMMON ENTRY / EXIT RAMPS





URBAN
CASE 3

12-3 a



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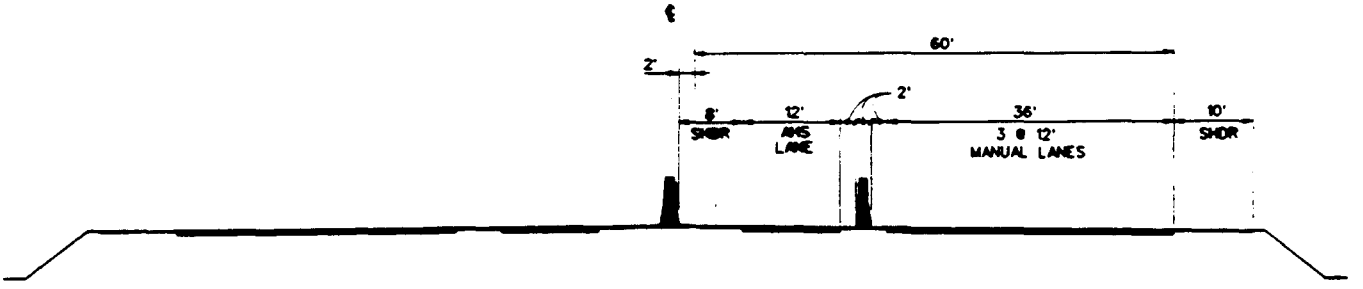

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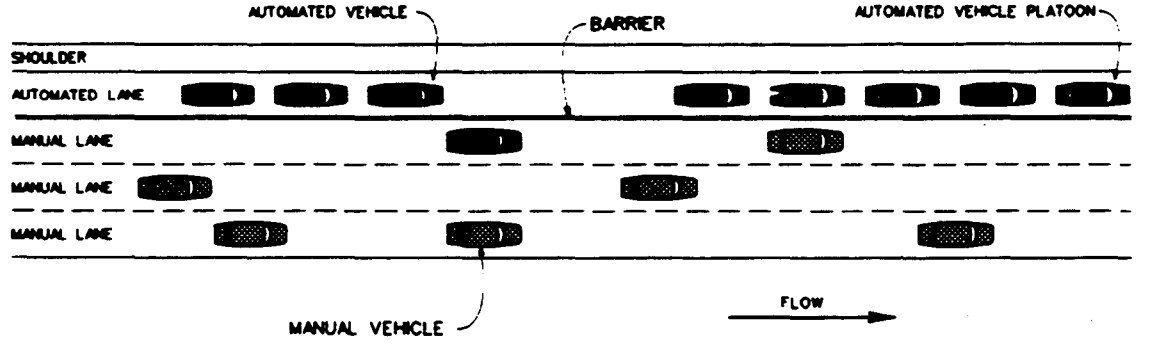
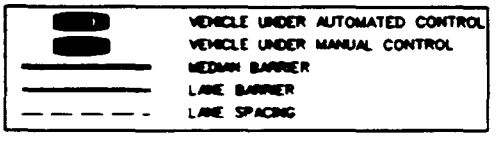
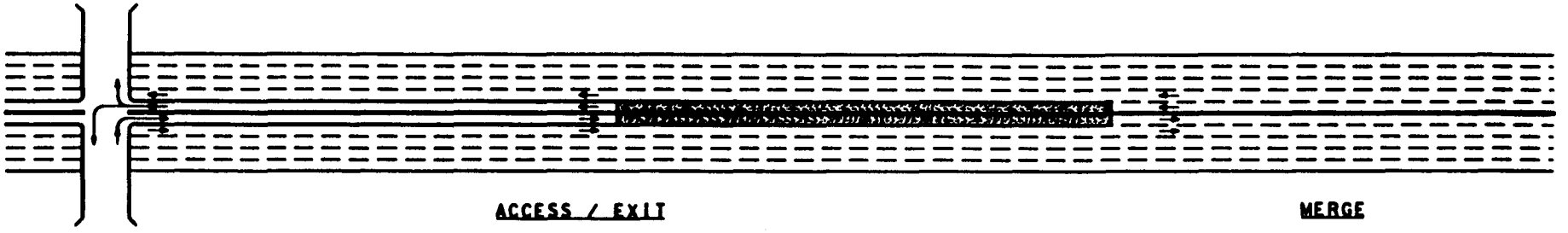
DEDICATED LANE -
DEDICATED ENTRY / EXIT RAMPS

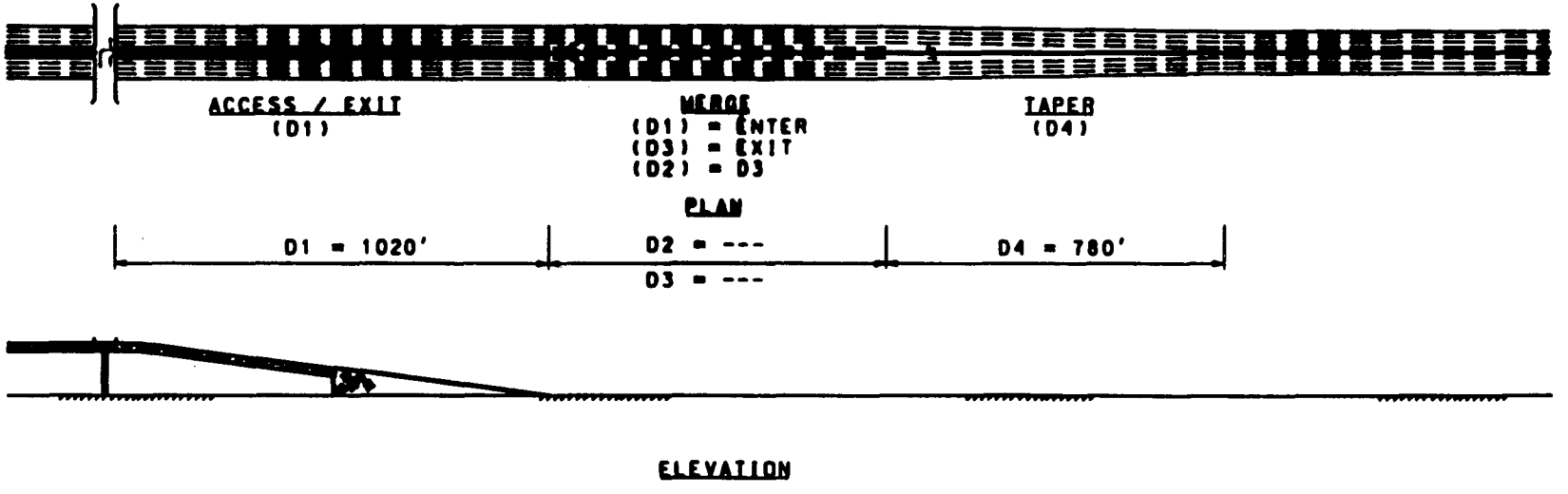




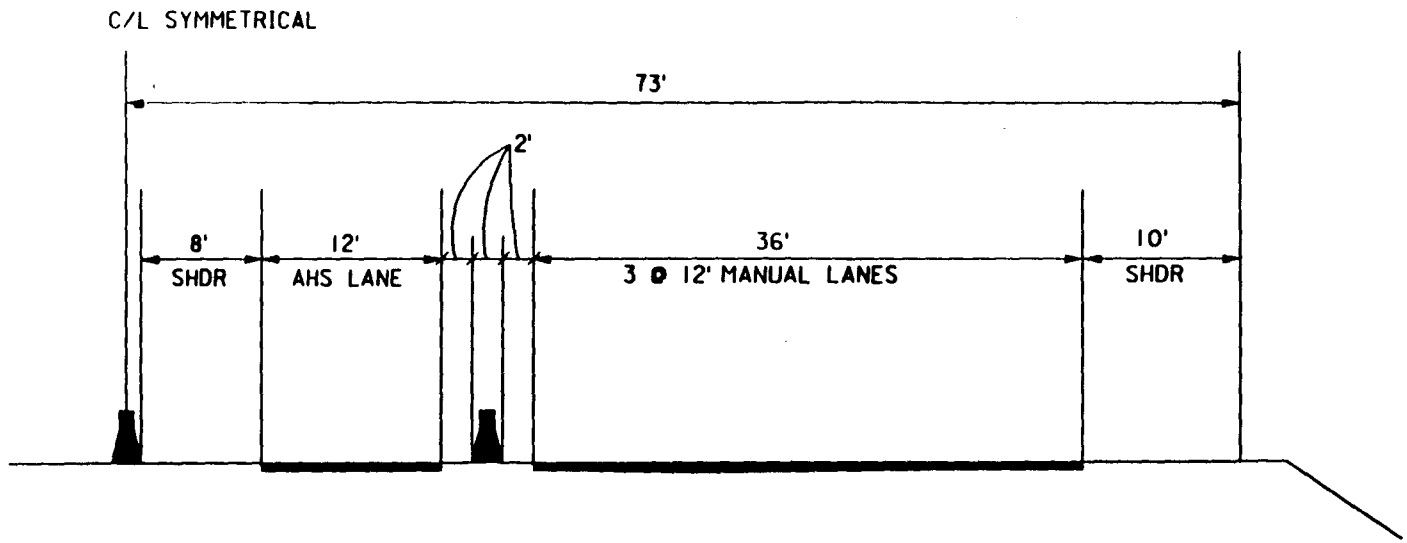
URBAN
CASE 1

12-36

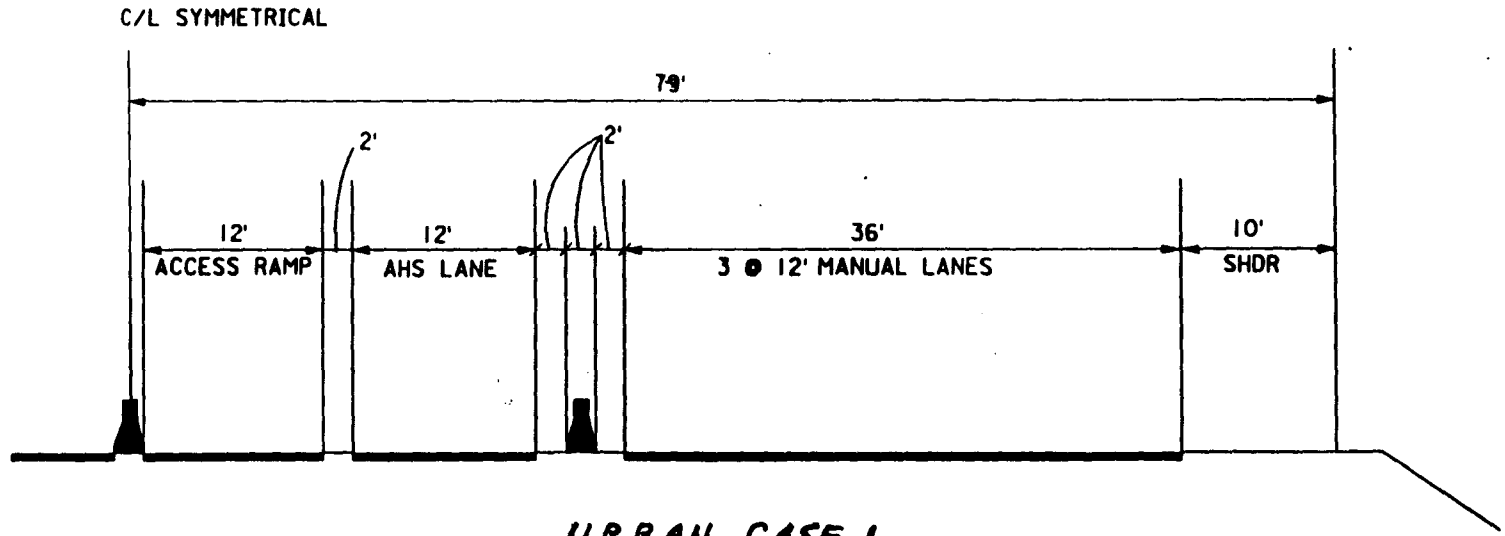




DEDICATED ENTRY / EXIT RAMP

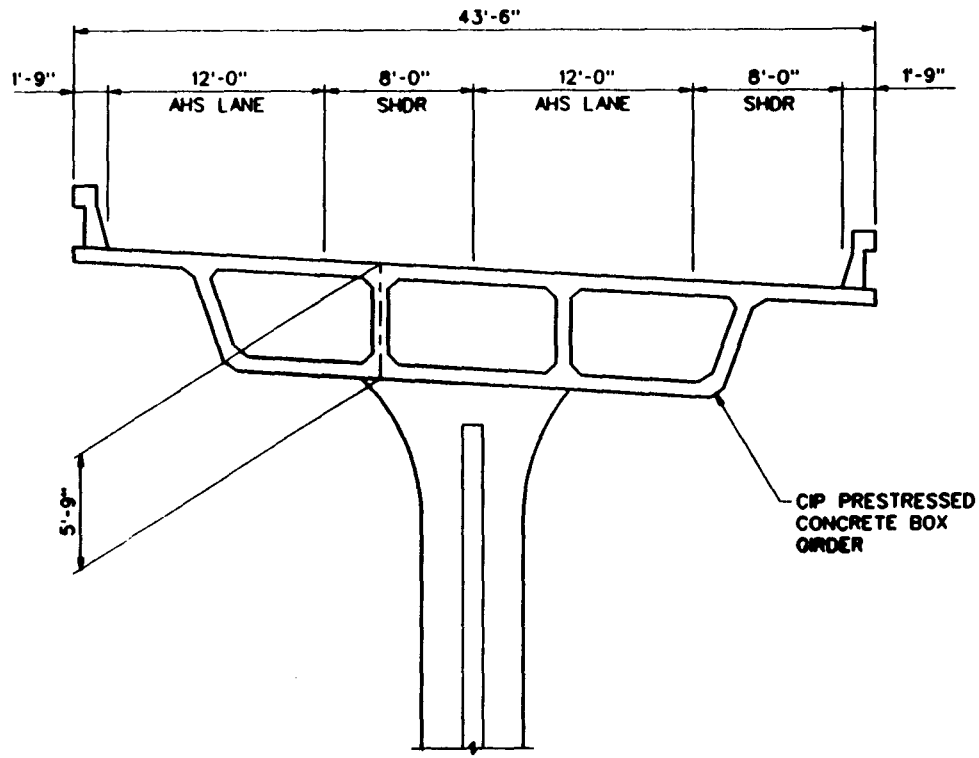


TYPICAL AHS / MANUAL CROSS SECTION



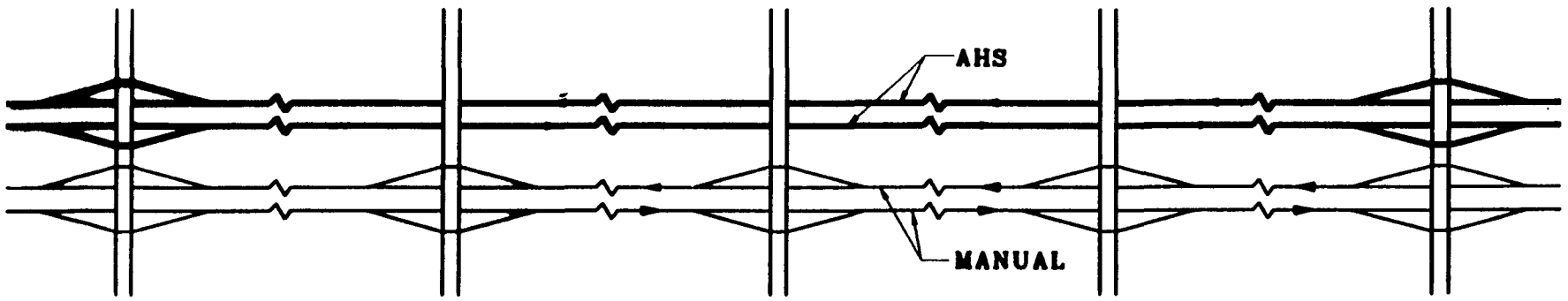
URBAN CASE 1

TYPICAL AHS RAMP / AHS / MANUAL CROSS SECTION



URBAN SCENARIO

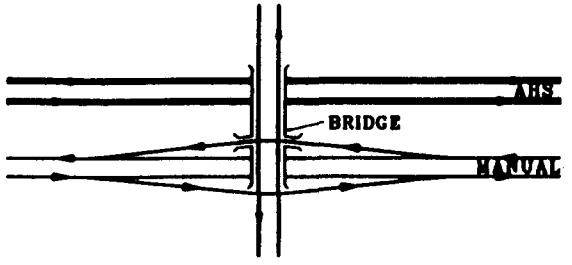
DEDICATED AHS STRUCTURE - ELEVATED



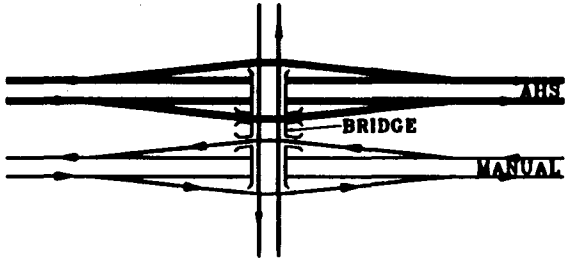
AHS INTERCHANGE SPACING
(AS REQUIRED)

AHS I/C	LOCAL I/C	LOCAL I/C	LOCAL I/C	AHS I/C
DETAIL 2	DETAIL 1	DETAIL 1	DETAIL 1	DETAIL 2

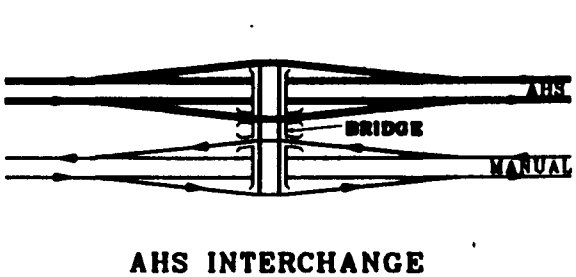
CORRIDOR I/C LAYOUT



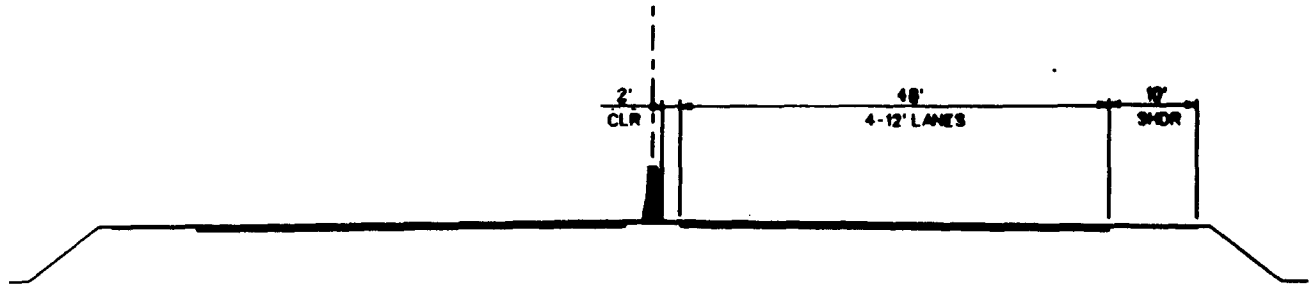
LOCAL INTERCHANGE
DETAIL 1



AHS INTERCHANGE
DETAIL 2



AHS INTERCHANGE
OPTION A
(NO STREET CONNECTION)



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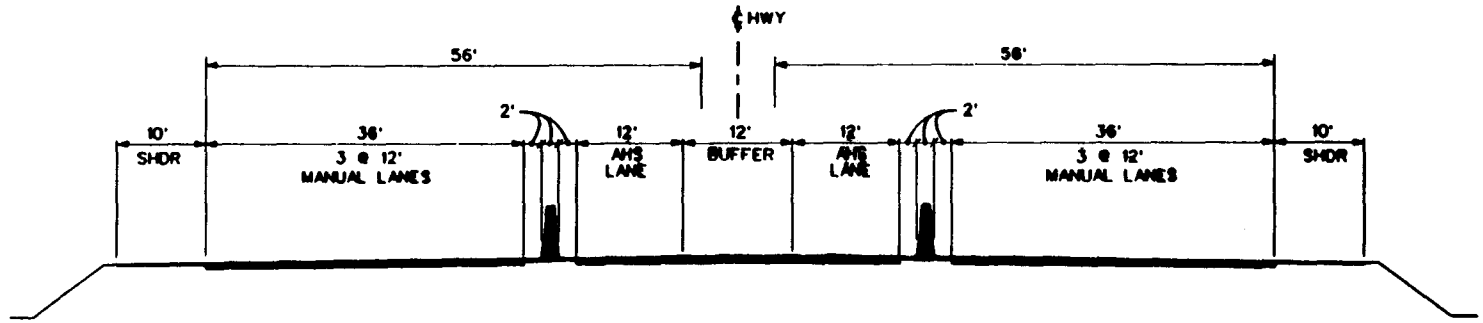

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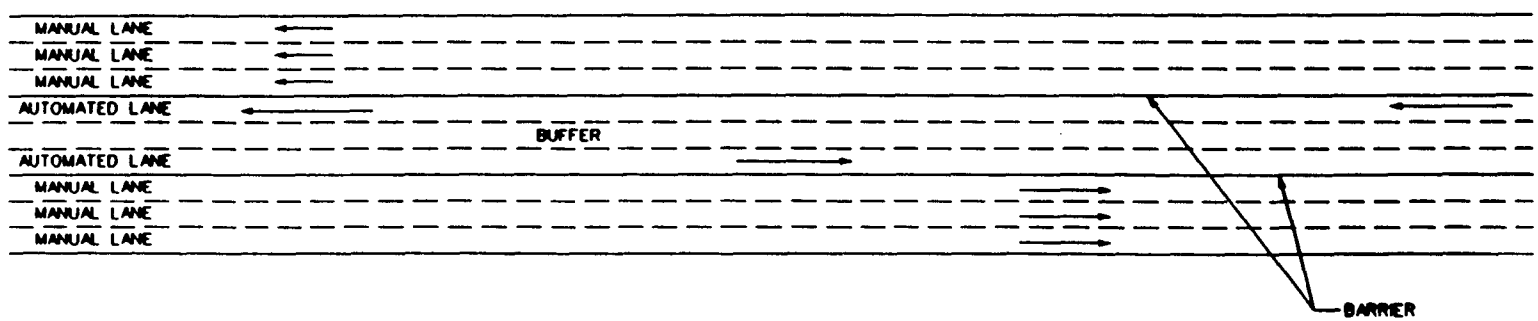
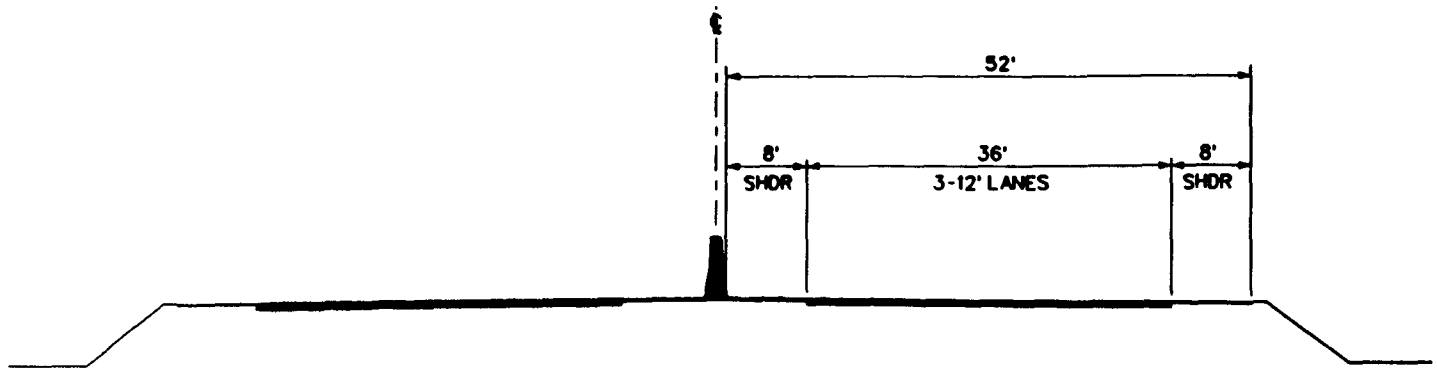
BUFFER SEPARATION



URBAN
CASE 2

12-4a



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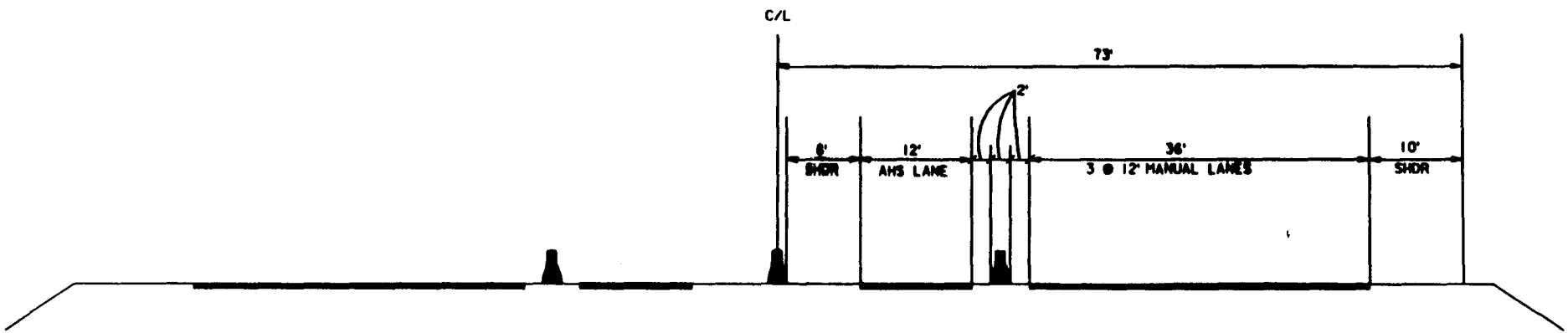

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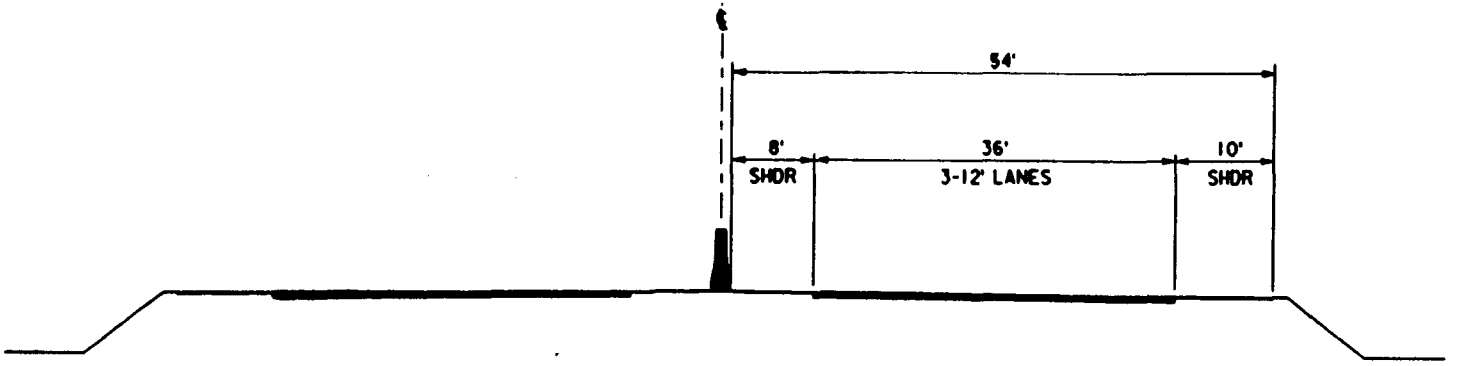
ADD / AHS LANE
WITH BARRIER

INTERURBAN

12 - 46



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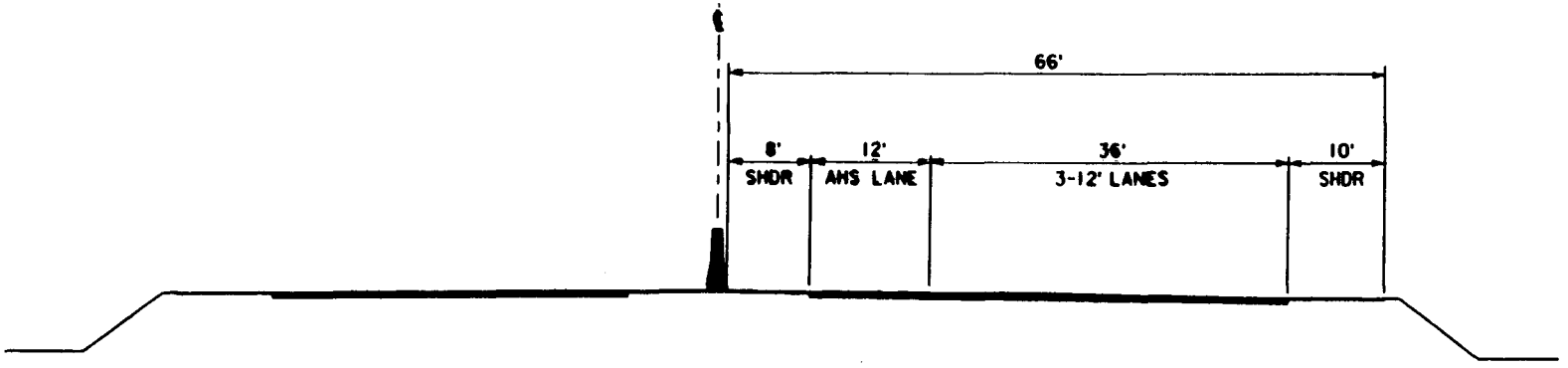

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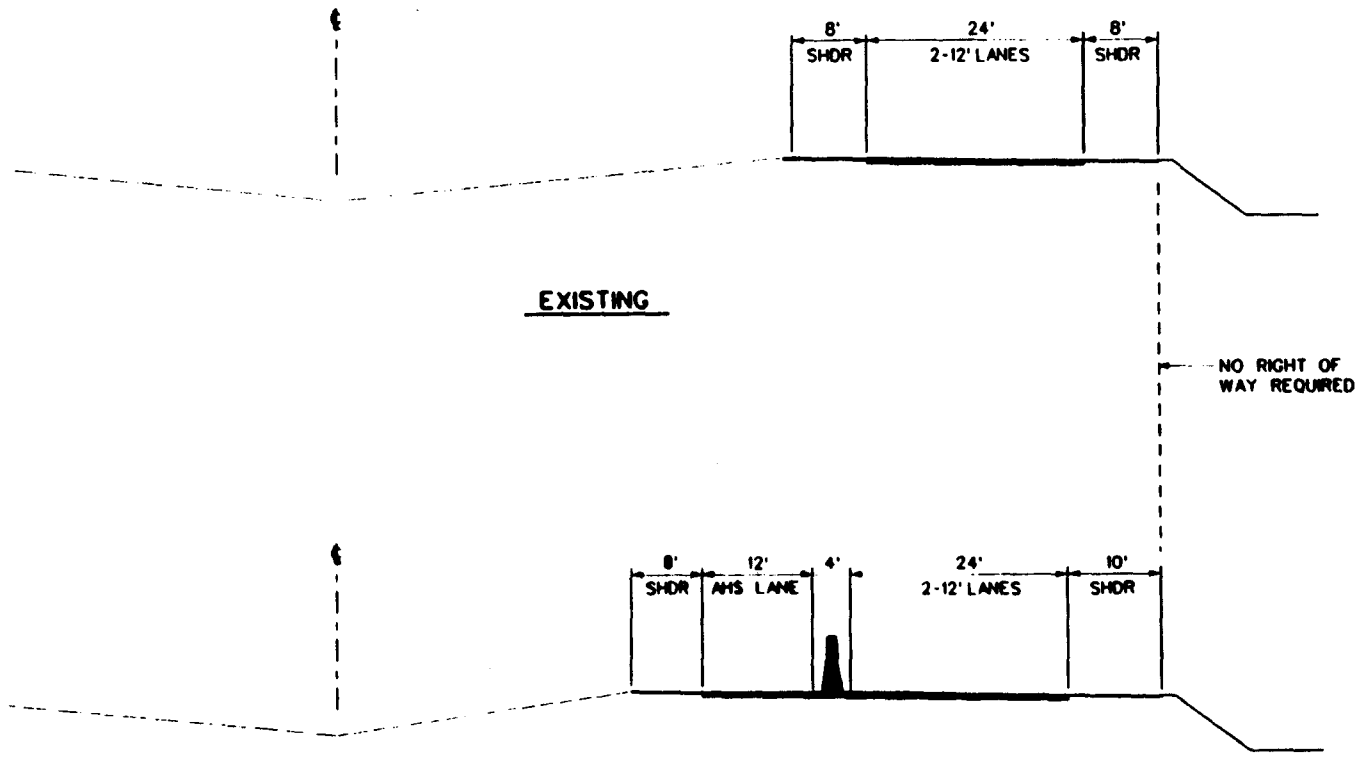
3-4 LANE WIDENING
1 AHS LANE

12-4c

FIGURE 1



RURAL
CASE 1

12-4d

Major Drivers Influencing Geometric Standards

- Automation
  - Width of lane, shoulder, buffer/barrier, etc.
  - Horizontal clearances
  - Horizontal curves
  - Separation from manual traffic, passenger cars, trucks
  - Need for (sharing of) breakdown lane/areas
  - Moving into & out of manual lanes

12-5

Major Drivers Influencing Geometric Standards (cont'd)

- Throughput
  - Length and width of ramps
  - Length of entry and exit lanes
  - Impacts on manual traffic operations
  - Negotiating interchanges
  - Negotiating bridges, tunnels, and viaducts
  - Merging 2 dedicated AHS lanes, ramps
  - Addition of manual lanes for weaving

12-6

Major Drivers Influencing Geometric Standards (cont'd)

- Planning / Environmental Issues
  - Future addition of dedicated lanes (deployment scheme)
  - Noise mitigation, especially for elevated structures
  - Air pollution mitigation measures

12-7

Configuration Issues

- Right-of-Way (ROW) availability and acquisition cost
- Separation of automated and manual traffic: physical barriers, virtual barriers, and buffer areas/zones
- Safeguards against rogue vehicles, especially trucks and barriers design
- Interchange spacing as dictated by lengths of entry/exit lanes

12-8

Configuration Issues (cont'd)

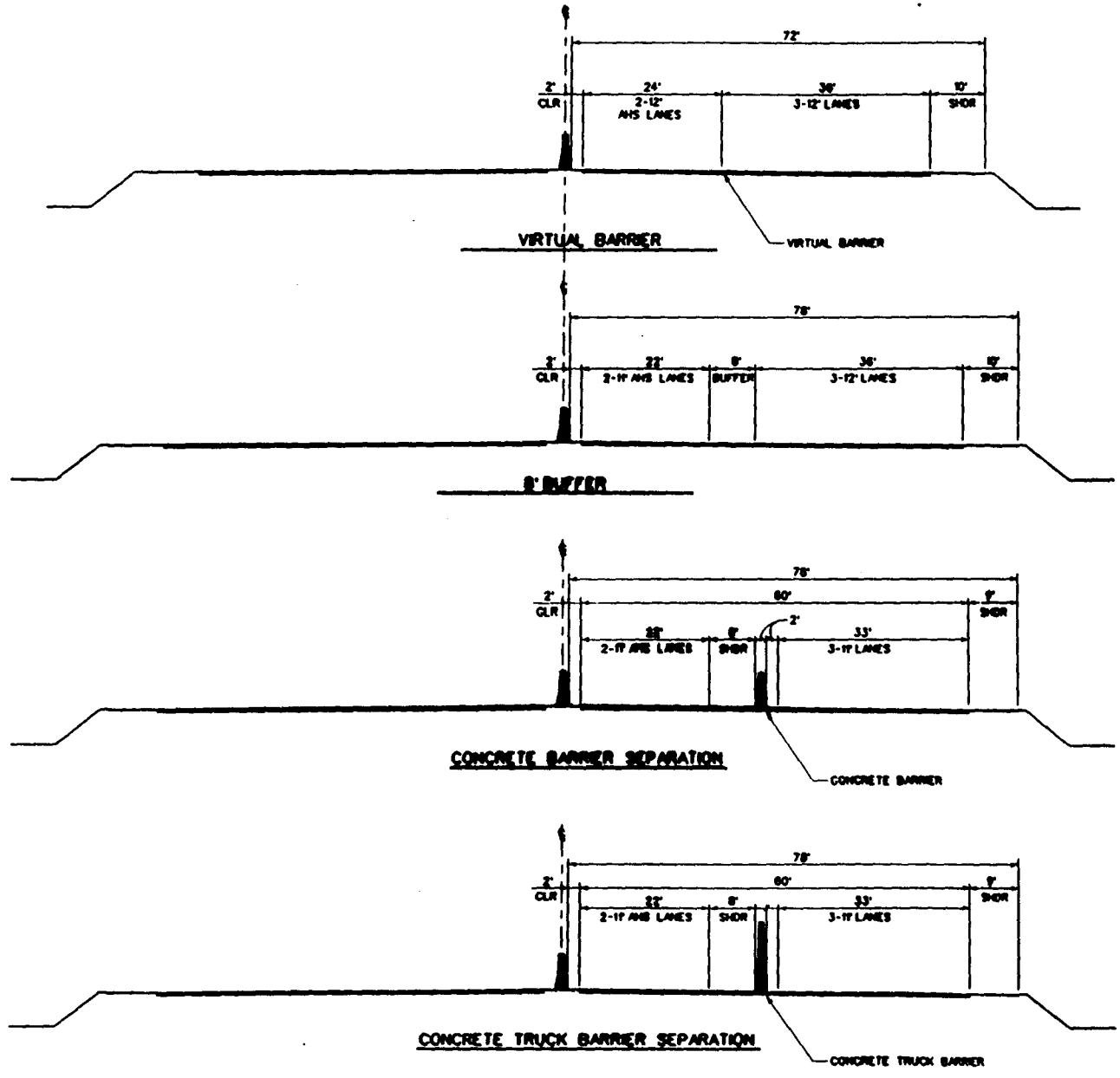
- Options for negotiating freeway to freeway interchanges
- Partial use of a manual lane for a "dedicated" AHS transition lane
- Continuous vs. shared breakdown lane
- Need for breakdown lane/area
- Continuity of AHS operations through long bridges, tunnels, and viaducts

12-9

Urban Application Issues

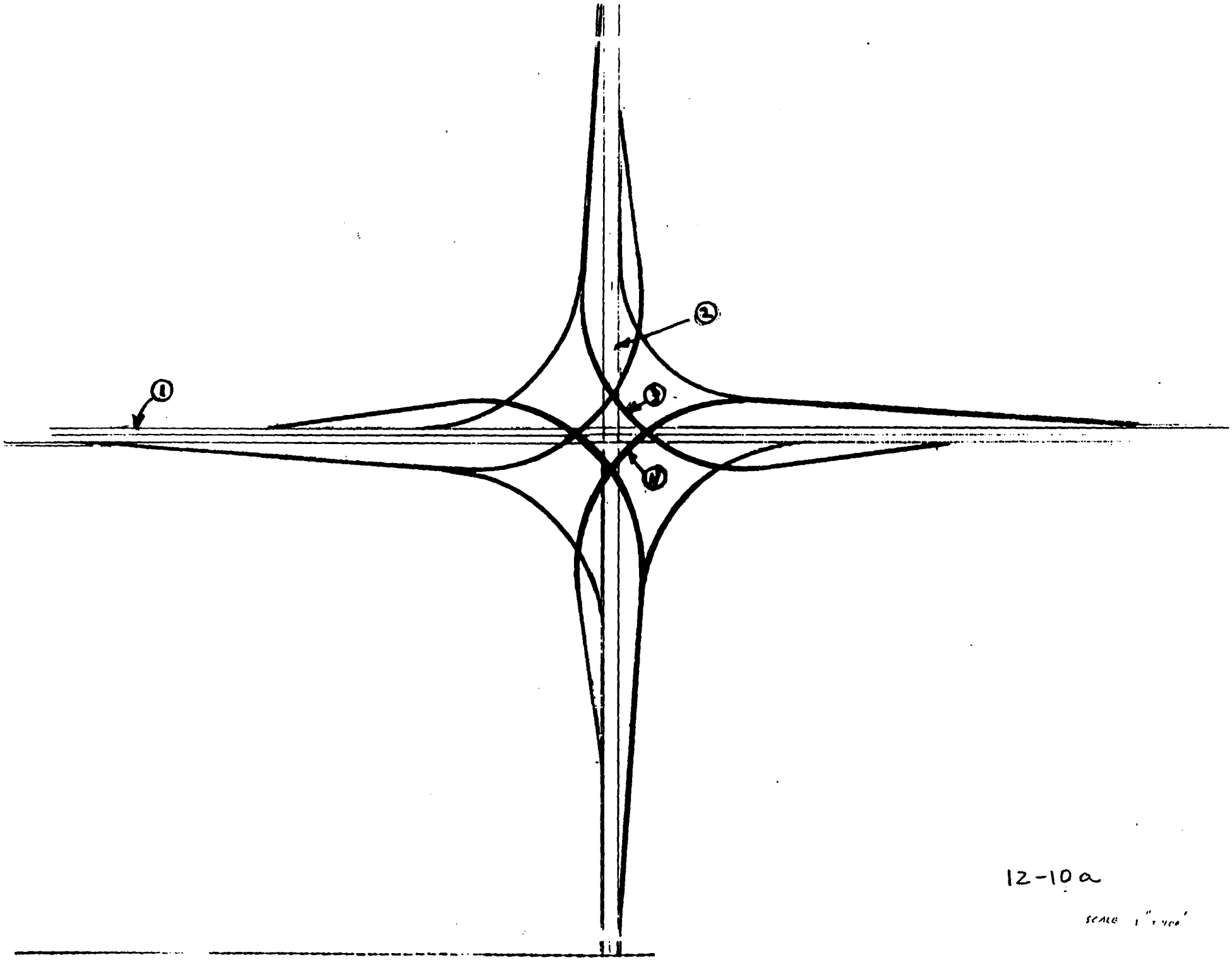
- Fully dedicated AHS :
  - Width of moving lanes
  - Width of breakdown lane
  - Sharing breakdown lane between opposing directions; configuration, safety, buffers, ...
  - Length of merging/exit lanes
  - Minimum spacing between interchanges

12-10



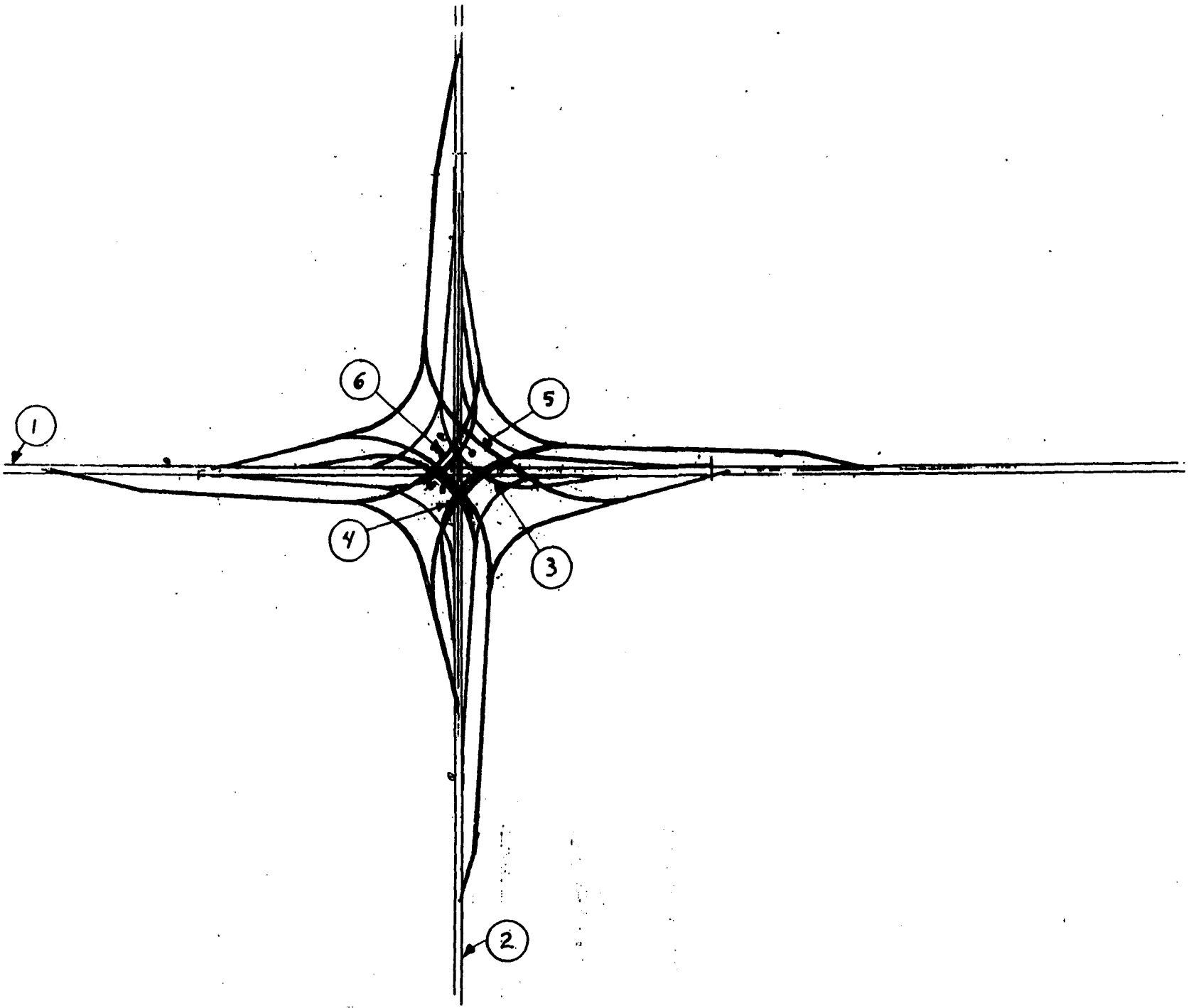
SEPARATION ISSUES

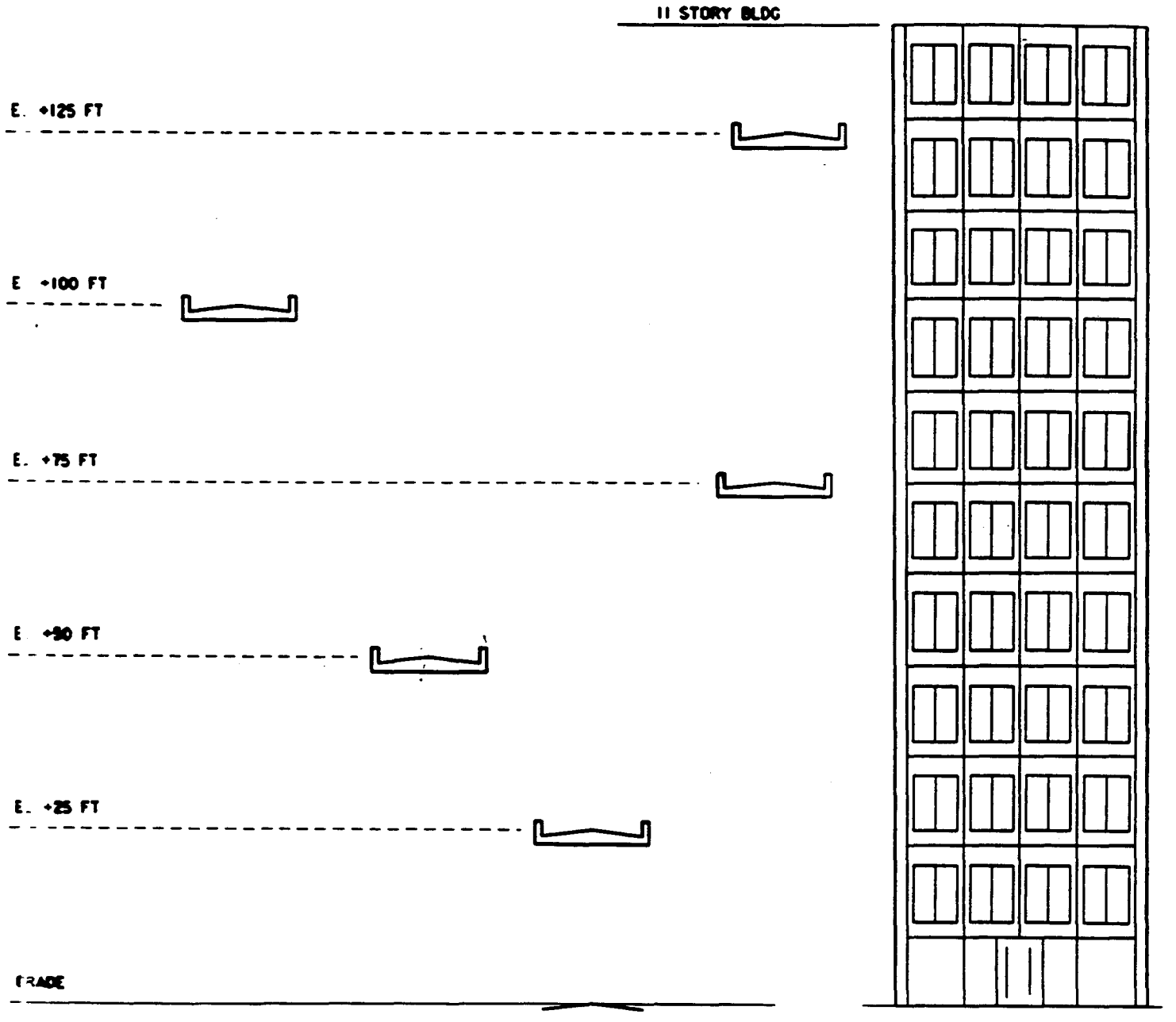
12-9a



12-10a

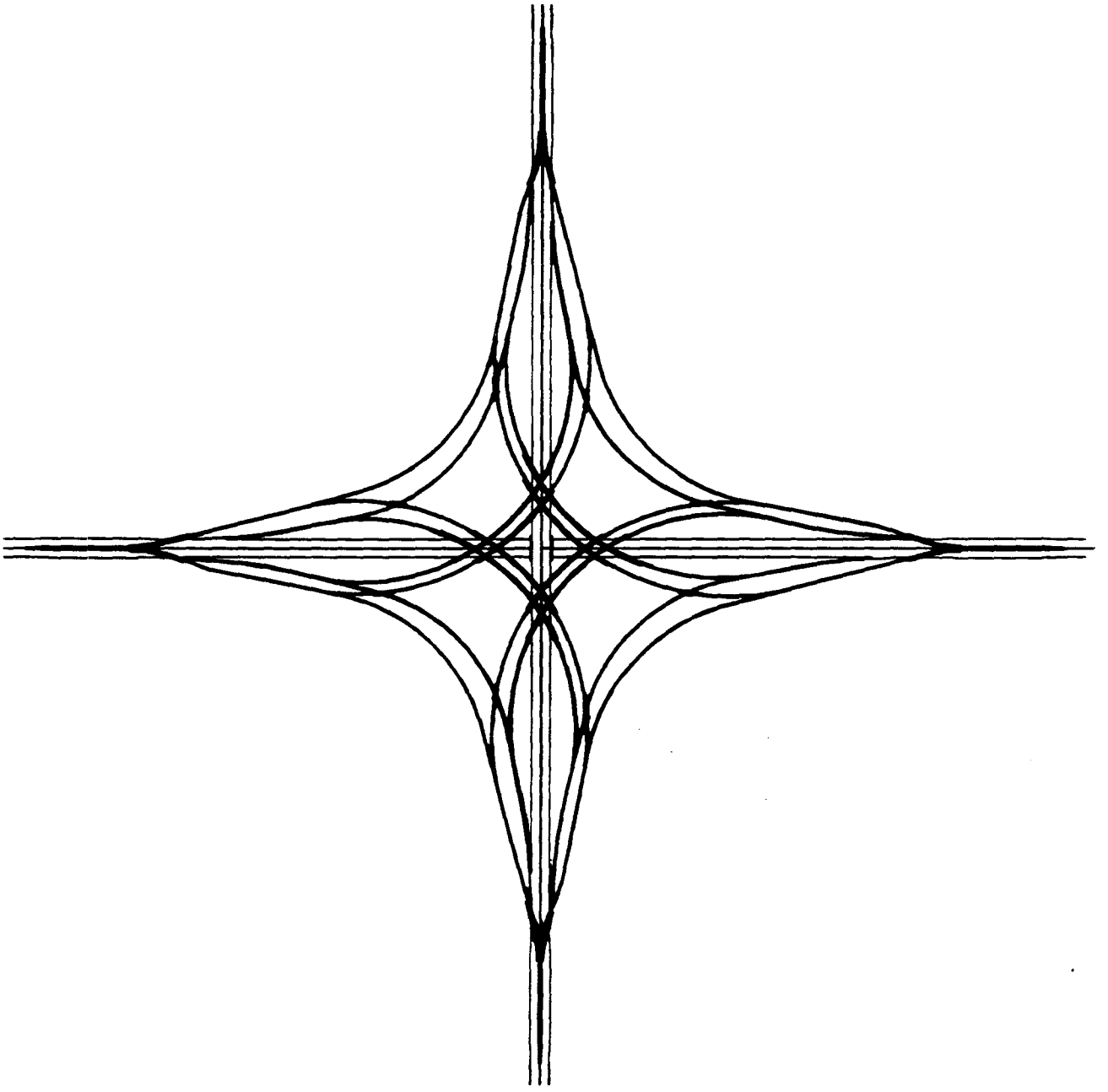
SCALE 1" = 100'


1
2
3
4
5
6



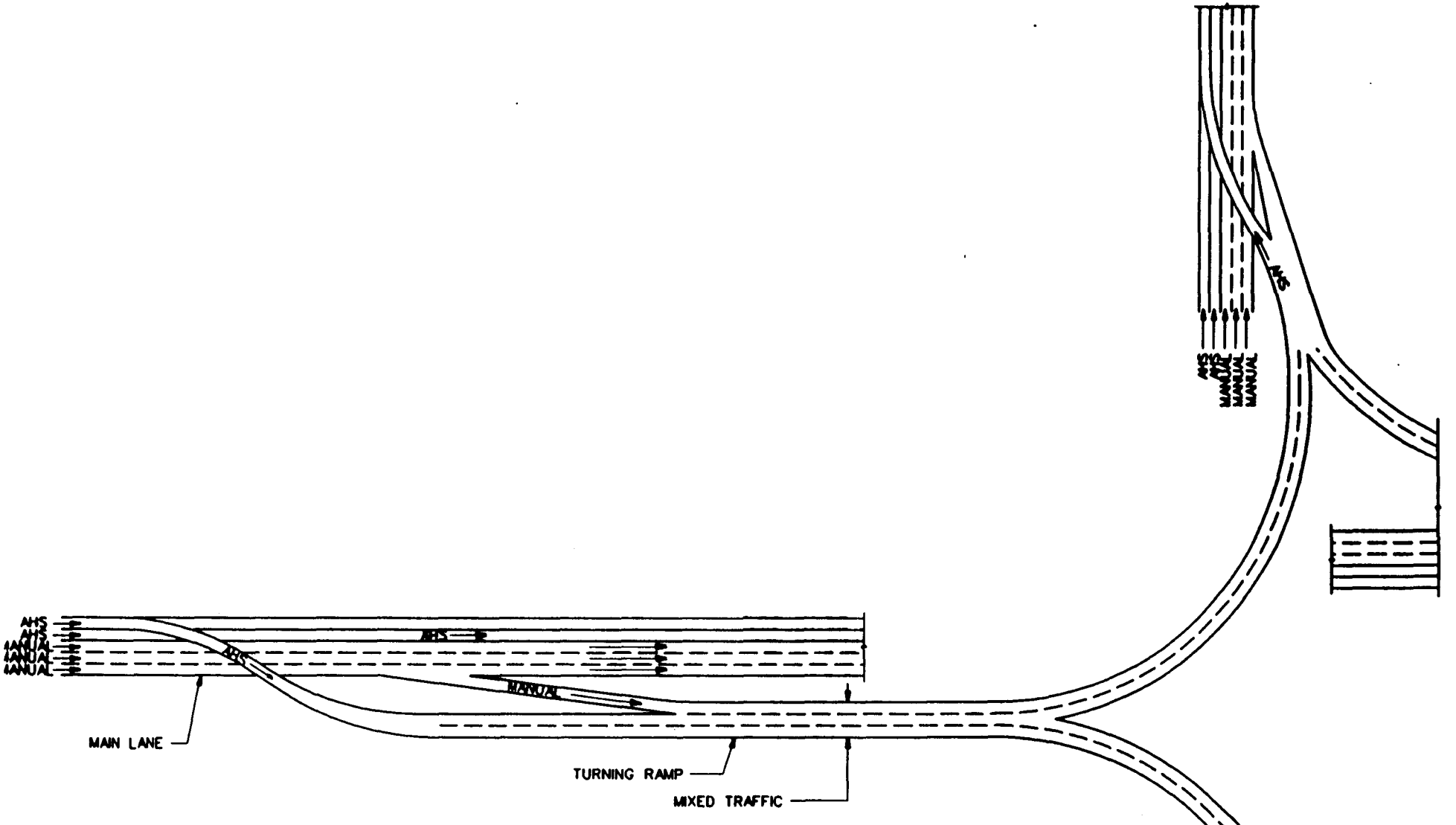
SECTION @ INTERCHANGE

12-10c

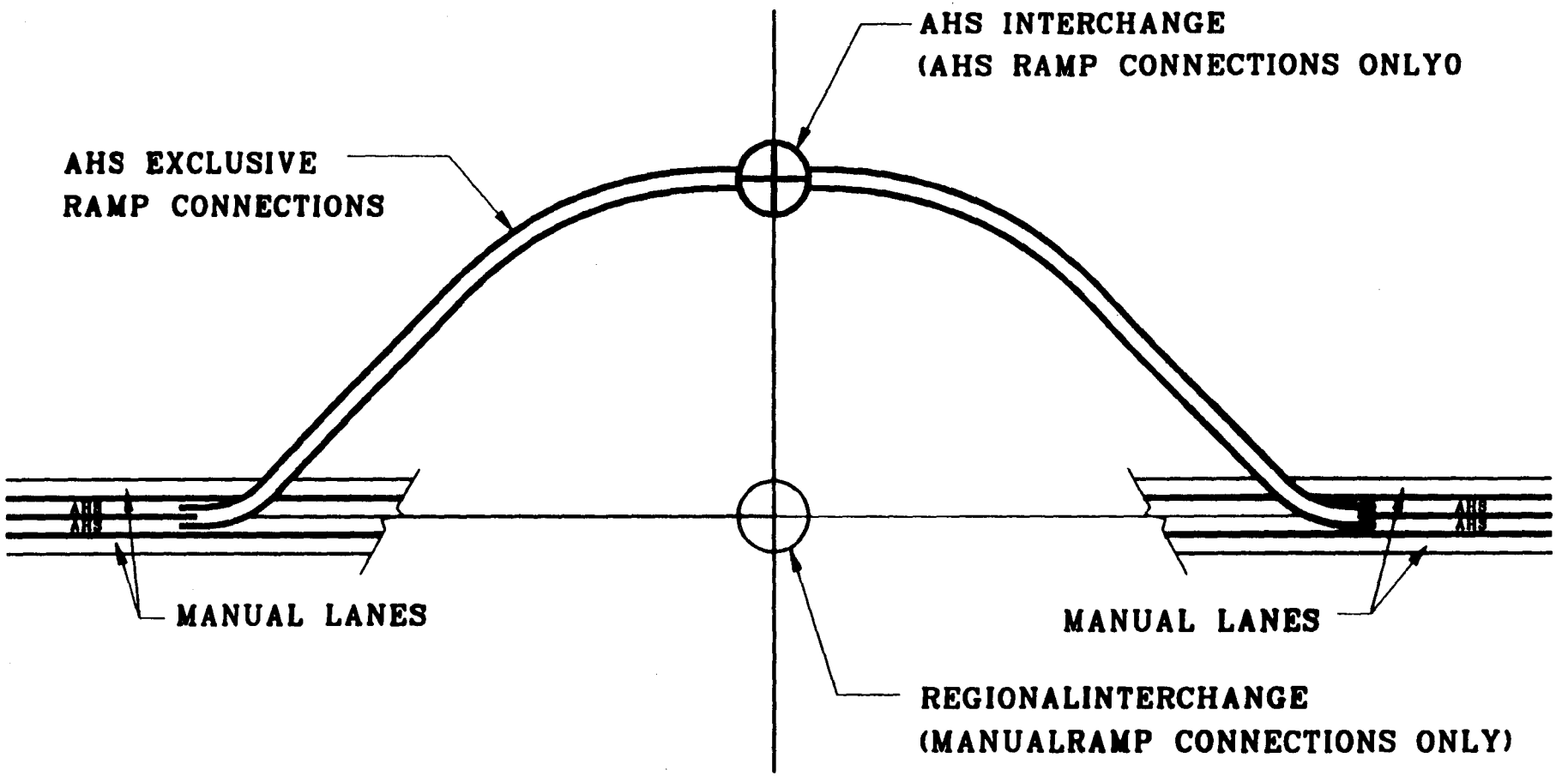


TYPICAL AHS/MANNUAL HIGHWAY TO HIGHWAY INTERCHANGE

4 LEVEL



SCHEMATIC OF AHS / MANUAL TRAFFIC MERGE
FOR COMMON RAMP CONNECTIONS AT
REGIONAL INTERCHANGE



AHS EXCLUSIVE

REGIONAL INTERCHANGE

12-10f

12-10f

Inter-urban and Rural Application Issues

- Use of a part of manual lane for transition into/out of AHS lane
- Transition length as compared to interchange spacing
- Selective use of dedicated entries/exits
- Interruption of AHS operation at long bridges, tunnels, and viaducts
- Exclusive AHS truckways

12-11

Traffic Operations Issues

- Impacts on arterials feeding AHS and manual freeways due to increases in throughput
- When sharing entry/exit ramps with non-AHS vehicles, increased throughput will affect the capacity of shared ramps and the throughput on manual lanes due to weaving of AHS vehicles across manual lanes to reach dedicated AHS lane

12-12

Planning Issues

- Existing and predicted future highway supply/demand imbalance
- "Add-a-lane" vs. "take-away-a-lane"
- Addition of dedicated AHS lane(s) in the future to accommodate increases in market penetration and demand
- Selective application of exclusive AHS facilities: severely congested urban areas, transitways, and truckways

12-13

Deployment / Financing Issues

- Time needed to plan, approve, design, and build AHS facilities
- Case for public/private partnerships for project financing and development
- "Acceptable" construction cost of AHS infrastructure per vehicle of throughput

12-14

Human Factors Issues with Automated Highway Systems (AHS)

Thomas A. Dingus

The Automated Highway System may place the driver into a role of Supervisory Control

- **Question: To what level should the highway system be automated, and what will the driver's role be in such a system?**
- **Question: What are the human factors, safety, and associated system level issues for different levels of automation?**

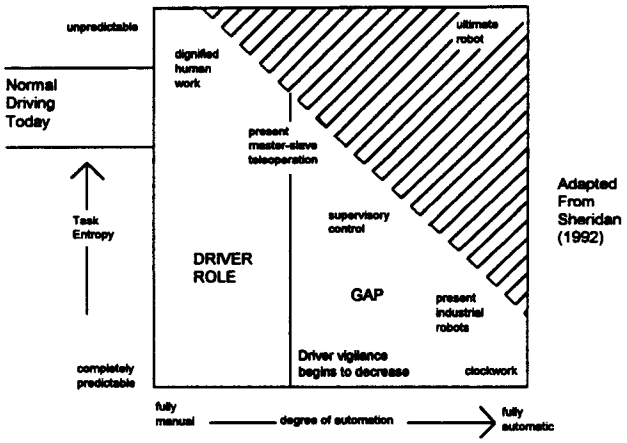
There are Degrees of Automation

- **Manual Control: The computer offers no assistance, the driver must do it all**
- **Computer offers a complete set of action alternatives and narrows selection down to a few**
- **Computer suggests one alternative and executes that selection if the driver approves**
- **Computer allows the driver a restricted time to veto before automatic execution**

Degrees of Automation (Continued)

- **Computer executes automatically, then informs the driver**
- **Computer informs driver after execution only if driver asks**
- **Computer informs driver after execution if the computer decides to**
- **Fully automated: The computer decides everything and acts independently of the driver**

How do we consider supervisory control relative to the degree of automation?



Adapted From Sheridan (1992)

HF Issues Associated with the AHS

- **Required/Realistic Driver Performance**
- **Collision Avoidance Systems Issues**
- **Intelligent/Autonomous Cruise Control Issues**
- **Privacy Concerns**
- **Dedicated Versus Mixed Traffic**

HF Issues Associated with the AHS (Continued)

- Obstacle Detection
- Platoons (Strings)
- Driver Override Capabilities
- Distribution of Intelligence
- Deployment Sequences

Selected Research Results

- Drivers would prefer "large" gaps between vehicles.
- Drivers are not uncomfortable at speeds up to 95 mph.
- Drivers become uncomfortable when another vehicle enters the lane ahead of them while leading a platoon.
- Simply giving control back to the driver would be unacceptable at high speeds due to collision potential.
- With a hard-over steering failure, it would not be reasonable to expect the driver to provide any meaningful steering response.

Future Issues to be Addressed

- **Based on the attributes of each AHS concept, how will each attribute affect driver monitoring, decision making and response?**
- **What will be the ultimate effect on driver-influenced safety, system usability and driver acceptance of each attribute?**
- **Will it be possible to optimize each human factors issue within each AHS concept?**
- **To what degree will each attribute/concept require the driver to monitor the environment within the vehicle? Outside the vehicle? How can the allocation of attention be optimized?**

Future Issues to be Addressed (Continued)

- **To what degree will each attribute/concept require driver involvement and driver vigilance? If involvement is low and monitoring vigilance is required, what will be the compromise to overall system safety?**
- **To what degree will each attribute/concept require a driver decision and reaction? Under what circumstances?**
- **How does the attribute/concept affect driver decision making uncertainty?**
- **How does the attribute/concept contribute to a clear understanding of control authority?**
- **How easily will the attribute/concept afford stimuli that are expected and elicit quick and accurate responses?**