Module 2B: Stage 1 Survey and Design

Headings	Description	Reference Documents
Introduction	• Stage 1 survey is carried along the best route recommended in walkover survey • Is the first level detailed survey in which necessary measurements/details are taken for subsequent design • Field data translated to design which serves as a guiding document for construction of 2.5 m track opening • Cost estimate based on the design is taken as a basis for overall resource/budget planning	1. RAP3 ToR for Stage 1 Survey, Design and IEE 2. Nepal Rural Road Standard, 2012 3. MRE Handbook (Part I and II), ICIMOD 4. Overseas Road Note 16 and 20 , ODA/TRL 5. Green Roads Best Practices Report, 1999, GTZ/SDC 5. Construction Guidelines for Low Cost Feeder Road, DoR,1995 6. Roadside Geotechnical Problems: A Practical Guide To Their Solution, DoR, 2007 7. IRC: SP48 Hill Road Manual, 1998
Stage 1 Survey Overview	• Survey of the best possible alignment identified from walkover survey • Obligatory points taken as control points to guide how and where the road alignment should pass • CL fixation with establishment of horizontal/vertical control and cross-section measurement are the key activities to be undertaken	
Stage 1 Survey Steps	**Desk Study** • Review the walkover survey report and confirm the best alignment option recommended • Collect the details of obligatory points that the alignment should pass **Field Survey** • Follow the best alignment from the walkover and make corrections to errors/lapses, if any found in the field • Mark CL with Abney Level by setting the gradients within the max. acceptable limit (i.e. 12%) • Run traverse survey along the marked points (pegs) with Total Station • Establish benchmark at 500 m interval at permanent points (like big boulder, outcrops of rocks) with adequate reference points • Fix CL pegs at 20 m interval or less as required and record coordinate data of adequate points along 10 m on either side of CL or go beyond that if CL shifting is likely to happen during design • While fixing CL with Abney Level key aspects to be considered are: o Make proper judgement that no kinks (alignment deflecting sharply in and out) will be formed. o Alignment should not have deep ups and downs to avoid heavy box cutting and high retaining wall. o CL should be so positioned that cut and full could be achieved transversely as well as longitudinally. o Do not go beyond ruling gradient of 7% in normal case o If there is a need to adopt gradient above 7%, limit the length within the allowable value and provide grade recovery length as necessary.	

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	• Record details of CL pegs on a strip map establishing reference point for pegs on an interval of 250 m • Identify possible disposal sites for those locations where huge surplus is likely to come up • Record soil/rock classification as per DoLIDAR's norms. • With proper engineering judgement select best location for cross-drainage structures over rivers and major Kholas. • Make best attempt to avoid geologically unstable areas and hazardous sections. • Survey land use and plant availability for bioengineering. **<u>Locating Hairpin Bends</u>** • Minimise number of hairpin bends as it increases project cost and reduces vehicle driving comfortability. • Stack of hairpin bends (one closely spaced above other) should be avoided as far as possible. • Bend is to be located on relatively flatter terrain as far as possible. • Hazardous and unstable areas need to be avoided. • Layout configuration of a cluster of bends should be such that upper bend should extend horizontally beyond the lower one to facilitate the proper drainage	
Lessons Learned	• Digital Terrain Model (DTM) developed using inadequate cross-section data (coordinates) do not produce the cross-sections reflecting the actual transverse ground profile. The every point where transverse profile changes has to be recorded during the survey for developing DTM in design office. • It is impossible to bring down the high gradient by adjusting gradients in preceding and following sections at design office unless CL pegs are fixed with proper consideration of permissible values and lengths of gradients right in the field.	

Stage 1 Design and Estimates Overview	• Principle underlying the Design
	  ○ Low cost and labour-based
	  ○ Min. disturbance to natural profile/morphology
	  ○ Take MRE hand book as the reference document
	  ○ Optimization of cut and fill/due care to spoil management
	  ○ Extensive use of softline (flexible) structures
	• Design and Estimates clearly separated for 2.5 m width (first phase) and for full completion (all phases)	

Stage 1 Design and Drawings	• The same survey engineer need to be involved in the design because of him or her having detail information and knowledge of the ground features	

Headings	Description	Reference Documents

	• Horizontal Alignment – fully define intersection points (IP) with beginning of the curve (BC), middle of the curve (MC) and end of the curve (EC)
	• Vertical Alignment – fully define key points of vertical curve: BC, MC, EC and highest and lowest points w.r.t. designed point of intersection
	• Mass Management – design mass management and haulage plan (mass haul diagram) and show on profile design drawings
	• Cross-section Design
	  ○ minimum changes/disturbance to the natural profile ensuring optimum cost
	  ○ Define and draw various cross-section elements – roadway width, side drain and type, retaining and breast walls, passing bay as required
	  ○ Show different phases work – Year I: 2.5 m wide track, Year II: 3.5 m wide track (introduce structures), Year III: full width 4.5 m and retain. Structure complete and Year IV: side drain and cross drain, additional width for passing bay, bioengineering works
	Drawings:
	• Road Plan to 1:1000 scale, coordinates of IPs and all parameters for horizontal alignment set out (e.g. deflection angles, point of tangent, radius of curve etc)
	• Profile to H1:100 and V1:200 (for hills) and V1:100 (for plains) scale showing vertical curve data, soil type, drain type and mass haul diagram
	• Cross-section at 25 m interval or less covering at least 10 m on either side showing ground level, areas of cut/fill, soil type, drain type, phase wise earthwork areas and structures details.
	• D-card with full details (including coordinates) of benchmark and CL reference points	

Stage 1 estimates	• Estimates for each phases of work • EW in excavation to be broken down as OS, HS, OR, MR, and HR as per DoLIDAR norms • EW also to be categorized as cut to fill, cut to tip and borrow to fill with required lead distances • Estimates for different type of structures e.g. retaining/breast/toe/check walls, cross drainage structures and protection works • Estimates for quantities of stones to be quarried and collected along with the transportation lead distances • Rate analysis using DoLIDAR norms and approved district rates for labour and materials and current market prices of non-local materials	

Headings	Description	Reference Documents
	• Abstract of Cost – total for the road and VDC/LRUC wise • Cost estimates for bioengineering and environmental mitigation measures • Total labour days requirements and number of RBGs to be deployed for completion based on the available duration of the project	
Lessons Learned	• Because of the centre line shifting/adjustment in most cases in pursuit of optimised design of horizontal and vertical alignment during design work in office and not setting out the horizontal curves during survey, it is felt that CL setting out and verification of design is necessary prior to start-up of construction • In absence of inadequate field data, the cross-section derived from DTM do not match the actual ground profile and when CL is changed from the surveyed position in design office, the discrepancies in the cross-sections would further increase. • EW volume being significant even in phase I, need of provision of toe/check wall felt • Structure design varies consultant to consultant, so for consistency a guideline outlining basic and fundamental aspects to be considered in the design is to be provided to the consultants. • Little care was seen in the design with regard to management of spoils, so specific plans/designs/provisions need to be emphasized in the ToR. • To overcome the above lapses, in addition to providing a brief design guideline it could be worthwhile having an one-day orientation to the consultants on the design concept and approach prior to mobilisation to the field survey.	