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Introduction

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1.1 STUDY PURPOSE

The purpose of the Colfax-Federal Interchange Study is to gain an understanding of the potential economic and multi-modal connectivity benefits of alternative intersection configurations. The city also hopes to gain a better understanding of engineering feasibility, phasing opportunities and costs. Colfax-Federal is an intersection of two urban arterials at the gateway of Downtown Denver and adjacent to a light rail station, a recreation center, a soon-to-be constructed library, Denver’s football stadium and several established neighborhoods. The study goes beyond a typical traffic study to also consider pedestrian and bicycle connections, access to adjacent properties and quality of redevelopment opportunities. This study complements the city’s Decatur-Federal Station Area Plan process and allows the city to better understand the range of possibilities for the future of the intersection. It helps set the stage for a formal CDOT-approved study process.
1.2 STUDY GOALS

Several goals have been identified by the planning team for this Federal and Colfax Interchange Study. These goals are consistent with higher-level plan goals as determined through extensive public outreach as part of the Decatur-Federal Station Area Plan and GDP.

GOAL: Maximize Economic and Development Potential
- To determine if land currently used by the interchange can be freed up for development, especially Transit-Oriented Development (TOD).
- To determine if the land can be leveraged to establish a larger TOD opportunity around the station and the interchange.
- To contribute to the economic success of the businesses along the Federal and Colfax corridors by establishing the interchange as a gateway to the area.
- To use Return on Investment (ROI) as a criteria for determining the best solution for both short-term and long-term investments.

GOAL: Enhance Multi-Modal Connectivity
- To balance and integrate the needs of all modes.
- To create better pedestrian and bicycle connections between the four “quadrants” of the interchange with a focus on linking neighborhoods to destinations such as the light rail station, parks, the library, grocery stores, and schools.
- To provide efficient and attractive connections to the stadium with capacity for game days for cars, buses, pedestrians, and pedicabs.
- To improve bus routing and passenger transfer between rail and bus.

GOAL: Improve Placemaking and the Public Realm
- To make Federal-Colfax a gateway to the West Colfax Corridor, the Federal Boulevard Corridor, the Sun Valley and Villa Park neighborhoods and to the west side of Denver in general.
- To create an urban intersection that contributes to placemaking within the City.
- To enhance the current physical and visual connections between neighborhoods near the interchange.
- To improve the context of the transit station and intersection by creating more room for development around it.

GOAL: Create Innovative Transportation Solutions while Ensuring Compliance with Transportation Engineering Standards
- To be sensitive to existing short term infrastructure projects in the area, including CDOT’s new $6 million Federal Boulevard Bridge.
- To ensure operational functionality at every stage of development of the plan for the interchange.
- To utilize innovative engineering solutions to optimize the interchange/intersection.
- To establish an integrated solution that balances transportation and land use and solve for the goals of the project.
- To achieve a multi-modal person trip capacity that is functional for this context.
- To consider engineering feasibility given the grade changes and floodplain boundaries in the vicinity of the interchange.
GOAL: Maintain or Improve Environmental Conditions

- To improve, if possible, or confine, if not, any contamination in the vicinity of the interchange.
- To evaluate the water quality issues to determine if there are alternative solutions within the basin and sub-basin, and whether or not green infrastructure solutions might help meet water quality and economic development objectives.
- To select an interchange reconfiguration that minimizes air quality and noise impacts.
1.3 COMPLETED STUDIES

As part of this analysis, the team reviewed several studies previous conducted to understand this interchange and its impacts on the neighborhood.

**Federal Boulevard (5th Avenue to Howard Place) Planning and Environmental Linkages Study**

A draft Planning Environmental Linkage (PEL) study was completed in October, 2009, for Federal Boulevard directly south of the Colfax interchange. The following cross section was identified in the study for the corridor:

The pedestrian zone of 8 feet identified in the PEL is sub-standard for an arterial roadway. The interchange should comply with the standard 8-foot detached walkway in order to provide a pedestrian environment that is inviting and conducive to travel by foot. This will also allow for bicycle access to and from the area.

**Federal Boulevard (Howard Place to 20th Avenue) Conceptual Alignment and Interchange Study**

An additional study was completed in September, 2009, to evaluate the proposed cross section between Howard Place and 20th which included the interchange at Colfax Avenue. The study identified potential interchange alternatives at the Colfax Avenue intersection, but based on limited resources only looked at a few options. The alternatives considered the new bridge that is currently under construction for Federal Boulevard at Colfax Avenue. Based upon the preliminary evaluation, with the few criteria utilized in the study, the tight diamond interchange alternative was determined to be an appropriate alternative to the current configuration. This option is included in the current study in order to test it against a more robust set of criteria developed as part of the planning effort for the entire Station Area.

Funding has not been identified to implement the cross section shown in the Draft PEL. However the Federal Boulevard bridge over Lakewood gulch which is directly south of the Interchange has been funded and constructed and the intent is to tie into this new bridge.

**Health Impact Scoping: Denver’s Federal / Colfax Area Planning Process**

A Health Impact Study (HIS) was completed in April, 2012, for the Denver Department of Environmental Health addressing the Sun Valley, West Colfax and Villa Park neighborhoods.

The primary goal of the study was to “construct a health lens” through which Denver health and other city agencies could view the subject area as they conduct studies on how to
improve it. The Decatur Federal Station Area Plan is specifically mentioned as one of the efforts underway to analyze the neighborhoods and shape their future. The HIS intended to “‘flag’ questions, ideas, and recommendations regarding potential health risks and opportunities presented by the larger project.” The HIS ascribes to the idea that “complete neighborhoods” are part of forming healthy people in healthy communities.

The study recommended a full Health Impact Assessment be completed and addressed the current interchange from a Health impact perspective. The recommendation related to the interchange was as follows:

**Cloverleaf:** Redesign of the Federal Boulevard/Colfax Avenue cloverleaf could improve health with a safer environment for pedestrians and cyclists, unite the three neighborhoods in a way that has not existed previously, improve access across the entire area, and offer streetscaping at a human scale.
Interchange Alternatives

Process and Evaluation Criteria
Interchange Alternatives and Context
Existing Intersection — Partial Cloverleaf
Modified Partial Cloverleaf
Tight Diamond
Re-Established Grid
At-Grade
As part of the Station Area Plan for Decatur Federal it was recognized that the existing interchange is within the influence area of the Station. In order to connect the surrounding neighborhood with the station area, the interchange needed to be evaluated and alternatives needed to be identified that fit the goals and multi-modal requirements of the area. A number of meetings were held with the City and County of Denver (CCD) to determine the appropriate number of alternatives for study. The meetings included representatives of Public Works, Community Planning and Development (CPD), the Office of Economic Development, Budget Management Office, Parks and Recreation, the consulting team, and Colorado Department of Transportation (CDOT).

A Federal Boulevard workshop was held in July, 2012. The workshop was attended by approximately 60 residents, business owners, and property owners. Draft Interchange Alternatives were presented to the group and well received by the attendees. In addition to the identified goals it was recommended to explore maintaining the Federal Boulevard bridge over Colfax Avenue and Lakewood Gulch. This bridge has been recently replaced with CDOT’s FASTER funds.

Due to the interchange’s proximity to the Denver’s Sports Authority Field at Mile High, the interchange configuration will need to balance the daily multimodal connection needs with the unique traffic patterns and access requirements surrounding game day and special events occurring at the stadium. For the purposes of this study and to understand the typical demand, each alternative was analyzed based on a review of existing and projected daily and peak hour traffic. Additionally, each alternative assessed pedestrian, bicycle, and transit connections on a qualitative level.

Alternatives

Eleven alternatives were identified during the preliminary assessment of alternatives. They included:

1. No Build-Existing Conditions (identified as the base case)
2. Modified Partial Cloverleaf (identified for further study)
3. Tight Diamond (identified for further study)
4. At-grade intersection (identified for further study)
5. At-grade Continuous Flow Intersection (CFI)
6. At-grade 4-Square intersection (previous study)
7. Single Point (SPUI) (previous study)
8. Offset SPUI
9. Double Roundabout (Dog Bone)
10. Diverging Diamond
11. Re-established Grid (identified for further study)

During a workshop on issues related to Federal Boulevard, a suggestion was made to consider making Federal into a one-way couplet north of the bridge over Colfax. While that consideration goes beyond the scope of this study, the geometry necessary to connect Colfax and Federal in that situation are addressed, for the most part, by the alternatives identified for further study in this report. In future studies of this interchange, the couplet concept should be considered and analyzed if it meets the criteria identified in those analyses.
**Evaluation Criteria**

A matrix of criteria was established to rank the options for further study. The criteria included the following:

- Development Potential
  - Reclaimed Land
  - Development Opportunity
  - Parcel Usability
  - Land Accessibility
- Multi-modal Accessibility and Connectivity
  - Pedestrian/Bicycle Connectivity/Mobility
  - Pedestrian/Bicycle Comfort
  - Transit Access
- Gateway/Placemaking
  - Gateway/Placemaking Opportunity
  - Neighborhood Connections
- Environmental Sustainability
  - Water Quality
  - Air/Noise Impacts
- Balanced Transportation Solutions
  - Intersection/Interchange Operations
  - Network Operations
  - Safety
  - Multi-modal Capacity
- Implementation
  - Constructability
  - Cost
  - Reuse of Existing Infrastructure
  - Phasing (Mid/Long Term)

A three level ranking system was used, reflecting the preliminary level of detail included in each analysis. While the study was shallow, the breadth allowed for more alternatives to be reviewed and considered. The rankings ranged for More Desirable to Less Desirable with a neutral middle ground.
2.2 INTERCHANGE ALTERNATIVES AND CONTEXT

Five design alternatives were developed and chosen for further study and analysis for the Federal Boulevard and Colfax Avenue interchange including:

- Existing Configuration (No-Build)
- Modified Partial Clover
- Tight Diamond
- Re-Established Grid
- At-Grade Intersection.

It is assumed that the widths of all travel lanes, pedestrian facilities, medians, and landscape buffers are consistent throughout all the alternatives.

See the matrix (Exhibit A) at the end of the report for a graphical summary.

**Context**

The Decatur Federal Station Area Plan covers the half mile radius around the new light rail station, as well as the industrial land use area north of 6th Avenue. The Colfax-Federal Interchange serves the same area, in addition to its regional importance as the intersection

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*Proposed Transportation Network from the Decatur Federal Station Area Plan*
of two major arterials. From a local context perspective, this study focuses on the need for the interchange to serve the needs travelers seeking to access the new light rail station, the new West Side Library, Sports Authority Field at Mile High and the new riverfront park as well as the homes and businesses in the neighborhood in general. There is also a need for residents and workers in the area to be able to access those amenities on foot or bicycle comfortably, and the current configuration of the interchange is an impediment to that.
2.3 EXISTING INTERSECTION — PARTIAL CLOVERLEAF

Existing Geometry
Colfax Avenue at Federal Boulevard is currently configured as a cloverleaf interchange, with three “leaves” and four directional ramps, as shown to the right. This type of configuration does not require any traffic signals and allows for free-flow traffic conditions to exist through the interchange complex. Currently, the transit, pedestrian, and bicycle accommodations are limited in the vicinity of the interchange.

EVALUATION OF EXISTING CONFIGURATION — PARTIAL CLOVER LEAF

Development Potential
The current interchange configuration requires a large footprint for transportation infrastructure with approximately 29 acres of land within the ramp area being undevelopable. Providing new access along either roadway in the vicinity of the interchange is problematic based on insufficient intersection spacing and the restricted access to the cloverleaf ramps. There is poor visibility to the development that is near the interchange, because of the speed and orientation of drivers on the clover leaf ramps. Currently the only form of development within the interchange area is the RTD bus transfer point in the north east quadrant (the only non-clover leaf quadrant). This will become a staging area for buses once the light rail station is open, but it does not provide any real estate value.

Multi-Modal Accessibility and Connectivity
Pedestrians currently avoid the interchange area, because it is an uncomfortable and unsafe environment for walking (see image to the right). Connectivity and mobility are limited or non-existent near the interchange. Attached sidewalks exist on the north side of Colfax Avenue and along the north side of the directional ramps that connects Colfax Avenue to Federal Boulevard. Sidewalks are also provided on both sides of Federal Boulevard. The few sidewalks in the area do not fully connect between neighborhoods and popular destinations. With the free-flow operations and resulting high travel speeds in the vicinity of the ramp locations, pedestrians experience difficulty crossing the roadway in these locations. Because improved crossing opportunities are so far apart along Federal Boulevard, pedestrians cross Federal Boulevard today midblock.

The signalized intersections of 17th and Holden Place are the only improved pedestrian crossings on Federal in the vicinity of the interchange and are approximately 0.5 miles apart. Crossing opportunities exist along Colfax Avenue at Irving (at grade) and Mile High Stadium Circle (below grade). These are also 0.5 miles apart. Recent improvements have been made along Lakewood Gulch, which includes a wide multiuse path. This connection continues under the new Federal Boulevard bridge.

Currently there are no designated bike facilities at the interchange. Most bicyclists are utilizing the sidewalk or other parallel roadways. South of the interchange there is a multi-use path that runs along Lakewood Gulch connecting the South Platte River Trail to various neighborhoods and recreational amenities.

The Colfax-Federal Transfer Center is located in the northeast quadrant of the interchange. This facility is a transfer center for bus riders and does not accommodate park-n-ride, kiss-n-ride, or pedestrian/bicycle activity. There are many bus routes that travel through this interchange and to the Transfer Center. Because of the difficulty of walking through the interchange area, this transfer facility is not very accessible to residents in the area. The
new light rail station, opening in Spring of 2013, is physically close to the interchange, but the current conditions do not make it very accessible.

**Gateway/Placemaking**

While there is a potential for placing monuments and signage in the open space left by the clover leaves, the existing interchange does not create a welcoming gateway that identifies Sun Valley as a place to stop and linger. Because the land area is taken up by transportation infrastructure there is no room for placemaking elements, and due to the speed of the cars on the ramps, no one would notice them if they were there.
Environmental Sustainability
The current configuration of the interchange does allow for the open land to be used for water quality and detention purposes. The topography of the land surrounding the interchange generally slopes downward from the northwest quadrant to the southeast quadrant towards Lakewood Gulch and results in an approximate 30-foot drop in elevation. This area is in the 100-year floodplain emanating from Sloan’s Lake and any changes in landform within this area (Flood Zone A) will require review by the City’s floodplain manager to ensure that there are no adverse effects.

The air and noise impacts of the current configuration are moderate. The clover leaf ramps allow for faster vehicle speeds, which can increase noise, but there is no idling of cars or trucks which would cause greater air pollution impacts.

Balanced Transportation Solutions
Currently the interchange only has one signal on Colfax Avenue, just east of Federal Boulevard. The existing interchange configuration maximizes traffic operations on most approaches by allowing for free flowing traffic conditions and does not require any signal coordination with adjacent intersections. Colfax and Federal carry approximately 35,000 vehicles per day. Each ramp carries approximately 1,000 vehicles per day.

The interchange, in its current configuration, does not generate a level of service (LOS) rating due to the absence of conflicting movements and lack of control delay. The interchange operates with no delay to motorists.

While the pedestrian and bicycle comfort levels are low under the current conditions, the safety from a vehicle perspective is relatively high, because there are few conflict points and no traffic signals.

However, the fact that there is such an imbalance between bicycle and pedestrian usability and vehicle mobility – the interchange was designed with the latter as the primary focus – the multi-modal capacity is poor.

Implementation
The current condition is the base case for constructability – everything is built and all infrastructure would be reused maximizing the value of its construction. Currently the bridge over Colfax is being rebuilt, and it was designed to accommodate some future reconfigurations. The order of magnitude cost comparisons for each of the alternatives is based on costs for material and installation for each condition and do not include traffic control, temporary improvements, land acquisition, design, etc.
2.4 MODIFIED PARTIAL CLOVERLEAF

The partial clover design maintains the existing bridge along Federal Boulevard but eliminates the existing on/off-ramps on the east side of Federal Boulevard and incorporates those eliminated movements into reconfigured ramps on the west side of the interchange. Preliminarily, it is anticipated that two new signalized intersections will be created along Federal Boulevard to provide controlled access between Federal Boulevard and Colfax Avenue, as illustrated below. The intersection configuration along Colfax Avenue where the Federal Boulevard access ramps are provided will be limited to a right-in/right-out movement with a barrier median along Colfax Avenue to enforce this restriction. This configuration can be flipped so that ramps are also on the east side of Federal Boulevard.
EVALUATION OF MODIFIED PARTIAL CLOVERLEAF

**Development Potential**
This design will allow for the reactivation of the land vacated by half of the cloverleaf (in this case three acres on the east side of Federal) and allow for development up against the roadway. Depending upon the configuration of the cloverleaf and the intersection treatments at Colfax Avenue and at Federal, portions of the interior of the cloverleaf ramps might be developable. By eliminating the cloverleaf and access ramps on the east side of Federal, development pads could be created by reintroducing the street grid and using above ground structured parking to bring new buildings to street level. This solution creates development opportunities across the street from the LRT station and additional north-south access across Colfax Avenue. Access to the new development parcels on the east quadrants could be provided so that the access lines up with the proposed ramp terminal signalized intersections along Federal Boulevard. Buildings would most likely front Colfax Avenue and the East/ West streets.

**Multi-Modal Accessibility/Connectivity**
The new design will include sidewalks along both roadways, along the cloverleaf ramps, and depending on land development scenarios, pedestrian ramps could be provided to transition down to Colfax Avenue on the east side of Federal Boulevard. The sidewalks will enhance the pedestrian accessibility throughout the interchange and minimize out of direction travel. Pedestrian connectivity will also be improved through the signalized intersection crossings and reduced vehicle speeds at the ramp terminals. Pedestrian travel across Colfax Avenue will be a challenge and will need to be addressed with this option.

Designated bicycle facilities are not proposed as part of this interchange design because neither roadway upstream or downstream of the interchange can accommodate them. The recently constructed Lakewood Gulch multi-use trail just south of Howard Place does provide bike connections to the adjacent local street network and proposed light rail station in the vicinity of the interchange.

Since the Transfer Center will be relocated at the new light rail station, bus routes will be rerouted and required to travel through the new interchange. The alternative may have a slight increase in travel time for buses based on the signalized intersections associated with the reconfigured interchange and added distance to the new station. Pedestrian access to the light rail station is improved because the ramps on the east side of Federal are removed. Travel from the west of Federal is improved, because pedestrians and cyclists can cross Federal to the north or south of the ramps and travel down the east side.

**Gateway/Placemaking**
This alternative offers more opportunity to create neighborhood connections and add placemaking amenities on the east side of Federal (or whichever side does not have the two clover leaf ramps). Traffic is slowed at the ramp intersections on Colfax and stopped intermittently at the lights on Federal, which allows motorists to look around and see signage and other elements of a gateway development.

**Environmental Sustainability**
Because the ramps are removed from the east side of Federal, there would need to be some re-engineering of the 100-year flood plain from Sloan’s Lake in order to make the newly available land usable. The undevelopable area within the two remaining clover leaves
could be used to accommodate water quality and detention, potentially freeing up land elsewhere for development.
The air quality associated with the configuration would be relatively good, because vehicles would only be stopped at the lights on Federal. Noise levels would be reduced compared with the existing conditions, because speeds would be reduced.

**Balanced Transportation Solutions**
The existing signalized intersection on Colfax Avenue, just east of Federal Boulevard, will be eliminated. Two new signals will be installed on Federal Boulevard, one just north of bridge over Colfax Avenue in the vicinity of Conejos Place and one further south. Depending on signalized intersection spacing requirements, this intersection could be located further south and incorporated into the Howard Place intersection.

With the added signals and relocation of the Colfax Avenue signal, coordination will need to be evaluated on both roadways to provide adequate progression in the network, if necessary, and mobility. Traffic will no longer be free-flowing through the interchange. Using the projected 2035 peak hour intersection volumes, the signalized intersections will operate at LOS C or better during both peak hours.

**Implementation**
The ramp on the north side of Colfax Avenue would drop from an approximate elevation of 5275’ at Federal Boulevard to an elevation of approximately 5270’ at Colfax Avenue. The ramp on the south side would run from 5260’ at Federal Boulevard to approximately 5270’ at Colfax Avenue. The developable area on the east side of Federal Boulevard would sit at an elevation between 5260’ and 5250’. Little to no grading would be required to re-purpose the west side ramps. More substantial effort would be required to prepare development parcels...
on the east side, but overall the grading would be moderate. The Federal Boulevard bridge will be maintained. The cost to implement would be moderate – in the range of $5 to $10 million.

As a first phase of development, construction of the redesigned west cloverleaf ramps could potentially occur with minimal impact to the existing interchange configuration. The connections on Federal Boulevard and Colfax Avenue could be phased as needed while the interchange continues to operate in its current state.
2.5 TIGHT DIAMOND

A tight diamond interchange would compress the current interchange and remove the cloverleaf and directional ramps. It would reuse the existing bridge along Federal Boulevard and provide access to both roadways via ramps that would intersect Colfax Avenue at two new signalized intersections. The ramp terminals along Federal Boulevard would be similar to the existing configuration and would be free flow movements on and off of Federal Boulevard. Based upon the close spacing of the traffic signals along Colfax Avenue, they would be managed together as a paired signal.
EVALUATION OF A TIGHT DIAMOND

Development Potential
This design will reduce the amount of land required for the interchange by about seven acres, however based on the length and restricted access nature of the ramps along Federal Boulevard, property access will be limited. Based upon the highway access code, the intersection spacing along Colfax Avenue would require site access to be located further from the interchange and depending on spacing requirements, may result in restricted access (i.e. right-in/right-out) in those locations. Because of the restricted access, buildings would most likely front internal roadways to the site and will not front Federal Boulevard or Colfax Avenue. In addition, the angle of the ramps create irregularly shaped parcels which would lead to relatively less efficient site plans for any new development. The tight diamond incorporates straight ramps that allow relatively fast travel speeds and, therefore, visibility into development will not be ideal.

Multi-Modal Accessibility/Connectivity
Sidewalks would be constructed along both roadways and along the ramps connecting the two roadways. Pedestrians would be able to cross at the signalized intersections on Colfax Avenue, but would have to cross Federal Boulevard at existing signalized intersections to the north and south. The pedestrian connectivity would be enhanced for North-South travel; however, East-West travel would be accommodated through the existing signalized intersection on Federal Boulevard and via the newly constructed Lakewood Gulch trail which would not eliminate out of direction travel.

Designated bicycle facilities are not proposed as part of this interchange design based on neither roadway accommodating them upstream or downstream of the interchange. The recently constructed Lakewood Gulch multi-use trail just south of Howard Place does provide bike connections to the adjacent local street network and proposed light rail station in the vicinity of the interchange.

Since the Transfer Center will be relocated at the new light rail station, bus routes will be rerouted and required to travel through the new interchange. There will likely be a minimal increase in travel time for buses based on the signalized intersections associated with the reconfigured interchange and added distance to the new station. Pedestrian access to the LRT station is moderately improved in that the total area covered by the intersection is reduced, but the ramps are not comfortable to walk or bike along and the crossing points on Federal are pushed far apart.

Gateway/Placemaking
The Tight Diamond configuration does not lend itself to placemaking, given the fact that development would orient away from the roadway. Because there is land make available for development, there is the potential for architectural statements that could create a gateway, and the lit intersections at Colfax stop drivers and allow them to look at signage and other gateway elements, but the opportunities are for drivers and not for creating pedestrian friendly places.

Environmental Sustainability
The tight diamond does have capacity to handle water quality, but the reduction in total area and the grading necessary for the ramps does not leave a great deal of space for detention. The air quality would be moderate and the noise impacts would be low considering the estimate of vehicle starts and stops and the proximity to receptor locations.
Pedestrian Routes and Development Potential for Tight Diamond Alternative

**Balanced Transportation Solutions**
The existing signalized intersection on Colfax Avenue will be removed and relocated slightly to the west, closer to the Federal Boulevard bridge, to control the northbound on/off ramps. Two new signalized intersections will be added on Colfax Avenue, east and west of Federal Boulevard, to control the northbound and southbound on/off ramps.

With the signals on Colfax Avenue being very close to one another, coordination will need to be evaluated for the paired signals and upstream intersections to provide adequate progression within the network. Traffic will no longer be free-flowing onto and off-of Colfax Avenue; however, vehicles merging/diverging on Federal Boulevard will continue to be free-flowing.

Both signalized intersections are expected to operate at LOS C in the AM and PM peak hours for the 2035 projections.

**Implementation**
There would be 20 to 30-foot grade drops between the bridge and the ramps in the Tight Diamond configuration. Retaining walls and steep slopes would be needed to facilitate the grade differences, which would increase the cost. The bridge over Federal would be retained, reducing potential expense. The overall construction cost would be in the same range as the Modified Partial Cloverleaf, approximately $5 to $10 million.

Each ramp could be constructed in separate phases and each phase would require adequate detour plans to accommodate the movements being impacted by the ramp closure and construction. Phasing the construction of this interchange would likely require the closure of one cloverleaf ramp at a time resulting in detouring those impacted movements during construction of that phase. Long term phasing of the alternative can be implemented.
2.6 RE-ESTABLISHED GRID

The Re-Established Grid design will remove the interchange and free-flow operations to create a grid system with multiple at-grade intersections, as shown below. This configuration will maintain the existing bridge structure along Federal Boulevard. Signalized intersections would most likely be placed on Federal Boulevard and on Colfax Avenue. The diagram shows the roadways necessary to move vehicles from one arterial to the other, but it would be appropriate to establish the grid on the northeast corner as well as the southwest corner of the interchange as well.

![Re-Established Grid Alternative Diagram]
EVALUATION OF RE-ESTABLISHED GRID

Development Potential
All quadrants are integrated back into the street grid in this alternative, freeing up approximately 8 acres for development. The grade differential presents some challenges but through use of above-ground structured parking, the buildings have potential to front north-south and/or east-west streets. Some challenges will remain due to the Federal Boulevard bridge, and the gulch will need to be accommodated. Access spacing requirements will need to be met, but there is potential that access in some form may be allowed along the established roadways. Based upon the close proximity of the intersections and projected volumes, most of the access points will likely be limited to right-in/right-out.

Multi-Modal Accessibility/Connectivity
The new design will include sidewalks along both roadways and access to and from Federal Boulevard and Colfax Avenue will be provided via the proposed street network. Pedestrian connectivity between the neighborhoods will be improved and convenient.

Designated bicycle facilities are not proposed as part of this interchange re-design based on neither roadway accommodating them upstream or downstream of the interchange. The recently constructed Lakewood Gulch multi-use trail just south of Howard Place does provide bike connections. The connections that are shown as part of the Station Area Master Plan will apply to the alternative.

Since the Transfer Center will be relocated at the new light rail station, bus routes will be re-routed and required to travel through the new interchange. There will likely be an increase in travel time for buses based on the signalized intersections associated with the reconfigured interchange and added distance to the new station. The additional intersections in this sce-
nario will likely result in slightly longer travel times for vehicles to the new light rail station, most notably from Colfax Avenue. Pedestrians will find this configuration more comfortable and convenient, because they will be walking on sidewalks in front of buildings for the most part.

**Gateway/Placemaking**
This configuration offers the highest number of access points to the community and the best opportunity for placemaking. Because it returns the interchange to an urban grid, the fabric of the surrounding neighborhood can reach up to the arterial roadways. More buildings with more street frontage make a more pedestrian-friendly environment and provide facades for motorists to look at. The gateway aspect will be created by the density of buildings, and there is the potential to have a smaller, pedestrian scale signage pattern.

**Environmental Sustainability**
Water quality and detention would have to be handled the same way they are in the rest of the grid. There is no additional space to accommodate regional detention ponds. This configuration poses some challenges when considering the Sloan’s Lake flood plain, not only because the land is occupied, but because the new development will have to be built so that water does not encroach into the buildings. Presumably, the value of having development there will offset the need to accommodate the water flows.

Air quality will be somewhat compromised, based on the slower roads with more traffic lights stopping cars and idling them. Noise impacts will be lower based on the slower speeds.

**Balanced Transportation Solutions**
Five intersections will be added to the network with at least three of them being signalized. The traffic will no longer have free-flow movement and the signalized intersections will have to be coordinated amongst themselves and upstream/downstream signals in order to make the network operate efficiently.

Preliminarily, the signalized intersections will operate at LOS C or better in both peak hours for the 2035 condition. No queuing challenges were noted on Federal Boulevard or Colfax Avenue; however, as the intersections are evaluated closely, the queues should be noted and mitigated if needed.

**Implementation**
The northern intersection on Federal Boulevard and the western intersection on Colfax Avenue would be at approximate elevations of 5275’. The southern intersection on Federal Boulevard and the eastern intersection on Colfax Avenue would be at approximate elevations of 5255’ and 5245’ respectively. The Federal Boulevard bridge can be maintained. Grading will need to be considered and 4 to 6 signals installed to ensure traffic flow and pedestrian crossing can be implemented. Given the complexity of the modifications, and the need to make development pads in each quadrant, this configuration would probably be more expensive than the Tight Diamond and the Modified Partial Cloverleaf. Construction would be approximately $10 to $15 million.

Construction of each of the two quadrants could be phased to minimize detours. During construction, the ramps within the southwest and northeast quadrants will continue to operate fully, while the other two quadrants are being constructed. Once one of the new grid quadrants is constructed, the traffic from the other redesigned quadrant would be able to be diverted to the new grid roadways.
2.7 AT-GRADE

This alternative will remove the interchange configuration and the Federal Boulevard bridge and establish a new at-grade intersection. The new intersection would be signalized and would likely require additional travel lanes along both roadways to accommodate the traffic volumes and maintain an appropriate vehicular level of service at the intersection. Intersecting roadways will need to follow the CDOT Access Policy. In general, full movement intersections are appropriate on ½ mile intervals.
Development Potential
This design has a smaller footprint than the existing design, freeing approximately 12 acres, and may allow development in all four quadrants. Access spacing requirements will need to be met, but based on the single intersection configuration; there is greater opportunity to provide site access to the four quadrants. With re-grading of the area, buildings could front on Federal Boulevard and Colfax Avenue without any special building design, creating a pedestrian, urban condition and increasing visibility. Traffic delay and anticipated queuing may reduce the desirability of the site and limit access to parcels. The width of the lanes and potential for stacking will limit the entrances to parcels to right-in, right-out along Colfax and Federal. However, because there is no need for ramping or connecting roadways, the parcelization of the surrounding lots would be the most flexible of all the alternatives.

Multi-Modal Accessibility/Connectivity
Sidewalks would be installed along both roadways for pedestrian connectivity. Pedestrians would be able to cross at the intersection; however, the width of the intersection would require longer pedestrian clearance times and result in a less comfortable experience.

Designated bicycle facilities are not proposed as part of this interchange design based on neither roadway accommodating them upstream or downstream of the interchange. The recently constructed Lakewood Gulch multi-use trail just south of Howard Place does provide bike connections to the adjacent local street network and proposed light rail station in the vicinity of the interchange.

Since the Transfer Center will be relocated at the new light rail station, bus routes will be rerouted and required to travel through the new intersection. There may be an increase in travel time for buses based on the timing of traffic signals at the intersection. Compared to other alternatives, the travel distance through the interchange will be shorter since there will only be one intersection.

Gateway/Placemaking
The large single intersection creates a definite sense of arrival in the neighborhood. With the additional land made available, there is great potential to create signature architecture at the intersection that will brand the region a would define a gateway.

Environmental Sustainability
In this configuration, all of the ancillary land is used for development, so there is no “extra” land for regional detention. The impact on the Sloan’s Lake floodplain would have to be studied carefully, but the flattening of the site would make development potentially more vulnerable to flooding.

The noise impacts would be a bit less that the other alternatives due to the much slower speed of the vehicles moving through the intersection. However, the long wait times at the light would, increase idling and thereby air pollution.

Balanced Transportation Solutions
The existing signal on Colfax Avenue would be removed and a new signal would be installed at the intersection between Federal Boulevard and Colfax Avenue. There is only one
signal in configuration, but it has to accommodate all movements. Vehicles will no longer be free-flowing. The signal will need to be coordinated with the upstream/downstream intersections.

It is anticipated that the intersection will operate at LOS E or F in the peak hours, based on 2035 modeling, and will require an additional southbound through lane on Federal Boulevard to maintain an acceptable LOS.

**Implementation**
The general topography of the land surrounding the interchange generally slopes downward from the northwest quadrant to the southeast quadrant towards Lakewood Gulch and results in an approximate 30-foot drop in elevation. This drop in elevation will require a significant re-grading of the existing interchange area and could pose challenges from a parcel development and site access standpoint.

Phasing would be difficult with this design and detouring would have to play a large role to accommodate the high traffic volumes. There could be potential for construction of temporary roadways to reduce the detour route distances. Long term phasing would not be recommended.

The interchange will be fully reconstructed, the Federal Boulevard bridge removed, and significant grading will be required. Each of these efforts represents significant costs, bringing the total budget in to the $6 to $10M range. The material costs and construction of this alternative are less than those for the Grid alternative, but the logistics, including traffic control, would no doubt be more intense.
Conclusions and Next Steps

Ranking Alternatives
Costs and Benefits
Next Phase of Analysis
Funding
3.1 RANKING ALTERNATIVES

The analysis of the alternatives demonstrates that there are strengths and weaknesses to each option. The critical factors in determining a preferred alternative are setting the goals and defining the criteria. In the case of this analysis, because of its association with the Decatur Federal Station Area Plan, the goals are focused on how the interchange contributes to making the Sun Valley neighborhood more complete and connected and to maximizing the value of the new light rail station. If we prioritize the Development Potential and Multi-Modal Accessibility/Connectivity categories, The Re-established Grid and At-Grade alternatives are clearly preferable, with the Modified Partial Cloverleaf as a close third. Overall, the Modified Partial Cloverleaf is the only alternative with no "less Desirable" rankings. The Re-Established Grid has the most "More Desirable" rankings.

Of the three highest ranking alternatives -- Re-established Grid, At-Grade and Modified Partial Cloverleaf -- the last one is probably the least complicated to implement because it leaves two of the existing loop ramps and then clears the eastern half of the property, putting in retaining walls along one side of Federal. The Re-established Grid requires dismantling the cloverleaf ramps, grading the four quadrants to take gridded streets, establishing retaining walls along each of those and then layout out the streets. The At-Grade intersection causes the most disruption by dismantling the Federal bridge, requiring massive changes to the current grading, and creating the most conflicting traffic movements.
3.2 COSTS AND BENEFITS

The rough order of magnitude costs for materials and installation of the alternatives range from $5 million to $15 million, not accounting for traffic control, temporary improvements, land acquisition, design, etc. In previous studies the cost for reconfiguring the roadways has been estimated at between $25 and $30 million. The figures used in this analysis are intended to illustrate the relative costs of each alternative, not used to gauge absolute costs. In some cases, like the Re-established Grid, there is not even a good precedent project to use as an estimating tool. A total pricing of the planning, design, engineering, construction and right of way acquisition, would depend upon many factors, including the review process, stakeholder engagement, phasing strategy and material costs at the time of construction.

It may be possible to gather benefits from closely synchronizing development of real estate projects with the interchange development, since elements like parking garage walls and retaining walls could be the same. However, it is much more likely that the interchange improvements will need to be complete before development is attracted to the site. Reconfiguring the interchange could contribute to the development potential of adjacent and created land parcels. Despite the fact that this can save money through economies of scale, if it accelerates the developer’s expenditures, the cost of that capital could outweigh the savings. Logistical issues may also discourage a master developer from choosing to “overdesign” infrastructure to accommodate future development, especially if they end up selling pads to a different vertical developer. The vertical developer may rather pay a construction premium when the actual building is developed because they can be assured that the additional investment will be positioned properly, timed efficiently and would be performed by their contractor. The parking garages shown in the diagrams in this report tend to be stand-alone structures, because those are the most economical to construct. If the structure is stand alone, it has a higher likelihood of being usable. If the parking is intended to be below the building, the structure needs to be integrated into the overall building design since structural piers need to be designed to accommodate appropriate loads (which can vary based on building height and building skin material) and vertical penetrations (elevator and stair cores) will be fixed.

Similarly, the potential revenue from development is influenced by many factors including likely land use, site dimensions and market characteristics. The land uses in the recovered parcels would be primarily commercial - office and some retail. Based on the market analysis conducted as part of the Decatur Federal Station Area Plan, office land would trade in the $10 to $12 per square-foot range, depending on entitlements. While multi-family residential land currently trades around $50 per square foot (psf), the land that would be freed up by interchange redevelopment is unlikely to be developed in this way.

Currently, given the parcel sizes and desired scale of the development proposed in the Plan, most of the buildings will require structured parking. While structured parking increases density at the TOD and typically leads to higher rental revenue, the cost associated with structured parking can often offset the increased revenue and make projects infeasible and/or drive down the residual land value. The required rental rates to justify new development with structured parking would be in $26-32 NNN psf range. That means office developments around the interchange will have little or no rental rate discount relative to current rental rates downtown. This can create a challenge to development unless a tenant(s) desires to be proximate to the football stadium because the Decatur Federal area has a locational disadvantage compared with the Central Business District (CBD). Future office supply limitations could drive CBD rents higher creating a larger cost discount in the Federal-Decatur Area making it more attractive, but there will be
market challenges for the site relative to competitive office markets (e.g., Colorado/I-25 and TOD locations in the southeast and southwest suburban office markets).

For the purposes of this evaluation, we are using a land value of $520,000 to $870,000 per acre (~$12-$20 psf). Considering the fact that the Modified Partial Clover Leaf design had three acres of recovered land and the At-Grade intersection had 12 acres, the total value could be $1.6M to $10.4M.

Some of the assumptions that would be need to be addressed are listed below:

- Sufficient site configuration, room for retention/detention, soil conditions, etc. for feasible development. Using gross acreage numbers does not take into account site shape or efficiency related to scale and size. This is more relevant for MF and parking structure configuration for commercial uses.
- Sufficient access to the site.
- Current market pricing for uses, which reflects relatively high MF land prices. This may not be the case in the future as significant supply is planned for the surrounding area and region.
- Assumes dirt prices for a finished pad. Vertical developer does not pay for any of the interchange improvements.
- Market for residential will not be impacted by adjacency to an interchange. As noted certain configurations are more conducive to development than others.
- Price for land reclaimed is the same as the dirt surrounding it when reclaimed land is used to create a viable “assembled” parcel.
3.3 NEXT PHASE OF ANALYSIS

Colfax Avenue and Federal Boulevard are US Highways. Because of the federal designation, an environmental assessment that follows state and federal guidelines will provide the necessary information for CDOT and FHWA to move forward. According to FHWA, a Planning and Environmental Linkage (PEL) study is required prior to beginning a NEPA study. The PEL already completed for Federal Boulevard did not extend to the interchange, therefore we recommend the PEL be completed for this section of Federal Boulevard. The intent will be to identify the planning already completed for the interchange so that the alternatives work is not re-done during the NEPA process. Upon completing the PEL, the type of NEPA study can be determined (i.e., categorical exclusion, environmental assessment, or environmental impact assessment). Any future configuration would have to include a special event transportation management plan.

At the time of redevelopment of the Colfax/Federal interchange, a drainage study will be required to analyze the impacts to the FEMA mapped 100-yr floodplain at this location. Depending on the final design of the interchange, it is likely that the existing floodplain will need to be modified to accommodate the proposed improvements. In order to provide adequate storm water conveyance, it is possible that additional storm sewer, open channels or other routing methods may be necessary in order to preserve the integrity of the new development. The City’s Master Drainage Plan should also be verified at the time of development to ensure the project is meeting the needs of any additional upstream storm water conveyance elements. Analysis of building finished floor elevations in relation to the 100-year floodplain elevations will be evaluated at the time of development.
3.4 FUNDING

The financing of the improvements at the interchange is a significant undertaking, especially in the context of shrinking federal and municipal budgets. There are four primary sources of funds for a project of this type:

- Federal and State money: CDOT/FHWA
- City money: Improvement bonds
- Private money: Developer contributions to infrastructure costs
- Public/private partnership: Combination of the resources above

The first effort should be to focus on securing federal and state transportation funds to finance the planning and, at least a portion of the interchange construction. Assuming those sources will not be sufficient on their own, the City needs to identify what it can and will put forward for the effort to prove it is committed to the goals identified in this document. This should be a priority project for infrastructure funding in the City.

Typically, private sector investment is expected to pay for the next tier of infrastructure improvements – the local streets adjacent to and serving a development project in the case of transportation improvements. There is often an “off site” infrastructure improvement component to a development project and those costs must be balanced against the returns to see if the project is financially feasible. In this case, as outlined above, the returns are not sufficient for the private developer to bear a large share of the interchange reconstruction. In addition, the interchange must be funded and built before private sector developers will be interested in making a significant commitment. Given that the area will begin redeveloping around the interchange before it is rebuilt, it may be possible for a Special District or a TIF mechanism to build value that can be applied to this project; however, there are many infrastructure needs in the Station Area and those potential funding sources are being considered for other improvement projects.

The fact that land could be freed up for development with the creation of a smaller interchange “footprint” raises the hope that the value of that new land could be harnessed in some way to help pay for the interchange improvements. Applying the pure cash value of the land to the interchange redevelopment is one approach. As noted above, the sale of that land would not be possible until after the improvements are made, so it would be reimbursing another source. There is also the question of ownership of the land and how it can be transferred, which must be worked out before any of these scenarios can be fully vetted. Assuming public sector ownership of the land, the land assets could be an important component in a public-private partnership where private equity is brought to bear for the funding of front end improvements at the interchange based on some level of guarantee that the private party would have development rights on the land made available. In a partnership of this type both City and developer can clearly state their goals and requirements to reach a successful result. This clarity will be necessary to reduce the risk and uncertainty that keeps investors away from a project of this type. Private sources of funds will have requirements for return on investment and concerns about mitigating risk, and the public sector will have requirements as well, but only through a mix of sources will the full potential of the project be realized.
Appendix

Federal/Colfax Interchange Ranking
### Federal/Colfax Interchange Ranking

#### Evaluation Criteria

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Partial Cloverleaf (Existing)</th>
<th>Modified Partial Cloverleaf</th>
<th>Tight Diamond</th>
<th>At-Grade</th>
<th>Re-established Grid</th>
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#### Discussion/Qualifiers

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**Exhibit A**