# Nevada Water Well Regulations

## NAC 534

## Well Casing

**NWRA Conference**
February 3, 2014

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Roscoe Moss Company

# Well Casing

NAC 534

# NAC 534.050 “Casing” defined

*“Casing “ means the conduit required to prevent waste and contamination of the groundwater and to hold the formation open during the construction and use of the well.*

*“Casing “ means the conduit required* ***to convey water and*** *prevent waste and contamination of the groundwater and to hold the formation open during the construction and use of the well.*

# NAC 534.080 “Conductor casing” defined

*“Conductor casing “ means the temporary or permanent casing used in the upper portion of the well bore to prevent collapse of the formation during the construction of the well or to conduct gravel pack to the perforated or screened areas in the casing.*

# NAC 534.340 Log and Record of Work

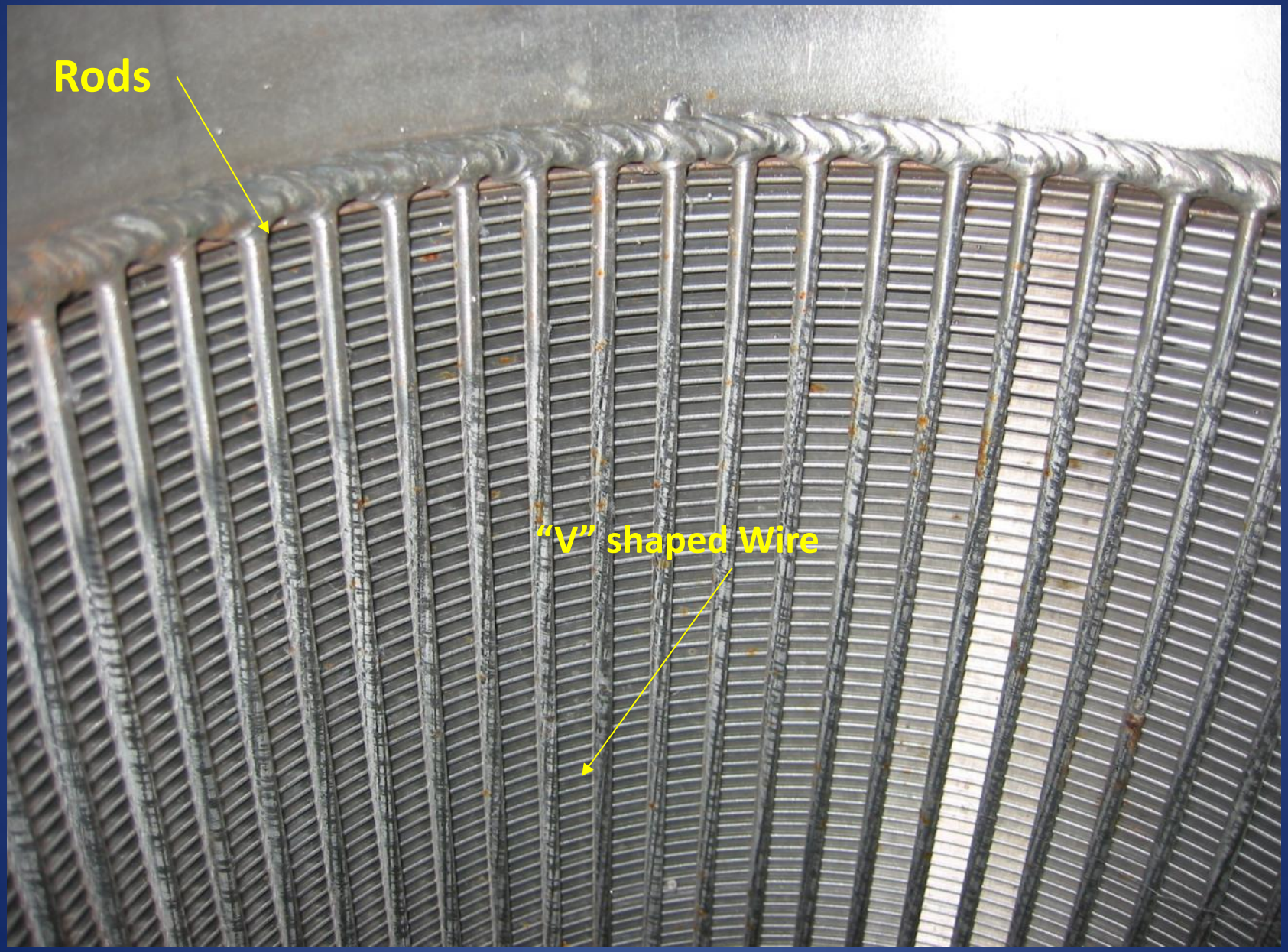
- Section 3. *An accurate description of the perforations in the casing must be set forth in the  section of the log and record of work that contains a record of the well casing.*

- Mills knife
- Torch cut
- Mill slot
- Bridge slot
- Wire wrap
- Louvered

# Mill's Knife Openings

# Mill Slot and Bridge Slot Screen

# Wire-Wrapped Screen



# Louver Screens

# DRILLING, CONSTRUCTION, AND PLUGGING OF WELLS AND BOREHOLES

## NAC 534.360 Construction of Well: Casing

- Bottom of well & casing issues
- Section 2. …if no water developed from bottom of the well, grout/cement to fill area from bottom of the bore to bottom of casing.
- If solid bottom required, suggest use of bottom plate or semi-elliptical (SE) head

# NAC 534.360 Construction of well: Casing

- Section 3. *The casing must:*

*(a) Except as otherwise provided in this paragraph and NAC 534.362, be of new steel or clean and sanitary used steel.*

*(b) Be free of pits and breaks.*

Documentation issues with used steel or pipe

ASTM steel and manufacturing compliance

Mill certificates – verify physical and chemical properties

# Typical Mill Certificate

NAS

6870 HIGHWAY 42 EAST

## METALLURGICAL TEST REPORT

NORTH AMERICAN STAINLESS
6870 HIGHWAY 42 EAST
GHENT, KY 41045

Certificate: 746462 1
Customer: 005437 002

Mail To:
ROSCOE MOSS COMPANY
C/O JIT STEEL
2000 SOUTH O STREET
TULARE, CA 93274

Ship To:
ROSCOE MOSS COMPANY
C/O JIT STEEL
2000 SOUTH O STREET
TULARE, CA 93274

Date: 6/18/2012 Page: 1
Steel: 304/304L
Finish: HRAP

Your Order: 31184-00
NAS Order: IN 0148587 01
Corrosion: ASTM A262/02aE;180Bend-OK

**PRODUCT DESCRIPTION:**

STAINLESS STEEL COIL, HRAP; UNS 30400/30403
ASTM A240/11b,A480/11b,A666/10;ASME SA240/11a,SA480/11a,SA666/11a
CHEM ONLY ON POLLOWING ASTM: A276/10,A479/11,A484/11,A312/11
CHEM ONLY ON POLLOWING ASME: SA312/11,SA479/11
AMS 5511H/5513J XMRK; MIL-5059D AMD3(X CRN MEAS); MIL-4043B
NACE MR0175/ISO 15156-3:2003 A, MR0103/07;QQS766D-A X MAG PERM
MIN. SOLUTION ANNEAL TEMP 1900F, WATER QUENCHED

**REMARKS:**

Mat'l is Free of Mercury Contamination. No weld repairs.
EN 10204:2004 3.1; QQS763P Cond A; RoHS Compliant
Material is Free of Radioactive Contamination
NAS Steel Making Process: EAP, AOD, & Cont. Casting
Product Mfg.by a Quality Mgt.Sys. in Conf. w/ISO 9001
*Melted & Manufactured in the USA; Mat'l is DFARs Compliant

| Product Id | Coil # | Skid # | Thickness | Width | Weight | -------Length------ | Mark | Pieces | Commodity Code |
|---|---|---|---|---|---|---|---|---|---|
| 04C2P2 C | 04C2P2 C | | .1830 | 48.0000 | 16,830 | COIL | 1 | 1 | |

**CHEMICAL ANALYSIS** CM(Country of Melt) ES(Spain) US(United States) ZA(South Africa) JP(Japan) Chemical Analysis per ASTM A751/08

| HEAT | CM | C % | CR % | CU % | MN % | MO % | N % | NI % | P % | S % |
|---|---|---|---|---|---|---|---|---|---|---|
| C2P2 | US | .0136 | 18.1515 | .4945 | 1.8030 | .3715 | .0819 | 8.0005 | .0335 | .0010 |

| SI % |
|---|
| .2675 |

**MECHANICAL PROPERTIES**

| Product Id# | Coil # | loc | dir | UTS KSI | .2% YS KSI | ELONG %-2" | Hard RB | Tail Hard |
|---|---|---|---|---|---|---|---|---|
| 04C2P2 C | 04C2P2 C | P | T | 90.02 | 45.95 | 49.64 | 88.00 | 88.00 |

NAS hereby certifies that the analysis on this certification is correct. Based upon the results and the accuracy of the test methods used, the material meets the specifications stated. These results relate only to the items tested and this report cannot be reproduced, except in its entirety, without the written approval of NAS.

Technical Dept. Mgr. ERIC HESS 6/18/2012

# ASTM Steel & ASTM Pipe Standards

# ASTM Steel Standards

## Steel Plate/Coil Standards

Mild/Low carbon: ASTM A36

Copper-Bearing: ASTM A36 with min 0.2%Cu

High Strength Low Alloy: ASTM A606 Type 4

# ASTM Steel Standards

## Stainless Steel Plate/Coil Standards

## ASTM 304, 304L, 316, 316L

# ASTM Steel Pipe Standards

## Carbon (Non-Stainless) Steel

**A139, A53**

Mild Steel, Copper-Bearing

High Strength Low Alloy

## Stainless Steel

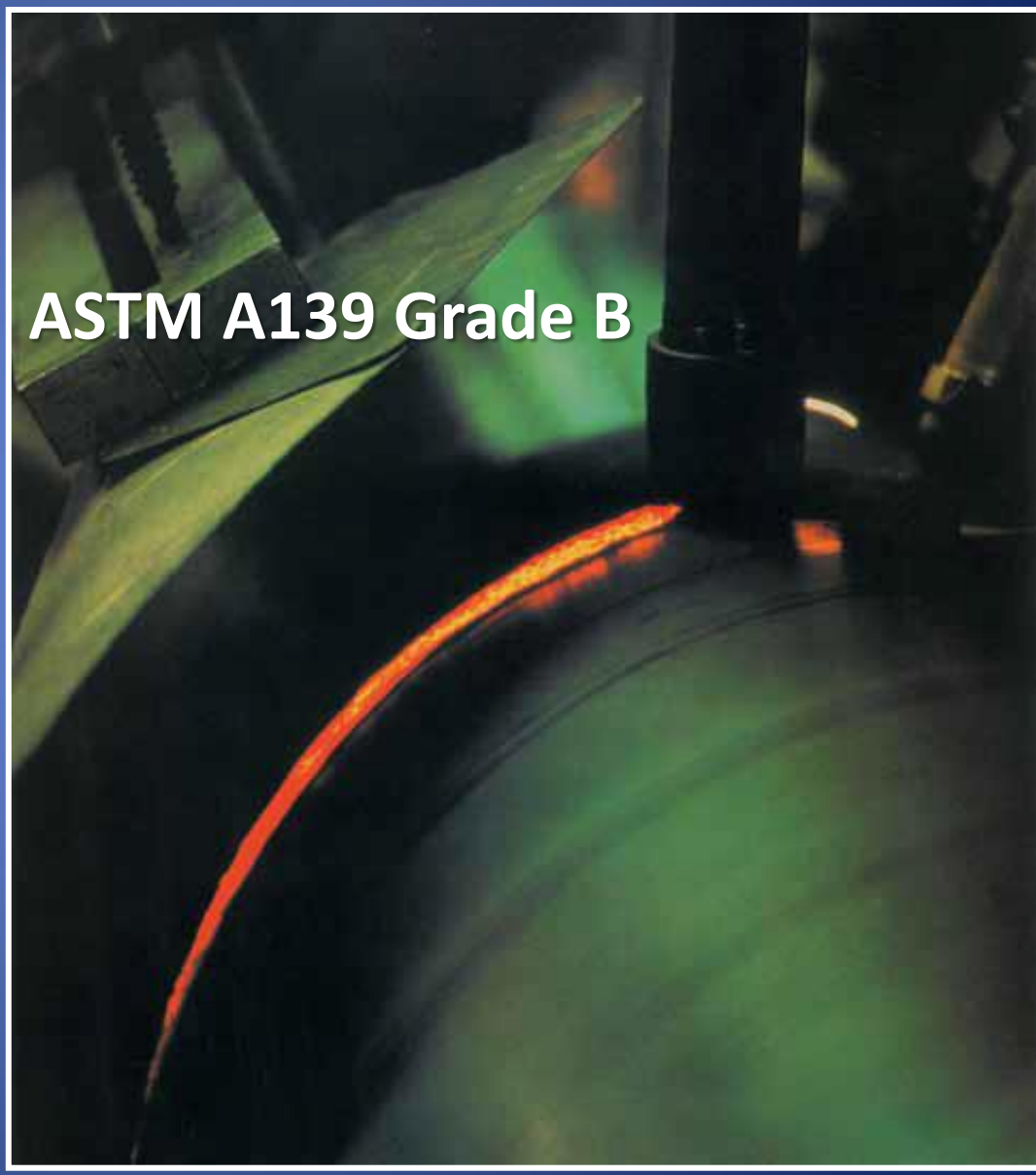
**A778**

# ASTM Steel Pipe Standards

Mild Steel

Copper-Bearing

High Strength Low Alloy



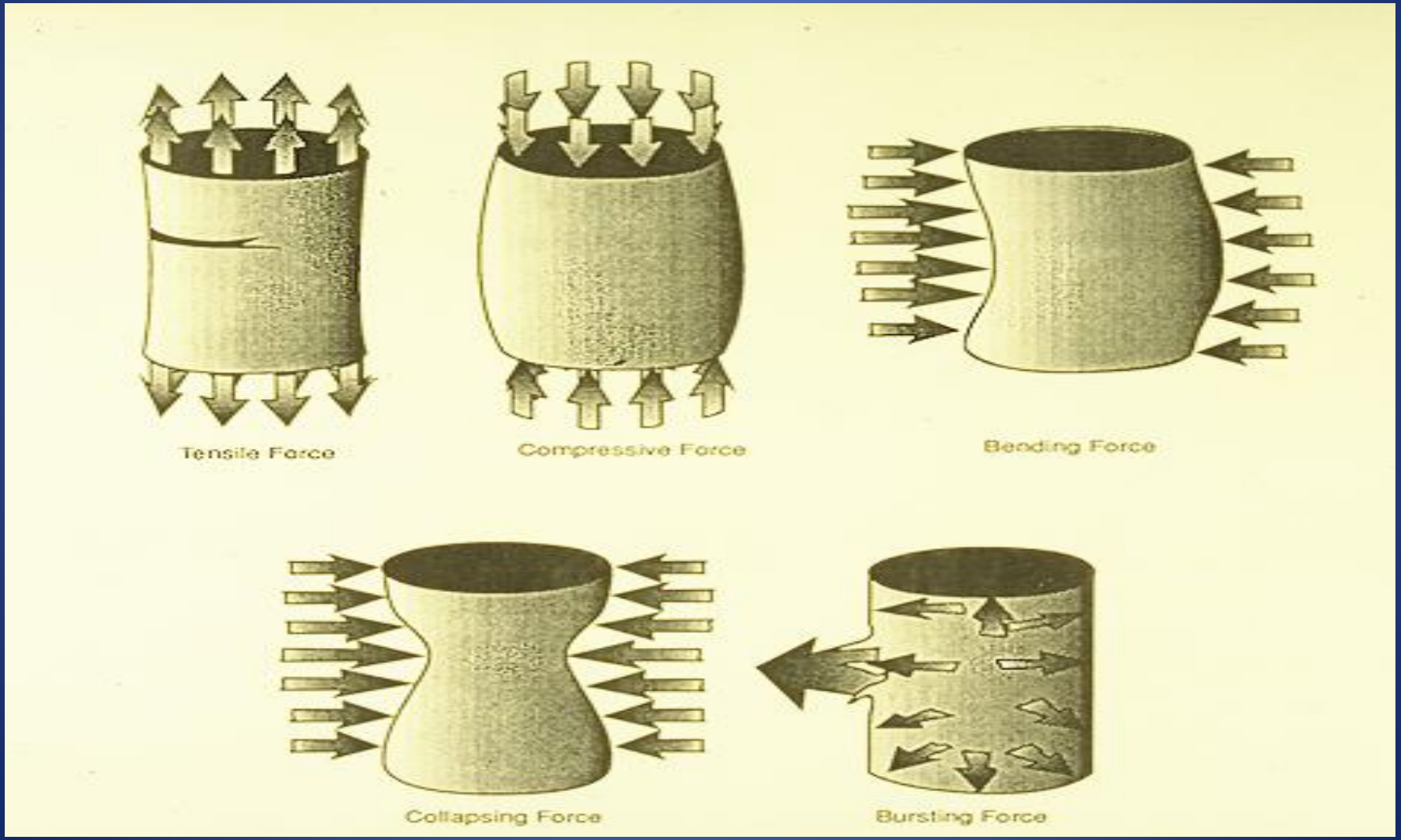
# ASTM Steel Pipe Standards

Stainless Steel Types
304, 304L, 316, 316L

ASTM A778

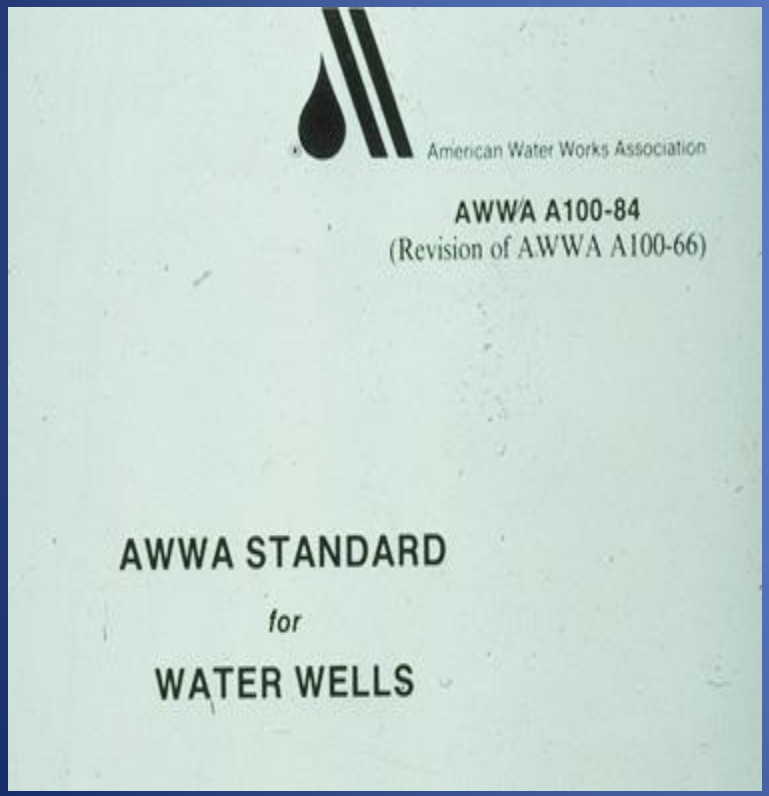
# Casing Strength Considerations: Diameter & Wall Thickness

# Forces on Casing & Screen



# Physical Properties – Hydraulic Collapse Pressure

## AWWA A-100-06


American Water Works Association

AWWA A100-84
(Revision of AWWA A100-66)

AWWA STANDARD

for

WATER WELLS

## Timoshenko Formula

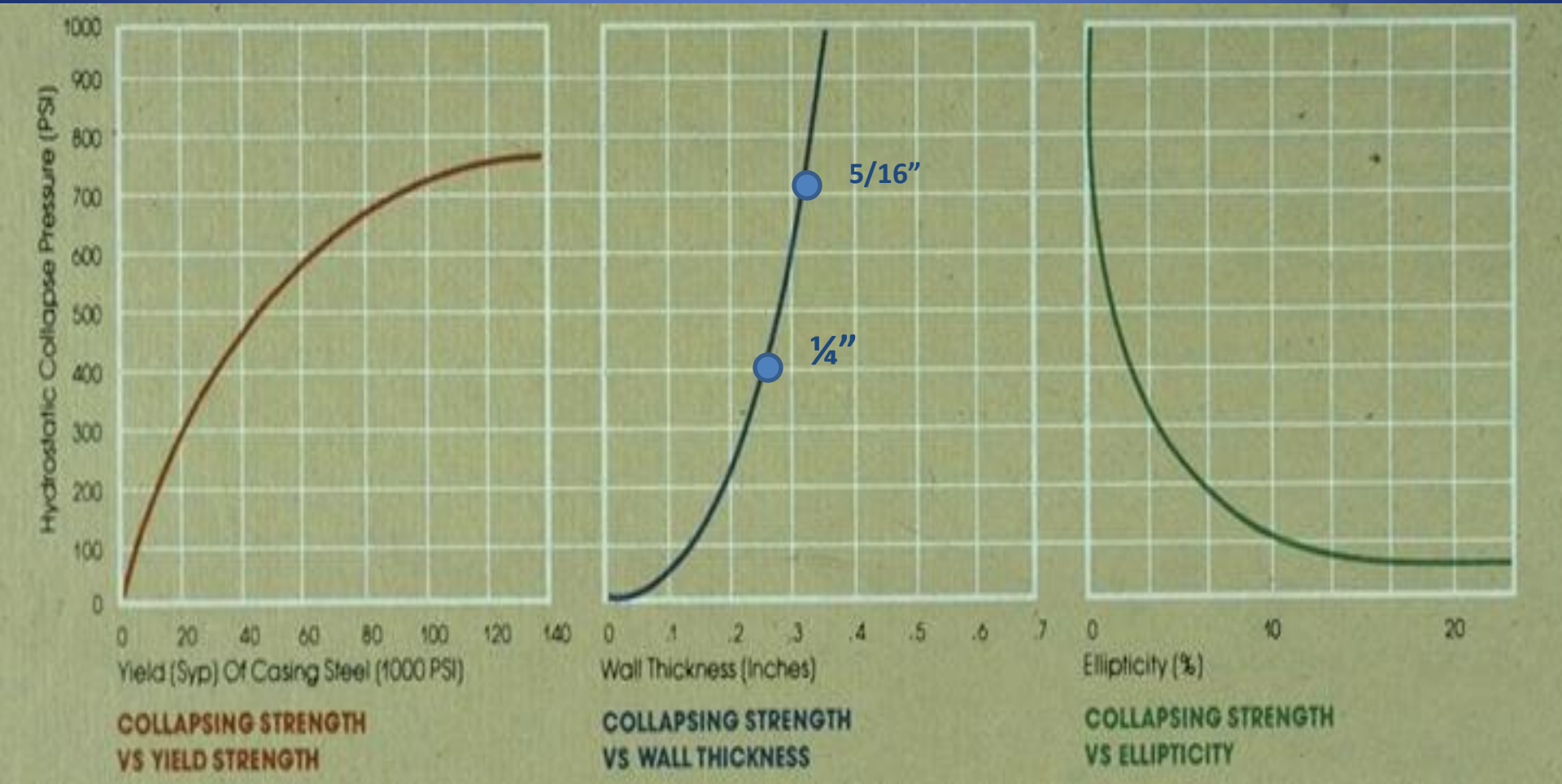
$$P_e^2 - \left\{ \frac{2S}{\frac{D_o}{t} - 1} + \left[ 1 + 3 \left( \frac{D_o}{t} - 1 \right) e \right] P_{cr} \right\} P_e + \left( \frac{2\,SP_{cr}}{\frac{D_o}{t} - 1} \right) = 0$$

$$P_{cr} = \frac{2E}{1-M^2} \left( \frac{1}{\frac{D_o}{t} - 1} \right)^3$$

Where:

$E$ = Youngs modulus = $30 \times 106$ psi
$M$ = Poisson's ratio = 0.3
$D_o$ = casing outside diameter
$t$ = casing wall thickness
$e$ = casing ellipticity = 1%
$S$ = yield strength = 35 000 psi
$P_e$ = collapse pressure with ellipticity, psi

# Yield Strength, Wall Thickness & Ellipticity



# Scale Buildup inside Well

# Wall Thickness & Corrosion Impacts

# Casing Tensile Strength

$$C_{ts} = \frac{\pi t S_t (D_o - t)}{2{,}000}$$

Where:

$C_{ts}$ = casing tensile strength, in tons (kilograms)

$D_o$ = casing outside diameter, in inches (millimeters)

$S_t$ = tensile strength of material, 60,000 psi (413.7 MPa)

$t$ = casing wall thickness, in inches (millimeters)

# AWWA A100-06 Appendix K
## Collapse, Axial Compression, and Tensile Strength

TABLE L.1

*Collapse Strength of Steel Well Casing*

| Nominal Diameter | | Wall Thickness | | | Outside Diameter | | Inside Diameter | | Weight | | Collapsing Strength | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *in.* | *(mm)* | *in.* | *in.* | *(mm)* | *in.* | *(mm)* | *in.* | *(mm)* | *lb/ft* | *(kg/m)* | *psi* | *ft water* | *(kg/cm²)* | *(m water)* |
| 8 | (203) | 1/4 | 0.250 | (6.35) | 8.625 | (219.08) | 8.125 | (206.38) | 22.36 | (33.28) | 755.54 | 1745.29 | (53.20) | (531.96) |
| 8 | (203) | 5/16 | 0.3125 | (7.94) | | | 8.000 | (203.20) | 27.74 | (41.29) | 1191.21 | 2751.70 | (83.87) | (838.72) |
| 10 | (254) | 1/4 | 0.250 | (6.35) | 10.750 | (273.05) | 10.250 | (260.35) | 28.04 | (41.72) | 461.08 | 1065.10 | (32.46) | (324.64) |
| 10 | (254) | 5/16 | 0.3125 | (7.94) | | | 10.125 | (257.18) | 34.84 | (51.84) | 760.25 | 1756.18 | (53.53) | (535.28) |
| 12 | (304) | 1/4 | 0.250 | (6.35) | 12.750 | (323.85) | 12.250 | (311.15) | 33.38 | (49.67) | 306.09 | 707.06 | (21.55) | (215.51) |
| 12 | (304) | 5/16 | 0.3125 | (7.94) | | | 12.125 | (307.98) | 41.51 | (61.78) | 520.68 | 1202.78 | (36.66) | (366.61) |
| 14 | (355) | 1/4 | 0.250 | (6.35) | 14.00 | (355.60) | 13.500 | (342.90) | 36.71 | (54.64) | 242.43 | 560.02 | (17.07) | (170.69) |
| 14 | (355) | 5/16 | 0.3125 | (7.94) | | | 13.375 | (339.73) | 45.68 | (67.98) | 418.68 | 967.15 | (29.48) | (294.79) |
| 14 | (355) | 3/8 | 0.375 | (9.53) | | | 13.250 | (336.55) | 54.57 | (81.21) | 636.10 | 1469.39 | (44.79) | (447.87) |
| 14 | (355) | 1/4 | 0 250 | (6.35) | 14.50 | (368.30) | 14.000 | (355.60) | 38.05 | (56.62) | 221.82 | 512.41 | (15.62) | (156.18) |
| 14 | (355) | 5/16 | 0.3125 | (7.94) | | | 13.875 | (352.43) | 47.35 | (70.47) | 385.11 | 889.59 | (27.11) | (271.15) |
| 14 | (355) | 3/8 | 0.375 | (9.53) | | | 13.750 | (349.25) | 56.57 | (84.19) | 588.19 | 1358.72 | (41.41) | (414.14) |
| 16 | (406) | 1/4 | 0.250 | (6.35) | 16.00 | (406.40) | 15.500 | (393.70) | 42.05 | (62.58) | 172.25 | 397.90 | (12.13) | (121.28) |
| 16 | (406) | 5/16 | 0.3125 | (7.94) | | | 15.375 | (390.53) | 52.36 | (77.92) | 303.15 | 700.27 | (21.34) | (213.44) |
| 16 | (406) | 3/8 | 0.375 | (9.53) | | | 15.250 | (387.35) | 62.58 | (93.13) | 469.53 | 1084.62 | (33.06) | (330.59) |
| 16 | (406) | 1/4 | 0.250 | (6.35) | 16.625 | (422.28) | 16.125 | (409.58) | 43.72 | (65.07) | 155.89 | 360.11 | (10.98) | (109.76) |
| 16 | (406) | 5/16 | 0.3125 | (7.94) | | | 16.000 | (406.40) | 54.44 | (81.02) | 275.69 | 636.84 | (19.41) | (194.11) |
| 16 | (406) | 3/8 | 0.375 | (9.53) | | | 15.875 | (403.23) | 65.08 | (96.85) | 429.18 | 991.40 | (30.22) | (302.18) |
| 18 | (457) | 1/4 | 0.250 | (6.35) | 18.00 | (457.20) | 17.500 | (444.50) | 47.39 | (70.53) | 126.48 | 292.16 | (8.90) | (89.05) |
| 18 | (457) | 5/16 | 0.3125 | (7.94) | | | 17.375 | (441.33) | 59.03 | (87.85) | 225.76 | 521.49 | (15.90) | (158.95) |
| 18 | (457) | 3/8 | 0.375 | (9.53) | | | 17.250 | (438.15) | 70.59 | (105.05) | 354.92 | 819.86 | (24.99) | (249.89) |
| 18 | (457) | 1/4 | 0.250 | (6.35) | 18.625 | (473.08) | 18.125 | (460.38) | 49.06 | (73.01) | 115.51 | 266.84 | (8.13) | (81.33) |
| 18 | (457) | 5/16 | 0.3125 | (7.94) | | | 18.000 | (457.20) | 61.12 | (90.96) | 206.95 | 478.05 | (14.57) | (145.71) |
| 18 | (457) | 3/8 | 0.375 | (9.53) | | | 17.875 | (454.03) | 73.09 | (108.77) | 326.64 | 754.54 | (23.00) | (229.98) |
| 20 | (508) | 1/4 | 0.250 | (6.35) | 20.00 | (508.00) | 19.500 | (495.30) | 52.73 | (78.48) | 95.46 | 220.52 | (6.72) | (67.21) |
| 20 | (508) | 5/16 | 0.3125 | (7.94) | | | 19.375 | (492.13) | 65.71 | (97.79) | 172.25 | 397.90 | (12.13) | (121.28) |

# NAC 534.360 Construction of well: Casing

- Section 4. *The thickness of the wall of the casing must :*

*(a) Depths ≤ 300 ft*

*(1) Conductor casing set ≤ 50 ft, thickness minimum:*

*9/64" for non-corrugated, galvanized steel pipe*

*7/64" for corrugated*

Collapse needs to be calculated for all diameters

Example:

16" x 9/64" wall non-corrugated pipe collapse: 36.6 psi

# NAC 534.360 Construction of well: Casing

- Section 4. *The thickness of the wall of the casing must :*

  *(a) Depths ≤ 300 ft*

  *(2) Conductor casing set > 50 ft, casing thickness minimum :*

| NV Regulations | | AWWA formula results | |
|---|---|---|---|
| Diameter *(in)* | Wall *(in)* | Collapse *(psi)* | Tensile *(tons)* |
| < 10” | .188” | | |
| 8 5/8” | .188” | 393 | 149 |
| 6 5/8” | .188” | 718 | 114 |

- Section 4. *The thickness of the wall of the casing must :*

  *(a) Depths ≤ 300 ft*

  *(2) Conductor casing set > 50 ft, casing thickness minimum :*

| NV Regulations | | AWWA A100 | |
|---|---|---|---|
| Diameter *(in)* | Wall *(in)* | Collapse *(psi)* | Tensile *(tons)* |
| 10 3/4” | .25” | 461 | 247 |
| 12 3/4” | .25” | 306 | 295 |
| 14” | .25” | 242 | 336 |
| 16” | .25” | 172 | 371 |
| 18” | .312” | 226 | 521 |
| 20” | .312” | 172 | 580 |
| > 20” | .375” | | |

# NAC 534.360 Construction of well: Casing

Section 4. *(b) For depths of more than 300 ft, thickness increased according to AWWA A100*

AWWA A100-06 Table 4

| **Depth of Casing (ft)** | **Minimum Wall Thickness (in fractions of an inch)** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Nominal Casing Diameter (inches)** | | | | | | | | | |
| | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 30 |
| 0 – 100 | 1/4 | 1/4 | 1/4 | 1/4 | 1/4 | 1/4 | 1/4 | 5/16 | 5/16 | 5/16 |
| 100 – 200 | 1/4 | 1/4 | 1/4 | 1/4 | 1/4 | 1/4 | 1/4 | 5/16 | 5/16 | 5/16 |
| 200 – 300 | 1/4 | 1/4 | 1/4 | 1/4 | 1/4 | 5/16 | 5/16 | 5/16 | 5/16 | 3/8 |
| 300 – 400 | 1/4 | 1/4 | 1/4 | 1/4 | 5/16 | 5/16 | 5/16 | 5/16 | 3/8 | 3/8 |
| 400 – 600 | 1/4 | 1/4 | 1/4 | 1/4 | 5/16 | 5/16 | 5/16 | 3/8 | 3/8 | 7/16 |
| 600 – 800 | 1/4 | 1/4 | 1/4 | 5/16 | 5/16 | 5/16 | 3/8 | 3/8 | 3/8 | 7/16 |
| 800 – 1000 | 1/4 | 1/4 | 1/4 | 5/16 | 5/16 | 5/16 | 3/8 | 7/16 | 7/16 | 1/2 |
| 1000 – 1500 | 1/4 | 5/16 | 5/16 | 5/16 | 3/8 | 3/8 | 3/8 | 7/16 | | |
| 1500 – 2000 | 1/4 | 5/16 | 5/16 | 5/16 | 3/8 | 3/8 | 7/16 | 7/16 | | |

# NAC 534.360 Construction of well: Casing

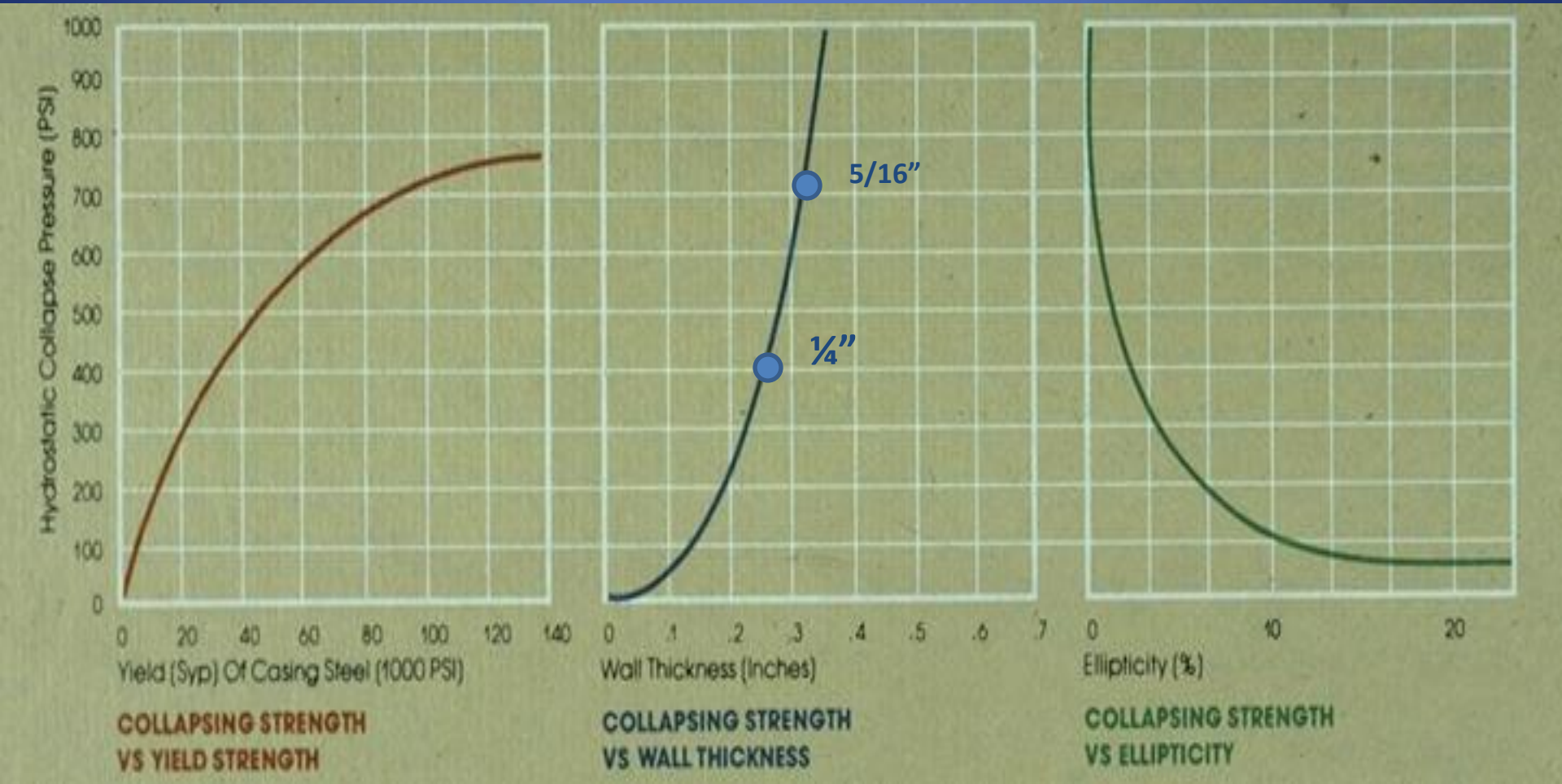
6. *All production casing joints must be threaded and coupled or welded and be water tight. If the casing joints are welded, each joint must be welded separately. Spot welds of casing are prohibited.*

# NAC 534.360 Construction of well: Casing

7. *The well driller shall ensure that the integrity of any casing to be used in the construction of the well has not been impaired by storage, shipping, handling, perforating or exposure to ultraviolet light*

# Collapse Strength of damaged , out-of-round casing is significantly compromised

Ellipticity Effect



# NAC 534.362 Construction of well: Thermoplastic casing

- Follow NV Well Regulations and ASTM Standards

# NAC 534.450 Waiver of requirement of this chapter

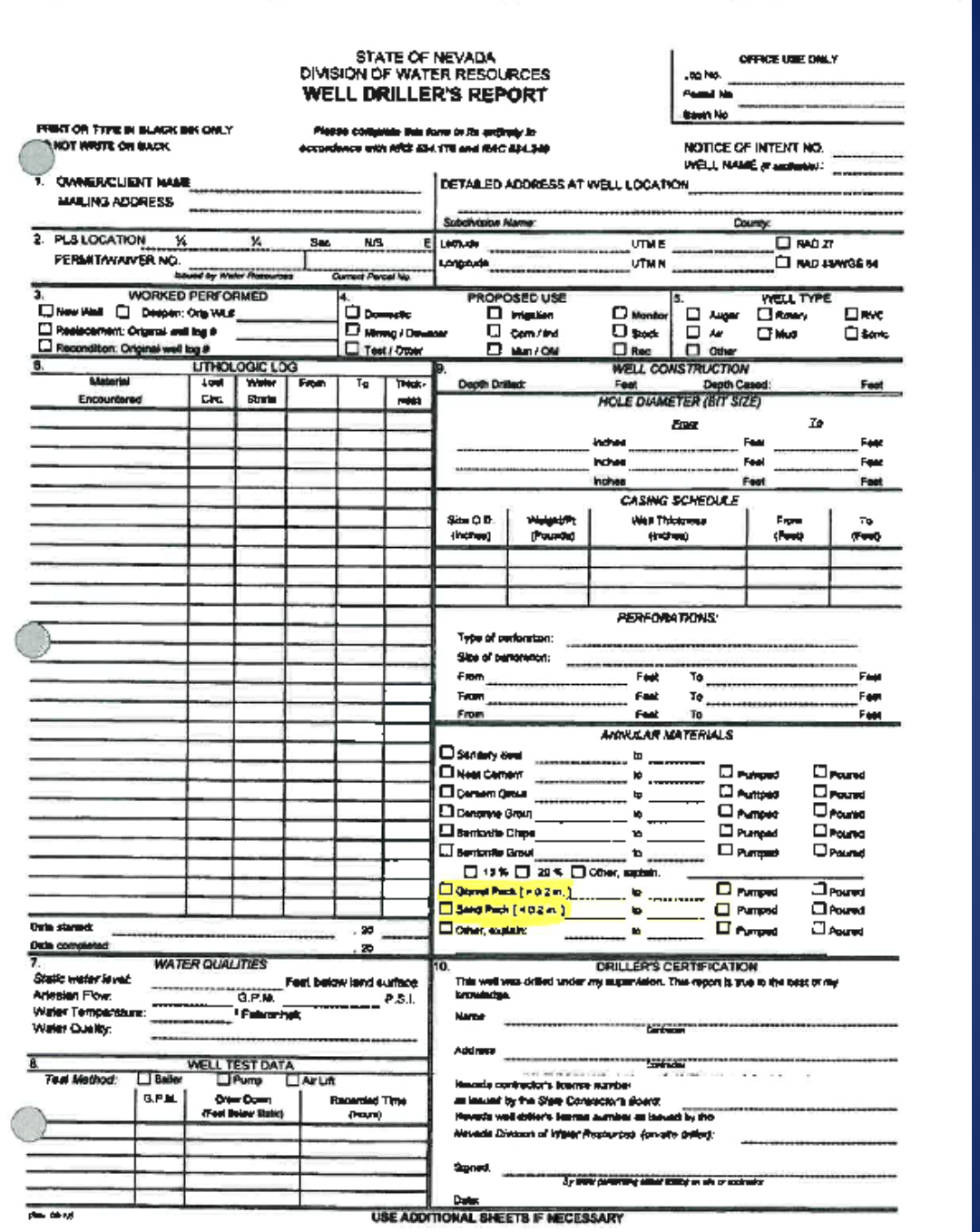
*Summary: The R-Waiver may be issued for a unique circumstance to waive any requirement, with good cause shown, of NAC Chapter 534 except well casing thickness.*

# Well Drillers Report

Provide as much data as possible in order to facilitate the development of maintenance plan and rehabilitation programs in the future.

Casing Schedule –
- reference steel type

Annular Materials –
- reference sand/gravel pack gradation



STATE OF NEVADA
DIVISION OF WATER RESOURCES
WELL DRILLER'S REPORT

OFFICE USE ONLY
Log No.
Permit No
Start No

PRINT OR TYPE IN BLACK INK ONLY
DO NOT WRITE ON BACK

Please complete this form in its entirety in accordance with NRS 534.170 and NAC 534.340

NOTICE OF INTENT NO.
WELL NAME (if applicable):

1. OWNER/CLIENT NAME
MAILING ADDRESS
DETAILED ADDRESS AT WELL LOCATION
Subdivision Name: County:

2. PLS LOCATION ¼ ¼ Sec. N/S E
PERMIT/WAIVER NO.
Issued by Water Resources Current Parcel No.
Latitude UTM E NAD 27
Longitude UTM N NAD 83/WGS 84

3. WORKED PERFORMED
☐ New Well ☐ Deepen: Orig WL#
☐ Replacement: Original well log #
☐ Recondition: Original well log #

4. PROPOSED USE
☐ Domestic ☐ Irrigation ☐ Monitor
☐ Mining / Dewater ☐ Comm / Ind ☐ Stock
☐ Test / Other ☐ Mun / Old ☐ Rec

5. WELL TYPE
☐ Auger ☐ Rotary ☐ RVC
☐ Air ☐ Mud ☐ Sonic
☐ Other

6. LITHOLOGIC LOG

| Material Encountered | Level Circ. | Water Strata | From | To | Thickness |
|---|---|---|---|---|---|
| | | | | | |

Date started: , 20
Date completed: , 20

9. WELL CONSTRUCTION
Depth Drilled: Feet Depth Cased: Feet

HOLE DIAMETER (BIT SIZE)

| Size | From | To |
|---|---|---|
| Inches | Feet | Feet |
| Inches | Feet | Feet |
| Inches | Feet | Feet |

CASING SCHEDULE

| Size O.D. (Inches) | Weight/Ft. (Pounds) | Wall Thickness (Inches) | From (Feet) | To (Feet) |
|---|---|---|---|---|
| | | | | |

PERFORATIONS
Type of perforation:
Size of perforation:
From Feet To Feet
From Feet To Feet
From Feet To Feet

ANNULAR MATERIALS

| | | | |
|---|---|---|---|
| ☐ Sanitary Seal | to | | |
| ☐ Neat Cement | to | ☐ Pumped | ☐ Poured |
| ☐ Cement Grout | to | ☐ Pumped | ☐ Poured |
| ☐ Concrete Grout | to | ☐ Pumped | ☐ Poured |
| ☐ Bentonite Chips | to | ☐ Pumped | ☐ Poured |
| ☐ Bentonite Grout | to | ☐ Pumped | ☐ Poured |
| ☐ 13 % ☐ 20 % ☐ Other, explain: | | | |
| ☐ Gravel Pack [ > 0.2 in. ] | to | ☐ Pumped | ☐ Poured |
| ☐ Sand Pack [ < 0.2 in. ] | to | ☐ Pumped | ☐ Poured |
| ☐ Other, explain: | to | ☐ Pumped | ☐ Poured |

7. WATER QUALITIES
Static water level: Feet below land surface
Artesian Flow: G.P.M. P.S.I.
Water Temperature: ° Fahrenheit
Water Quality:

8. WELL TEST DATA
Test Method: ☐ Bailer ☐ Pump ☐ Air Lift

| G.P.M. | Draw Down (Feet Below Static) | Recorded Time (Hours) |
|---|---|---|
| | | |

10. DRILLER'S CERTIFICATION
This well was drilled under my supervision. This report is true to the best of my knowledge.
Name (Contractor)
Address (Contractor)
Nevada contractor's license number as issued by the State Contractor's Board:
Nevada well driller's license number as issued by the Nevada Division of Water Resources (if applicable):
Signed (By state licensed driller or his or contractor)
Date:

USE ADDITIONAL SHEETS IF NECESSARY

# Questions?

Kevin McGillicuddy, P.G.

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