A Discussion of the Coordination of Railroad Engineering Amidst Right-Of-Way Constraints For On-Time and On-Budget Project Needs

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ABSTRACT

There has been a tendency for railroad design engineers to complete the geometric layout of tracks with little consideration of right-of-way needs and acquisition. With the desire to increase the speed and capacity of main line tracks, the challenge of engineering higher speed alignments in congested areas is greater than ever. In many cases these improvements are in urban or industrial areas where the established right-of-way is tightly constrained. While these constraints make horizontal design difficult, the criteria set forth in the current AREMA standards for vertical curves can also become a factor. In some instances these standards are difficult to meet without the acquisition of additional right-of-way and the ultimate use of the track must be considered to determine if a deviation from standards is necessary, feasible, or safe. Coordination with right-of-way engineers is mandatory to avoid fatal flaws that may become stumbling blocks for the proposed alignment. This is especially important with fast track projects since challenges to acquisition may result in delays of several months to over a year.

Public infrastructure programs such as the Alameda Corridor, a railroad grade separation project between the San Pedro Bay ports and downtown Los Angeles, exemplify this coordination. In this heavily congested corridor containing operating railroads and industrial and urban development, design and right-of-way needs have met significant challenges. Satisfying the requirements of the design while addressing the right-of-way issues with the development of this demanding project will be discussed.
INTRODUCTION

One of the main concerns facing railroad designers and planners is increasing the capacity of established rail lines. While a significant increase in capacity can be achieved by modern signaling systems, desired capacities beyond those achieved through these relatively simple means may call for additional tracks or increasing the design speed of the existing tracks. Often additional right-of-way is needed to allow for the additional tracks or the realignment of lower speed curves to accommodate the higher speed operations. In some cases, the simple relocation of an industry lead from a main track to a new siding track will result in right-of-way acquisition costs that can be so prohibitive that the benefits of the project may not justify the capital expenditure. These issues are magnified in urban areas where railroad-highway interfaces, adjacent industrial complexes, and residential developments restrict the available right-of-way. Environmental issues also add to the acquisition costs and can be very prohibitive.

While the ultimate use and the forecasted future needs of the tracks are certainly a very important factor in corridor design, the impacts to adjacent right-of-way and other property must also be considered in the development of the project. While railroads enjoy condemnation rights over private property, they still must meet strict guidelines in this process and pay fair market value for the property. The act of condemnation must be a last resort since it can add delays of several months to over a year to the acquisition process. To this end, the designer must work with right-of-way engineers, acquisition specialists, and appraisers during the early design phases in order to minimize potential delays.
The Alameda Corridor Project is an excellent example where a higher-speed freight connection is under construction in constricted right-of-way. This consolidated rail corridor will provide a fully grade separated, multiple track connection between the Ports of Los Angeles and Long Beach, and the Burlington Northern and Santa Fe Railroad (BNSF) and Union Pacific Railroad (UPRR) yards east of Los Angeles. This corridor passes through heavily industrialized areas containing refineries and manufacturing plants, and in close proximity to shopping centers, schools, and residential areas. Additional challenges are the numerous industry leads and siding tracks that will be reconnected after completion of the improvements and, in most cases, must remain in service throughout construction. This is a fast-track project where part of the financing is obtained through a federal loan and revenue bonds, with repayment dependant on a substantial completion date of April 15, 2002, just 3 years and 3 months after the start of construction.

This twenty mile long project will include over 95 miles of track and will grade separate or eliminate conflicts at more than 200 public roadway crossings in the Los Angeles area. Some of the major features of the Corridor include:

- A ten mile long, 33 foot deep, 51 foot wide trench with 35 roadway overcrossings and two railroad overcrossings.
- An at-grade By-Pass track.
- Two major railroad viaducts at the north and south ends of the Corridor.
- Five water crossings.
- Seven new or modified railroad overcrossings.
- Three major roadway overpasses.
This project is being built in very constricted rights-of-way while both the BNSF and the UPRR maintain operations. Since most of the Corridor is on right-of-way purchased from the former Southern Pacific Transportation Company (SP) adjacent to operating UPRR yards, much of the entire construction zone is affected by ongoing intermodal freight traffic and service to the local industries. These factors have contributed to the challenges associated with right-of-way. Approximately 400 parcels have been acquired or are otherwise impacted as a result of this project. While some of these effects may be as innocuous as Temporary Construction Easements (TCE) or a Right of Entries (ROE), others have ranged from simple easements to full condemnation. In some acquisitions, businesses have been relocated, requiring relocation assistance and raising additional permitting issues.

**Right-Of-Way Impacts**

While significant capacity increases can be seen with the addition of main tracks to a corridor, there may also be increases with the simple relocation of an industry lead to a siding or other adjacent track. This avoids the constraint to main line operations that is caused by the switching of industry leads. Of course, additional right-of-way may be needed to add tracks to an established corridor, but one of the unforeseen impacts of adding main tracks to a corridor is relocating existing industry service or sidings. These relocations often affect adjacent properties through the change in the geometry of the industry lead. Most often, the constraints necessitate a horizontal and/or vertical curve that is considerably tighter than that which is existing. In many cases, the use of these substandard curves can be justified by the rail operations and equipment used on the lead. Of greater concern is the collateral affect of the realignment forcing the
modification of adjacent loading facilities and what could result in significant costs. These costs are magnified with environmental requirements that may be necessary due to the nature of the industry. It is very easy to overlook these features within the design process and often these nuances go unnoticed until discussions with the industry begin and the real impacts are realized.

The application of railroad design standards to achieve the desired improvements has the greatest influence on right-of-way needs. Often railroad design standards for vertical and horizontal geometry can be prohibitive if not impossible to apply without impacting the area surrounding the proposed improvements. This is especially evident in the application of the AREMA criteria for vertical curves. This criteria will often force the redesign of many of the adjacent facilities along the right-of-way including roadways and neighboring properties. To mitigate these effects, the designer may be forced to propose a vertical curve of substandard length in order to avoid major right-of-way acquisitions and project overruns. Any deviation from these standards should consider the ultimate use of the tracks for both safety and rider comfort. In many cases, an analysis of the drawbar forces will show that the operating equipment will support the more dramatic rate of change of shorter vertical curves that will fit within the project limits.

**RIGHT-OF-WAY ACQUISITION**

The acquisition of real property is a necessary factor in any large capital project and right-of-way engineers and acquisition specialists should become part of the design process in the early stages. Most often it is the right-of-way engineer, the acquisition specialist, or the appraiser, that discover the difficulties or fatal flaws that may be a part of the acquisition of a parcel. While the
major features of a given property may be clearly evident to the designer, the issues of permitting or other lesser known impacts may not. It is the unknown facets of the property that cause impacts or delays that can seriously hamper the progress of the project. These delays may be avoided if these legal and permitting issues are known early in the design process. In some cases, the design may be altered to avoid the trouble spot or an alternate solution may be found early enough in the process to mitigate the impacts. This becomes particularly important in cases where the lead agency must seek approval from a governing board to proceed with acquisitions and condemnations. If these problems are known in the early stages of the design, the proper steps can be taken early to avoid legal actions that can stall or stop a project.

Factors such as environmental, loss of revenue, utilities, and loss of overall goodwill can become stumbling blocks and cause unforeseen delays to capital improvement projects. These delays often result from oversights that force a project into expensive legal proceedings with far reaching impacts. In cases where condemnation is necessary, the delays can be as long as eighteen months and result in substantial legal costs.

In many cases, the acquisition of real property necessitates the relocation of the business into a suitable replacement location that is similar in zoning and access. Unfortunately, relocating an established business brings to light issues such as relocation assistance, loss of goodwill, and additional environmental issues. While these issues are significant, additional permitting that may be needed at the new location, in addition to any cleanup costs already associated with the acquisition of the property, may cause the property costs to skyrocket and result in costs and delays that can severely impact the project. In many cases, the costs of environmental cleanup
are borne by the property owner and not the buyer and can significantly delay the project. Special environmental regulations, such as the Resource Conservation and Recovery Act (RCRA), add other significant factors to the equation. In many cases, acquisition of all or part of real property that has been federally permitted may force the business into a long and expensive permitting process. A very distinct possibility is the inability to relocate the business at all due to environmental requirements or other permitting issues. In this case, the purchaser must buy the business, adding additional costs to the acquisition.

Large infrastructure programs that are dependant on federal or state funding as a portion of the construction budget must follow the guidelines set forth by government agencies for the use of those funds. These requirements call for the complete certification of the right-of-way prior to bidding or any construction. In this respect, the right-of-way must be “clear” from all encumbrances other than those certified as easements or other agreements. As a result of this, unless in extreme cases, all right-of-way is generally locked in before construction commences. A delay to this certification can result in costly delays to the construction that may force additional costs, or in extreme cases, may cause a project to lose its funding entirely due to reallocated appropriations or expiration of the government allocated funds.

COORDINATION

Coordination between engineering disciplines, including right-of-way, is a fundamental need for the efficient and timely completion of an engineering project. This is emphasized on a fast-track project where public and financial interests are dependant on its completion within schedule and
budget. During the progress of fast-track projects, when additional needs arise that force an alteration to the scope, a strong cooperative effort between all disciplines will minimize the impacts caused by the change. The additional needs that arise may force additional environmental permitting, unforeseen permitting for other municipal needs, or the need for additional right of way. Involvement by all disciplines in the planning process and early stages of the change can mitigate these issues, causing little impact to the delivery of the project. In cases where the Environmental Impact Report or Environmental Impact Statement may be insufficient to cover the change in scope, methods may be taken to mitigate the problem, thereby minimizing delays. For unplanned right-of-way needs, this coordination is mandatory to avoid acquisition problems and minimize the chances of a costly condemnation. This is not to say that condemnation can always be avoided, but it should be used as a last resort to avoid the costly time and budget impacts. Often the acquisition can be achieved with minimal impact to the project, under normal instances where all parties are cooperative.

The engineering needs of the Alameda Corridor have been balanced with right-of-way needs to minimize time impacts and costs. In this project, as with other fast-track projects, the enemy is time and delays due to right-of-way or other issues could cost hundreds of thousands of dollars if the substantial completion date is missed. To this end the coordination between track design and right-of-way engineers has been an important factor in maintaining the fast-track momentum of design and construction. The potential problems are determined after preliminary alignments are set and the right-of-way engineer has had an opportunity to identify potential issues that may impact construction schedule. The solution may be a compromise between design needs and right-of-way concerns. Clearly this process is beneficial by identifying any needs and addressing
them in the early stages. This is not to say that right-of-way impacts dictate the engineering, but supplement the process to achieve the best overall design. The needs of the railroad dictate the acquisition regardless of the affects of the design. The process benefits from an early knowledge of impacts and the proper measures to address these impacts can be taken.

Each segment of the Alameda Corridor had significant right-of-way issues that were the direct result of the dense industrial areas that the corridor traverses. Of course the relationship of right-of-way to these impacts extended beyond the acquisition of real property to access rights, operations, and utility placement. Many of the access and operations issues were resolved as part of the many agreements in place prior to the construction of the Corridor. Additional issues that have been determined as construction progressed were the product of the mitigation of the impacts to the many parcels. Cooperation between the parties resolved many of these issues and minimized the impacts to the schedule or costs.

The long, continuous, and fairly straight characteristics of railroad right-of-way create prime locations for utilities. The locations of railroads within industrial areas, for obvious reasons, add to the tendency for utilities to be located within or adjacent to these areas. While a proper discussion of utilities is beyond the scope of this paper, it is important that the effects that utilities on acquired rights-of-way be discussed. The impacts of existing utilities on property acquired for the adjustment of alignments can have significant impacts and in many cases can often be under estimated. Often the acquired property has existing utilities that are the subject of franchise agreements between the property owner and the utility that place the responsibility of relocation requested by the owner on the utility. In many cases the agreements are transferred
with the purchase. At times they “slip through the cracks” and conflicts are discovered that can cause delays.

It is important for the acquisition to address the issue of utilities. For example, a parcel containing several power poles was acquired to allow the relocation of an existing track to make room for the trench. The parcel was acquired on schedule and without delays to the tracks construction. Unfortunately, the impact of the power poles on the track construction was not known until the property was available and the new track was located. In fact one of the poles closely marked the center line of the new track. This utility had not been addressed during the purchase and further negotiations with the property owner that could have been addressed within this original purchase were required. The new track was constructed as the process of relocating the power poles continued. The final surfacing and tamping was delayed until the pole was removed. The result was a semi-completed track with one tie removed to allow for a power pole. While this delay did not hamper the construction schedule for the main tracks it did impact the scheduling of railroad forces for several weeks.

MINIMIZING THE EFFECTS

The northern portion of the Alameda Corridor Project is essentially the crossroads of railroad operations in Los Angeles. At this location, operations of the AMTRAK, BNSF, Southern California Regional Rail Authority (SCRRRA), and the UPRR interact. This is the point where the Corridor connects to the BNSF and UPRR main tracks east of downtown Los Angeles, and the handoff point for three different railroad signaling systems. This is also the point where the
BNSF San Bernardino Sub-Division, a track used by AMTRAK, BNSF, and the SCRRRA, crosses the UPRR main lines at Redondo Junction. The crossing was replaced with a flyover structure that will enable AMTRAK, BNSF, and SCRRRA to cross over the Corridor main tracks without impeding either passenger or freight operations. In addition to the rail work in this area, several street improvements and grade separations were necessary to separate the vehicular traffic from the railroad traffic. Important to the maintenance of traffic on the Corridor main tracks are the connections to each rail yard. These connections were optimized to maximize the capacity off the Corridor, minimizing delays created by trains moving into the yards.

Significant challenges faced the design of the UPRR connection between the Corridor and the UPRR main tracks east of the Los Angeles River. The existing connections are a 20 mph single track connection to East LA Yard and a 10 mph single track connection to areas north of Los Angeles. The east connection track crosses over a single track-open deck bridge that separates this track from vehicular traffic. This bridge is adjacent to a double track-open deck bridge for the UPRR main lines. In order to maintain maximum Corridor operations a 30 mph double track connection to East LA Yard was necessary.

The original concept was a double track connection with an additional track added along the UPRR main tracks. Four industry leads would be relocated to southern connection track. The existing single track bridge will be replaced by a two track ballasted deck bridge (See Figure 1). In order to maintain adequate vertical clearance above the existing roadway, the tracks will be
raised through this area. Unfortunately this concept, incorporating railroad standards for design, passed within twenty feet of the secondary containment of the oil storage tank area, eliminating the adjacent fire road. Original right-of-way cost estimates were in the $2-5 million price range. Upon further research into the impacts on the business it was found that the actual right-of-way costs would be several times that amount. This included the relocation of the business, the only one of its kind on the west coast, provided that a suitable location could be found. Adding to the acquisition concerns was the environmental permitting process that the business had been involved with for several years.

Because of these problems a solution was necessary that would allow this higher speed connection without the massive right-of-way costs and inevitable condemnation proceedings.
The engineers again looked at the ultimate needs for the connection and the industry lead connections. Since many of the right-of-way impacts were due to the additional track, the engineers looked at taking that additional track and ending it with the last industry connection just east of the business. This moved all industry lead switching the main track to a single lead, with a connection to the main track, an operational improvement from the existing configuration. The two connection tracks, the two main tracks, and the bridge were moved north and raised (See Figure 2). The extent of this shift was limited by the two track open deck bridge adjacent to the one being replaced. These limitations made it necessary to use substandard vertical curves in this area in order to minimize the impacts to the adjacent tracks and open deck bridge. Moving the existing UPRR main tracks to the north and raising them to the level of the connection tracks allowed the connection to be completed with minimal impacts to the business and no modifications were necessary to the storage tank area. This coordination between the operating railroad and the agency saved a costly impact to the project.

Figure 2: Final Configuration After Coordination
Several features were incorporated into the design of the trench that reduce or eliminate impacts to adjacent right-of-way. The trench, built on right-of-way purchased from the SP, is constructed between two major streets, Alameda Street West and Alameda Street East. Consequently the efforts are more to maintain the existing street configuration rather than mitigate right-of-way impacts. The design of the trench itself allows the streets to cross over the trench at street grade, thereby eliminating right-of-way impacts that may have ensued with a conventional overcrossing or under-crossing of at-grade tracks. The trench walls are constructed using cast in drilled hole (CIDH) piles with cross struts at the top of trench. This method of construction eliminates the use of tie backs and the resulting sub-surface easements. In addition, where the right-of-way was not wide enough to accommodate the trench, the roadway and two sections of at-grade drill tracks are cantilevered over the trench.

The most significant potential impact to adjacent facilities of the trench is at both the north and south ends. In these locations the slope is 1.13% and 1.15% respectively. While these are not the defining grade for the area, the transitions at each end are significant since they meet a 0% grade. In each case the base of the slope is constricted by overhead street crossings where it is necessary to maximize the vertical clearance. The track geometry at each end is constricted by several crossovers and turnouts. In each case the vertical curves are due to these constraints. The length of the vertical curve is limited to meet these constraints in order to satisfy the needs of both railroads to serve their customers and maintain the operations of the Corridor. The south end of the Corridor, while having fewer special trackwork impacts affecting the vertical and horizontal geometry, was constrained by street and highway overpasses and a bridge over a channel immediately south of the trench. The close proximity of these structures to each other
forced the “weaving” of the alignment between them and limited the options available. In each case the resulting vertical curves were modeled where the resulting drawbar forces were examined to confirm that the design was possible and safe.

The south end of the Corridor, with its many connections to local industries, had challenges with constrained right-of-way and the relocation of several industry tracks. Many potential issues regarding operations and the relocation of existing tracks were addressed within the original purchase of the right-of-way and subsequent operations agreements. In this segment of the Corridor two significant bottlenecks existed that, if not corrected, would significantly slow down operations in this critical area. Significant impacts existed that threatened to delay the project. In one instance the horizontal design requirements of a curve forced the acquisition of a portion of a property to allow for the design. The impacts to the industry were such that one business on the property was to be relocated, while some of the facilities of the second business were relocated within the property. Unfortunately a suitable location was difficult to find due to the nature of the business. After several months of unsuccessful attempts to find a suitable location, the move was made to condemn the business while the search continued. The search was eventually successful and the business was relocated with minimal impacts. The relocation of facilities of the second business within the property was delayed and steps were taken to transload the material that would otherwise be transported by rail in order to maintain the construction schedule.

The most difficult challenge in the south corridor was the junction where the ACTA main tracks split and lead to each port. In this case the junction was bracketed on four sides with a refinery.
Original concepts had the leads heading east significantly impacting the “cracker” unit (the facility where oil is broken down into its products). This connection was to be a 25 mph connection to one of the ports, improving the existing 10 mph connection, with an industry spur to the refinery. Original estimates for this right-of-way were approximately $5 million dollars. Further investigation showed that this unit was significantly impacted to warrant relocation, a prohibitively costly exercise even if a suitable location could be found. Numerous attempts to reach a solution to this problem were necessary, including countless design options and negotiations. The eventual agreement gave the desired connection without sacrificing track design criteria or operational goals. The agreement that was reached between the property owner and the agency was one that was mutually beneficial. Again it was clear that the connection would not have been completed on time without the cooperation of either party.

LESSONS LEARNED

The impacts that right-of-way acquisition can have on a fast-track project can be severe. In order to significantly reduce these impacts on project schedule, designs that increase the capacity of rail corridors within constrained rights-of-way must be analyzed during the early phases. While design in constricted rights-of-way is always tempered by the limitations imposed by adjacent constraints, railroad design, where straight contiguous right-of-way is necessary to maintain the desired speeds, increases the magnitude of these constraints. While existing alignments for main line railroad operations may be suitable for operations and capacities as they are today, they may not be in the future. Because of this more and more projects such as the Alameda Corridor will be constructed in the future. In many of these projects right-of-way will be the main obstacle in
the timely completion of the project. With the trend to fast-track design build projects, the issues of right-of-way become even more important. Because of this the experiences of past projects will benefit the projects of the future.

Close coordination between all involved parties will minimize the effects of design and right-of-way interaction. Conflicts with utilities, environmental regulations, and public interests, when determined at an early date in the project, can be effectively mitigated and delays can be minimized. While there will always be some right-of-way issues that just cannot be minimized, proper exploration of the alternatives and a thorough discussion between all parties will achieve a logical solution that is mutually beneficial.

As was mentioned previously, any deviation from railroad design standards in order to minimize right-of-way impacts should be used as a last resort, when no other means of a solution are possible, and when the fate of the project actually hinges on the acquisition. Factors that enter into this equation are safety, operational needs, and maintenance. In no instances should safety be compromised in order to mitigate right-of-way issues. Since deviations can have long term affects that may be costly in terms of maintenance or a sacrifice of operations, the decision to adopt a substandard design should take this into account. In all cases minimizing low impact right-of-way needs, does not come before a compromise of railroad design.

The coordination that is necessary for the completion of these types of projects is not limited to the designers, but involves many interested parties. In some instances within the Alameda Corridor, a viable and cost effective solution to problems such as that existing at the north end of
the corridor and the grades at each end of the trench could not have been achieved without effectively partnering with the operating railroads for an adequate solution. It is this coordination and partnership that will be necessary for the success of future capacity enhancement projects and has been a significant reason for the success of the Alameda Corridor.