

FHWA's Bottleneck Impact Matrix

A brief overview of unique traffic chokepoints; what are their causes, impacts, and resolutions?

| Traffic Bottlenecks – Localized sections of highway where traffic experiences reduced speeds and delays due to recurring operational conditions or nonrecurring traffic-influencing events. | | | |
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| Occurrences: | <p>Recurring – “Predictable” in cause, location, time of day, and approximate duration.</p> <p>Nonrecurring – “Random” (in the colloquial sense) as to location and severity. Even if planned in some cases, like work zones or special events, these occurrences are irregular and are not predictably habitual or recurring in location.</p> | | |
| Causes: | <p>Recurring: Operational Causes – A “facility determinate” condition wherein a fixed condition (the design or function of the facility at that point) allows surging traffic confluence to periodically overwhelm the roadway’s physical ability (i.e., capacity) to handle the traffic, resulting in predictable periods of delay.</p> <p>Nonrecurring: Dynamic Occurrences – An “event determinate” occurrence, wherein a dynamic situation either reduces available capacity (e.g., loss of lanes due to incident or work zone) or increases demand (e.g., special event).</p> | | |
| Examples: | <p>Recurring: Ramps, lane drops, weaves, merges, grades, underpasses, tunnels, narrow lanes, lack of shoulders, bridge lane reduction, curves, poorly operating traffic signals.</p> <p>Nonrecurring: Work zones, crashes, incidents, special events, weather.</p> | | |
| Supplementary Terms: (applies to either type) | <p>“Active” bottlenecks – When traffic “released” past the bottleneck is not affected by a downstream restriction (i.e., queue spillback) from another bottleneck. “Hidden” bottlenecks – When traffic demand is metered by another upstream bottleneck(s); i.e., either a lesser or nonexistent bottleneck that would increase or appear, respectively, if only unfettered traffic could reach it.</p> | | |
| Identification of: (applies to either type) | <p>Motorists typically refer to bottlenecks in terms of added time delay when compared to the same nondelayed trip, but engineers and agencies also measure performance data: average speed (travel time), lane densities, queue lengths, queue discharge rates, vehicle miles of travel (VMT), and vehicle hours of travel (VHT).</p> | | |
| Measurement of: (applies to either type) | <p>Data is collected using manual techniques (e.g., floating cars, aerial photography, or manual counts from video recordings) or from dynamic surveillance (e.g., detectors, radar, video, etc.) collected in real time. Modeling, especially microsimulation, can be used to study the impacts of bottleneck remediation on upstream and downstream conditions.</p> | | |
| Classification of: | <p>Recurring: Type I – Demand surge, no capacity reduction (typically at freeway on-ramp merges). Type II – Capacity reduction, no demand surge (typically changes in freeway geometry; lane drop, grade, curve). Type III – Combined demand surge and capacity reduction (typically in weaving sections).</p> <p>Nonrecurring: Usually classified by the type of event (e.g., incident, work zone) and severity of impact (e.g., duration of the number of lanes lost, closed, or impassable).</p> | | |
| Signature Trigger: | <p>Recurring: Bottleneck is due to over-demand of volume (i.e., peak-hour conditions). The bottleneck clears from the rear of the queue as volume declines.</p> <p>Nonrecurring: Bottleneck is due to loss of capacity due to an incident, or short-term over-demand due to a spot event. The bottleneck clears from the front or rear of the queue, depending on whether the cause is incident-related (former) or volume-related (latter), respectively.</p> | | |
| Disappears when: | <p>Recurring: When volume over-demand drops back to manageable levels for available capacity (i.e., when off-peak conditions return).</p> <p>Nonrecurring: When dynamic event is removed; queue should dissipate, thereafter.</p> | | |
| Practical Mitigations: | <u>Recurring: Corridor Congestion</u> | <u>Recurring: Localized Bottlenecks</u> | <p style="text-align: center;">Nonrecurring</p> <p>Improve incident response capabilities; reduce incident impact; reduce on-scene time for clearing incidents; reduce facility “downtime” during the event.</p> <p>In work zones, maintain maximum number of open lanes during peak times; shorten durations using innovative methods and contracting practices; minimize number of times a section is an active work zone by combining improvements (e.g., paving and safety) and using highly durable materials; employ least intrusive detour(s).</p> <p>Pre-plan for and coordinate special events to adequately and efficiently handle event traffic, including not only the main event but the subordinate deliveries, VIP access, emergency response, and pre- and post-event activities.</p> <p>Have predetermined detour plans for particular sections of highway in the event of weather- or incident-related events, including available tools (i.e., arrows, sign stands, VMS boards, public information conduits, etc.).</p> |
| | Dynamic pricing | Use shoulder lane | |
| | Transit alternatives | Restripe weave area | |
| | Ridesharing, telecommuting | Improve merge area | |
| | High-occupancy lanes | Widen, extend, remove, or consolidate ramps | |
| | Successive ramp metering | Individual metered or signalized ramp | |
| | New construction | Improve signalization or intersection design | |
| | Install frontage roads | Install frontage road | |
| | Traffic demand management (TDM) techniques | Effect “speed harmonization” as in Europe | |
| | Build park-and-ride lots | Encourage “zippering” | |
| | “Downtown” or cordon congestion pricing | Use access management techniques | |
| | Provide traveler information | Provide traveler information | |
| Proactive signal timing plans (including adaptive control) | | | |