

**PIMA COUNTY REGIONAL FLOOD CONTROL DISTRICT'S  
TECHNICAL POLICY**

**POLICY NUMBER:** Technical Policy TECH-030

**EFFECTIVE DATE:** April 29, 2015

**REVISED:** N/A

**POLICY NAME:** Construction, Maintenance & Repair of Unpaved Roads

**PURPOSE:**

To provide guidance regarding the construction, maintenance and repair of private dirt or graveled roads and driveways (unpaved roads) to improve road stability and to avoid capture and diversion of cross drainage. Although the District's jurisdiction extends only to regulatory flood hazard, erosion hazard, and/or riparian habitat areas, this Policy may be applied outside these regulated areas. To further simplify the Policy, discussion is limited to unpaved roads which are intended to handle low volume, light duty traffic such as roads typically used to access single or multiple residential lots. This Policy does not apply to unpaved roads that are located within residential subdivisions or commercial developments since those roads are subject to the Subdivision and Development Street Standards, Pima County.

**BACKGROUND:**

Unpaved roads exist throughout unincorporated Pima County. Often, these roads were created with minimal consideration for road drainage. To limit initial construction costs, these roads might have received little more than initial blading to smooth the surface and remove vegetation. Road alignment might not be ideal for drainage due to constraints of easement boundaries or the road following the shortest route. Road surface might be unimproved, consisting only of compacted native soil.

The quality of road construction directly impacts future maintenance requirements. An unpaved road with inadequate protection of the road surface may be susceptible to rutting or wash-boarding and during the Monsoons, and may become impassable due to inadequate drainage of the road surface. In addition, off-site drainage flows may scour at a wash crossing, or may erode along the alignment if the road captures the off-site flows. These issues may be addressed during initial construction by judicious choice of the road alignment, use of a gravel surface with proper gradation, provisions for proper drainage, and incorporation of wash crossings or cross drains.

Several factors may affect the ability of property owners to maintain and repair existing unpaved roads. These factors include initial poor construction, the absence of readily available guidance to provide adequate drainage, the high cost of periodic maintenance, and the difficulty in distributing these costs among users.

## **POLICY:**

Technical Policy 027 *Protective Measures for Private Vehicular Access*, (Tech 027) presents guidelines for constructing wash crossings for roads and driveways. Since proper construction of wash crossings is a necessary prerequisite to minimizing flood and/or erosion damage to an unpaved road, all new wash crossings of regulatory washes ( $Q_{100} > 100$  cfs) shall conform to Tech 027.

Guidelines for construction of a cross drain are presented in this Policy. Application of a cross drain shall be limited to locations where flows crossing the road are non-regulatory ( $Q_{100} < 100$  cfs). Cross drains include a rolling dip and a flat land drain.

In this Policy, a drainage structure refers to a constructed wash crossing or cross drain.

The construction, maintenance, and repair guidelines presented in this Policy do not constitute or replace the value of a site-specific engineered roadway design. This Policy is available for general use, but the District accepts no responsibility for the performance of roads conforming to this Policy, nor is the District liable for any damage resulting from the use of this Policy.

### **A. General**

1. Unless accepted by the County for maintenance, the construction, maintenance, and repair of unpaved roads and associated drainage structures is the responsibility of the user(s) of the unpaved road.
2. A Floodplain Use Permit (FPUP) is required for an **improved** at-grade wash crossing, or a **culverted** wash crossing. Construction of these structures is described in Tech 027. The FPUP application shall be accompanied by a site plan, drawn to scale, showing property/easement lines, all existing & proposed improvements, the dimensions & location of the road, drainage structure(s) and existing & proposed utilities. Ref. Technical Procedure 102 *Site Plan Requirements*.
3. A rolling dip/flat land drain (cross drain) requires an FPUP only when proposed in an area that did not previously convey drainage flows. Construction of a cross drain shall be in accordance with this Policy. FPUP application shall be as described in A.2. above.
4. Construction of an **unimproved** at-grade wash crossing, or conversion of a **culverted** wash crossing to an **unimproved** at-grade wash crossing, shall not require an FPUP.
5. An FPUP is not required for maintenance of an existing unpaved road. Maintenance is defined as work to return the road and its drainage structure(s) to original configuration.
6. An FPUP issued under this Policy shall include Covenants. If the unpaved road is located within an access easement, then Covenants shall be prepared that establish maintenance responsibility for the drainage structure(s) and shall be signed by all owners who will be responsible for road maintenance. The Covenant shall contain the statement:

If the unpaved road or drainage structure creates a hazard to adjacent properties at any time in the future, it shall be the Owners' responsibility to make any and all necessary alterations to the unpaved road or drainage structure(s) to eliminate the hazard, including, but not limited to, the complete realignment of the unpaved road or relocation of the drainage structure(s).

7. All existing utilities shall be located prior to any significant earth-work; know where they are, and how deep they are in order to avoid damage to the utility and possible injury to equipment operators. Utility companies must be notified prior to beginning excavation. Call the Blue Stake Center at (800) 782-5348 at least 2 days prior to beginning work.
8. Minimum recommended road width is 12 feet. The maximum recommended road grade is 8 percent. These and other requirements should be verified through the local fire department to insure the unpaved road provides adequate access to emergency vehicles.

#### **B. Construction of a New Unpaved Road (See Figure 30-A)**

1. A road alignment should be chosen with a mild road grade (1% to 3%) to facilitate drainage of the road surface. A road on a flat grade cannot be properly drained, and a road on a steep grade will be prone to erosion damage. An alignment which runs near-perpendicular to existing ground surface contours (unless alignment is along a ridge line) should be avoided to minimize the capture of off-site drainage flows by the road. Road alignment at wash crossings should cross the wash perpendicular to the direction of natural drainage flow along the wash. See Figure 030-D Selection of Driveway Alignment.
2. Drainage flows should cross the road only at locations where the road has been stabilized with a drainage structure.
3. Cross drains are illustrated in Figures 030-A Cross Drain for New Unpaved Road and 030-B Cross Drain for Existing Entrenched Road for applications where road grade is  $\leq 3\%$ , and the natural hillslope is  $\leq 5\%$ . For road grades between 3% and 8%, or for hillslopes  $> 5\%$ , refer to construction guidance presented in the literature (Zeedyk) for a rolling dip.
4. To prevent ponding in the road, the slope and geometry of the cross-ditch portion of the cross drain must be selected to maintain or increase the flow velocity of the flow path which enters the cross drain.
5. To prevent ponding on the road surface, the road cross section should be outsloped. The cross slope should be at least 3 inches vertical per 12 feet of width (2%). A cross slope of 6 inches vertical per 12 feet of width (4%) is recommended.
6. Roadside ditches along the upslope edge of the road should collect off-site drainage flows intercepted by the road, and convey them along the road alignment to a low point where they can be released. Flows should be released at the upstream side of a natural wash crossing, if available. If a natural wash crossing is not conveniently available, cross drains should be constructed when tributary drainage area to the ditch exceeds the values listed in Table 030-A,

or at a minimum every 500 feet along the alignment. See Figure 030-C Maximum Tributary Drainage Area for Cross Drain for a typical application of this criteria.

**Table 030-A: Cross Drain Maximum Tributary Drainage Area**

Road Grade (%)	Flow Velocity in Ditch (ft/s)	Maximum Tributary Drainage Area (acres)
0.4	1.1	1.1
0.8	1.6	1.6
1.0	1.8	1.8
2.0	2.6	2.6
4.0	3.6	3.6
6.0	4.4	4.4
8.0	5.1	5.1

7. Roadside ditches should be constructed with a trapezoidal cross section having a flat bottom 2 feet wide (minimum), a 6-inch flow depth and 4:1 (H:V) or flatter side slopes adjacent to the road. Side slope opposite the road should be flatter than 2:1. The flow depth in the ditch must be provided below the bottom of the road surface gravel layer (if any). When flow velocity in the roadside ditch exceeds 2 feet per second (see Table 030-A), the ditch should be riprapped per Detail A on Figure 030-A to reduce the frequency of ditch maintenance due to erosion.
8. Road surface should be graveled to harden it against the effects of traffic. Recommended layer thickness is 4" to 6". The gravel should consist of fractured (sharp and angular) rocks with some fines to act as a binder. The fines should have significant plasticity. Road surface gravel characteristics are presented in Table 030-B on Figure 030-A.
9. A new road or drainage structure located in a regulated riparian habitat (RRH) area shall minimize disturbance of the RRH. Drainage structures shall be located to maintain historic flow locations to support the existing riparian habitat. Cumulative disturbance of more than 1/3 of an acre on a parcel or within an easement will necessitate a Riparian Habitat Mitigation Plan.

**C. Repair of Existing Unpaved Roads (See Figure 30-B)**

Capture of off-site drainage flows by an unpaved road increases the amount of water that flows along the road alignment instead of crossing the road. This increased flow deepens the road surface by erosion. Deepening results in capture of more flows, which flow faster in the deepened road bed causing more road erosion and down-cutting. In this manner, down-cutting may increase with each subsequent storm. Eventually, the down-cut road may attain equilibrium with the predominant flows, and turn into a sand bottom channel. Even when dry, this channel may be difficult to travel without four-wheel drive. Restoration of the natural drainage paths across the road will prevent capture of the off-site flows by the road. The following repair solutions are offered:

1. If feasible, import fill to replace road surface material lost to erosion. This fill must be sufficient to raise the road bed to match the natural grade of the adjacent properties, plus material to establish a proper outslope. If the erosion is too severe or if limited fill is available, road conditions may be improved by constructing cross drains. The best location for the cross drain is just downstream of the location of where the natural drainage path is intercepted by the unpaved road. In sheet flow areas, frequent cross drains may be required. These cross drains may require a Floodplain Use Permit to ensure that adjacent properties are not adversely affected (see A.3. above).
2. The initial bottom width of the lead-out ditch for the cross drain should be at least equal to the roadway width. The configuration of the lead-out ditch may taper in the downslope direction both in width and depth until it is similar to the geometry of the natural drainage path.
3. For roads which are impractical to reclaim, a new road alignment should be selected, and a new unpaved road should be constructed following the guidelines presented in Section B above. In this case, the old road will be allowed to convert into to a defined flow path. Progress of this conversion should be monitored to insure lateral bank erosion does not jeopardize the new road or buildings adjacent to the old road. Lateral bank erosion may be controlled by stabilizing the bank with riprap (dumped or grouted) or gabion baskets; application of these measures will require an FPUP. Refer to *Tech 006 Erosion Protection of Fill Pads (Rev.1)* or contact the District for guidance.

#### **D. Maintenance of Unpaved Roads**

1. Periodic maintenance should be performed annually & after significant storms.
  - a) Reshape the road outslope to maintain proper drainage of the road surface. The outslope should be a minimum of 2 percent (3 inches in 12 feet of width), with an outslope of 4% (6 inches vertical for 12 feet of width) recommended.
  - b) Replace lost road surface material. Road material may be lost due to erosion by drainage flow, or the wheel action of traffic. If the road is surfaced with native soil, replacement of lost material will involve borrowing material from a suitable source nearby. Borrow should be well graded with a plasticity index between 4 and 12 to improve road stability and reduce future maintenance.

If new gravel is to be placed on an existing road surface, the characteristics of the gravel should follow the specifications in Table 030-B presented in Figure 030-A. Whether placing soil or gravel, the road outslope must be properly restored and the road surface should be smoothed prior to placement of the material. Washboarding, rutting, and potholes must be filled in with soil and compacted, and high shoulders must be removed. The outslope must then be reestablished. The material should then be placed in a well-blended, smooth layer of uniform thickness. It is recommended that moisture be added during placement and the material compacted with rollers or traffic to improve the installation.

- c) Remove accumulated sediment from the roadside ditches. Roadside ditches should be graded to maintain gravity flow to the point of outlet.

d) Maintain drainage structures. Remove accumulated sediment from the inlets of culverted crossings. Inlets will accumulate sediment and debris which must be removed to prevent blockage. Control vegetation at the inlet/outlet which may collect debris and reduce culvert capacity. The downstream side of drainage structures may develop a scour hole; this hole will serve as a stilling basin and may be lined with riprap to limit its expansion, or the hole may be allowed to expand to its equilibrium dimensions and the road surface adjacent to the scour hole may be protected by a vertical concrete cutoff wall. The stilling basin must be maintained by replacing lost or degraded riprap, or by repairing the cutoff wall. If damage occurs frequently, future repair costs may be reduced by paving the road surface through the crossing, increasing the number or diameter of culverts, increasing the rock size or blanket thickness of the stilling basin riprap, or deepening the cutoff wall. Refer to Tech 027 or contact the District for guidance.

2. Check for needed cross drains where minor flows ( $Q_{100} < 100$  cfs) concentrate and cross the road, or where minor flows collect within the roadway and subsequently follow the road alignment. Either situation will lead to erosion and destabilization of the road surface. These flows should be collected and conveyed across the road using a cross drain per Figures 030-A and 030-B.

#### **E. Construction, Maintenance and Repair tips**

1. Moisture facilitates compaction. Perform construction/maintenance operations during times when moisture is present in the soil. However, avoid construction/maintenance operations during periods of anticipated heavy rains.
2. Construction, maintenance, and repair of an unpaved road is guided by the need to prevent standing water on either the road surface or within the roadside ditch; standing water in either of these locations is a primary cause of distress of unpaved roads.

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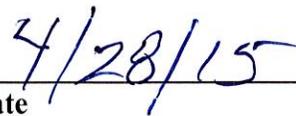
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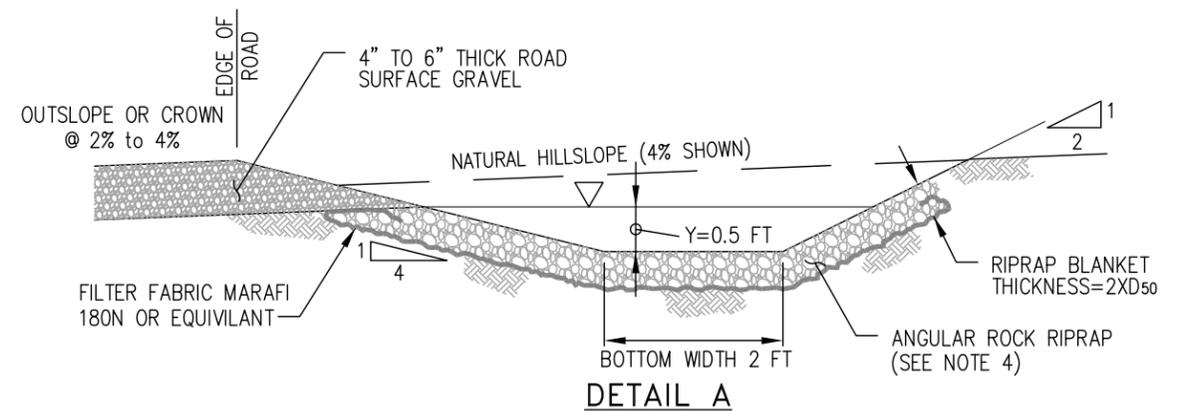
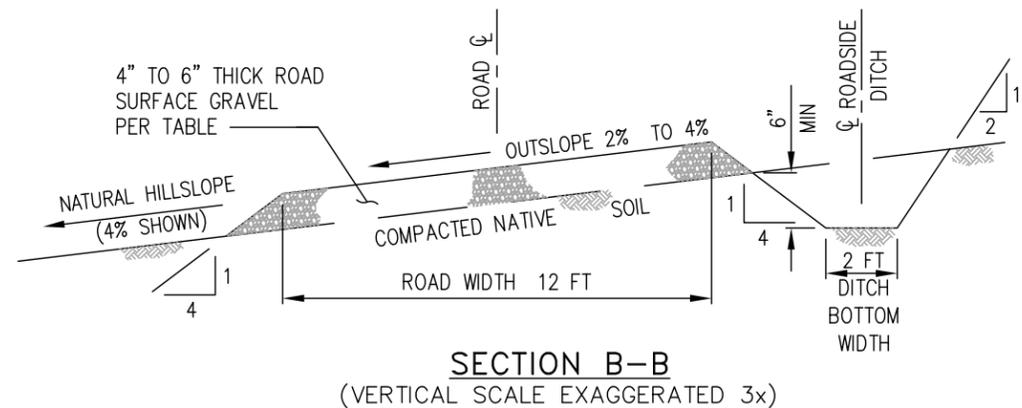
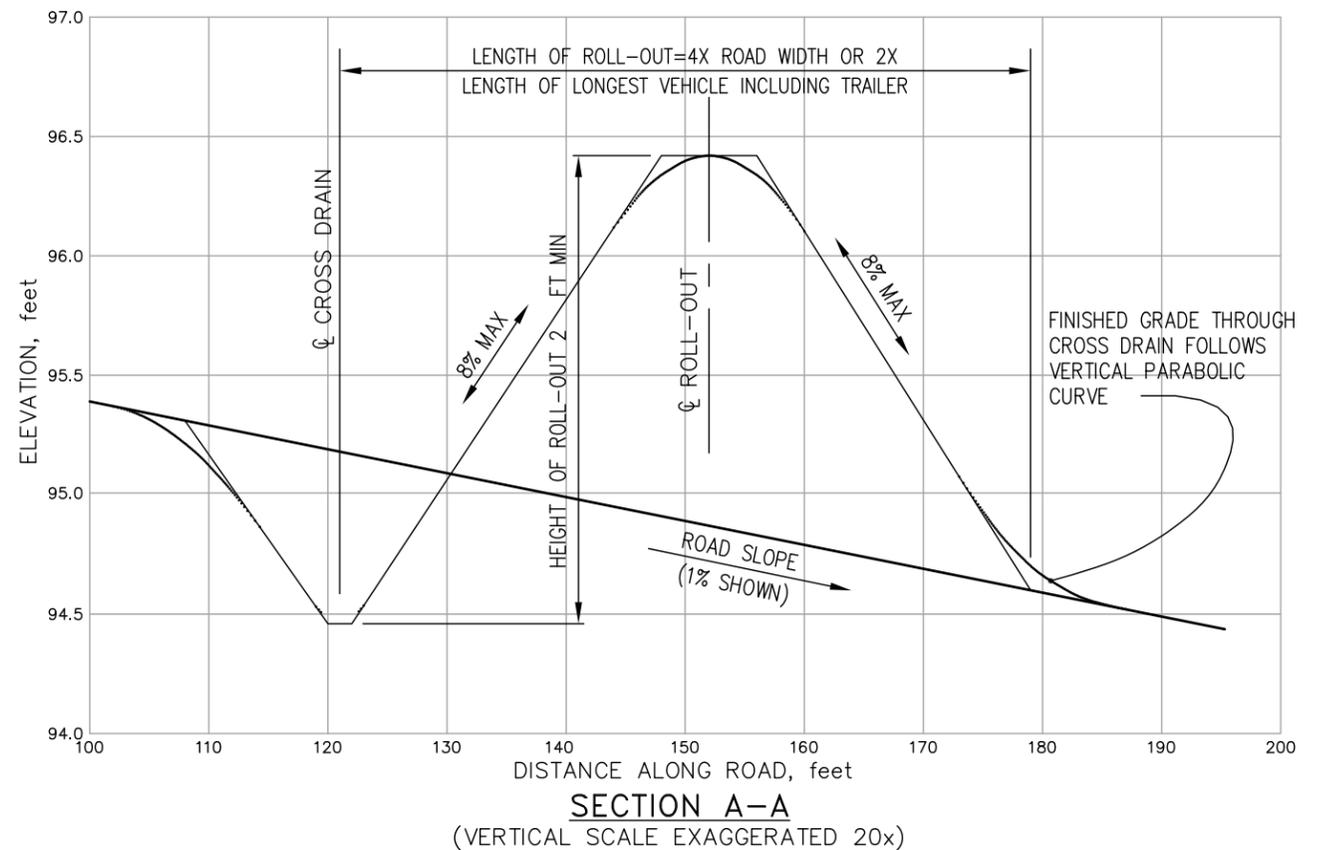
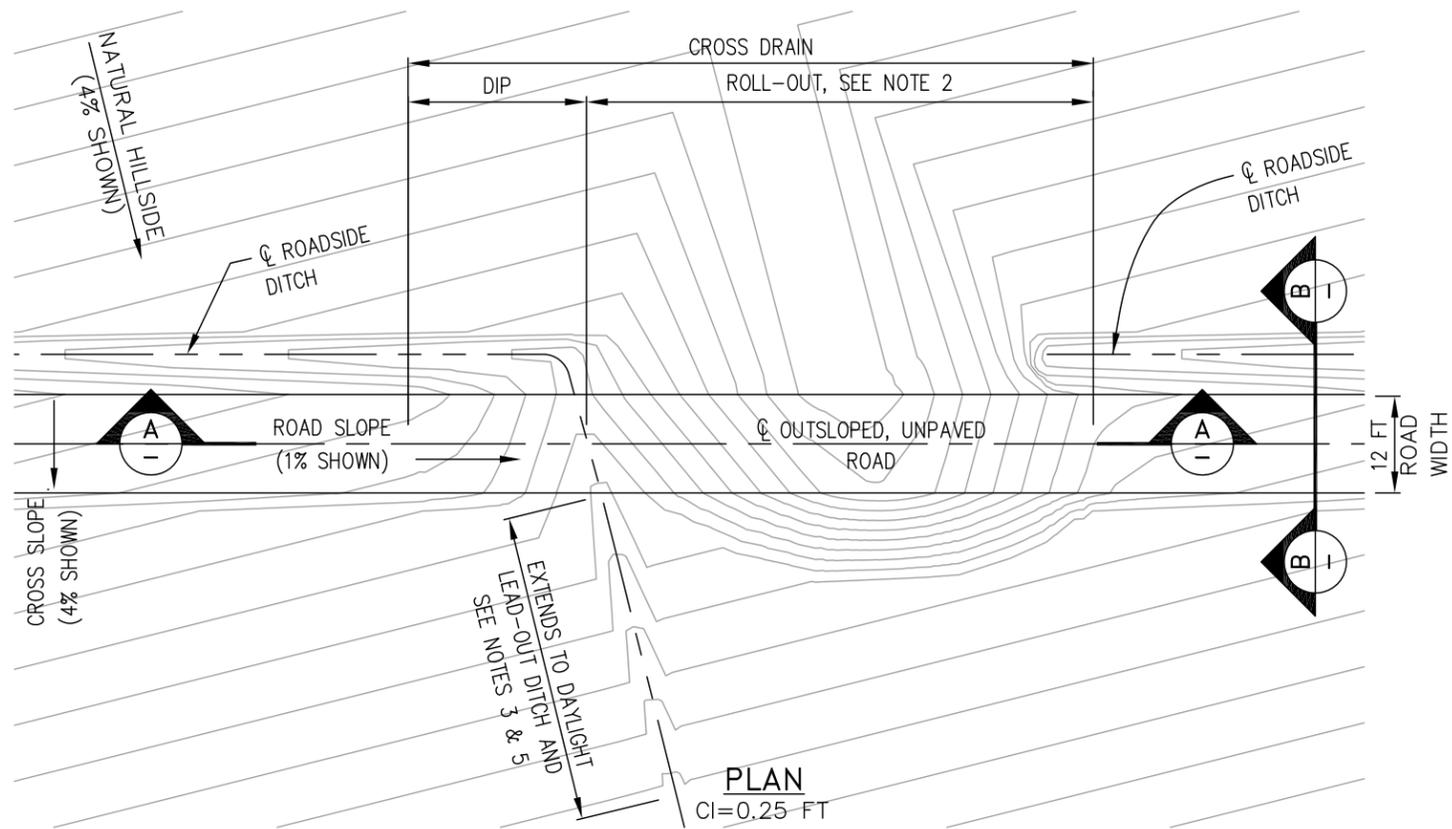
## APPROVED BY:



Suzanne Shields, P.E.  
Director and Chief Engineer

Date





**NOTES**

1. SPEED LIMIT  $\leq 25$  MPH.
2. ROLL-OUT: MIN HEIGHT=2FT ABOVE CROSS DRAIN INVERT (SEE SEC A-A). MIN LENGTH=4X ROAD WIDTH OR 2X MAX VEHICLE LENGTH INCL TRAILER. MAX ROAD SLOPE INTO AND OUT OF ROLLOUT=8%; CONSTRUCT ROLLOUT WITH COMPACTED SOIL.
3. LEAD-OUT DITCH: CONTINUE CROSS SECTION OF ROADSIDE DITCH ON SLOPE  $\geq$  SLOPE OF ROADSIDE DITCH; EXTEND DITCH TO DAYLIGHT. PLACE LEAD-OUT DITCH AT EXISTING NATURAL DRAIN PATH IF POSSIBLE.
4. RIPRAP GRADATION FOR ROADSIDE DITCH PER TABLE THIS SHEET:  
STRAIGHT OR CURVED ROADSIDE DITCH SLOPE  $\leq 2\%$ , NO RIPRAP LINING NECESSARY.  
STRAIGHT DITCH ON SLOPE  $>2\%$  BUT  $\leq 4\%$ , D<sub>50</sub>= 2 IN; SLOPE  $> 4\%$  BUT  $\leq 8\%$ , D<sub>50</sub>= 4 IN.  
CURVED DITCH ON SLOPE  $>2\%$  BUT  $\leq 4\%$ , D<sub>50</sub>=4 IN; SLOPE  $>4\%$  BUT  $\leq 8\%$ , D<sub>50</sub>=6 IN
5. DITCH FLOW TO BE CONVEYED ACROSS ROAD IN CROSS DRAIN AT FIRST OPPORTUNITY.
6. CHARACTERISTICS OF ROAD SURFACE GRAVEL PER TABLE, THIS SHEET.

**TABLE 030-B:  
CHARACTERISTICS FOR ROAD SURFACE GRAVEL**

SIEVE SIZE	ROAD SURFACE GRAVEL % PASSING
3/4"	100
NO. 4 (4.75 mm)	50-78
NO. 8 (2.36 mm)	37-67
NO. 40 (0.425 mm)	13-35
NO. 200 (0.075 mm) (FINES)	4-15
PLASTICITY INDEX OF FINES	4-12

**DUMPED/HAND-PLACED  
RIPRAP GRADATION**

% PASSING	SIZE
100 - 90	2.00 D <sub>50</sub>
85 - 70	1.50 D <sub>50</sub>
50 - 30	1.00 D <sub>50</sub>
15 - 5	0.67 D <sub>50</sub>
5 - 0	0.33 D <sub>50</sub>

% PASSING BY WEIGHT

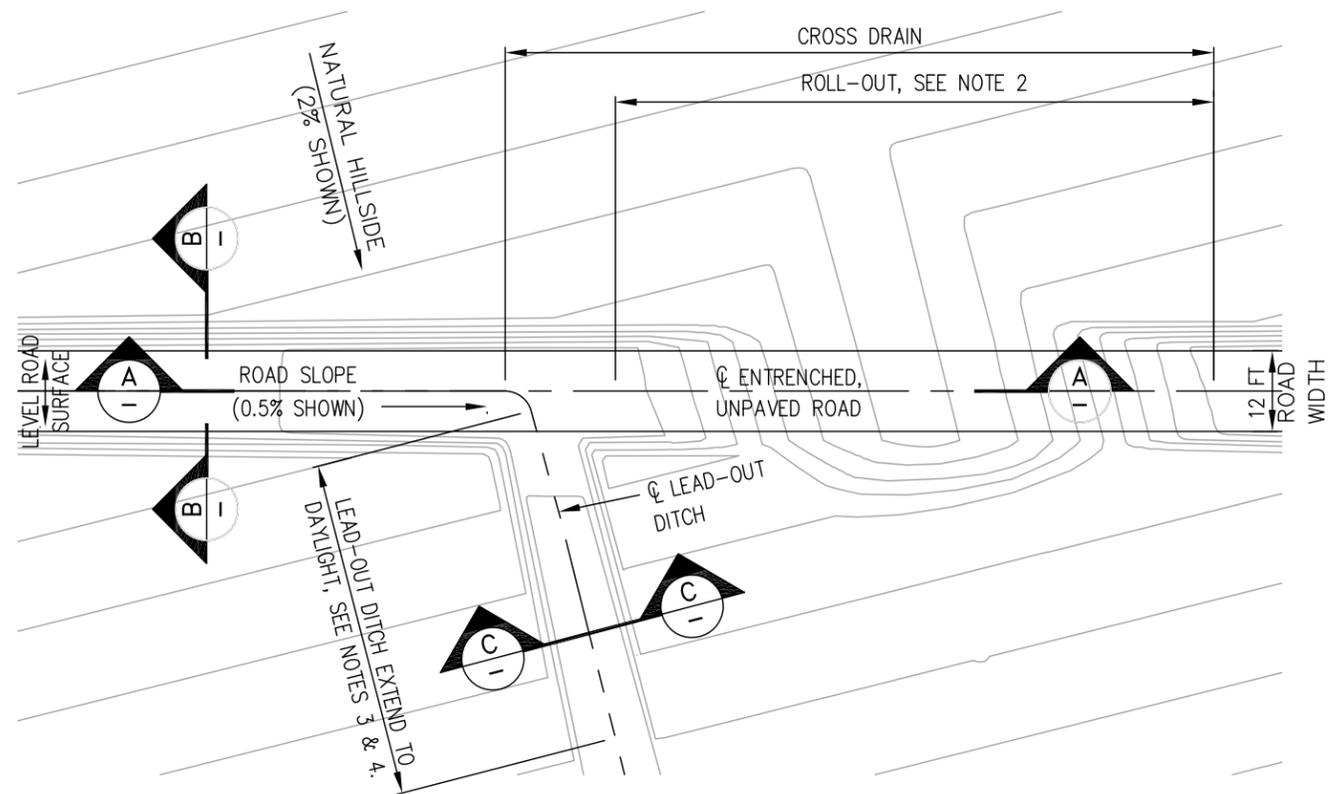
**FIGURE 030-A  
CROSS DRAIN FOR NEW UNPAVED ROAD**



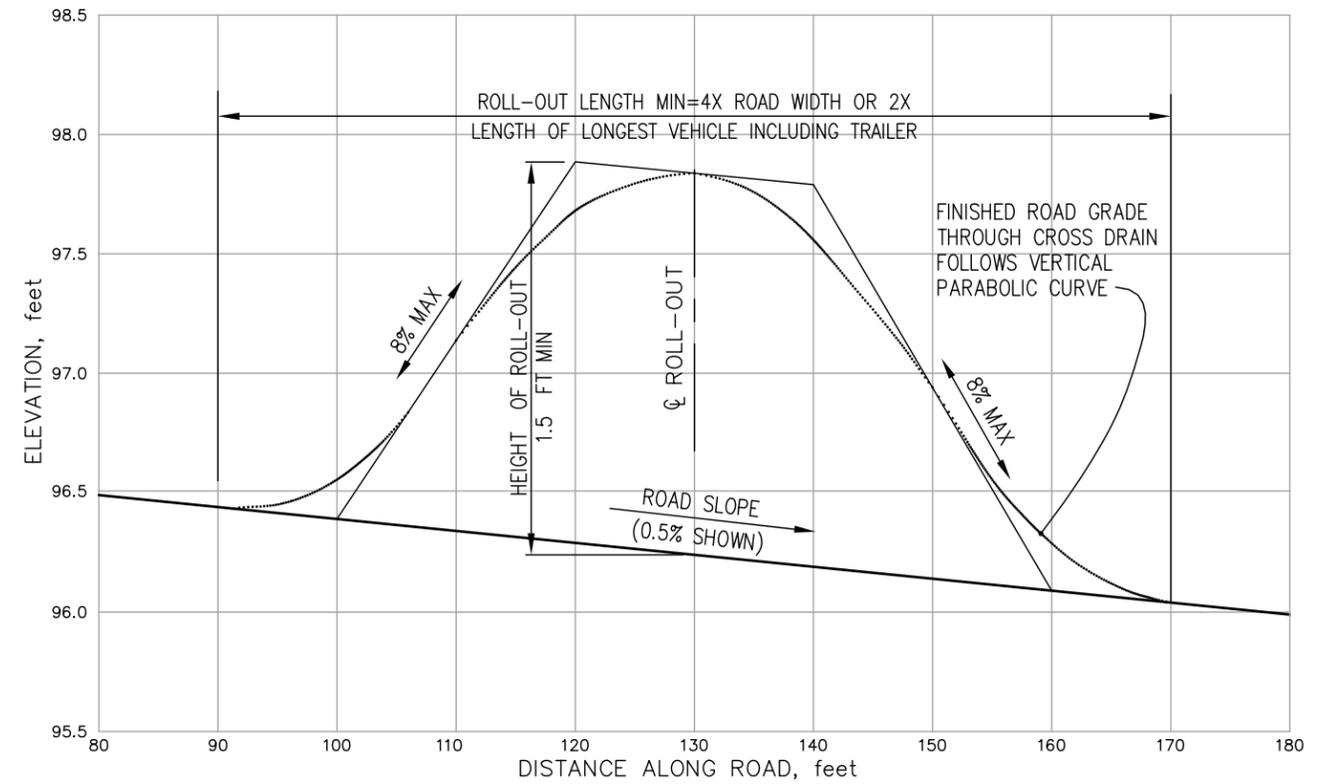
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DRAWN BY: sak

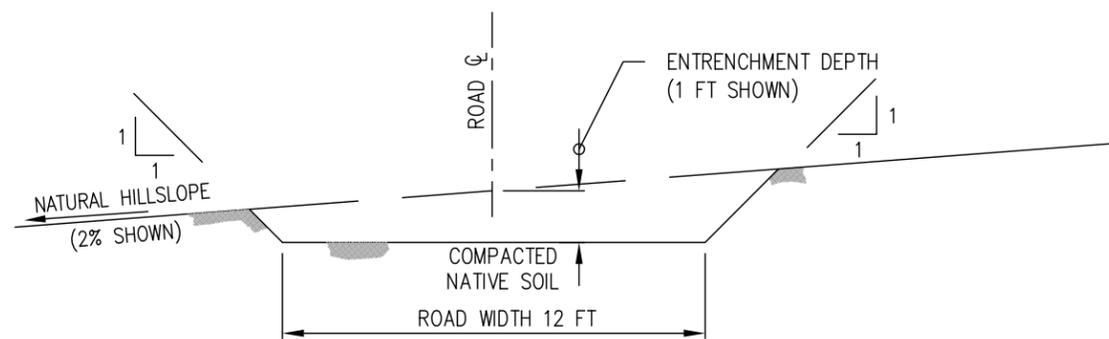
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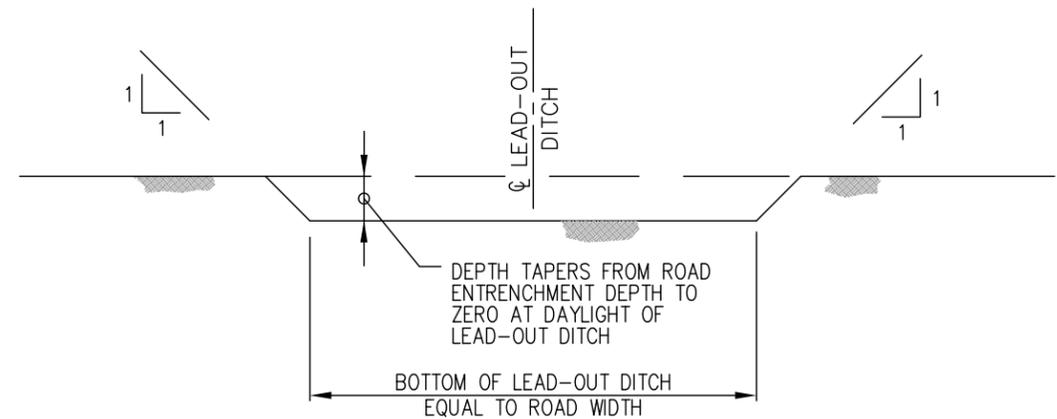
PLAN  
CI=0.25 FT



SECTION A-A  
(VERTICAL SCALE EXAGGERATED 20x)



SECTION B-B



SECTION C-C

NOTES

1. SPEED LIMIT <=25 MPH.
2. ROLL-OUT: MIN HEIGHT=1.5 FT ABOVE CROSS DRAIN INVERT (SEE SEC A-A). MIN LENGTH=4X ROAD WIDTH OR 2X MAX VEHICLE LENGTH INCL TRAILER. MAX ROAD SLOPE IN ROLLOUT=8%; CONSTRUCT ROLLOUT WITH COMPACTED SOIL.
3. LEAD-OUT DITCH: CONTINUE ENTRENCHED CROSS SECTION OF ROAD ON SLOPE >=SLOPE OF ROAD; EXTEND LEAD-OUT DITCH TO DAYLIGHT. PLACE LEAD-OUT DITCH AT EXISTING NATURAL DRAIN PATH IF POSSIBLE.
4. DITCH FLOW TO BE CONVEYED ACROSS ROAD IN CROSS DRAIN OR WASH CROSSING AT FIRST OPPORTUNITY.

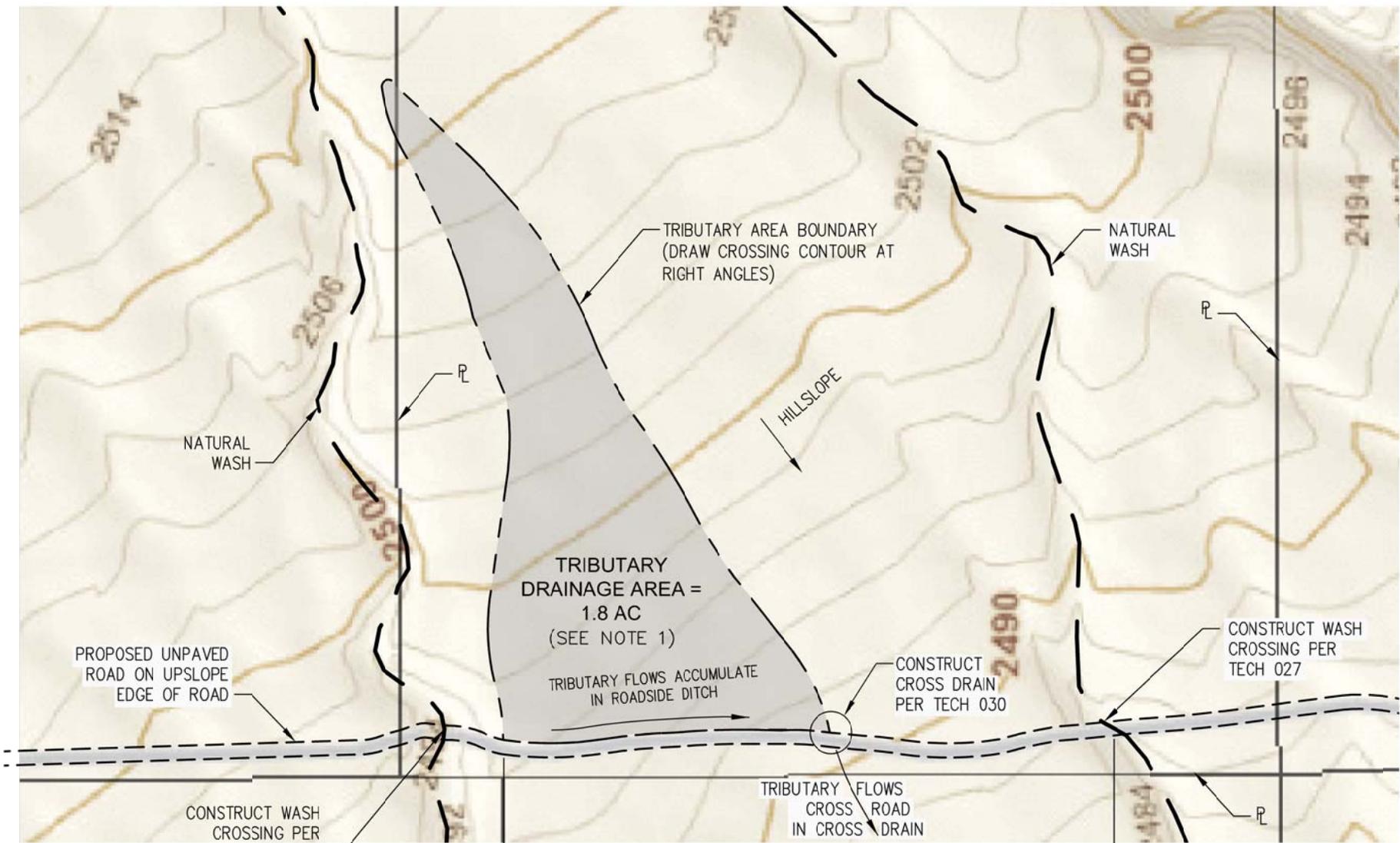


SCALE: N.T.S.

FIGURE 030-B  
CROSS DRAIN FOR EXISTING ENTRENCHED ROAD

DRAWN BY: sak

DATE: May 2015



**NOTES**

1. REFERENCE TABLE 030-A FOR MAX TRIBUTARY DRAINAGE AREA OF CROSS DRAIN AS A FUNCTION OF ROAD GRADE

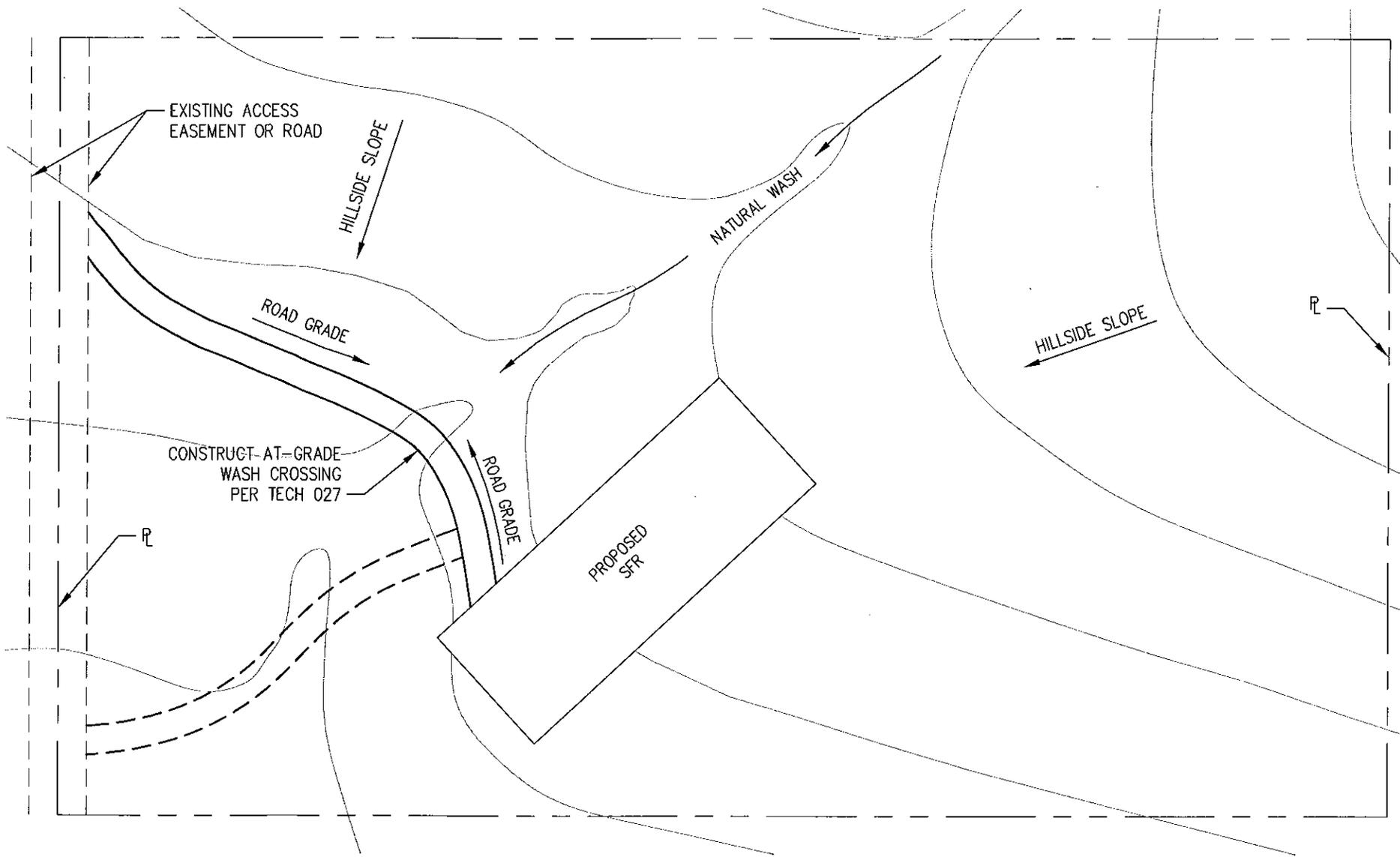


**FIGURE 030-C**  
MAXIMUM TRIBUTARY DRAINAGE AREA for CROSS DRAIN

SCALE: N.T.S.

DRAWN BY: sak

DATE: May 2015



 	<p>RECOMMENDED DRIVEWAY ALIGNMENT</p>	 	<p>DISCOURAGED DRIVEWAY ALIGNMENT</p>
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**FIGURE 030-D**  
SELECTION OF DRIVEWAY ALIGNMENT

SCALE: N.T.S.

DRAWN BY: sak

DATE: Jan 2015