STONE & WEBSTER ENGINEERING CORPORATION

5010.64

CALCULATION SHEET

CLIENT & PROJECT	PAGE 1 OF 8
PRIVATE FUEL STORAGE, LLC – PFSF	+ ATTACHMENTS (13 pp)

CALCULATION TITLE	QA CATEGORY (✓)
DETERMINATION OF AQUIFER PERMEABILITY FROM CONSTANT HEAD TEST AND ESTIMATION OF RADIUS OF INFLUENCE FOR THE PROPOSED WATER WELL	☑ I NUCLEAR SAFETY RELATED ☐ II ☐ III ☐ (other)

CALCULATION IDENTIFICATION NUMBER				OPTIONAL WORK PACKAGE NO.
JOB ORDER NO.	DISCIPLINE	CURRENT CALC NO	OPTIONAL TASK CODE	
059960200	**G(B)**	**15**		N/A

APPROVALS - SIGNATURE & DATE			REV. NO. OR NEW CALC NO.	SUPERSEDES CALC NO. OR REV NO.	CONFIRMATION REQUIRED ☑	
PREPARER(S)/DATE(S)	REVIEWER(S)/DATES(S)	INDEPENDENT REVIEWER(S)/DATE(S)			YES	NO
DLAloysius DLAloysius 4-22-99	JCShiau JCS 4-22-99	JCS 4-22-99	0	N/A		✓

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RECORD OF REVISIONS

REVISION 0

Original Issue

OBJECTIVE OF CALCULATION

The objectives of this calculation are: 1) to provide an estimate of aquifer permeability at the proposed Private Fuel Storage Facility (PFSF), based on field test data, and 2) to provide an estimate of the radius of influence (i.e., cone of depression) for a proposed water well at the site, based on estimated aquifer parameters and anticipated withdrawal times.

CALCULATION METHODS AND ASSUMPTIONS

Aquifer Permeability

A short-duration constant head test was performed on a 2-inch diameter well (CTB-5) installed at the PFSF site. The well is screened from 142 to 152 feet below ground surface in a dense, uniform sandy silt to silty sand material. The sand pack around the well screen extends from 125.5 to 157 feet below ground surface; the top of groundwater was measured to be approximately 124.5 feet below ground surface. A copy of the well record is provided in Attachment A.

During the test, the water level within the well was maintained at a fixed height above the equilibrium groundwater level (i.e., top of casing) by injecting water under pressure through a flexible hose. The amount of water injected into the well was monitored over time by means of an in-line flowmeter. The acquired test data were subsequently incorporated into a standard analytical equation (CANMET, 1977) for estimating aquifer permeability. A copy of the field test data is provided in Attachment A.

Radius of Influence

Approximations of radius of influence (R) for the PFSF water well were made based on estimated aquifer parameters. In an ideal aquifer, without recharge, R is a function of the transmissivity, the storage coefficient, and the duration of pumping. By adapting the Jacob formula, R can be estimated to within an order of magnitude (neglecting recharge) by use of a standard analytical equation (Powers, 1992; Heath, 1998).

SOURCES OF DATA

As mentioned above, copies of the well record (CTB-5) and field permeability test data are provided in Attachment 1.

Anticipated withdrawal rates for the proposed PFSF water well (between the years 2000 and 2022) have been itemized on one page, provided in Attachment B.

As presented in Attachment B, the maximum anticipated withdrawal rate for the proposed PFSF water well will be approximately 8,500 gal/day (6 gpm or 9.7 ac-ft/yr) during the first nine months of operation and will decrease thereafter. Over a 20-year period (year 2002 through 2021), the average withdrawal rate from the well will be approximately 3,850 gal/day (2.7 gpm or 4.3 acre-ft/yr). It should be noted that six existing wells within five miles of the site have water rights ranging from approximately 11 to 1,600 acre-ft/yr (refer to Geotechnical Sketch as cited in the Reference Section). This information and additional details on these wells are included in the response to comments on Nuclear Regulatory Commission RAI No.1, Safety Analysis Report (SAR), Question 2-3.

Note: 1,000 gpm = 4.42 acre-ft/day

HYDRAULIC CALCULATIONS

Aquifer Permeability

Aquifer permeability was estimated using the following equation (CANMET, 1977):

$$K = (5.833/\pi L)\,(Q/h)\,(10^{-5})$$

where,

K = permeability (meters/sec)
L = length of permeable test section (meters)
Q = water flow rate into well (liters/min)
h = height of water above static, equilibrium level (meters)

Input parameters to the equation, which were collected during the field test included:

L = 152.0 ft - 125.5 ft = 26.5 feet or 8.1 meters = total length of sand pack around and above the well screen. (Note: the total length of the sand pack was used as opposed to the screen length since the sand pack would have a permeability at least two orders of magnitude greater than the surrounding native deposits.)
Q = 44.9 gallons over 20 minutes = 2.25 gpm or 8.50 L/min.
h = 124.5 ft + 2.8 ft (casing height above grade) = 127.3 feet or 38.8 meters.

The above numbers yield a permeability of 5.0×10^{-7} m/sec (5.0×10^{-5} cm/sec or 0.143 ft/day).

The above permeability result compares favorably with a regional study of the adjacent Bonneville Region (Bedinger et al., 1990) that indicated that the fine-grained basin fill deposits had a permeability of approximately 2.3×10^{-5} cm/sec.

Radius of Influence

Approximations of radius of influence (R) for the PFSF water well can be made based on estimated aquifer parameters. In an ideal aquifer, without recharge, R is a function of the transmissivity, the storage coefficient, and the duration of pumping. By adapting the Jacob formula, R can be estimated to within an order of magnitude (neglecting recharge) by use of the following equation (Powers, 1992; Heath, 1998):

$$R = (Tt / 7200S)^{0.5}$$

where,

R = radius of influence (feet)
T = transmissivity (ft^2/day)
t = pumping time (minutes)
S = storage coefficient (dimensionless)

The above equation is intended for confined aquifers, but results obtained for water table aquifers are reasonable, provided the drawdown is not a large percentage of the original saturated thickness. In applying the equation, it is apparent that R computed for a typical confined aquifer (S = 0.001) will be approximately 10 times greater than that in a water table aquifer (S = 0.1) with the same transmissivity and pumping times. (Note: the proposed PFSF water well will be installed in deposits, which will probably exhibit hydraulic characteristics that are more representative of a water table aquifer than a confined aquifer.)

Transmissivity for that portion of the aquifer affected by pumping is estimated by multiplying the aquifer permeability of 0.144 ft/day (i.e., 5.1×10^{-5} cm/sec) by the assumed screen length of the PFSF water well (approximately 100 feet); the resulting transmissivity would be equal to 14.4 ft^2/day. The pumping time over a 22-year period would equate to approximately 1.16×10^7 minutes. By allowing the storage coefficient (S) to vary from 0.1 to 0.001, the radius of influence is found to vary from approximately 480 to 4800 feet (the higher number, for a confining condition, is considered to be a worst case scenario).

Drawdown Estimate for PFSF Water Well

An estimate of localized drawdown, due to pumping of the proposed PFSF water well, was made using the Jacob Modified Nonequilibrium Equation (Driscoll, 1986), as presented below:

$$\Delta s = (264Q/T) \log (0.3Tt/r^2S)$$

where,

Δs = drawdown at well (feet)
Q = pumping rate (gpm)
T = transmissivity (gpd/ft)
S = storage coefficient (dimensionless)
r = radius of well (feet)
t = pumping time (days)

Input parameters to the equation (assuming water table conditions) are as follows:

Q = 2.7 gpm
T = 14.4 ft^2/day or 107.7 gpd/ft
S = 0.1
r = 1-foot (assuming a 24-inch diameter well)
t = 8030 days (22 year time frame)

The above numbers yield a drawdown of approximately 43 feet in the immediate vicinity of the PFSF water well. The drawdown would decrease significantly at greater distances from the well.

CONCLUSIONS

Past measurements of water levels in wells in Skull Valley indicate that, as a whole, the withdrawal of water from wells has not appreciably altered the natural balance (Hood and Waddell, 1968). Limited well records (Hood and Waddell, 1968) indicate that water levels fluctuated no more than five feet from an average mean. Only in the immediate vicinity of the Town of Dugway (16 miles from the PFSF), where water has been pumped for public supply, have water levels declined appreciably in response to pumping, indicating changes in aquifer storage (Hood and Waddell, 1968).

Based on the anticipated withdrawal rate for the proposed PFSF water well, the maximum radius of influence is expected to be no greater than 4,800 feet. Considering that the nearest existing well is situated approximately 9,500 feet away from the site (refer to Attachment 3), operation of the PFSF water well should have no adverse impacts to private or Reservation groundwater users.

REFERENCES

Bedinger, M.S., Sargent, K.A. and Langer, W.H. 1990. Studies of Geology and Hydrology in the Basin and Range Province, Southwestern United States, for Isolation of High-Level Radioactive Waste: Characterization of the Bonneville Region, Utah and Nevada. U.S. Geological Survey Professional Paper 1370-G, 38 pp.

Canada Centre for Mineral and Energy Technology (CANMET). 1977. Pit Slope Manual: Chapter 4 - Groundwater. Mining Research Laboratories, *Energy, Mines and Resources Canada*, CANMET Report 77-13.

Driscoll, F.D., 1986. Groundwater and Wells. Published by Johnson Division, St. Paul Minnesota.

Heath, R.C. 1998. Basic Groundwater Hydrology. U.S. Geological Survey Water Supply Paper 2220, 86 pp.

Hood, J.W. and Waddell, K.M. 1968. Hydrologic reconnaissance of Skull Valley, Tooele County, Utah. Technical Publication 18, State of Utah Department of Natural Resources, 57 pp.

Nuclear Regulatory Commission RAI No.1, Safety Analysis Report (SAR), Question 2-3.

Powers, J.P. 1992. Construction Dewatering: New Methods and Applications. Wiley Series of Practical Construction Guides, John Wiley & Sons, Inc., New York, 2nd edition, 528 pp.

Stone & Webster Engineering Corporation. Geotechnical Sketch 05996.02-GSK-B-27-1. Water Wells within 5 Miles of the PFSF Site.

ATTACHEMENT A

WELL RECORD AND PERMEABILITY FIELD TEST DATA

STONE & WEBSTER ENGINEERING CORPORATION

5010.65

CALCULATION SHEET

CALCULATION IDENTIFICATION NUMBER				PAGE A 2 OF 3
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	
0599960200	G(B)	15	N/A	

PIEZOMETER INSTALLATION REPORT
STONE & WEBSTER ENGINEERING CORP.

PIEZOMETER NO. CTB-5

SITE PFSF

J.O. NO. 05996.02

DATE JAN 6, 1999 DRILLER W. FRANKLIN LAYNE-CHRISTENSEN INSPECTOR R. GILLESPIE

COORDINATES N7320087 E1282057 GROUND ELEV. _____

INSTALLED IN BORING CTB-5 ELEV. TOP OF LEADS _____

RIG & CREW TIME 1.75

9 BAGS #20-30 SILICA SAND
21 SKS CEMENT, 75# BENTONITE

DETAILED INSTALLATION DESCRIPTION:

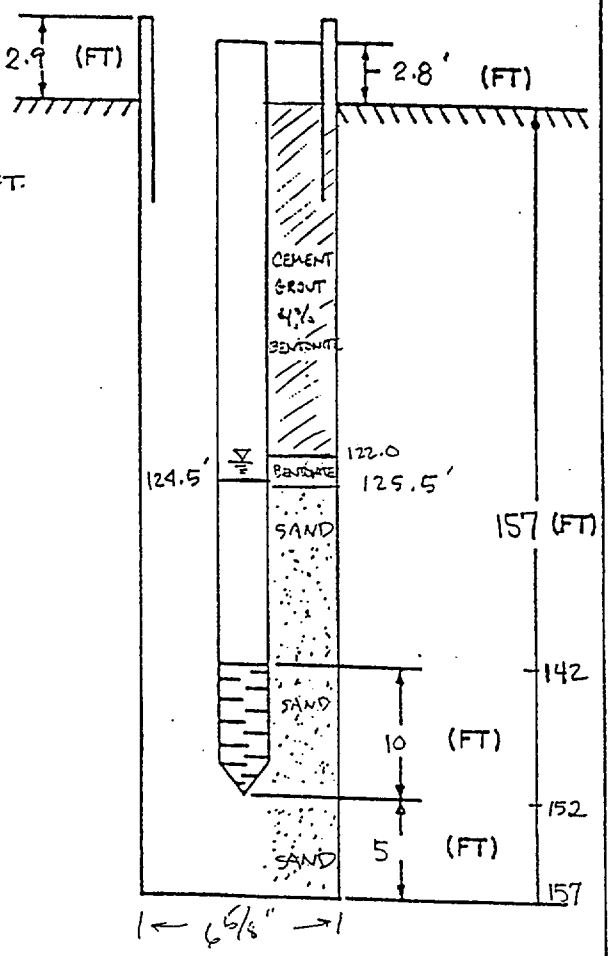
7.5 IN. HOLE DRILLED TO 157 FT.
NO. 20-30 SILICA SAND PLACED TO 152 FT. WELL SCREEN (.02 IN. SLOT) 10 FT PLACED ON SAND @ 152 FT. SAND PLACED OVER SCREEN AND RISER TO DEPTH OF 125.5 FT. BENTONITE PELLET SEAL PLACED ON TOP OF SAND TO DEPTH OF 122 FT. BENTONITE HYDRATED W/ WATER. REMAINDER OF HOLE IS FILLED W/ CEMENT-BENTONITE (4%) GROUT. 50# BENTONITE PELLETS 3/8 IN. Ø 5 FT STEEL GUARD PIPE W/ LOCKING CAP CEMENTED INTO SURFACE.

DESCRIPTION OF PIEZOMETER TIP AND STAND PIPE ASSEMBLY

2.0 IN ID. SCHEDULE 80 PVC FLUSH JOINT W/ BOTTOM CAP 10 FT SCREEN W/ 0.02 IN. SLOT SIZE

DESCRIPTION OF SOIL AT TIP ELEVATION:

SILTY SAND/SANDY SILT - UNIFORM FINE, V. DENSE



NOTE: SKETCH IN ALL COMPONENTS PERTINENT TO THE INSTALLATION WITH APPLICABLE DIMENSIONS EG: FILTER SAND, SEALS, GROUT, CASING, ETC.

5010.65

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CALCULATION SHEET

J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE
0599960200	G(B)	15	N/A	A 3 OF 3

CALCULATION IDENTIFICATION NUMBER

JAN 7 1998 RPG

ONSITE @ 9:15

CHECK GWT IN WELL @ 124.5' G.L.

DRILLERS ARR. @ 10:00

GET LOAD OF WATER 1 HR

SET UP FOR HOLDING TEST

RIG & CREW TIME 10:30 – 11:45 1.25 H.

HOLDING TEST RESULTS →

REGROUT WELL TO SURF.

REGROUT TOP OF CTB-1 TO SURF.

MIX 7 SKS CMT.

SET GUARD PIPE ON WELL 1/2 HR

RIG & CREW 1.75 H. TOTAL

1 SK QUIKCRETE

TOTAL 9950 gal H_2O from truck

CONSTANT HEAD TEST DATA

	GAGE READING
1 MIN	2.45 gal
2 MIN	4.75
5 MIN (3 MIN) →	7.10 / 11.80
10 MIN	22.80
15 MIN	33.85
20 MIN	44.90

ATTACHMENT B

ANTICIPATED WITHDRAWAL RATES FOR PFSF WATER WELL

ANTICIPATED WITHDRAWAL RATES FOR PFSF WATER WELL

Years 2022 to the end of the service life, construct 100 storage casks per year

Assume a 9 month working year and 20 days per month (Reference 30)

[100(58)]/(9 x 20) = 32.2 cy/day

32.2 cy/day x 34 gal/cy = 1095 gal/day ≡ 1100 gal/day

Note that during these years the workers will be staff, which used 2000 gal/day (Section 9)

Totals

9/00 - 5/01 **(Rev. 2)**

2500 (worker) + 6000 (concrete) = 8500 gal/day **(Rev. 2)**

6/01 - 3/02 **(Rev. 2)**

2500 (worker) + 2800 (concrete) = 5300 gal/day

Years 2002 through 2011

2000 (worker) + 1600 (concrete) = 3600 gal/day

Years 2012 through 2021

2000 (worker) + 2100 (concrete) = 4100 gal/day

Years 2012 to end

2000 (worker) + 1100 (concrete) = 3100 gal/day

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CALCULATION TITLE PAGE

CLIENT & PROJECT: Private Fuel Storage, LLC-Private Fuel Storage Facility	PAGE 1 OF 44 Plus 26 attached pages
CALCULATION TITLE (Indicative of Objective): PFSF Flood Analysis at 3-mile-long Portion of Rail Spur	QA CATEGORY ☒ ☒ - I Nuclear Safety Related ☐ - II ☐ - III ☐ - Non-Safety Related ☐ - ☐ - Fossil/Industrial Plant

CALCULATION IDENTIFICATION NUMBER

J.O. or W.O. NO.	DIVISION & GROUP	CURRENT CALC NO.	OPTIONAL TASK CODE	OPTIONAL WORK PACKAGE NO.
0599602	G(B)	16		345W

APPROVALS - SIGNATURE & DATE

PREPARER(S)/DATE(S)	REVIEWER(S)/DATE(S)	INDEPENDENT REVIEWER(S)/ DATES(S)	REV. NO. OR NEW CALC. NO.	SUPERCEDES CALC. NO. OR REV. NO.	CONFIRMATION REQUIRED ☒ YES	NO
Ven Nan Zeng 03/03/99 Ven Nan Zeng	George H.C. Liang 03/09/99 George H.C. Liang	George H.C. Liang 03/09/99 George H.C. Liang	Original Issue		☐	☒
Ven Nan Zeng 05/19/99 Ven Nan Zeng	George H.C. Liang 05/19/99 George H.C. Liang	George H.C. Liang 05/19/99 George H.C. Liang	1		☐	☒
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