CRWMS/M&O

Design Analysis Cover Sheet

Complete only applicable items.

(1.)

QA: L

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2. DESIGN ANALYSIS TITLE			
ESF LAYOUT CALCULATION			
3. DOCUMENT IDENTIFIER (Including Rev. No.)		4. REV. NO.	5. TOTAL PAGES
BABEAD000-01717-0200-00003 REV 02C		02C	24
6. TOTAL ATTACHMENTS	7. ATTACHMENT NUMBERS - NO. OF PAGES IN EACH		8. SYSTEM ELEMENT
NONE	N/A		MGDS-ESF

	Print Name	Signature	Date
9. Originator	W. R. KENNEDY		
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13. Department Manager			

14. REMARKS

THIS CALCULATION PROVIDES THE BASIS FOR THE COORDINATES, ELEVATIONS, DIMENSIONS, STATIONING, AND GRADIENTS SHOWN ON THE ESF NORTH RAMP, MAIN DRIFT, AND SOUTH RAMP LAYOUT DRAWINGS.

TBD - 097, PAGE 5 of 24
TBV - 056, PAGES 6 & 10 of 24, and Figure 1, PAGE 24 of 24

2. DESIGN ANALYSIS TITLE	
ESF LAYOUT CALCULATION	
3. DOCUMENT IDENTIFIER (Including Rev. No.)	4. REVISION NO.
BABEAD000-01717-0200-00003 REV 02C	02C

5. Revision No.	6. Total Pages	7. Description of Revision
00	21	APPROVED BUT NOT ISSUED
01	22	Revised various sections of the document as follows: Revised QA Classification (Section 2); Called out references (Sections 3 and 4); Referenced a new document (Section 6); Included basis for assumption and referenced section where assumption was used (Section 7); Included additional references (Sect 8); Changed section title and included reference to ESF/Repository Interface dwgs and editorial change (Section 10); The above described changes were made primarily in response to comments resulting from various QA checks/audits.
02C	24	THIS REVISION INCORPORATES NUMEROUS CHANGES TO THE CALCULATION: o The scope is increased to include coordinate geometry for the entire "TS Loop" o Changes are made to horizontal and vertical alignment of the North Ramp o Slope of the Main Drift is revised to match the latest ESF/Repository Conceptual Layout from the ACD Report o The format is revised in accordance with QAP-3-9 Rev 05 o Editorial changes are made throughout o Text changes are made throughout to enhance clarity o Borehole locations/data are shown on Figure 1 o Revised fault traces are shown on Figure 1 o TBV-056 is placed on South Portal coordinates

1.0 PURPOSE

The purpose of this calculation is to establish the geometric parameters which define the subsurface Exploratory Studies Facility (ESF) layout. Coordinate geometry will be developed for the TS North Ramp, TS Main Drift, and TS South Ramp, which together form the "TS Loop" portion of the ESF. Specifically, key azimuths, coordinates, elevations, stations, and gradients will be determined.

2.0 QUALITY ASSURANCE

The openings which comprise the "TS Loop" portion of the ESF are included in the Main Access Openings configuration item. Main Access Openings are conservatively classified as QA-2 to ensure repository layout criteria are met and also to account for their potential importance in establishing seals for the potential repository (See Reference 5.7).

3.0 METHOD

Standard trigonometric calculations are employed to develop the coordinate geometry for the ESF layout. The coordinates and distances determined by this calculation are based on the Nevada State Plane Coordinate System, Central Zone, North American Datum of 1927 (NAD 27) converted to meters (See Design Criteria 4.2.5). As such, the actual ground distances are greater than the calculated grid distances and surveyors will need to apply correction factors when laying out construction lines or survey control points, or when measuring distances (See Reference 5.1). It should also be noted that all the metric coordinates are based on an initial conversion of the North Portal coordinates from English to metric units using a conversion factor of 0.30480061, per ASTM E 380-86, Standard For Metric Practice (See Reference 5.10).

4.0 DESIGN INPUTS

4.1 DESIGN PARAMETERS

The following design parameters were used as design input to the coordinate geometry calculations:

DESCRIPTION & SOURCE	VALUE
Coord. @ North Portal (Ref. 5.2)	N233279.969825 E173679.767563
Station @ North Portal (Ref. 5.2)	00+00.000
Elev. - Starter Tunnel Excavated Invert (Ref. 5.3)	1122.560 m
Elev. - Invert @ Start of Bored Tunnel (Ref. 5.3)	1122.992 m
Azimuth - Portal to Start of Bored Tunnel (Ref. 5.2)	298° 58' 29"
Coord. @ North Ramp Offset Point (Ref. 5.15)	N233331.869677 E173584.196829
Station @ North Ramp Offset Point (Ref. 5.15)	01+08.750
Azimuth - Offset Point to Nor. Ramp PC (Ref. 5.15)	298° 58' 29"
Elev. - North Ramp PT/VPI (Ref. 5.14)	1065.000 m
Elev. - Main Drift VPI (Ref. 5.14)	1107.750 m
Slope - Main Drift (Ref. 5.14)	1.5%
Dist. - Nor Ramp VPI to Main Drift VPI (Ref. 5.14)	2850 m
Station @ North Ramp VPI (Ref. 5.15)	01+08.250
Curve Type (Ref. 5.15)	Parabolic
Curve Length (Ref. 5.15)	35 m
Elev. of VPI @ Tunnel Invert (Ref. 5.15)	1121.763*
Station @ North Ramp VPI (Ref. 5.15)	01+62.500
Curve Type (Ref. 5.15)	Parabolic
Curve Length (Ref. 5.15)	50 m
Elev. of VPI @ Tunnel Invert (Ref. 5.15)	1121.763*

* Elevation @ excavated invert calculated from springline elevation based on 7.62 m diameter tunnel (See Ref. 5.13 and Design Criteria 4.2.4).

4.2 CRITERIA

The following design criteria were developed to respond to ESFDR (Ref. 5.9) requirements applicable to the ESF layout. Applicable ESFDR requirements are cited for each criteria statement.

4.2.1 The ESF subsurface layout will be based on the enhanced layout concept presented in "Description and Rational for Enhancement to the Baseline ESF Configuration" (Ref. 5.4). [3.2.1 C, 3.2.1 D, 3.2.1 I1, 3.2.1 I2, 3.2.1 I4, 3.2.1 J3, 3.2.1 J4, 3.2.1 J5, 3.2.1 J8, 3.2.1 J9, 3.2.1 W, 3.2.1.4, 3.2.1.4 C2, 3.2.2 B, 3.2.2 E, 3.2.2.4 A, 3.2.2.4 A1, 3.2.2.4 A1(a,b,c), 3.2.2.4 B, 3.2.2.4 B2, 3.2.2.4 C, 3.2.2.4 C1, 3.2.2.4 C3, 3.2.2.4 C4, 3.2.2.4 C7, 3.2.2.4 F4, 3.2.2.4 I, 3.2.2.4 I1, 3.2.2.4 I3, 3.2.2.4 I5, 3.2.2.4 N, 3.2.2.4 P, 3.2.2.4 P2, 3.2.2.4 T, 3.2.2.4 T1, 3.2.9 A, 3.2.9.4 D1(TBD-097), 3.2.9.4 D3, 3.2.9.4 D5, 3.2.9.4 E]

TBD-097 is associated with ESFDR requirement 3.2.9.4 D1 but will not be carried down to output documents. ESF layout features such as tunnel gradient and size will facilitate the accommodation of such additional testing as may be required by the NRC.

4.2.2 The ESF subsurface layout will closely correspond to the ESF/Repository Interface Layouts included in Appendix A.2 of the ESFDR (Ref. 5.9). [3.2.1 H, 3.2.1 H1(a), 3.2.1 Z, 3.2.1 Z1, 3.2.1 Z2, 3.2.2 F, 3.2.2 G, 3.2.2.4 A1(a,b,c), 3.2.2.4 D4, 3.2.2.4 H4, 3.2.2.4 L, 3.2.2.4 L1, 3.2.4 L7, 3.2.2.4 M, 3.2.2.4 M4, 3.2.2.4 N1, 3.2.2.4 O3, 3.2.2.4 Q, 3.2.2.4 R, 3.2.2.4 R1, 3.2.2.4 S2]

4.2.3 Locations and data for surface boreholes which could interfere with ESF or repository subsurface workings will be shown on the design drawings (Reference 5.16). [3.2.1 C, 3.2.2.4 L2]

4.2.4 The ESF layouts for the TS North Ramp, TS Main Drift, and TS South Ramp will be based on 7.62 m diameter TBM bored openings, in accordance with the YMSCO decision on ESF ramp diameter (Ref. 5.13). [3.2.1 K, 3.2.1.9.3 C1, 3.2.1.9.3 C1(a), 3.2.2.4 D9, 3.2.2.4 E,

3.2.2.4 F, 3.2.2.4 F1, 3.2.2.4 F3, 3.2.2.4 G, 3.2.2.4 H, 3.2.2.4 H1, 3.2.2.4 H2, 3.2.2.4 J, 3.2.2.4 U, 3.2.2.4 U3, 3.2.9.4 D4]

4.2.5 Coordinates for the ESF subsurface layout will be based on the Nevada State Plane Coordinate System, Central Zone, North American Datum of 1927 (NAD 27) converted to meters. [3.2.2 C]

4.3 ASSUMPTIONS

The following assumptions are necessary to perform the ESF layout calculation:

4.3.1 Assumed values for the South Portal coordinates and elevation (TBV - 056) are shown below:

N 230615.000000
E 172880.000000
Bored Invert Elevation: 1160.000 m

This site is very near the location shown in the "Description and Rational for Enhancement to the Baseline ESF Configuration" (See Reference 5.4).

This assumption, which is used throughout Section 7, requires verification since changes to these values will affect the coordinate geometry of the South Ramp and the Main Drift/South Ramp interface.

TBV-056 will be carried down to the drawings and a HOLD on construction of the Main Drift beyond Station 56+00 will be placed on the appropriate design drawings until TBV-056 is released.

4.4 CODES AND STANDARDS

The following codes and standards are applicable to this calculation:

4.4.1 ASTM E 380-86, Standard For Metric Practice (Ref. 5.10)

5.0 REFERENCES

5.1 Meeting Notes MN-041, dated March 16, 1994. Survey Correction Factors for ESF Construction

5.2 Package 1A drawing YMP-025-1-MING-MG121 Rev 3 (BABEA0000-01717-2100-10121-03), Starter Tunnel Gen Arrangement, Plan (Sht. 2)

5.3 Package 1A drawing YMP-025-1-MING-MG123 Rev 4 (BABEA0000-01717-2100-10123-04), Starter Tunnel Gen Arrangement, Section (Sht. 2)

5.4 McKenzie, December 1993. Description and Rational for Enhancement to the Baseline ESF Configuration, DI: B00000000-01717-0200-00089 Rev 01

5.5 Comment #167, 90% Design Review of Design Package 2C, May 1994

5.6 Interoffice Correspondence from Bhattacharyya to Saunders, June 30, 1994. Realignment of TS Main Drift/Repository Service Main, LV.SB. KKB.6/94-083

5.7 Gwyn, April 1995. QA Classification Analysis of Main Access Openings (CI: BABEAD000), DI: BABEAD000-01717-2200-00002 REV 00

5.8 Interoffice Correspondence from Nieder-Westermann to Kennedy, May 11, 1995. Fault Traces at Specified Depths, LV.ESSB.GNW.05/95-582

5.9 Office of Civilian Radioactive Waste Management, May 08, 1995. Exploratory Studies Facility Design Requirements, Document No. YMP/CM-0019, Rev. 01 ICN 2

5.10 ASTM E 380-86, Standard For Metric Practice

5.11 Peele, 1941. Mining Engineer's Handbook, Third Edition

5.12 Hickerson, 1964. Route Location And Design, Fifth Edition

5.13 Letter from Simecka to Bullock, December 2, 1992. Exploratory Studies Facility (ESF) Ramp Size Requirement, EDD:EHP-1262

5.14 Bhattacharyya to Kennedy, April 28, 1995. Design Input Transmittal

5.15 Skorseth, December 23, 1994. Disposition of NCR No. YMSCO 95-0043

5.16 Transmittal from Ezra to Kennedy, March 09, 1995. Existing Borehole Information, Product No. YMP-95-133.0, Tracking Designator: NR95030701

5.17 Civilian Radioactive Waste Management System M&O Contractor, August 29, 1994. Initial Summary Report for Repository/Waste Package Advanced Conceptual Design, DI: B00000000-01717-5705-00015 Rev 00

5.18 Office of Civilian Radioactive Waste Management, May 24, 1995. Exploratory Studies Facility Technical Baseline, Volume 2 of 2, Document No. YMP/CM-0016

6.0 USE OF COMPUTER SOFTWARE

Not Used

7.0 DESIGN ANALYSIS

The concept for a revised ESF subsurface layout was described in an earlier analysis (See Reference 5.4). This calculation is based on that enhanced ESF configuration (See Design Criteria 4.2.1), and is

consistent with the conclusions and recommendations presented in that analysis. The layout developed herein is also similar to the conceptual ESF/Repository layouts included in Appendix A.2 of the ESFDR (See Reference 5.9 and Design Criteria 4.2.2). The following discussion provides a brief description of the general approach that was used to establish key geometric parameters which define the ESF subsurface layout.

7.1 GENERAL APPROACH

The location and elevation of the North Portal and the alignment of the North Ramp were established in Title II ESF Design Package 1A. From Section 4.1:

Coord. @ North Portal:	N 233279.969825 E 173679.767563
Elev. - Starter Tunnel Excavated Invert	1122.560 m
Azimuth - Portal to Start of Bored Tunnel	298° 58' 29"

Problems in maintaining the designed horizontal and vertical alignment of the tunnel immediately after launching the TBM resulted in a change to the design. The revised tunnel centerline is offset 893 mm horizontally from the originally designed centerline. The azimuth of the tunnel remains the same. From Section 4.1:

Coord. @ North Ramp Offset Point	N233331.869677 E173584.196829
Station @ North Ramp Offset Point	01+08.750
Azimuth - Offset Point to North Ramp PC	298° 58' 29"

Details of the revised vertical alignment of the tunnel are shown on Table 1 of this calculation.

The South Portal was located near the site shown in the ESF Technical Baseline (see Reference 5.18), but on the "nose" of the ridge and at a lower elevation. Portal coordinates were set at N 230615.000000 and E

172880.000000 and the invert elevation was set at 1160.000 m (See Assumption 4.3.1). The TS South Ramp alignment was established at an azimuth of 91°. It should be noted that the actual coordinates and elevation will be determined by Title II Design of the South Portal facilities and are likely to differ from the assumed values. If the actual values do differ from the assumed values, the coordinate geometry of the South Ramp and the Main Drift/South Ramp interface will be affected. Therefore, a HOLD on construction of the Main Drift beyond Station 56+00 will be placed on the appropriate design drawings until the South Portal coordinates and elevation are finalized and TBV-056 is released.

The initial step in locating the TS Main Drift was projecting the surface traces of major faults to the approximate level of the ESF (See Reference 5.8). The TS Main Drift was then located along the west side of the Ghost Dance Fault. Initially, the Main Drift was designed to run generally parallel to the fault in two straight segments connected by a short curve, with a minimum lateral offset from the fault of approximately 120 meters (See Ref. 5.4). In response to a 90% design review comment by repository subsurface designers, the TS Main Drift was realigned to enhance future repository operational aspects (See Ref. 5.5 and 5.6). The slight "dogleg" in the Main Drift was eliminated to provide a single straight drift segment oriented at an azimuth of 183.00°. The minimum offset of approximately 120 meters from the fault is maintained with the new alignment. The coordinates of a control point on the centerline of the Main Drift were graphically determined to be N 232691.3500 and E 171240.5960.

The elevation and grade of the TS Main Drift are also designed to be compatible with the potential repository. Based on the latest ESF/Repository conceptual layout, the Main Drift would serve as a repository service main (See Reference 5.14). Consistent with the repository layout, the elevation of the North Ramp PC/VPI was set at 1065 m and a slope of +1.5% was established in the Main Drift from the North Ramp PC/VPI south 2850 m to another VPI at an elevation of 1107.75 m (See Section 4.1).

This configuration results in the Main Drift being located near the top of the TSw2 unit and ensures that drainage will be toward the north end of the Main Drift to a low point where the Main Drift transitions into the North Ramp.

The TS Main Drift location, alignment, and gradient resulting from the general approach discussed above are shown on Figure 1. The layout also shows the TS North and TS South Ramps and west trending extensions of both ramps (See Reference 5.17, Figure 8.6.3-1).

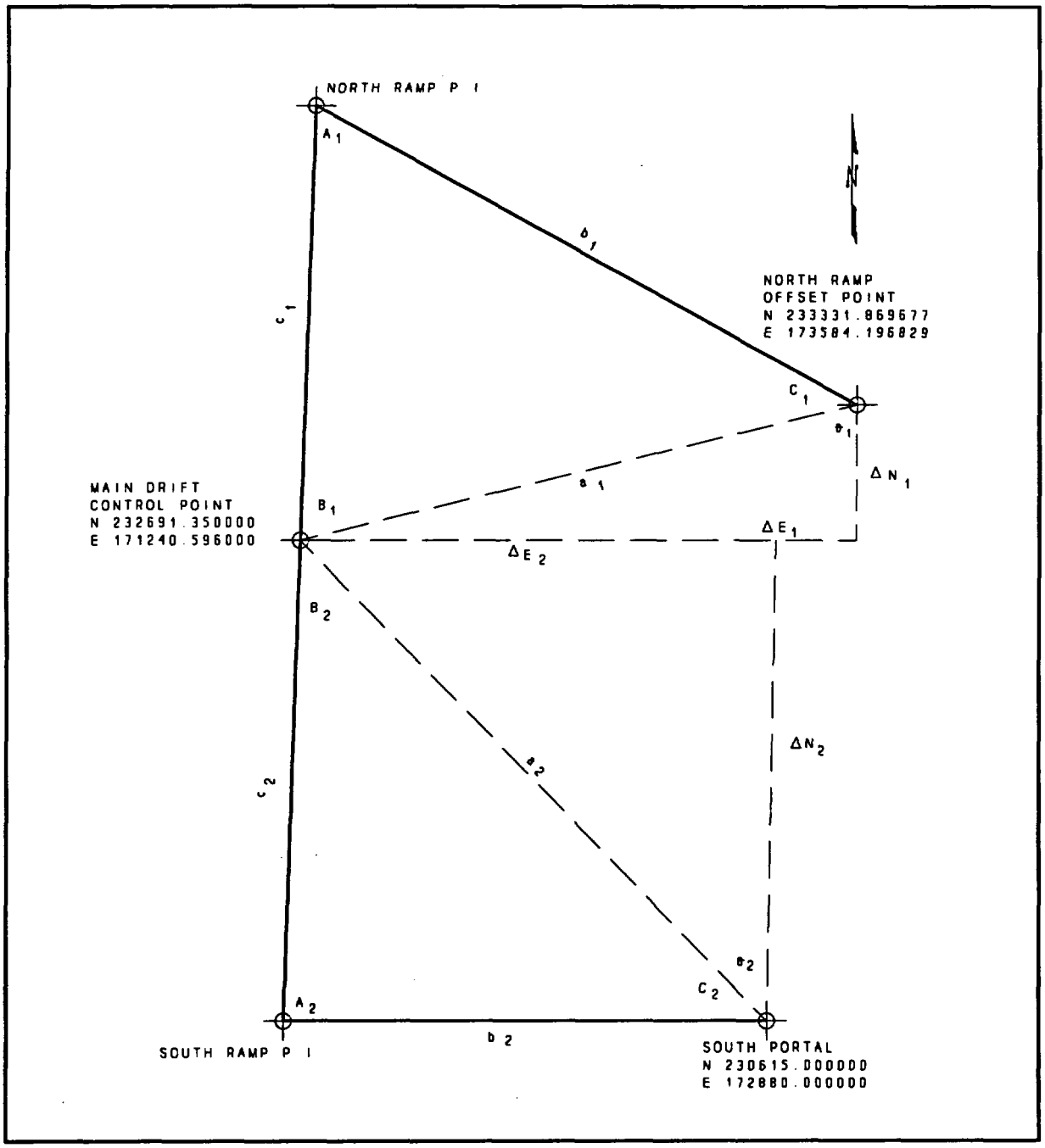
The remainder of this calculation establishes the coordinate geometry for the "TS Loop" portion of the layout. Drifts other than those which comprise the "TS Loop" (North Ramp/Main Drift/South Ramp) are shown for reference purposes only.

7.2 CALCULATIONS

Hand calculations are used to establish the configuration of the "TS Loop". These calculations are presented on the pages which follow and the resulting azimuths, coordinates, stationing, elevations, and grades are shown on Figure 1.

7.2.1 COORDINATE CALCULATIONS

Refer to the sketch below for the calculations which follow.



$$\theta_1 = \arctan \frac{\Delta E_1}{\Delta N_1} = 74.71403397°$$

Az - North Ramp Offset Point to North Ramp PI	= 298.97472222°
Az - North Ramp Offset Point to Main Drift Control Point	= 254.71403397°
Az - North Ramp PI to Main Drift Control Point	= 183.00000000°
Angle A_1 = (183.00000000°) - (298.97472222°- 180°)	= 064.02527778°
Angle B_1 = 254.71403397° - 183.00000000°	= 071.71403397°
Angle C_1 = 298.97472222°- 254.71403397°	= 044.26068825°

$$Distance\ a_1 = \sqrt{\Delta N_1^2 + \Delta E_1^2} = 2429.55351913\ m$$

$$Distance\ b_1 = (a_1)\left(\frac{\sin B_1}{\sin A_1}\right) = 2566.07256041\ m$$

$$Distance\ c_1 = (a_1)\left(\frac{\sin C_1}{\sin A_1}\right) = 1886.17099348\ m$$

$$\theta_2 = \arctan \frac{\Delta E_2}{\Delta N_2} = 38.29322831°$$

Az - South Portal to Main Drift Control Point	= 321.70677169°
Az - Main Drift Control Point to South Ramp PI	= 183.00000000°
Az - South Ramp PI to South Ramp Portal	= 091.00000000°
Angle A_2 = 091° - 003°	= 088.00000000°
Angle B_2 = 183° - (321.70677169° - 180°)	= 041.29322831°
Angle C_2 = 180° - 88.00000000° - 41.29322831°	= 050.70677169°

$$Distance\ a_2 = \sqrt{\Delta N_2^2 + \Delta E_2^2} = 2645.53865928\ m$$

$$Distance\ b_2 = (a_2)\left(\frac{\sin B_2}{\sin A_2}\right) = 1746.88917425\ m$$

$$Distance\ c_2 = (a_2)\left(\frac{\sin C_2}{\sin A_2}\right) = 2048.67021144\ m$$

HORIZONTAL CIRCULAR CURVE CALCULATIONS

North Ramp

Δ = Central Angle = 180° - A_1	= 115.97472222°
R = Curve Radius	= 305.00000000 m[1]
T = Tangent Length = [R][tan ($\Delta \div 2$)][2]	= 487.86252698 m
L = Curve Length = [πR][$\Delta \div 180$][3]	= 617.36292931 m

South Ramp

Δ = Central Angle = 180° - A_2	= 092.00000000°
R = Curve Radius	= 305.00000000 m[1]
T = Tangent Length = [R][tan ($\Delta \div 2$)][2]	= 315.83674571 m
L = Curve Length = [πR][$\Delta \div 180$][3]	= 489.73938811 m

[1] A curve radius of 305 m was selected to facilitate the use of conventional belt conveyors for muck haulage.
[2] Reference 5.12, Chapter 3
[3] Reference 5.11, page 36-12

TRAVERSE FROM NORTH RAMP OFFSET POINT TO NORTH RAMP PC

Distance = b_1 - tangent length	= 2078.21003343 m
Azimuth	= 298.97472222°
α = Azimuth - 270°	= 028.97472222°
ΔN =(2078.21003343 m)(sin α)	= + 1006.73421025 m
ΔE =(2078.21003343 m)(cos α)	= - 1818.08777923 m

North Ramp PC Coordinates:

N 234338.603887
E 171766.109050

TRAVERSE FROM NORTH RAMP PC TO NORTH RAMP PI

Distance = tangent length	= 487.86252698 m
Azimuth	= 298.97472222°
α = Azimuth - 270°	= 028.97472222°
ΔN =(487.86252698 m)(sin α)	= + 236.33217428 m
ΔE =(487.86252698 m)(cos α)	= - 426.79848715 m

North Ramp PI Coordinates:

N 234574.936061
E 171339.310563

TRAVERSE FROM NORTH RAMP PI TO NORTH RAMP PT

Distance = tangent length	= 487.86252698 m
Azimuth	= 183.00000000°
α = Azimuth - 180°	= 003.00000000°
ΔN =(487.86252698 m)(cos α)	= - 487.19392834 m
ΔE =(487.86252698 m)(sin α)	= - 025.53275186 m

North Ramp PT Coordinates:

N 234087.742133
E 171313.777811

TRAVERSE - NORTH RAMP PT TO MAIN DRIFT CONTROL POINT

Distance = c_1 - tangent length	= 1398.30846650 m
Azimuth	= 183.00000000°
α = Azimuth - 180°	= 003.00000000°
ΔN =(1398.30846650 m)(cos α)	= - 1396.39213334 m
ΔE =(1398.30846650 m)(sin α)	= - 0073.18181072 m

Main Drift Control Point Coordinates:

N 232691.350000
E 171240.596000

TRAVERSE - MAIN DRIFT CONTROL POINT TO SOUTH RAMP PC

Distance = c_2 - tangent length	= 1732.83346573 m
Azimuth	= 183.00000000°
α = Azimuth - 180°	= 003.00000000°
ΔN =(1732.83346573 m)(cos α)	= - 1730.45867769 m
ΔE =(1732.83346573 m)(sin α)	= - 0090.68949644 m

South Ramp PC Coordinates:

N 230960.891322
E 171149.906504

TRAVERSE FROM SOUTH RAMP PC TO SOUTH RAMP PI

Distance = tangent length	= 315.83674571 m
Azimuth	= 183.00000000°
α = Azimuth - 180°	= 003.00000000°
ΔN =(315.83674571 m)(cos α)	= - 315.40390243 m
ΔE =(315.83674571 m)(sin α)	= - 016.52961810 m

South Ramp PI Coordinates:

N 230645.487420
E 171133.376886

TRAVERSE FROM SOUTH RAMP PI TO SOUTH RAMP PT

Distance = tangent length	= 315.83674571 m
Azimuth	= 91.00000000°
α = Azimuth - 90°	= 01.00000000°
ΔN =(315.83674571 m)(sin α)	= - 005.51211125 m
ΔE =(315.83674571 m)(cos α)	= + 315.78864224 m

South Ramp PT Coordinates:

N 230639.975309
E 171449.165528

TRAVERSE FROM SOUTH RAMP PT TO SOUTH PORTAL

Distance = b_2 - tangent length	= 1431.05242854 m
Azimuth	= 91.00000000°
α = Azimuth - 90°	= 01.00000000°
ΔN =(1431.05242854 m)(sin α)	= - 0024.97530862 m
ΔE =(1431.05242854 m)(cos α)	= + 1430.83447232 m

South Portal Coordinates:

N 230615.000000
E 172880.000000

Since the calculated coordinates for the South Portal match the assumed South Portal coordinates, the horizontal control traverse closes and coordinates of all intermediate stations are correct as calculated.

7.2.2 ELEVATIONS

The elevations of the vertical control points shown below refer to the excavated invert. It should be noted that the starting point for the bored tunnel is approximate; the actual station will be field determined.

LOCATION	ELEVATION	SOURCE
North Portal @ Sta 00+00	1122.560 m	Ref. 5.14
Launch Chamber Face @ Sta 00+60	1122.560 m	Ref. 5.14
Start of Bored Tunnel @ Sta 00+60	1122.992 m	Ref. 5.14
VPI @ Sta 01+08.2500	1121.763 m	Table 1
VPI @ Sta 01+62.5000	1121.763 m	Table 1
VPI @ Sta 28+04.3229	1065.000 m	Table 2
VPI @ Sta 56+54.3229	1107.750 m	Table 2
South Portal @ Sta 78+56.2568	1160.000 m	Assumption 4.3.1

TABLE 1
VERTICAL CURVE DATA SHEET

VERTICAL CURVE @ STATION 01+08.250[1]

CURVE TYPE: EQUAL-TANGENT PARABOLIC
CURVE LENGTH: 35.000 m

CONTROL PT	STATION	ELEV. @ EXC. INVERT	ELEV. @ SPRINGLINE
VPC	00+90.75 m	1122.025 m	1125.835 m
VPI	01+08.25 m	1121.763 m	1125.573 m
VPT	01+25.75 m	1121.763 m	1125.573 m

VERTICAL CURVE @ STATION 01+62.500[1]

CURVE TYPE: EQUAL-TANGENT PARABOLIC
CURVE LENGTH: 50.000 m

CONTROL PT	STATION	ELEV. @ EXC. INVERT	ELEV. @ SPRINGLINE
VPC	01+37.50 m	1121.763 m	1125.573 m
VPI	01+62.50 m	1121.763 m	1125.573 m
VPT	01+87.50 m	1121.220 m	1125.030 m

Note: Parabolic type curves are designed to provide smooth transitions into and out of vertical curves.
[1] Curve data, except for elevation @ excavated invert, taken from ss-m-sk104, Reference 5.15. Calculated elevation @ excavated invert based on a 7.62 m diameter tunnel (See Ref. 5.13 and Design Criteria 4.2.4)

TABLE 2
VERTICAL CURVE DATA SHEET

VERTICAL CURVE @ STATION 28+04.323

CURVE TYPE: EQUAL-TANGENT PARABOLIC
CURVE LENGTH: 30.000 m

CONTROL PT	STATION	ELEV. @ EXC. INVERT	ELEV. @ SPRINGLINE
VPC	27+89.323 m	1065.322 m	1069.132 m
VPI	28+04.323 m	1065.000 m[1]	1068.810 m[2]
VPT	28+19.323 m	1065.225 m	1069.035 m

VERTICAL CURVE @ STATION 56+54.323

CURVE TYPE: EQUAL-TANGENT PARABOLIC
CURVE LENGTH: 30.000 m

CONTROL PT	STATION	ELEV. @ EXC. INVERT	ELEV. @ SPRINGLINE
VPC	56+39.323 m	1107.525 m	1111.335 m
VPI	56+54.323 m	1107.750 m[1]	1111.560 m[2]
VPT	56+69.323 m	1108.106 m	1111.916 m

Note: Parabolic type curves are designed to provide smooth transitions into and out of vertical curves.
[1] See Reference 5.14
[2] Calculated elevation @ springline based on a 7.62 m diameter tunnel (See Ref. 5.13 and Design Criteria 4.2.4)

7.2.3 STATION CALCULATIONS

North Portal
Station (See Section 4.1) = 00+00.0000

VPI - North Ramp
Station (See Section 4.1) = 01+08.2500

North Ramp Offset Point
Station (See Section 4.1) = 01+08.7500

VPI - North Ramp
Station (See Section 4.1) = 01+62.5000

North Ramp PC
Station = 2566.0726 - 487.8625+108.7500 = 21+86.9601

North Ramp PT/VPI
Station = 2186.9601+617.3629 = 28+04.3230

VPI - Main Drift
Station =2804.3230+2850.0000 (See Section 4.1) = 56+54.3230

South Ramp PC
Station = 2804.3230+(c_1-487.8625)+(c_2-315.8367) = 59+35.4650

South Ramp PT
Station = 5935.4650+489.7394 = 64+25.2044

South Portal
Station = 6425.2044+(b_2-315.8367) = 78+56.2569

7.2.4 SLOPE CALCULATIONS (EXCAVATED INVERT)

TUNNEL SEGMENT	STA (m)	ELEV (m)	SLOPE
North Portal	00+00.000	1122.560	
to			0.0000 %
Launch Chamber Face	00+60.000	1122.560	
to			0.432 m step
Start of Bored Tunnel	00+60.000	1122.992	
to			Varies[1]
VPI	01+08.250	1121.763	
to			0.0000 %
VPI	01+62.500	1121.763	
to			- 2.1486 %
VPI	28+04.323	1065.000	
to			+ 1.5000 %
VPI	56+54.323	1107.750	
to			+ 2.3729 %
South Portal	78+56.257	1160.000	

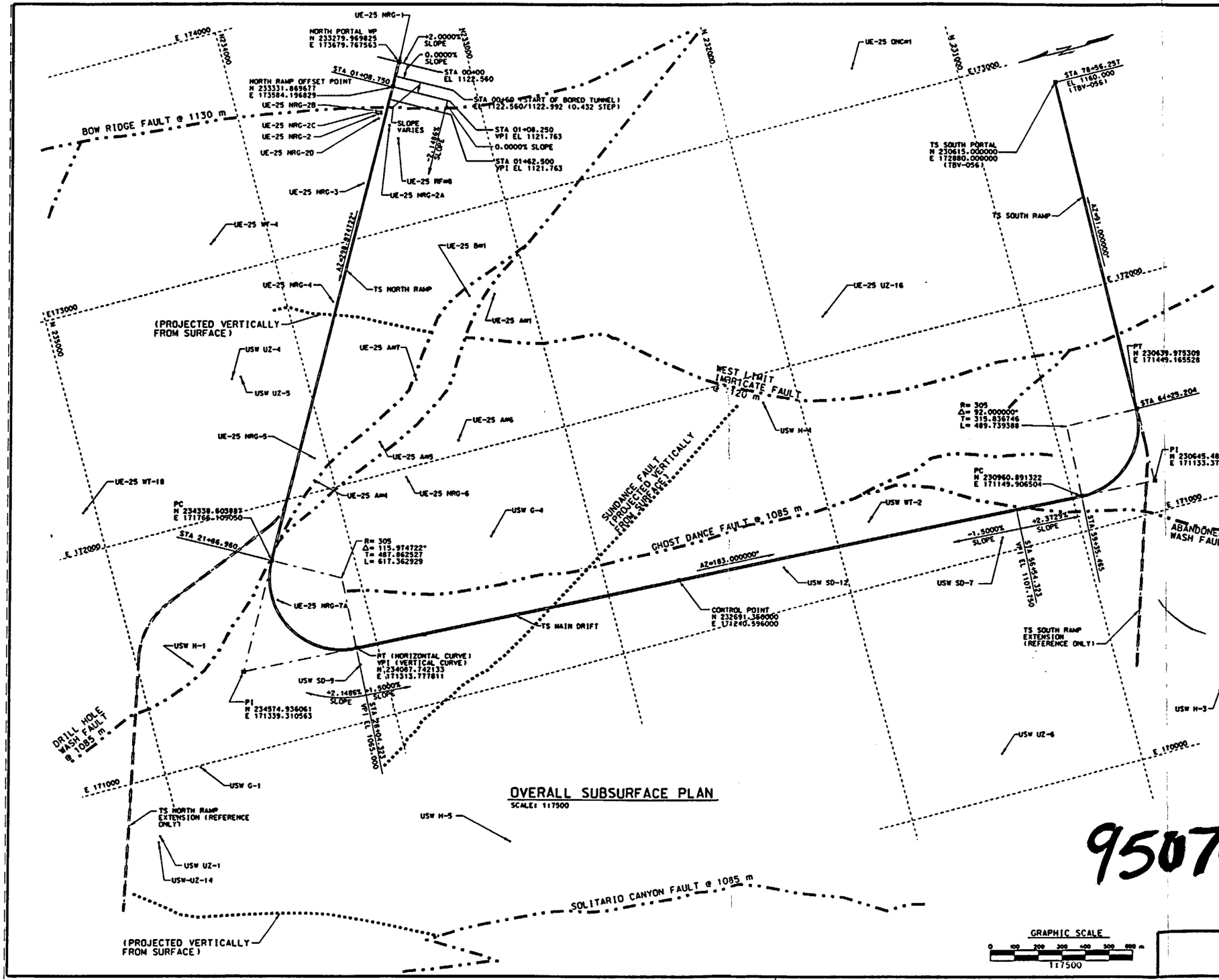
[1] Actual (existing) slope varies in this tunnel segment (See Reference 5.15)

8.0 CONCLUSIONS

The geometric parameters which define the "TS Loop" portion of the ESF have been defined in Section 7 of this calculation. Pertinent coordinate geometry data from the preceding calculations is shown on Figure 1. Also included on Figure 1, for reference only, are borehole locations (See Reference 5.16 and Design Criteria 4.2.3), fault trace locations (See Reference 5.8), and the North and South Ramp Extension drifts.

9.0 ATTACHMENTS

Not used



OVERALL SUBSURFACE PLAN

SCALE: 1:7500

NOTES:

1. ALL DISTANCES (INCLUDING STATIONING) SHOWN ON THIS DRAWING OR DERIVED FROM PLANE COORDINATES SHOWN ON THE DRAWING ARE GRID DISTANCES ON THE NEVADA STATE PLANE COORDINATE SYSTEM, CENTRAL ZONE (NAD 27). TO OBTAIN APPROXIMATE GROUND DISTANCES, DIVIDE GRID DISTANCES BY 0.999732.
2. COORDINATES, ELEVATIONS, DIMENSIONS, AND STATIONING ARE SHOWN IN METERS. UNLESS OTHERWISE NOTED. METRIC VALUES ARE ROUNDED TO THE NUMBER OF DECIMAL PLACES SHOWN. WHERE DISCREPANCIES BETWEEN ELEVATIONS AND GRADIENTS OCCUR DUE TO ROUNDING, ELEVATIONS WILL GOVERN.
3. ALL METRIC COORDINATES ARE BASED ON AN INITIAL CONVERSION OF THE NORTH PORTAL COORDINATES FROM ENGLISH TO METRIC UNITS, USING A CONVERSION FACTOR OF 0.30480061.
4. ELEVATIONS SHOWN REFER TO THE EXCAVATED INVERT WITH NO FILL, LINING OR CONCRETE. VPI ELEVATIONS REFER TO THE POINT OF INTERSECTION OF THE TANGENTS OF A VERTICAL CURVE.
5. FAULT TRACES ARE APPROXIMATIONS DEVELOPED FROM INFORMATION IN THE USGS LYNX MODEL YMP.R2.0 (JAN 95)
6. NORTH AND SOUTH RAMP EXTENSIONS ARE BASED ON FIGURE 8.6.3-1 FROM THE INITIAL SUMMARY REPORT FOR REPOSITORY/WASTE PACKAGE ADVANCED CONCEPTUAL DESIGN (AUG 1994)

BOREHOLE DATA

BOREHOLE	NORTHING	EASTING	GROUND ELEV	DEPTH
UE-25 NRG-1	233282	173676	1144	46
UE-25 NRG-2A	233421	173490	1157	90
UE-25 NRG-2B	233368	173552	1158	81
UE-25 NRG-2C	233406	173497	1158	100
UE-25 NRG-2	233408	173489	1158	42
UE-25 NRG-20	233424	173454	1156	45
UE-25 NRG-3	233354	173223	1165	101
UE-25 NRG-4	233807	172967	1259	221
UE-25 NRG-5	234053	172142	1252	111
UE-25 NRG-6	233699	171965	1247	325
UE-25 NRG-7A	234155	171838	1282	461
UE-25 RF#8	233365	173368	1158	39
UE-25 WT-1	231288	171908	1302	710
UE-25 WT-2	234089	171678	1324	670
UE-25 WT-3	232245	171178	1324	610
UE-25 WT-4	234849	170993	1335	1029
UE-25 WT-10	234419	170629	1270	915
UE-25 WT-12	234774	171416	1303	1829
UE-25 WT-13	230894	170216	1483	1219
UE-25 WT-14	232149	171880	1249	1219
UE-25 WT-15	233671	170356	1479	1219
UE-25 WT-17	235085	170756	1349	387
USW UZ-1	234305	172560	1200	112
USW UZ-4	234267	172558	1204	111
USW UZ-5	231566	170178	1501	575
USW UZ-14	235096	170731	1349	678
USW UZ-16	231812	172169	1219	514
USW WT-1	229802	171828	1202	515
USW WT-2	231850	171275	1301	628
UE-25 WT-3	234243	173139	1167	482
UE-25 WT-12	235052	172158	1336	623
UE-25 A #1	233142	172624	1199	762
UE-25 A #2	234078	172051	1250	152
UE-25 A #3	233769	172138	1236	148
UE-25 A #4	233447	172060	1235	152
UE-25 A #5	233553	172355	1221	305
UE-25 B #1	233247	172644	1201	1220
UE-25 ONC#1	231422	173159	1163	450

NOTE: BOREHOLE DATA IS SHOWN FOR REFERENCE ONLY AND WAS COMPILED FROM THE GENISES DATABASE. BOREHOLE COORDINATES CONVERTED FROM FEET TO METERS USING A CONVERSION FACTOR OF 0.30480061.

# DENOTES IN-PROGRESS BOREHOLES. (BOREHOLE DATA NOT FINALIZED)

GRAPHIC SCALE
0 100 200 300 400 500 600 m
1:7500

ESF COORDINATE GEOMETRY
FIGURE 1

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