Road Construction South of Rio Adentro
Pia's House to Escondido, Wooden Gate

1. Overview

The road is the main access to Panamaes resort and serves for both guest access as well as service vehicles. The typical users will be resort visitors using sedans or SUV. Other users are adjoining property owners, ranchers and also service vehicles necessary for the support of resort activities.

This report covers the segment form south of Rio Adentro (Pia's house re-connecting to the public access (camino public near Escondido

The road is laid out as a 1.5 lane road with turnouts to facilitate the passing of trucks, usually 2-axle trucks. Sedans and SUV's can pass within the standard 1.5 lane utilizing the shoulders. General design speed is max. 40 kmh. Typical daily traffic frequency is estimated at 20-50 vehicles per day. Turnouts will be required , on average about every 500 meters. For general road terms, see Figure 1.

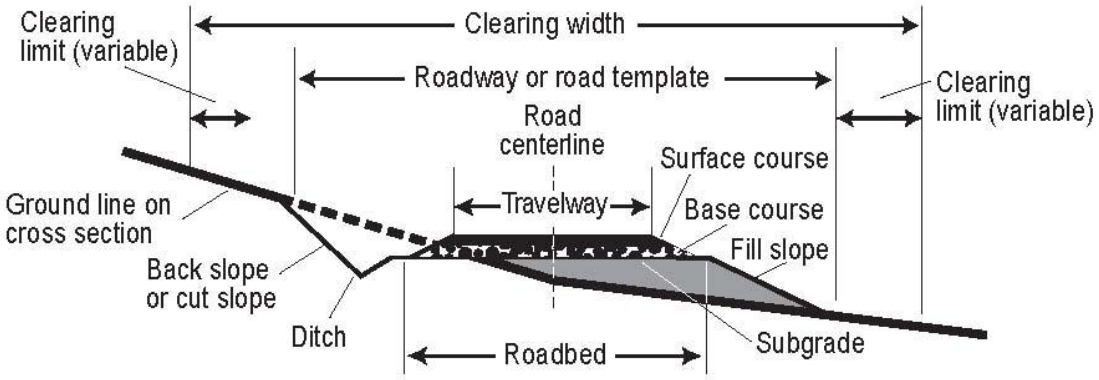


Figure 1: Road structure terms

1.1 Access

The total road length beginning at Pia's house and ending at the wooden gate, Escondido is 1,700 meters. The road has two distinct section, the first section from Pia's house to just before the first quebrada, shortly before it joins the public access again and a second part, form the quebrada to the end at the wooden gate (section 2)

1. Section 1: This part is characterized by gentle topography and rolling grades not exceeding 10%. Side slopes are less than 30%. Road construction typically is a cut/fill template with very little cuts or little fills
    a. Starts at station 1205.2 (Pia's house)
    b. Ends at station 2400 before quabrada
2. Section 2: This part has some steep grads up to 14% plus two quebrada crossings. It follows the public right-of-way and therefore has grades up to 14%. In order to keep the maximum grades to <14% some substantial cuts are required (up to 3 meters). The cross sections vary from full-bench to to through cuts and fills (quebradas). The crossings require
3. Stream crossings. Two streams are crossed at station 2512.8 and 2775.4
    a. Station 2512.8: culvert with 1.50meter dia. and approximate length of 21.0 meters. Final length has to be determined on location
    b. Station 2775.4: culvert with 1.00m dia. And approximate length of 17 m. . Final length has to be determined on location

Standard Template Design Parameters (Figure 2):	**1205.2 – 1789.0** **1814.0 - 1864.0** **1904.0 – 2483.2** **2525.4 – 2771.4** **2783.4 – 2904.3**
Road traveled width	4.8 meters
Subgrade (road bed) width	6.40 meters, ditch not included
Ditch:	1.3 m wide and 0.6 m deep
Fill slope	-67 % or 1.5:1 (run over rise)
Cut slope	100 to 200 % (1:1 to 2:1) depending on subgrade material
Ballast/surfacing	0.30 m, ~ 2,800 cubic meters
Final capping or surfacing:	0.10 m of select gravel (25 mm minus), appr. 1,200 m3
Road surface	crowned 3 %
Cross drain culverts:	Final locations to be determined. Currently five cross drain culverts identified at Stations 1318.5; 0.5 m dia and 11.3 m long Station 1493.7; 1.0 m dia and 11.0 m long Station 1584.4; 0.5 m dia and 11.5 m long Station 1947.6; .6 m dia and 110.9 m long Station 2395.9; 0.5 m dia and 10.5 m long
Total excavation:	~10,400 cubic meters

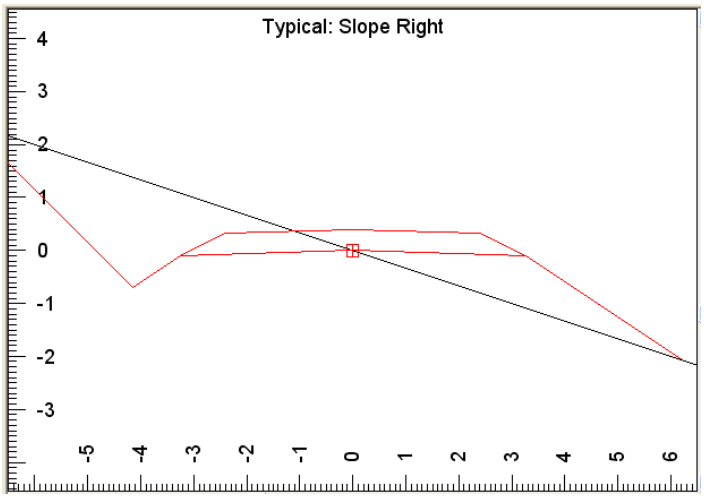


Figure 2: Standard road template with 4.80 meter traveled way, 6.40meter subgrade width based on a 0.40 combined base and final layer, shoulder and ditch line.

General Construction Practices

During construction of a temporary road (allowing construction access to Panamaes) and also during the construction of the final road no earth movements (loaded dump trucks) ae allowed across El Guabo, Rio Caldera or Rio Adentro. Such traffic will otherwise result in unacceptable levels of stream bed disturbances and excessive levels of sedimentation, which eventually will be harmful for the aquatic ecosystems.

Excess excavation material will have to be incorporated into the road template between those stream systems. Excavation amounts and transport issues will e discussed in detail in the appropriate sections below.

Excess excavation can be incorporated into the road systems by

a) Fill widening (wider subgrade)
b) Lifting the subgrade above the current road surface (Figure 3)

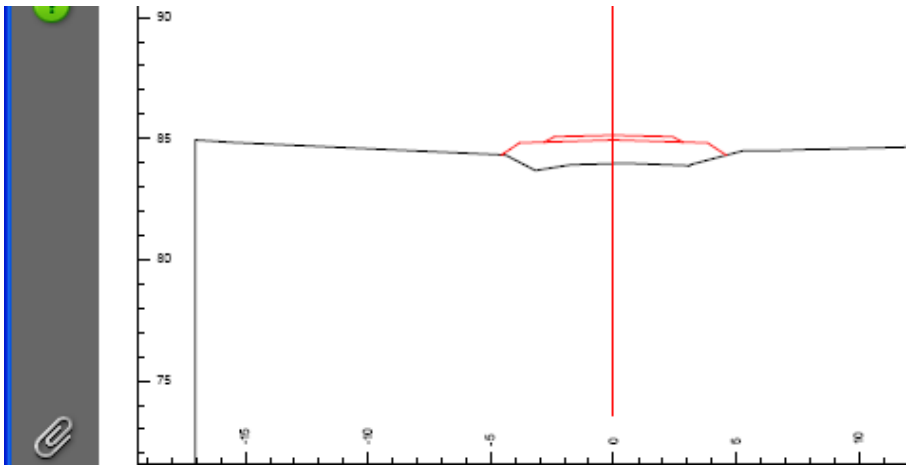


Figure 3: The current, entrenched road surface is shown with the black line. It clearly shows the road surface elevation below the surrounding pastures. Ditch water cannot drain away from the road bed. Raising the road surface brings the road bed above the surroundings and also allows for placement of excess excavation

Fill Widening Design Parameter template (Figure 4):

1789.0 - 1814.0	**1.0 m Left and 1.0 m right**
1814.0 – 1864.0	**1.0 m Left and 1.0 m right**
1864.0 – 1904.0	**1.0 m Left and 1.0 m Right**
2483.2 – 2525.4	**2.0 m Left and 2.0 m Right**
2771.4 – 2783.4	**1.0 m Left and 1.0 m right**

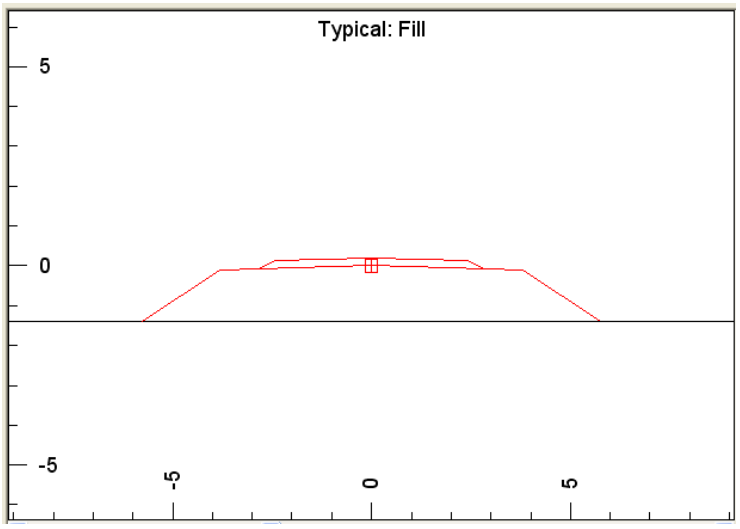


Figure 4: Typical fill widening Traveled width is the standard 4.8 meters.

1.2. Station 1205.2 to 1315.0

Use standard template

1.3. Station 1315.0 – 1435.0

The current trail goes through a flat, wet area. The road is moved to the left, towards the base of the hill to avoid the wet area and also to create a cut/fill cross section to improve drainage. This portion may require more than the standard 0.3 m of tusca.

Use standard template

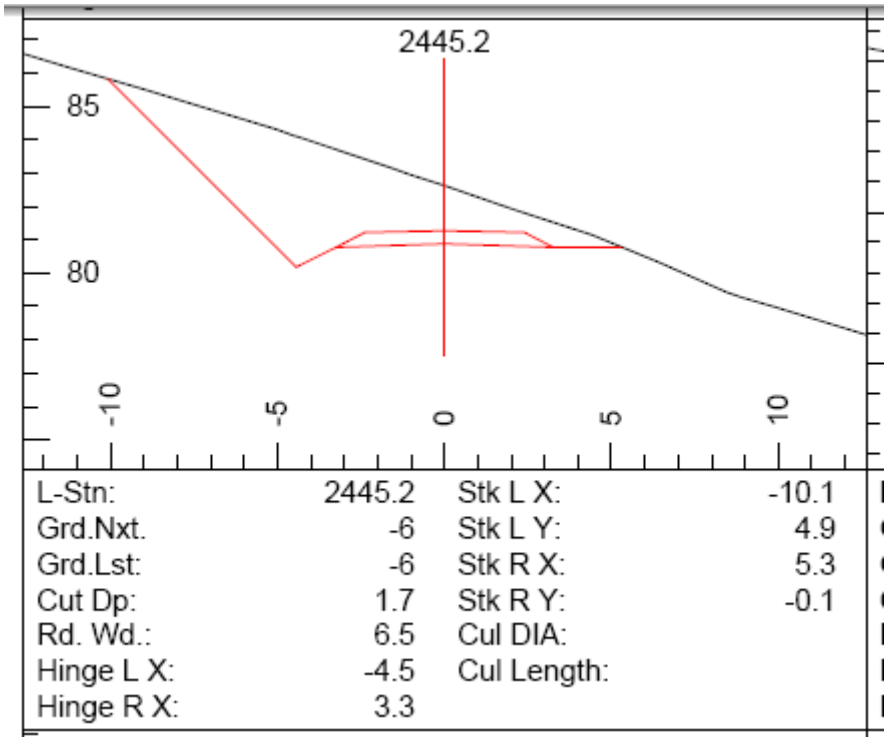
1.4. Station Station 1435.0 - 2435.0

rolling grades, varying between 5% and 9%. Special attention has to be given to drainage structures so water does not stagnate in the ditch lines and on road surface. Excess excavation from within this road segment can be used to lift subgrade in places.

1.5. Station 2435.0 – 2512.0 Approach to Quebrada and Public Access

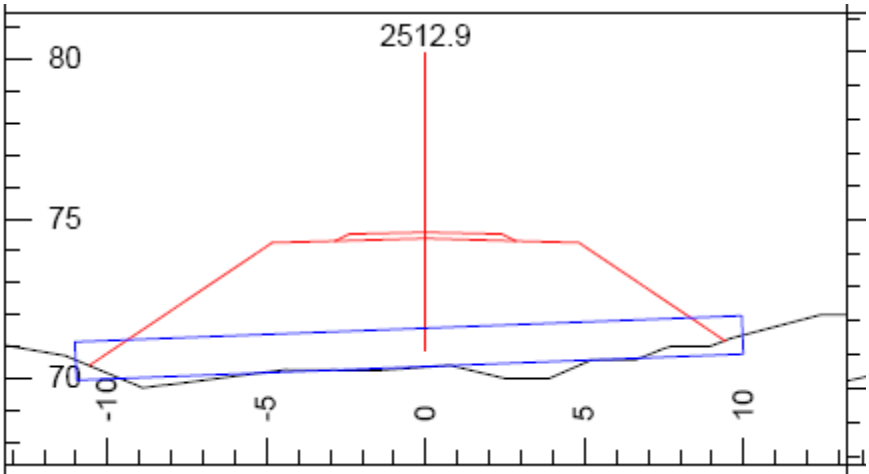
Road grade increases to a maximum design grade of -12%. In order to not exceed that, the road surface has to be lowered (cut) between 2 – 3 meters in order to maintain a -10 - -12% grade.

Most of the road is built as a full-bench road. No excavation can be deposited on the sidehill because of the stream to the right. All excavation has to be moved forward or backwards.



Excavation volumes for that distance will be approximately 1,700 cubic meters. That material can be used to create the fill to cross the quebrada. The rest can be used to the back to lift the subgrade in places to improve drainage conditions.
The stream crossing should have a subgrade width of 9.70 meters.

Use fill widening template of 2 m left and 2m right template

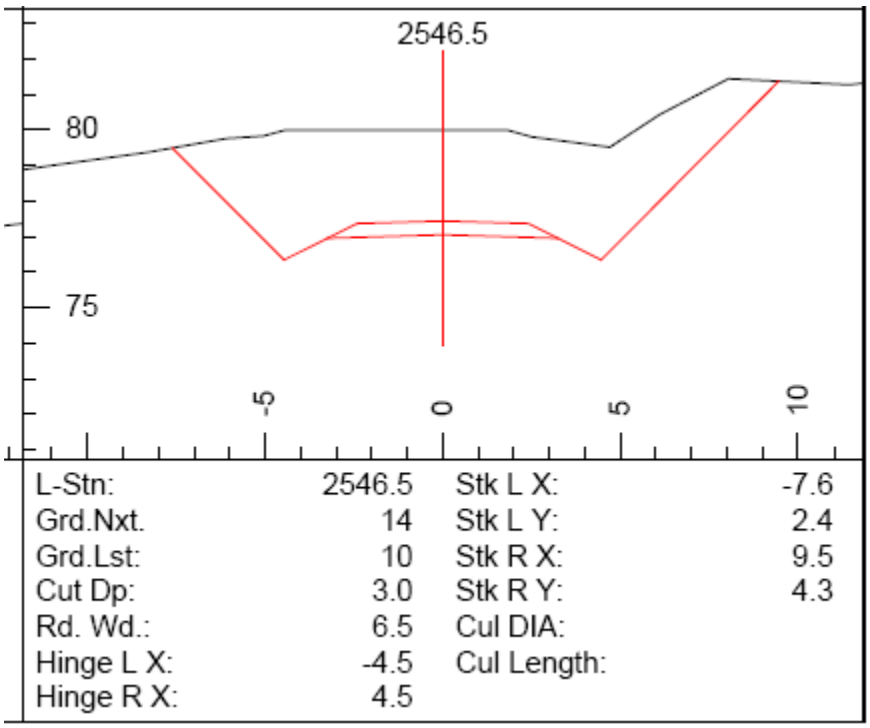


L-Stn:	2512.9	Stk L X:	-10.6
Grd.Nxt.	1	Stk L Y:	-4.0
Grd.Lst:	-2	Stk R X:	9.4
Cut Dp:	-4.0	Stk R Y:	-3.2
Rd. Wd.:	9.7	Cul DIA:	1200mm
Hinge L X:	-2.8	Cul Length:	21.0
Hinge R X:	2.8		

1.6. Station 2512.0 – 2650.0

The road now follows the public access (camino public). Substantial cuts and excavation are required so that the road grade does not exceed 14%. Up to 3 m in cuts are required. Most of the road is a through cut wih ditches on both side. At station 2650.0 the road drops into the next quebrada

Excess exaction can either be moved forward or backwards across the quebrada to incorporate into the subgrade ahead towards Escondido
Excess excavation between stations~2,800 cubic meters.



1.7. Station 2650.0 - 2775.0 Metal Corral

The road starts to drop at about 13% into the next quebrada at station 2775.0. Excavations excess can be used to create the fill crossing the quebrada. A 1.0 meter culvert is required. Final length will be determined on location. Fill widening is 1m left and 1 m right.

1.7. Station 2775.0 - 2904.3 Wooden Gate

The road climbs at 14 % and again, substantial cuts of up to 3 m are required so a maximum grade of 14% is not exceeded. Excess excavation shall be moved forward and be used to raise the subgade of the public access above the surrounding pastures. The same situation applies here (beyond station 2904 as exists at the beginning near Limon.

In order to improve the drainage, the subgrade needs to be raised above the surrounding pastures.

1.8. General Comments

Cut and Fill slopes will be seeded and require protective covers such as matting or mulch. This is especially critical for the fills that cross the quebrada

1.9. Turn-Outs

Typical dimensions for a turnout are
Width: 2 meters
Length 25 meters with transition
They can be placed on either side of the road.

2.0. CONSTRUCTION REQUIREMENTS

CONSTRUCTION STEPS

1. Pioneering can extend over the full road project during the dry season. However prior to the rain season the necessary steps shall be taken to protect subgrade, ditches and road features.
2. Drainage shall be provided before the on-set of the rain season on all uncompleted construction.
3. Road pioneering operations shall not undercut the final cut slope, deposit excavated material outside the clearing limits, or restrict drainage.
4. Clearing and grubbing (removal of organic debris and top soil) shall be completed prior to starting excavation and embankment.
5. Culverts shall be installed in completed subgrade as construction progresses, the latest before the on-set of the rain season.
6. Subgrade, ditches, and culvert installations and subgrade compaction shall be completed prior to the rain season. Rock application (tosca)shall be done before the rain season .

ROAD GRADE AND ALIGNMENT

Grade and alignment shall have smooth continuity without abrupt changes in direction.

CONSTRUCTION TOLERANCES

Roads shall be constructed to the dimensions shown on the design drawings, within the tolerance listed below.

Road Width (meter)	+0.5

SHAPING CUT SLOPE

Excavation (cut) and embankment (fill) slopes shall be constructed to a uniform line and left rough for easier revegetation

FILL WIDENING
Except as designed, Embankments shall be widened as follows:

Height at Shoulder	Subgrade Widening
0.2 to 2.0 meter	1.0 meter
2 meter or over	1.5 meter

FILL SLOPE RATIO
Embankment (fill) slopes shall be constructed no steeper than shown on the following table

Material Type	Embankment Slope Ratio	Percent
Common Earth and rounded rock	1 ½ :1	67
Angular Rock	1 ¼ :1	80
Sandy soils	2 : 1	50

DISPOSAL OF ORGANIC DEBRIS
Organic material (e.g. stumps, roots, branch material, organic soil) shall be excluded from embankment or fills

EMBANKMENT KEYS
Keys shall be constructed at toes of embankments.

FILL CONSTRUCTIONS
Fill constructions will require water to increase soil moisture content in order to achieve acceptable compaction. If rainfall did add acceptable levels of soil moisture, no watering is required. Fill layers shall be constructed (built-up) in 30 – 50 cm lifts, watered during fill application and then compacted with suitable compaction equipment. Where appropriate construction traffic shall be routed over the fill portions (road beds) where possible.

FILL COMPACTION
All fill material shall be compacted with proper compaction equipment. The minimum acceptable compaction is achieved by placing fill in 50 cm or shallower lifts and routing excavation equipment over entire width of the lifts. Side hill fills too narrow to accommodate excavation equipment may be placed by end-dumping or side casting until sufficiently wide to support the equipment.

All fills deeper than 1.5 m at the road shoulder shall be compacted full width in 30 cm lifts by four coverages with a drum roller weighing at least 6000 kg at a maximum operating speed of 5 km/hr.

SUBGRADE COMPACTION

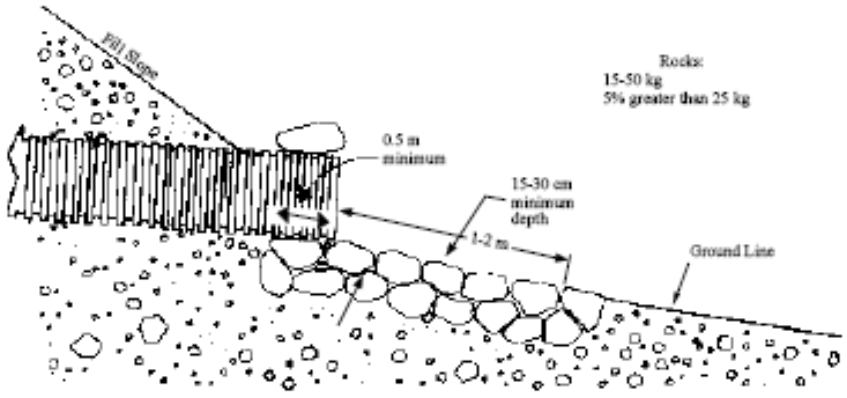
Constructed subgrades shall be compacted full width except ditch prior to rock application. Compaction shall be by a smooth-drum vibratory roller weighing at least 6000 kg. Four complete passes shall be made at a maximum operating speed of 5 km/hr.

SUBGRADE CROWN
Finished subgrade shall be crowned with a 3% cross slope and shall be uniform, firm, rut-free, and shaped to ensure surface runoff in an even, unconcentrated manner.

CROSS DRAIN CULVERTS
Culverts shall be installed on at least a 3% grade.
Culvert outlets shall not terminate directly on unprotected soil that will erode.
Downspouts, flumes, and energy dissipaters' shall be installed to prevent erosion.

CULVERT SPECIFICATIONS
Culvert, downspout, flume, and energy dissipater installation shall be in accordance with CULVERT AND DRAINAGE SPECIFICATION DETAIL provided by the manufacturer.

ENERGY DISSIPATORS
Drainage structure outfalls shall not terminate directly on unprotected soil that will erode.
Downspouts, flumes, and energy dissipaters shall be installed to prevent erosion



Example of a culvert outlet protection to prevent erosion of out flowing water

Photo 7.3 Use masonry, concrete, or metal inlet structures to control water in the ditch, direct the water into the cross-drain pipe, and prevent ditch down-cutting.

Possible example of culvert inlet

STREAM CULVERT ARMORING

Embankment slopes adjacent to culvert inlets and outlets at live stream crossings shall be armored with machine-placed light loose riprap for a distance of one culvert diameter-on each side of the pipe and one culvert diameter above the pipe

RIP RAP SPECIFICATION

Riprap shall consist of angular stone

Loose Riprap - The stone for loose riprap shall be hard, sound and durable. It shall be free from segregation, seams, cracks, and other defects tending to destroy its resistance to weather. Loose riprap shall be free of rock fines, soil, or other extraneous material.

Light Loose Riprap - Shall meet the following requirements for grading:

At Least/Not More Than	Size Range	Maximum Size
20% / 90%	300 lbs. to 1 ton	--
80% / --	50 lbs. to 1 ton	--
10% / 20%	--	50 lbs.

DITCH, HEADWALL, AND CATCHBASIN CONSTRUCTION

Shaping the ditchline, culvert headwalls, and catch basins shall be completed prior to application of rock

ROCK QUALITY FOR BALLAST

"2½ INCH MINUS CRUSHED" rock shall meet the following specifications for gradation and quality

2½ INCH MINUS CRUSHED ROCK

% passing 2½" square sieve 100%
% passing 2" square sieve .....65 -100%
% passing 1" square sieve .....50 - 70%
% passing ¼" square sieve .....30 - 50%
% passing U.S. #40 sieve .....16% Max
% passing U.S. #200 sieve .....5% Max

All percentages are by weight.
The portion of ballast retained on ¼ inch sieve shall not contain more than 0.1 percent vegetative debris or trash.

ROCK COMPACTION

Rock shall be spread and compacted full width in one lift not to exceed 50 cm uncompacted depth. Compaction shall be by smooth drum vibratory roller weighing at least 6000 kg. Four complete passes at a maximum speed of 5 km/hr shall be made on each lift.

DITCH CONSTRUCTION

Ditches shall be constructed concurrently with construction of the subgrade. Ditches shall drain to culverts, ditch-outs, and natural drainages.

Shaping the ditch line, culvert headwalls, and catch basins shall be completed prior to application of rock.

Where road and ditch line are steeper than 10% the ditch bottom shall be armored with angular rock unless the subgrade and ditch line are built into fractured rock. In addition rock barriers shall be placed in the ditch channels to break or reduce water velocity.

Ditch line armored with angular rock to withstand erosion