Fleming Ranch Drainage Considerations

In recent years at least one rain event caused several inches of water to enter the north end of the main house, resulting in significant damage. Rain data from the NOAA Climatic Data Center show several recent heavy rainfall events for Hunt. Given its position relative to the hills to the east, strong storms could produce an estimated 2.5 cubic feet per second of rain runoff at the house site during the peak of the rain event. Other buildings of the compound would likely be affected as well. During times of concentrated rainfall, such as more than one inch of rain per hour for a period of two or more hours, the drainage basin that includes the main house is probably being affected by drainage from the basins to the north and south.

Additionally, conditions in the immediate surroundings of the main house make it vulnerable to damage by heavy rains. Gutters and downspouts at the east side of the north wing must convey large quantities of water away from this area to avoid exacerbating the problem, and grades between the retaining wall and the house seem to be guiding runoff toward the northeast corner of the building.

Addressing the drainage issues from the steep grades to the east will likely require structures to reduce the velocity of runoff, and excavation of one or more swales to divert storm water out of the drainage basin of the central site. In tandem with these, modification of the retaining wall and nearby grades will likely eliminate or substantially reduce the threat of runoff entering the main house.

Characterization of drainage and topography

In determining locations and types of drainage structures used to mitigate damage from runoff it is necessary to sort out where the runoff is coming from and to characterize the types of events likely to produce damage based on a review of available data. It appears that the site of the main house was carefully chosen, with drainage of rain runoff a key consideration. The house sits at the base of the "nose" of the knoll to the east which generally divides and sheds the runoff of the drainage basin. Periods of heavy rain events, if spread out over a period of days, do not by themselves appear likely to cause water to enter the house.

The events capable of producing enough runoff to enter the main house seem confined to extremely heavy rains that fall within a period of hours. Under these circumstances it seems that the runoff, moving with velocity, spreads beyond the drainage contours it would normally follow in its course toward the Guadalupe River. It may be the case that either – or both – the drainage basins to the south and north of the house contribute to these conditions in periods of high rainfall intensity.

The main house and outbuildings are located on a gently sloping terrace between the South Fork of the Guadalupe River and a zigzagging formation rising to the east (figures 1-3). The part of this formation affecting the drainage of the area immediately surrounding the main house is roughly in the shape of a "W" turned on its side (i.e., north-south), with the main house approximately opposite the central vertices.

The elevation of the terrace on which the main house and outbuildings sit is between about 1776' and 1800' above sea level, while the peaks of the formation to the east are at about 1990'. Contours of the terrace show a strong north-south orientation, while the long axis of the house is northwest-southeast (figure 4). As the terrace/driveway area immediately in front of the house drops more than 10 feet across the east façade, from south to north, any runoff that makes its way to the house must pass along the northeast corner of the building. The west side of the house is unaffected by drainage issues.

figure 1. 2-D view of house site drainage basin (darker area) and basins to the north and south.

figure 2. 3-D view of site and hillside above from south.
(blue arrows indicate potential drain paths during intense rain)

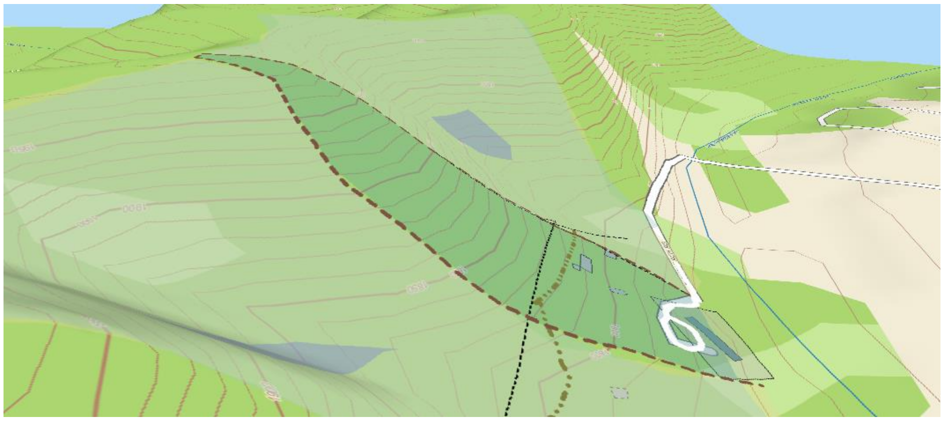


figure 3. 3-D view of site from north.

It is about a quarter of a mile from the main house to the peak of the center area of the “W”. This center slope that descends to the house is significantly less steep than the walls of the valleys to the north and south, but still has considerable grades. Between the house and the far side of the driveway circle 150’ away, the grade is from 8% to 12%. Fifty feet above the circle, which is at an elevation of about 1800’, the grade rises steeply from a 19% grade to a 26% grade at 1850’. This is significant because grade affects runoff rates and, relatedly, because the destructive power of runoff increases geometrically with its velocity.

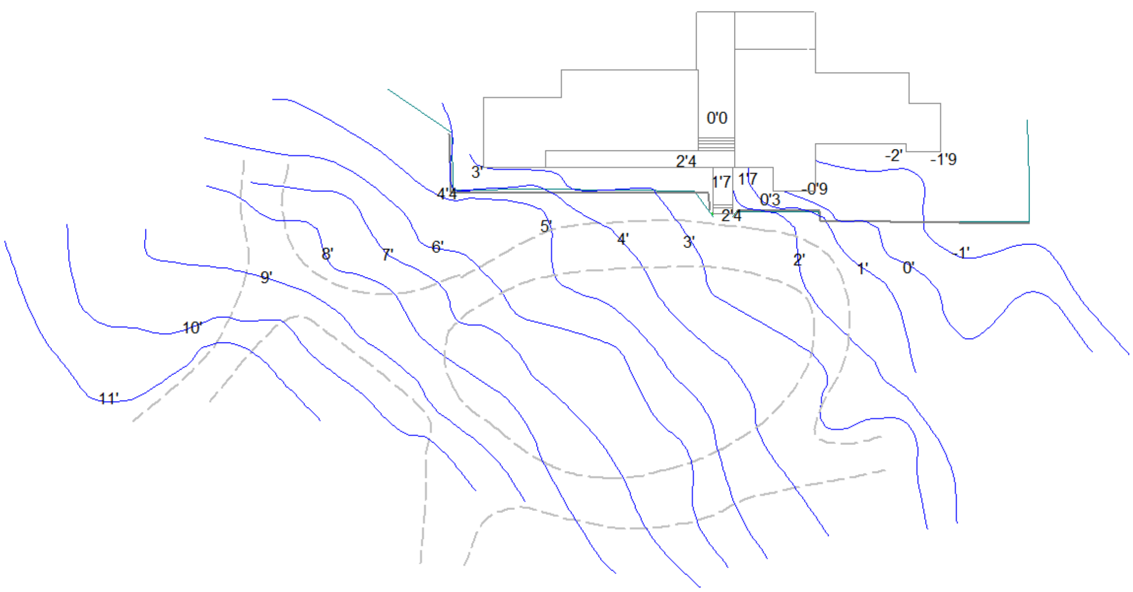


figure 4. 1’ contours of the terrace east of main house, with 0’0” elevation at lower breezeway level.

By drawing a polygon from the area of the main house site (including about 50' to the north and south) uphill to the peak at roughly right angles to contour lines, a watershed of approximately 6 acres is enclosed. Using similar methods, the areas to the immediate north and south of the house site include drainage areas of more than 20 acres and 15 acres respectively.

The most commonly used method for calculating peak runoff is the so-called "rational formula", Q=CiA, which is that peak runoff ("Q", measured in cubic feet per second) is equal to a coefficient of surface type and grade (C) times rainfall intensity ("i", measured in inches of rain per hour for a time of concentration) multiplied by the drainage area ("A", measured in acres). Without an in-depth hydrological analysis it isn't possible to be precise, but by making some assumptions the amount of peak discharge it has taken to put water into the house can be generally estimated.

Surface coefficients (C) are taken from published tables. A table recommended by the American Society of Civil Engineers was used for the values below. If the basin is homogeneous, a single value can be used. If it is not, a weighted combination of two or more coefficients is used. For open woodlands with grades considered steep (above 7%) a coefficient of .25 to .35 is usually shown. For the areas of the drainage basin that are much steeper and have exposed rock outcrops and/or shallow soils a value of .65 to .75 would be more accurate. Assuming these two pairs of values each characterize approximately 50% of the basin, an overall C value would be between .45 and .55.

The NOAA website is a good source for historical weather data, including hourly precipitation (www.ncdc.noaa.gov/cdo-web/search#t=secondTabLink). The heaviest 24 hour-period rains recorded in recent years at the Hunt weather station (Hunt 10W - NWS ID NUHT2) are 3.3" on 11 May 2012; 3.9" on 17 August 2007: and 3.05" on 25 May 2007. There probably have been several, perhaps heavier, rain events during this time period which may have overwhelmed the weather station equipment. Rain values for those times are shown in the data as "99999", which is the default for unavailable data.

The rain events of most interest to us are the ones most likely to produce sheets of runoff from the hills to the east. These would include events of more than 1" per hour, especially if preceded by enough rain to saturate the soil. Given the steep grades and relatively shallow soils, even one half to three quarters inches of rain might be enough to cause subsequent heavy rains to create sheets of runoff. Other factors can play influential parts. Drought conditions, which probably existed in the 2007 events, reduce the amount of grass and groundcover that would otherwise contribute to absorption, decrease runoff, and slow what runoff does occur.

The most intense rain events shown in the Hunt station data for the past 12 years are 4.8" in 6 hours on 6 April 2004; 4.3" in 8 hours on 23 October 2000; and 2.8" in 2 hours followed by another 1.3" in 2 hours, 8 hours later, on 19 May 2000. The greatest one hour rain totals shown are 2.1" during the 23 October 2000 event; 2.0" during the 6 April 2004 event; and several slightly smaller one hour totals of more than one inch of rainfall. A rain event of 4" over a 2 hour period would exceed available recorded totals, and will be considered for design purposes.

Recommendations

The following recommendations will likely require adjustments in the field as they are implemented, but in approximate order of efficacy and need, they include: modifications to the retaining wall north of the entry gate; construction of a swale south of the stables; optional perimeter drainage along the northeast façade; and construction of a speed-breaking gabion along the east property line north of the stables.

1. Retaining wall modification and regrading

Addition of 6-8" to the height of the retaining wall along the east side of the north wing is recommended, beginning at or near the entrance gate and continuing north to a point even with the north side of the sleeping porch. The object of this is to break the energy of – and divert – sheeting runoff approaching the house. It is not expected that this installation would be effective without the following recommendation for swale construction, which should reduce the amount of runoff reaching the house by 40-60%.

The area between the retaining wall and the house should be regraded where there is not positive drainage away from the house toward the wall. Mostly this will have to be done through cutting rather than filling because of threshold elevations at the laundry area and window sill elevations at the master bedroom. Earth removed in cutting could be used to provide positive drainage away from the wall toward the drive, but 4" to 6" of the stone should be exposed on the drive side.

2. South swale

A swale with a gabion is recommended against, or slightly above, the east side of the north stalls southward along the east side of the stables and extending south beyond the Caretaker's cottage. This structure is intended to break the velocity of sheeting runoff and convey as much of it as possible toward the steep decline west of the Caretaker's house. It could also provide a reasonably nice walking path.

The gabion should rise 6" to 8" above the uphill grade, and be set at least a foot into the ground or excavation. The swale should be kept to a 5% grade or less as it descends and diverts drainage to the south. The surface of the swale channel should be tempered with crushed rock, and it may be necessary to include turnouts. During the design event, this length of swale would be expected to experience peak discharge of more than 4 cfs, but that would be spread over about 175 lf.

3. Perimeter drainage

Although a French drain has been installed here in the past, a robust perimeter drain along the east side of the north wing may be worth the effort if the existing gutter/downspout drain system is not fully functional. These features should be carefully tested. It is important that the five downspouts in this area, which drain more than 1,000sf of the roof, convey the water away from this corner, which is the lowest finish floor elevation of the building. A rain event of 2", even if spread over several hours, would deposit more than 1,200 gallons of water along this area of the building. The design event would deposit twice that, and in a shorter period.

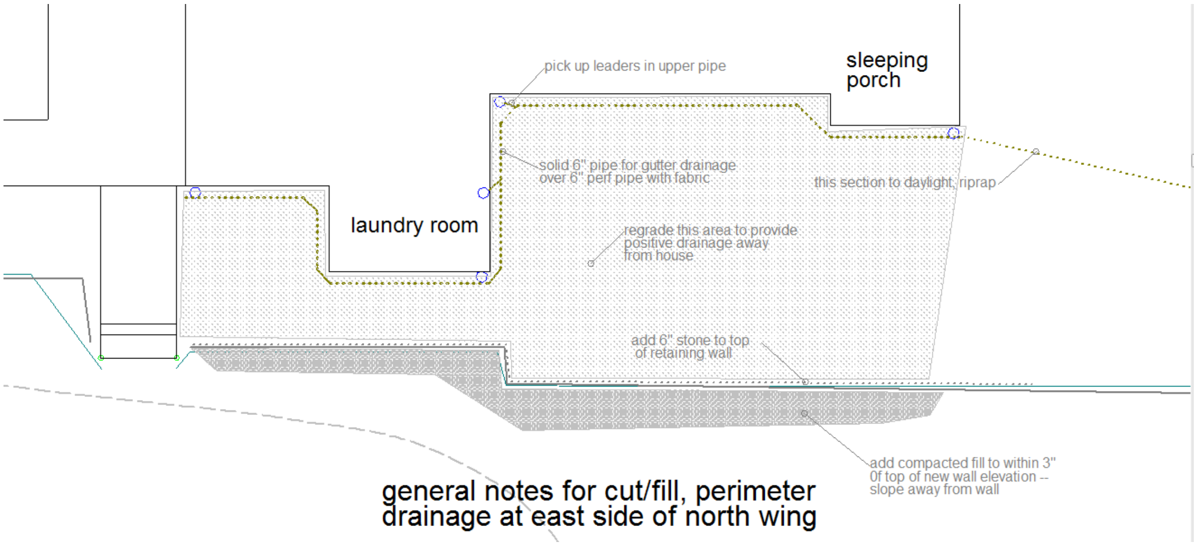
The proposed perimeter drain would include separate 6" pipes for downspouts and below-grade drainage. It would be installed along the edge of the house from at least the intersection of the kitchen with laundry room to the northeast corner of the house, where it would continue to daylight on the slope in that direction. However, it may be desirable to begin instead at the downspout beside the central breezeway, in order to address hydrostatic pressure that may have pushed water into the breakfast room in the past.

4. North gabion

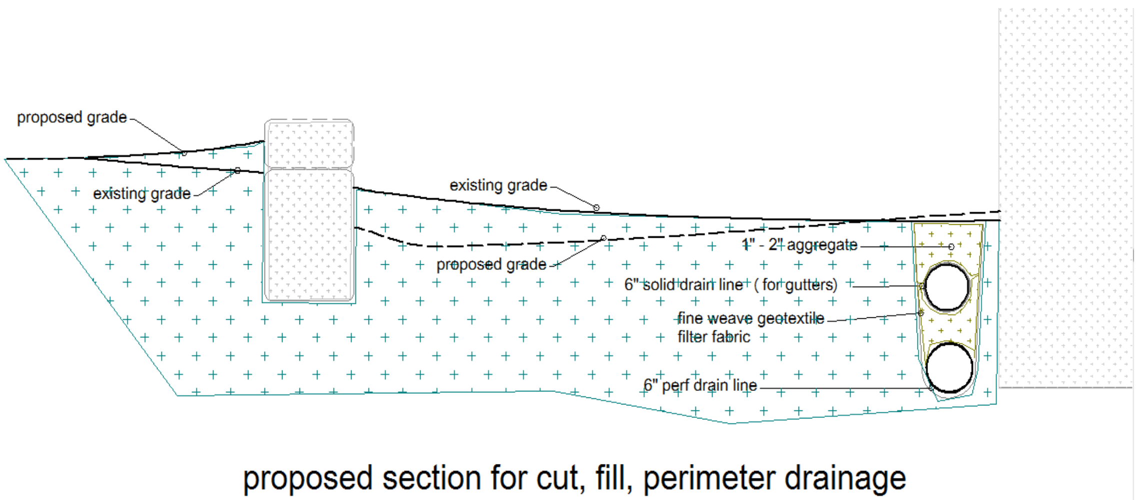
From review of 3-D topographic maps, it appears that during especially heavy rain events, runoff may be descending from the northeast with such velocity that it may enter the drainage basin of the main house. Mainly this would seem to come from the steep, south slope of the hill to the north of the knoll in front of the main house. The Maid's house seems to be in the line of the potential current, so if there has never been damage to this building or substantial scouring of the soil around it from runoff originating from the northeast, corrective action may not be necessary.

It is difficult to locate a structure for remediating this with precision, in part because of dynamics involved, but also because the area where this runoff would come from is well above the Fleming Ranch property. It appears that the best location would be centered approximately straight out from the center of the main house near the east property line, extending 50 – 75' in each direction.

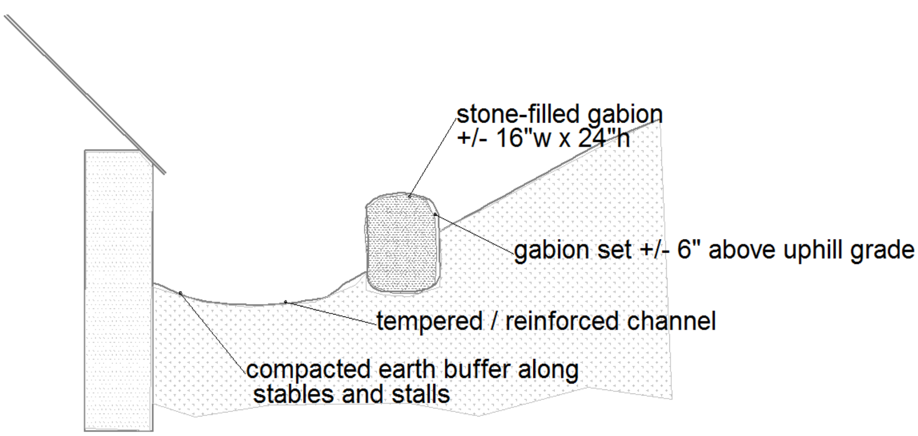
Breaking the velocity of the runoff would cause it to follow contours that would largely eliminate its threat to buildings, so diversion of the runoff with a swale is probably not central to the success of this structure. If a swale is not included, the northern part of the structure would probably be most effective angling northeast from its centerline, where it would drop about 20' in elevation before passing east of the Maid's house. To the south it appears most effective if directed toward the south swale, above the north stalls.



general notes for cut/fill, perimeter drainage at east side of north wing



proposed section for cut, fill, perimeter drainage



proposed section for swales