ACCESS ROAD AND STREAM CROSSING CONSIDERATIONS[1]

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As the title implies this paper presents information concerning an important phase of right-of-way (ROW) preparation; the art and science of locating and building the access road network necessary for construction of a transmission line facility. Although the paper explores concepts employed by the author during the course of the March-Massena-Quebec 765 KV Transmission Line Project, much of this material would undoubtedly be adaptable to lower voltage transmission facilities as well. As the environmental engineer assigned to this project by the Power Authority of the State of New York (PASNY), it was my responsibility to aid in the development of the Environmental Management and Construction Plan (EMCP) as required by the Public Service Commission (PSC) of New York State under the auspices of Article VII of the Public Service Law. An important part of the EMCP is the location and design criteria of the access road network including the erosion and sediment control measures. This endeavor was a mutual effort on the part of the Authority and the contracted engineering firm, Uhl, Hall & Rich. A multidisciplinary approach was used in planning the access road system utilizing a fruitful combination of both engineering and environmental expertise.

That access roads are a topic of interest to a group composed of utility arborists may seem a little odd at first to some. Why would people devoted by title mainly to vegetative concerns be interested in access roads? This circumstance has been brought about by two different yet connected phenomena. First, historically speaking, access roads were (prior to 1970) not high on the list of things to do for most utility system transmission line engineers. Basically it was the responsibility of the construction forces to get themselves from one tower work site to another as best as they could. They did this by staying on the ROW whenever possible and negotiating with adjacent property owners for off ROW access as required. At this time little planning went into road design of the location of access routes. As a result the access roads were often little more than "punched out" routes usually kept as close to the centerline of the ROW as possible. Predictably, one of the major environmental impacts associated with transmission line construction was the condition of the access road system. With the advent of public environmental awareness in the 1970's and the resulting implementation of regulatory procedures, the loose manner in which access roads were chosen for transmission lines came to an end.

Then at about this same period the ranks of utility arborists were being swelled by foresters, landscape architects, resource managers and other professionals geared to environmental concerns, who were being employed in increasing numbers of utility systems. Thus this "gap" in transmission line engineering fell to these individuals who professed a desire to minimize the environmental disruption resulting from transmission line construction and maintenance activities.

Although I refer to a "gap" in engineering this is not to say that engineering is not needed. In fact, a solid engineering approach to this design, location, construction, and maintenance of the transmission line access road system will go a long way in keeping environmental disruption to a minimum.

Not withstanding the above, this paper will not attempt to specify the engineering details such as road curvature, computing volumes for road cuts, determining surface bearings strengths, bridge loading design criteria, etc. The goal here is to simply review many of the factors in the decision making process related to locating access road systems and determining the standards to which

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they should be built.

The initial consideration for the access roads and their attendant stream crossing devices should take place as early as the transmission line corridor selection process. Such general considerations as type of terrain as related to road building, streams and wetlands to be traversed, the number and juxtaposition of intersecting and parallel public roads, and the feasibility of using adjacent existing utility corridors should be factored into the transmission line route selection process. When taken into consideration in the early planning phases, access to and along the ROW may indeed be a limiting and/or critical factor in the final alignment of the ROW.

Once the corridor is selected and ROW maps are prepared from aerial photos resulting in a preliminary plan and profile map of the transmission facility, the first step in laying out the access road system can then start. In order to begin determining access road location and types, a road classification system with appropriate standards must be developed. It should be noted that established criteria and specifications for high standard roads requires a need for significant engineering detail. However, the standards to which transmission line access roads usually need to be built emphasize techniques which are considerably less detailed yet adequate to get the job done.

Basically there are two types of roads, permanent and temporary. Temporary roads are usually "abandoned" after construction and scarified or rough graded and then mulched and seeded for stabilization. However, these routes are still usable for the infrequent passage of maintenance vehicles. These roads may be built to very low standards often offering little more than a cleared route over a graded terrain. In some cases, the unsuitable overburden is peeled back to the subbase and then simply graded, crowned, compacted, and ditched.

Roads classified as permanent are those planned to receive substantial traffic or are located through rugged terrain or over poor soil conditions. The engineering design standards for the various types of permanent roads set the limiting specifications for such items as road surface width, materials and depth, subgrade conditions, gradient, curvature, cut bank and fill slope ratios, drainage structures and stream crossing methods and devices, turn out spacings and criteria and details for all other erosion prevention and sediment control strategies. These detailed design specifications illustrated with appropriate drawings and the criteria for their use, should be decided upon and finalized prior to any field surveys. It should also be remembered that due to local conditions no set of physical standards applies universally. Thus some flexibility in the choice and combination of road standards is often necessary so that the best type of road is planned for the circumstances present. Even further flexibility is usually warranted during the actual road construction phase so that deviations from the plan can take into account seasonal changes and other unique site-specific conditions.

With the various standards of access roads known, the next step is the field reconnaissance in which the preferred route of the access road is layed out and the choice of road type is made. Selection of the best possible route coupled with the right type of road will often require the simultaneous consideration of many factors. Only after a study of the overall picture including facility construction factors can the proper road location, class, and standard be selected. The following are some of the more important factors to be considered in this undertaking.

Construction Requirements

Support structures fabrication sites. The primary purpose of an access road is, of course, to get equipment, men and materials in and out of these construction sites. Secondarily, these roads will provide maintenance access to the structures and the ROW in general. Access needs will vary depending upon support structure type; pole or lattice tower; structure function; heavy angle, light angle, tangent or dead end structure; and differences in foundation requirement; grillage, concrete, or rock anchor. These differences will cause substantial changes in the type and number of vehicles that must reach the work site.

Conductor stringing sites. The setup areas for conductor pulling and tensioning equipment should also be integrated into access road system plans. However, since these sites will be needed only for construction, temporary spur roads built off the main access road may be sufficient.

Need for continuity in work progression. Due to the cost of breaking down a crane and coupled with various stringing requirements, a continuous access road down the full length of the ROW from one public road to another is often a desirable criterion to follow. However, some idea of the construction costs to be incurred when leaving a span length of ROW without access, making it necessary to break down heavy equipment and transport it off ROW via public roads and re-enter the ROW from ahead should be estimated. Thus when faced with the dilemma of to build or not to build an access road from one span to the next, for whatever the reason, some economic analysis can be applied. Conductor stringing operations and maintenance needs should also be a factor here when a deletion in continuous access is being considered.

Off ROW access. Due to on ROW impediments the best route to a structure site may lie off the ROW utilizing for instance existing woods roads and farm lanes. Company policy in regards to the need for off ROW access should be known prior to field investigations. In some instances the most direct route may not be feasible due to the adverse ownerships encountered. These and other legal questions concerning the securement of off ROW easements need to be addressed prior to such access route alignments.

Maintenance requirements. The type of transmission line maintenance vehicles available to the company may alter the needs and standards for the access road system. For instance, such all-terrain vehicles as a flex track, dragon wagon, or jaggurnaut purport to need only minimum if any access improvements. Whereas conventional line trucks will require a substantially higher standard of road to insure site visits under adverse conditions. The vegetation management program planned for the ROW may also be a factor in the determination of access road type and location. For instance, vegetation treatments calling for selective ground applications may require a greater investment in access roads than in aerial spray programs.

Environmental Constraints

Topographic-edaphic characteristics. The routing of roads over terrain offering the path of least resistance usually provides the best access road location at the least cost both in terms of construction expenditures, maintenance work, and environmental disruption. Unfortunately, access road impediments in the form of steep slopes, erodible soils, rock outcrops, and sensitive streams abound. Herein lies the real challenge of fitting the appropriate road design specifications to the most suitable route location. Trade-offs among all the above factors and the ROW terrain and soil conditions will constantly occur. For instance, the trade-offs associated with the inherent problems of off ROW access even over favorable terrain requiring only modest road building effort must be weighed against locating the road on the ROW through rough terrain necessitating expensive high standard roads.

Erosion prevention and sediment control considerations. The projected requirements in terms of road stabilization throughout construction and into maintenance through the implementation of various temporary and permanent erosion and sediment control strategics may in certain sensitive environments dictate the location and type of road.

Land uses and natural habitat conditions. Although the ROW alignment and tower locations may pass through specialized land uses such as intensive agricultural operations or habitat conditions as deer softwood shelters and sensitive streams with minimum disturbance, the actual location and type of access road may still significantly disrupt the area. The location and type of road that will be most compatible with such a dominant land use may override many of the above considerations. For instance, it is often wise to follow hedge rows or fence lines rather than traverse in a straight line through such agricultural properties. If a road must be located straight through a crop field, temporary rutting and mud holes may be preferable from a site restoration standpoint rather than deposition of sterile fill materials over the productive soils.

It should be noted here that most access road system location and type determinations have cost as a common denominator. However, these costs, particularly when viewed in the long-term, are often difficult to quantify. The old road building adage of "determining the total cost of cheap transportation over expensive roads with that of expensive transportation over cheap roads" does not lend itself to any easy economic analysis.

The goal of the utility access road system planner should be to develop an access road system that will minimize the combined cost of facility construction, road building and maintenance, coupled with an objective of reasonably minimizing erosion and sedimentation and other forms of environmental disruption. It should also be apparent from the above discussion that the individuals who are delegated the responsibility for developing the road specifications, locating the access routes, and specifying the types of roads to be built should have a well balanced background including not only experience related to roads, but knowledge in the fields of transmission line construction, utility ROW maintenance, and the appropriate environmental disciplines. Given the premise that a standard set of sensible environmental guidelines will be adhered to, the cost of environmental disruption will in almost all instances be reflected in additional costs in road building and/or maintenance. Thus, protection of environmental values in terms of avoiding commonly defined sensitive environmental sites, or implementing the proper changes in access road specifications to accommodate the environmental conditions encountered will usually result in lower road related costs over the long run.

Road Construction Considerations

Integrated with the above general considerations are the site-specific requirements as determined by the field survey when the final alignment for the route is checked and the design features specified prior to the road building operation. The actual road building process then should be monitored or supervised to the level that is required to meet the goals established for the access road system. The amount of direct supervision of the crews will vary depending upon the anticipated problems. In environmentally sensitive sites or where detailed road design specifications are required, full-time supervision may be necessary. For low standard roads over normal terrain, short routine inspections for compliance may be all that is needed.

The first step in beginning the access road construction phase is flagging the route selected as located on the plan and profile maps from the prior route selection and design specification reconnaissance field work. The proposed route should be "flagged" in the field by the use of stakes or ribbons rather than blazed or painted with permanent markers. Minor deviation in the road location may occur and it is much easier to remove and replace the temporary ribbons and stakes. Also, permanent blazes may confuse the equipment operators resulting in road work along the wrong route.

If cut-and-fill operations are anticipated then the condition of the substrate for its suitability as fill material should be checked. If the substrate consists of poor materials then suitable materials must be brought in not only for the fill slopes but for the road surfacing operations as well. This necessitates that the borrow pits should be checked to see if the materials they contain meet the specifications. Materials from these approved pits should then be occasionally monitored to insure consistent quality.

When clearing in swampy areas it is usually best to cut the trees flush with the ground. A mat of slash material should then be laid down on the roadbed site to give a bridging effect for the clearing equipment and provide additional road bearing strength once the fill material is in place. In wet areas, having muck soils with little or no woody vegetation, a filter cloth may be laid over the roadbed prior to adding fill material. Use of such a sheet requires less fill material. If sufficient wood is available a corduroy road could also be established over such a poor subgrade. Winter work is recommended for road preparation in such wet terrain so that an ice cover will form allowing the use of heavy equipment with less impact.

Removal of stumps by a bulldozer blade or by a tractor with a winch is often recommended and even necessary for some access roads.

However, when fill material is to be added, it is easier to cut the stumps flush to the ground and add fill over them. To insure road surfaces that will resist erosion and allow water to run off and at the same time withstand heavy traffic, the roadbed and any fill material added should be compacted. A crawler tractor can be used for this operation if repeated staggered passes are made. The road surface itself should also be crowned as well as compacted. It is also very important, especially for permanent roads, to stabilize the road surface. The ideal smooth, long wearing, hard surface should be composed of a combination of hard, coarse gravel and sand. About 10% of the volume should be a clay binder to stabilize the sand and retain moisture so as to aid in the shaping of the road.

Drainage control is of utmost importance in maintaining road integrity. The crowned shape of the road surface should slide water into the side ditches. The ditches should then carry the water to frequent off-takes and level spreaders. On steep slopes, the grade of the ditches can be increased by using check dams or lining the side of the ditches with gravel to insure their stabilization. Water bars, open-top culverts, and road dips can also be used to aid the passage of water through and off the road. It is equally important to insure prompt drainage of the side ditches. Improperly drained ditches saturate the subgrade and even the road surface allowing for rutting and mud holes to form. Such sites should be reditched and graded to insure drainage. The mud holes and ruts should then be graded and filled with suitable material as required. Any maintenance of the road surface to eliminate ruts, bumps, and washboard conditions should take place soon after rains when the soil is not too sticky and not yet completely dry. However, such deterioration of the road surface can be reduced if heavy traffic is not allowed after heavy rains, when the road surface is at or near saturation. Temporary closures of this sort are, of course, difficult to implement during a tight construction schedule and thus road maintenance is often necessary.

The details of stream crossing consideration, techniques, and devices are too complex to be given adequate coverage here. However, instead of glossing over this important area, some useful tips will be presented.

Often the stream crossing is a ruling point in that the access road location is made subordinate to them. For instance, the availability for an unimproved or slightly improved stream ford through a bedrock or boulder-filled stream course would certainly be preferable to building a bridge or installing large culverts elsewhere. Further, in some limited situations the anticipated construction costs and environmental disruptions to certain streams may dictate no crossing at all.

The principal stream crossing method chosen is usually by some sort of culvert installation. one of the most difficult decisions to make is deciding upon the proper culvert size. The mathematical approach taking into consideration the size of the drainage area (watershed), rainfall intensity, and the quickness of run-off usually yields overly large culvert diameters. However, the fear or culverts being too small and washed out or otherwise too easily blocked is very real. One course of action is to check the nearby vicinity, preferably downstream, for the size and condition of culverts already installed.

Poor culvert installation will often lead to more drainage problems than size alone. The shallow placement of culverts by setting them too high, and the lack of or inadequacy of collector and discharge ditches often results in a failure to adequately drain the area on the higher side of the road. Further, such high culverts are often damaged by the road-grading equipment and are more subject to frost-heaving and the lifting action of water. To further minimize such movements, the well-placed culvert should have coarse gravel bedding placed under and at the side. Also necessary on well incised stream channels are stabilization measures at the inlet and outlet of culverts through the use of rock rip-rap or graded gravel in addition to headwalls to reduce erosion and undermining of the culvert. Particular care should be taken when placing the smaller diameter culverts, for it seems that it is through the use of these culverts that most of the above cross-drainage and maintenance problems occur.

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