

OWNER

Earthwork and Grading

Calculation



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Project:



TORUS

, County,

ISSUE SUMMARY AND APPROVAL

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1. OBJECTIVE

This calculation sets the finished elevation and slopes of the station pad and computes the earthwork for the site: topsoil stripping and respread, cut and fill for the pad, aprons, internal roads, access road, entrance and ditches, the import of general fill and select fill, and the disturbed area that sets the construction stormwater permit. It also sets the compaction requirements for every earthwork material.

2. METHODOLOGY

The pad is a single inclined plane. A plane drains every point to the perimeter without internal low points, needs no catch basins, and is simple to set out and to check with a laser level. TORUS chose the slope of the plane to follow the existing ground: 1.0 % east, close to the 1.2 % fall of the land, and 0.5 % south, against a 0.8 % fall. The flatter north-south slope keeps the northwest corner, the high point of the site, close to existing ground, which minimizes fill. The resultant fall of 1.12 % to the east-southeast exceeds the 1 % minimum of GEN-DB-001.

The elevation of the plane was then set as the lowest value, rounded up to 0.1 ft, that keeps the finished pad at least 0.5 ft above existing ground along every pad edge. This keeps the pad clear of sheet flow from the surrounding pasture, which the perimeter ditches intercept, and gives the pad edge a positive fall to those ditches.

Volumes were computed on a 5 ft grid over the pad, as the difference between the top of subgrade (finished grade less the aggregate surfacing) and the stripped existing surface. The 4:1 fill slopes at the pad edge were integrated along the perimeter. The access road, entrance, culvert embankment and ditches were computed from their typical sections and lengths. Compacted fill was converted to bank volume with a 15 % shrinkage factor, typical for lean clay compacted to 95 % of standard Proctor density.

3. DESIGN INPUTS

Table 3-1 lists the inputs.

Table 3-1: Design Inputs

Input	Value	Source
Local grid	Origin at SW fence corner, X east, Y north, ft	GEN-DB-001
Fenced area	X 0 to 250, Y 0 to 200	GEN-DB-001
Gravel pad	X -10 to 260, Y -10 to 210, 1.36 ac	10 ft beyond the fence (fence access, ground loop)

Input	Value	Source
West emergency apron	X -30 to -10, Y 122 to 162	CIV-CAL-003
Existing ground	Plane: 1,150.0 ft at (125, 100), falling 1.2 % east and 0.8 % south	Assumed (HOLD H-02)
Pad surfacing	6 in Type A aggregate	CIV-CAL-003
Road section (internal and access)	12 in Type A on geotextile	CIV-CAL-003
Internal roads	13,422 sf, roads R-1 to R-7 and gate apron	MEC-DWG-001 plot plan
Topsoil depth	6 in	Assumed (HOLD H-07)
Fill slopes	4H:1V	Mowable and traversable
Shrinkage, bank to compacted	15 %	Assumed (HOLD H-07)
Select fill under mats, slabs and buildings	2 ft, footprint plus 2 ft	CIV-RPT-001
Foundation excavation and select fill	686 CY and 289 CY	STR-CAL-002

4. ASSUMPTIONS

- Existing ground is the plane in Table 3-1. All volumes shall be recomputed from the topographic survey. *Verification required (HOLD H-02).*
- Topsoil is 6 in deep and the lean clay shrinks 15 % from bank to compacted volume. *Verification required (HOLD H-07).*
- Excavated clay from the ditches, road undercut and foundations is suitable as general fill (PI of 30 or less). *Verification required (HOLD H-07).*
- Groundwater is deeper than 20 ft and does not affect excavation. *Verification required (HOLD H-07).*
- No trees, structures or buried debris exist on the tract. *Verification required (HOLD H-02).*

5. REFERENCES

- ASTM D698, Laboratory Compaction Characteristics of Soil Using Standard Effort.
- ASTM D1557, Laboratory Compaction Characteristics of Soil Using Modified Effort.
- ASTM D6938, In-Place Density and Water Content of Soil by Nuclear Methods.
- Standard Specifications for Highway Construction (2019), Sections 202 and 703.
- OSHA 29 CFR 1926 Subpart P, Excavations.

6. GEN-DB-001, Basis of Design.
7. CIV-RPT-001, Civil Design Criteria and Site Description.
8. CIV-CAL-002, Hydrology and Drainage; CIV-CAL-003, Access and Internal Roads.
9. STR-CAL-002, Foundations.
10. CIV-DWG-003, Grading and Drainage Plan (Appendix A); CIV-DWG-004, Civil Sections and Details.

6. CALCULATION

6.1. PAD ELEVATION

The finished pad surface (top of aggregate) and the assumed existing ground are:

TORUS grading plane

$$FG(x, y) = Z_c - 0.010(x - 125) + 0.005(y - 100), \quad EG(x, y) = 1150.0 - 0.012(x - 125) + 0.008(y - 100)$$

The controlling point is the northwest pad corner, where the land is highest. Requiring $FG - EG \geq 0.5$ ft along the whole perimeter gives $Z_c = 1151.099$ ft, rounded up to 1151.10 ft.

The finished pad elevation is 1151.10 ft at (125, 100). The pad ranges from 1149.24 ft at the southeast corner to 1152.96 ft at the northwest corner.

Table 6-1 gives spot elevations at the pad corners, gates and center.

Table 6-1: Pad Spot Elevations

Point	X (ft)	Y (ft)	Existing (ft)	Finished (ft)	Fill height (ft)
Pad SW corner	-10	-10	1150.74	1151.90	1.16
Pad SE corner	260	-10	1147.50	1149.20	1.70
Pad NE corner	260	210	1149.26	1150.30	1.04
Pad NW corner	-10	210	1152.50	1153.00	0.50
Main gate	250	62	1148.20	1149.66	1.46
Emergency gate	0	142	1151.84	1152.56	0.72
Pad center	125	100	1150.00	1151.10	1.10

Note 1: Elevations in ft, NAVD88. Fill height is finished pad above existing ground, including the aggregate.

Table 6-2 gives the finished grade at each equipment center. Foundation top-of-concrete elevations in STR-CAL-002 are set 6 in above these values.

Table 6-2: Finished Grade at Equipment

Equipment	X (ft)	Y (ft)	Finished grade (ft)
PR-101	35.0	40.0	1151.70
SDV-101	65.8	26.0	1151.32
V-101	84.0	40.0	1151.21
FG-101	95.0	55.0	1151.17
SK-110	84.0	97.0	1151.49
B-101	118.0	118.0	1151.26
H-101	192.0	140.0	1150.63
FCV-131/132	150.0	90.0	1150.80
SDV-102	185.0	90.0	1150.45
CKV-171	200.0	90.0	1150.30
SDV-103	212.0	90.0	1150.18
IJ-102	220.0	157.0	1150.43
IJ-101	26.5	8.0	1151.62
VS-101	40.0	160.0	1152.25
T-101	30.0	100.0	1152.05
B-102	215.0	25.0	1149.82
G-101	185.0	22.0	1150.11
ANT-201	150.0	22.0	1150.46
JB-W01	214.0	197.5	1150.70
XF-101	240.0	8.0	1149.49

6.2. PAD FILL

At each grid cell the soil depth between top of subgrade and the stripped surface is:

TORUS grid method

$$\Delta z = (FG - t_{agg}) - (EG - t_{top}) = FG - EG \quad (t_{agg} = t_{top} = 0.5 \text{ ft})$$

Because the aggregate and the topsoil are both 6 in thick, the soil fill depth equals the height of the finished pad above existing ground. It ranges from 0.51 ft at the northwest corner to 1.69 ft at the southeast corner, averaging 1.10 ft. There is no cut on the pad. Summed over the 54 by 44 grid of 25 ft² cells:

TORUS grid method

$$V_{pad} = \sum \Delta z_i \times 25 \text{ ft}^2 = 65,340 \text{ ft}^3 = 2,420 \text{ CY}$$



The perimeter fill slopes add a wedge of height $H = 1.00$ to 2.20 ft (from the stripped surface to finished grade) on a 4:1 slope:

TORUS grid method

$$V_{slope} = \sum 0.5 (4H)(H) \Delta L = 190 \text{ CY}$$

The internal roads carry a 12 in section flush with the 6 in pad surfacing, so their subgrade is cut 6 in below the pad subgrade over $13,422 \text{ ft}^2$. This undercut yields 249 CY of clay that is reused as fill.

6.3. ACCESS ROAD, ENTRANCE AND DITCHES

The access road crown is 12 in above existing ground, on a 24 ft wide subgrade at existing grade. After the 6 in strip, the section needs 6 in of fill under the subgrade and a 4:1 shoulder wedge each side, 21.0 ft^2 per foot over 608 ft. The entrance returns add $1,673 \text{ ft}^2$ beyond the 20 ft road. Over CUL-1 the driveway fills the county ditch for 96 ft; the zone around the pipe is granular structural backfill and the rest is compacted clay. The perimeter and roadside ditches are cut in native soil, and Table 6-3 gives their excavation.

Table 6-3: Ditch Excavation

Ditch	Type	Length (ft)	Section area (ft ²)	Excavation (CY)
D-1, north interceptor	A	286	9.75	103
D-2, east swale north	A	136	9.75	49
D-3, west interceptor	A	236	9.75	85
D-4, south ditch	A	308	9.75	111
D-5, east swale south	A	62	9.75	22
D-6, access road north ditch	B	587	18.00	391
D-7, access road south ditch	B	587	18.00	391
Total				1,154

6.4. EARTHWORK BALANCE

Table 6-4 brings the volumes together. All on-site excavation that is not topsoil is clay that can be reused as general fill.

Table 6-4: Earthwork Balance

Item	Compacted (CY)	Bank (CY)
Pad fill	2,420	
West apron fill	20	
Pad fill slopes	190	
Access road embankment	473	

Item	Compacted (CY)	Bank (CY)
Entrance returns	31	
Driveway over CUL-1	59	
Total compacted general fill	3,193	
Bank volume required at 15 % shrinkage		3,757
Less ditch excavation		-1,154
Less internal road undercut		-249
Less foundation excavation (STR-CAL-002)		-686
Import general fill, bank volume		1,669

The site needs 1,669 CY (bank) of imported general fill. TORUS considered taking borrow from the tract itself, but the tract is only 2.41 ac and is almost entirely occupied by the pad, ditches and laydown, so a borrow pit would have to go outside the lease. Import from a commercial or landowner-approved source is specified instead.

In addition, 289 CY (compacted) of non-expansive select fill goes under the mats, slabs and buildings (STR-CAL-002), which is about 362 CY loose by truck. CUL-1 needs 50 CY of granular structural backfill.

6.5. DISTURBED AREA AND TOPSOIL

Table 6-5 builds up the disturbed area, which sets the construction stormwater permit requirement and the seeding quantities.

Table 6-5: Disturbed Area

Area	Area (ft ²)	Area (ac)
Pad, slopes, perimeter ditches (X -50 to 278, Y -28 to 228)	83,968	1.93
Temporary laydown / topsoil stockpile (X 40 to 240, Y -62 to -28)	6,800	0.16
Access road corridor (56 ft x 585 ft)	32,760	0.75
Entrance mouth and CUL-1 embankment beyond corridor	2,633	0.06
Outlet lateral trench, north of envelope to the tap (30 ft x 29 ft)	870	0.02
DW-101 temporary drill pad 30 x 30 ft and 12 ft grassed access track	1,992	0.05
Total disturbed area	129,023	2.96

The disturbed area of 2.96 ac is at least 1 ac and under 5 ac, so construction stormwater permit coverage and a SWPPP are required (CIV-RPT-002).

Topsoil is stripped from 128,363 ft², giving 2,377 CY. It is stockpiled in the laydown area and respread 6 in deep over the 1.21 ac that will be seeded (fill slopes, ditches, laydown and the road corridor), which uses 973 CY. The remaining 1,404 CY cannot be placed on the tract: spreading it 4 in deep would need 2.6 ac, more than the whole lease. It will be delivered to a stockpile location nominated by the landowner or hauled off site. Clearing and grubbing covers the full 2.96 ac of pasture.

6.6. COMPACTION REQUIREMENTS

Table 6-6 sets the compaction and moisture requirement for every earthwork material. Clay subgrade and clay fill are placed wet of optimum, 0 to +4 %, because clay compacted dry of optimum swells more when it later takes on water (CIV-RPT-001). Select fill under foundations is compacted harder, to 98 %, because it carries the foundation load directly.

Table 6-6: Compaction and Moisture Requirements

Material	Requirement	Compaction	Moisture	Lift	Test frequency
Subgrade under pad, roads and fill	Scarify and recompact top 12 in of native clay	95 % D698	0 to +4 %	12 in	1 per 5,000 ft ²
General fill	CL or SC, PI 30 max, no organics, 4 in max particle	95 % D698	0 to +4 %	8 in	1 per 5,000 ft ² per lift
Select fill	PI 8 to 20, LL under 40, 30 to 70 % passing No. 200	98 % D698	-1 to +3 %	8 in	1 per 1,000 ft ² per lift, 2 per foundation minimum
Aggregate surfacing and road section	Type A (Section 703.01)	95 % D1557	+/-2 %	6 in	1 per 300 ft of road, 1 per 5,000 ft ² of pad
Trench backfill outside roads	Excavated clay, clods under 3 in	90 % D698	0 to +4 %	8 in	1 per 100 ft per 2 lifts
Trench backfill under roads and pad	Select fill or flowable fill	95 % D698	-1 to +3 %	8 in	1 per crossing per lift
CUL-1 structural backfill	Type A, 1.5 ft each side, 1 ft over crown	95 % D698	+/-2 %	6 in, both sides together	1 per 2 lifts

Note 1: Moisture is relative to the optimum from the same Proctor test. D698 is standard Proctor and D1557 is modified Proctor.

All subgrade shall be proof-rolled with a loaded tandem-axle dump truck of at least 20 tons before fill or aggregate is placed, and yielding areas removed and replaced. Clay subgrade and fill shall be kept moist until covered, and no fill shall be placed on frozen ground.

7. RESULTS AND CONCLUSIONS

TORUS draws the following conclusions:

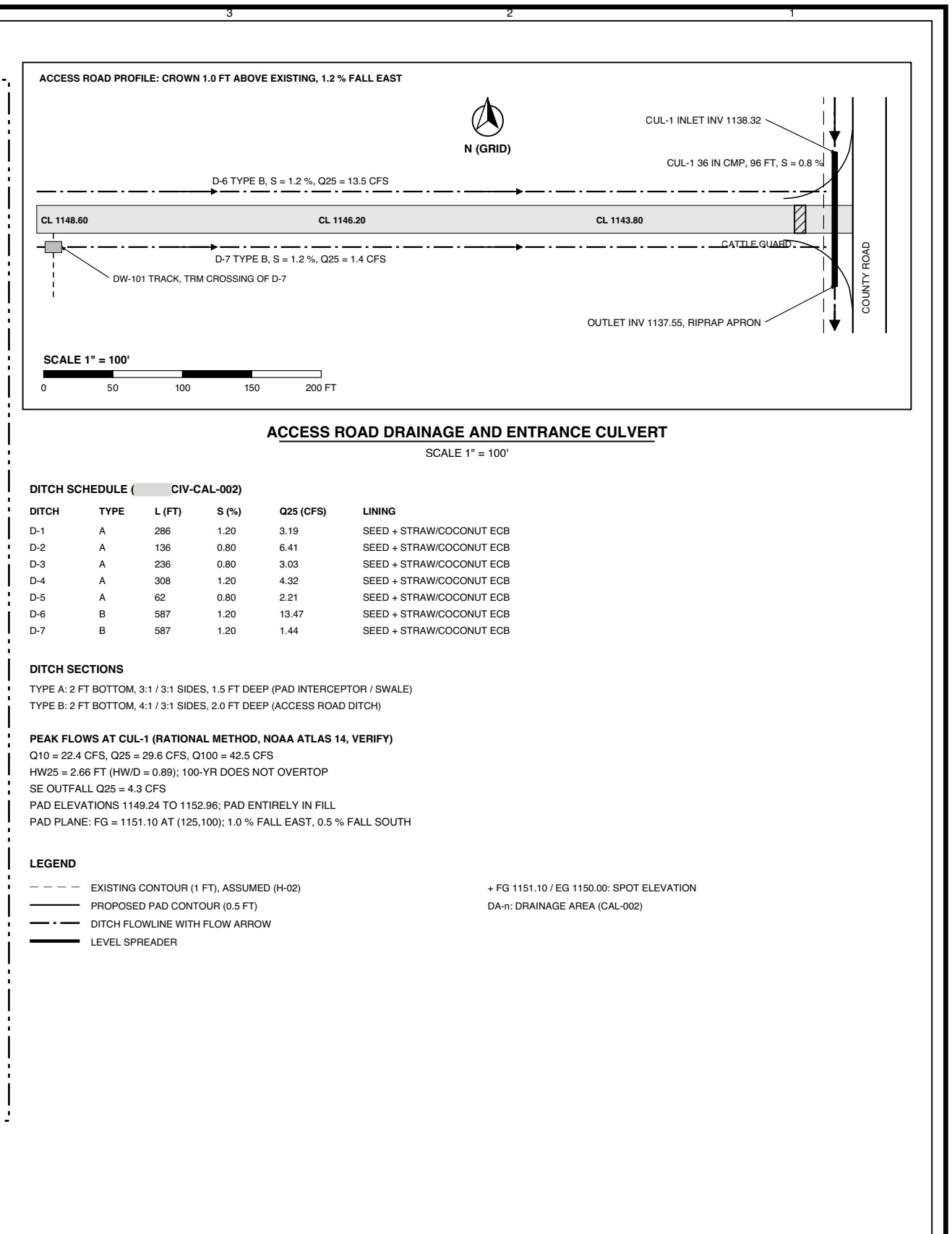
1. The finished pad is a plane at 1151.10 ft at (125, 100), falling 1.0 % east and 0.5 % south, ranging from 1149.24 to 1152.96 ft.
2. The pad is entirely in fill, 0.5 to 1.7 ft deep below the aggregate.
3. The site needs 3,193 CY of compacted general fill. On-site excavation supplies 2,088 CY (bank), and 1,669 CY (bank) is imported.
4. Select fill under foundations is 289 CY compacted, per STR-CAL-002.
5. Topsoil strip is 2,377 CY, of which 973 CY is respread and 1,404 CY exported.
6. The disturbed area is 2.96 ac, so construction stormwater permit coverage is required.

The next step is the topographic survey (HOLD H-02) and the geotechnical investigation (HOLD H-07), after which the grading plane and every volume in this calculation shall be recomputed.



APPENDIX A. GRADING AND DRAINAGE PLAN





1. EXISTING GROUND IS AN ASSUMED PLANE (HOLD H-02). REGRADE FROM THE TOPOGRAPHIC SURVEY BEFORE IFC
2. ELEVATIONS FT NAVD88. FG = TOP OF AGGREGATE. PAD MIN 0.5 FT ABOVE EXISTING AT EVERY EDGE.
3. FILL SLOPES 4H:1V FROM PAD EDGE TO EXISTING GROUND; DITCH SIDES 3:1 (TYPE A), 4:1 / 3:1 (TYPE B).
4. ALL DITCHES SEEDDED WITH STRAW/COCONUT ECB. CHECK DAMS AND SILT FENCE: CIV-DWG-005.
5. CUL-1 INVERTS FROM ASSUMED COUNTY DITCH DEPTH 3.0 FT; CONFIRM BY SURVEY AND COUNTY PERMIT (H-05).
6. LAYOUT AND ROADS PER MEC-DWG-001. DW-101 TRACK CROSSES D-7 ON TRM. DETAILS: DWG-004.

REF: CIV-CAL-001
REF: CIV-CAL-002

REV	DATE	DESCRIPTION	BY	CHK	APP
A	2026-09-29	ISSUED FOR REVIEW (IFR)			

PRELIMINARY - ISSUED FOR REVIEW - NOT FOR CONSTRUCTION

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120 MMSCFD RECEIPT INTO
COUNTY,
DISCIPLINE: CIVIL
SCALE: AS SHOWN

DRAWN: _____ CHECKED: _____ APPROVED: _____

DWG NO.

CIV-DWG-003

SHEET 1 OF 1 REV A