KOCH

KOCH HYDROCARBON LP

July 24, 2002

Dr. W. Lynn Watney
Kansas Geological Survey
1930 Constant Avenue
University of Kansas, West Campus
Lawrence, Kansas 66047-3726

HUTCHINSON TEST-1, API 15-155-21458-0000, SW NW NW 22-23S-6W, RENO COUNTY, KANSAS – CORE ANALYSIS- NJF-02-016

References:

a. Letter from N. J. Fix, KHLP, to D. Williams, KCC, Subject: "Hutchinson Test-1, API 15-155-21458-0000, SW NW NW 22-23S-6W, Reno County, Kansas - Request for Custodial Confidentiality- NJF-02-004," dated March 1, 2002.

b. Letter from N. J. Fix, KHLP, to D. Williams, KCC, Subject: "Hutchinson Test-1, API 15-155-21458-0000, SW NW NW 22-23S-6W, Reno County, Kansas - Electric Logs-NJF-02-005," dated March 1, 2002.

c. Letter from N. J. Fix, KHLP, to W. L. Watney, KGS, Subject: "Hutchinson Test-1, API 15-155-21458-0000, SW NW NW 22-23S-6W, Reno County, Kansas - Electric Logs-NJF-02-006," dated March 1, 2002.

Dear Dr. Watney:

Please find enclosed the core analysis report and field description notes from the Koch Hydrocarbon, LP (KHLP) Hutchinson Test-1 Well, API 15-155-21458-0000. The report is being submitted as required by Kansas Corporation Commission (KCC), Conservation Division, Rule K.A.R. 82-3-107(d)(1)(B) and (I). By separate letter referenced above, we have requested that all information related to this well be held in confidential custody for a period of one (1) year as allowed by KCC, Conservation Division, Rule K.A.R. 82-3-107(e)[a].

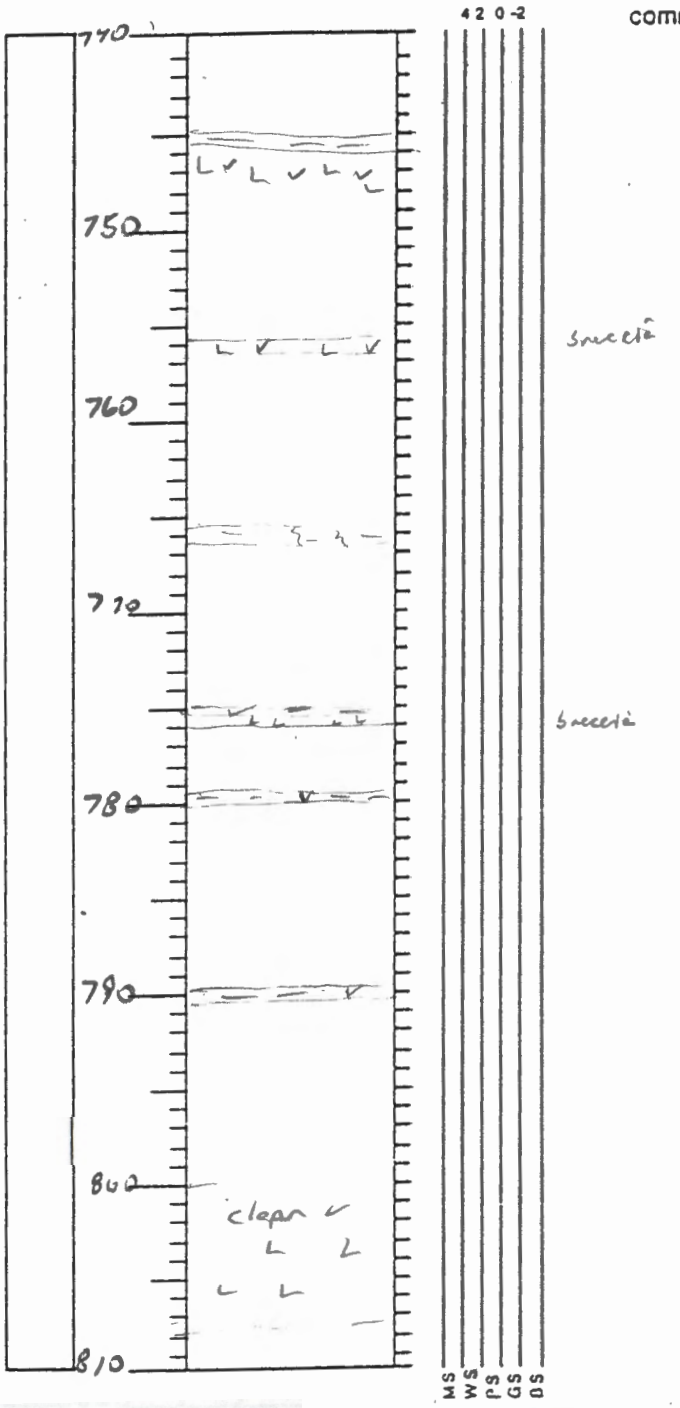
Please note that copies of the electric and radioactivity logs listed as Appendices D, E, F, and G in the attached report were submitted previously to the KCC and Kansas Geological Survey under separate transmittal letters referenced above[b&c].

1910 South Broadacres Road ▪ Hutchinson, Kansas 67501 ▪ 620/662-6691 ▪ FAX 620/662-0357

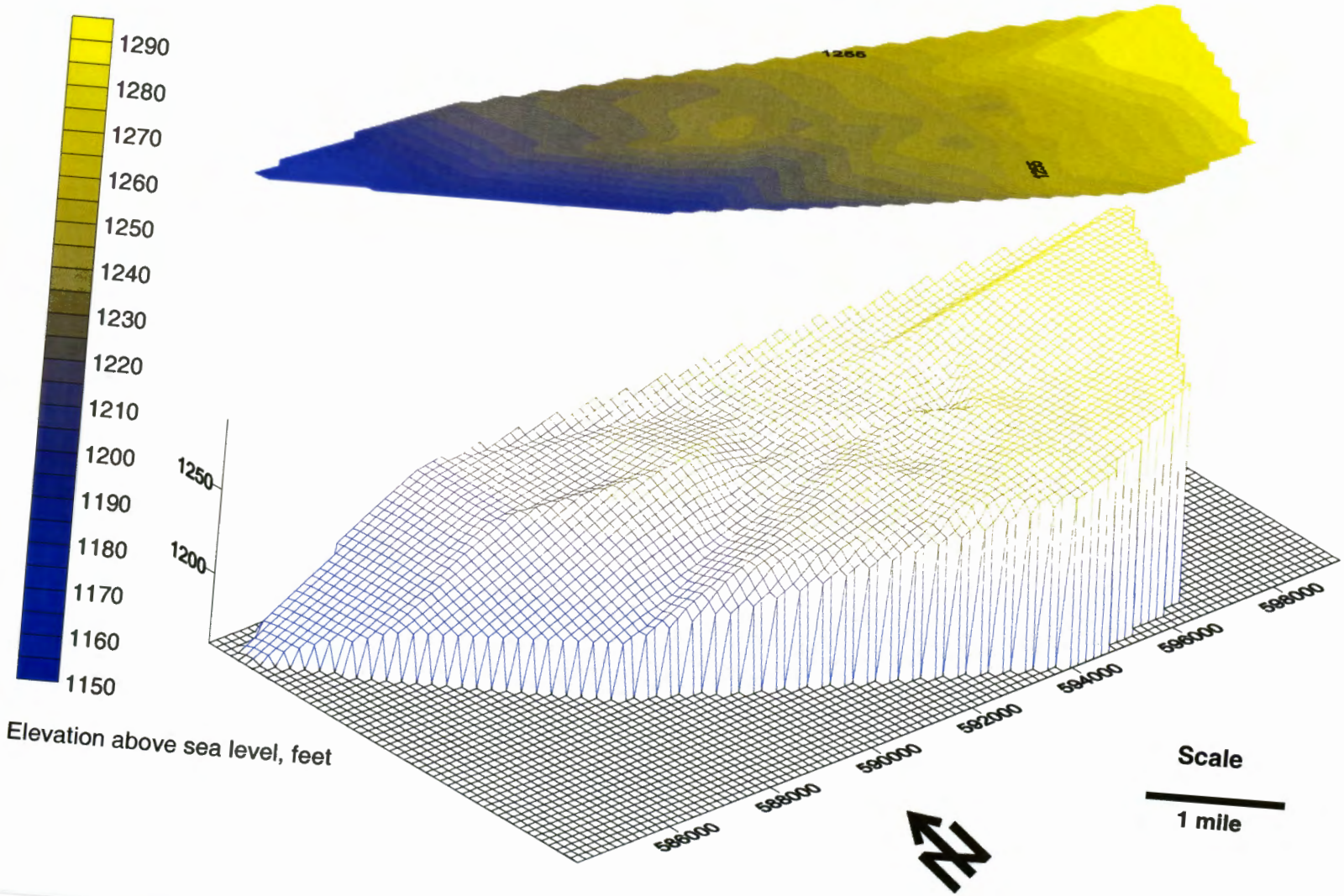
Operator _____ page _____

Lease _____ depths _____

Location _____



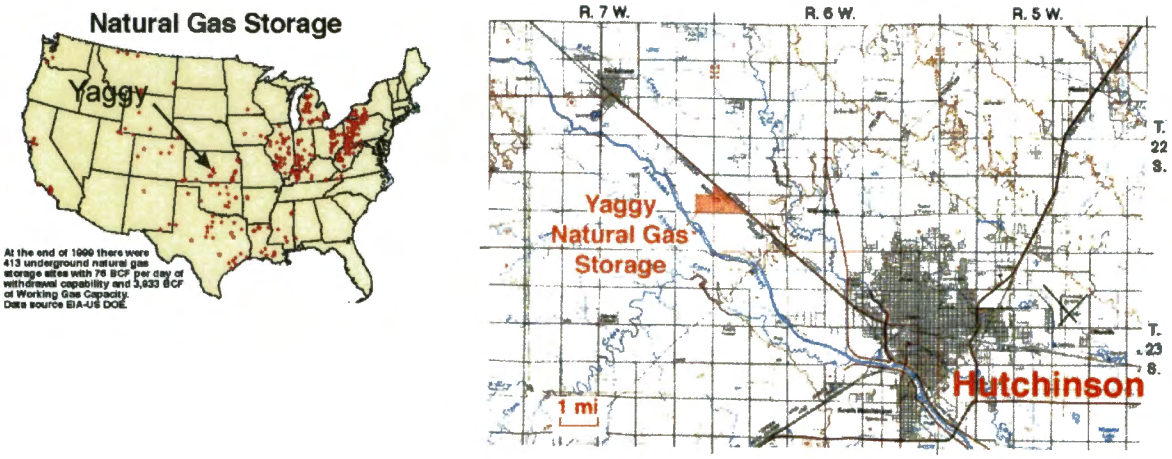
Configuration on top of the gas-bearing dolomite layers



Gas Leak at Hutchinson

On January 17 and 18, 2001 a series of natural gas explosions and geysers occurred at widely spaced locations within the City of Hutchinson. The outgassing in the city began three days after a major gas leak in a natural gas storage well, S-1, at the Yaggy Gas Storage Facility (Figure 1) located 7 miles northwest of Hutchinson. Two people were killed, several buildings destroyed, dozens of businesses and several hundred households were evacuated. A total of 54 vent and observation wells were drilled over several months subsequent to the gas leak and delineated linear and elongated gas accumulations, in part, corresponding closely with the crest of a small anticline.

Figure 1. Location map of Yaggy Gas Storage facility and Hutchinson, Kansas and national gas storage fields



Gas has been stored in a shallow (600 ft deep), thin-bedded (350 ft.) salt (halite) unit called the Hutchinson Salt Member of the Lower Permian Wellington Formation (Watney et al., 1988). Wells in Yaggy were drilled to depths of about 900 feet, into the lower parts of the Hutchinson Salt Member. The wells were cased with steel pipe into the salt. The top of each jug starts about 200 feet below the top of the salt layer to ensure an adequate cap that will not fracture or leak. The Yaggy Gas Storage Facility is composed of 16 pods containing 98 storage caverns in the Hutchinson Salt Member. Caverns are formed by drilling into the salt, pumping down fresh water and dissolving out the caverns by removing brine.

The salt bed dips westward at 20 ft/mi through the storage facility from a subcrop of the salt located approximately 25 mi east of the storage facility. Overlying the salt caverns is "overburden" strata consisting of 450 ft of Permian gypsiferous shales and thin (cm) beds of gypsum, anhydrite, and dolomite. The Equus Beds freshwater aquifer overlies the Permian strata (Figure 2). The Permian section is divided into an interval

consisting of primarily gray shale of the Upper Wellington Shale immediately overlying the salt succeeded by the reddish and more silty Ninnescah Shale. A unit designated the three-finger dolomite is developed in the upper portion of the Upper Wellington Shale. Gas appears to have been transmitted laterally along this dolomite beyond the storage field.

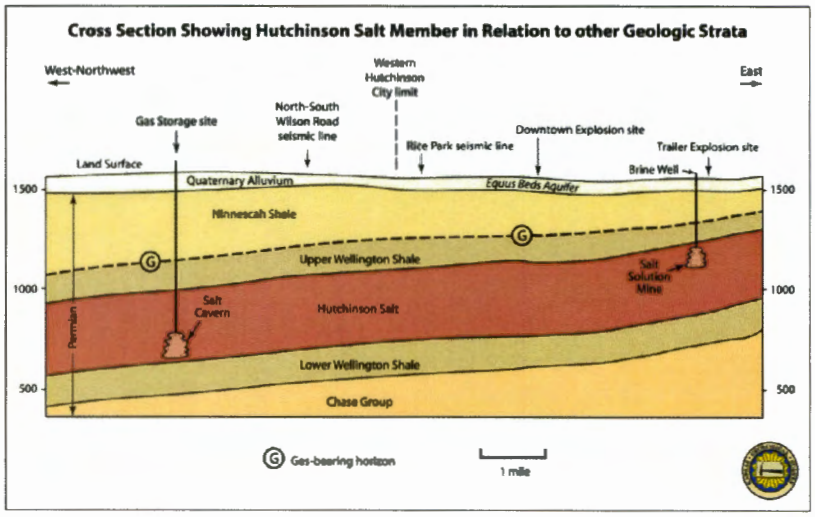


Figure 2. Cross-section showing Hutchinson Salt Member in relation to other geologic strata with gas-bearing interval shown.

The storage facility during operation holds 3.5 billion cubic feet (Bcf) of gas at pressures of about 600 pounds per square inch (psi). The storage field is one of 30 "hubs" in the national gas distribution system (Figure 1) and is a rapid response supplier. It is a key element in the gas supply in central Kansas. Beyond the events at Hutchinson, this incident is relevant to siting and operating new shallow underground gas storage facilities that will be inevitably be located near urban areas as domestic use of relatively clean gas increases.

Feature ID	TD (ft)	B/3F	T Salt	Wtr lvl 12/11/01	P @ TD psia	PSIG @ 674 hrs	PSIG @ 673 hrs	Wtr above 3F	Plug prospects	Pr @ 3F
DDV29	554	253	412	260	177.4	1	1	0	1	1
DDV19B		273		94	248.4	1	1	179	0	90.5
DDV1	550	327		206	173.4	0	1	121	0	60.5
DDV2	494	245	412	254	135.4	32	0	0	0	32
DDV3	331	310		45	162.4	0	0	265	0	132.5
DDV6	204	241	409	68	76.4	2	2	173	0	88.5
DDV8	210	290	459	170	33.4	1	1	120	0	61
DDV10	542	273	435	149	217.4	1	0	124	0	63
DDV1 I	554	292	458	149	224.4	0	1	143	0	71.5
DDV13	564	245	409	176	211.4	1	2	69	0	35.5
DDV14	218	266	443	30	95.4	-3	-3	236	0	115
DDV18	529	325	490	265	151.4	1	1	60	0	31
DDV19A	552	273	445	94	248.4	-1	0	179	0	88.5
DDV20	375	259		160	113.4	0	0	99	0	49.5
DDV23	548	289	466	130	217.4	1	1	159	0	80.5
DDV26	136			20	67.4	13	16	0	0	13
DDV27	554	306	470	164	218.9	1	1	142	0	72
DDV28	533	294	457	227	168.4	0	0	67	0	33.5
DDV30	562	287	441	250	177.4	1	1	37	0	19.5
DDV31	551	300	466	195	197.4	0	0	105	0	52.5
DDV35	502	320	486	220	150.4	2	2	100	0	52
DDV38	552	327	484	300	190.4	1	2	27	0	14.5
DDV39	205	274	443	130	53.4	0	1	144	0	72
DDV40	555	257	422	248	176.4	0	0	9	0	4.5
DDV45	547	278	438	136	220.4	6	6	142	0	77
DDV47	553	268	439	250	168.4	1	1	18	0	10
DDV50	424	245	417	280	88.4	4	4	0	0	4
DDV56	585	384	541	240	191.4	3	4	144	0	75
DDV57	561	345	508	168	201.4	1	0	177	0	89.5
DDV58	551	297	464	126	231.4	0	-2	171	0	85.5
DDV60	490	295	462	284	137.4	1	1	11	0	6.5
DDV61	552	270	432	250	169.4	0	1	20	0	10
DDV63	567	344	498	310	144.4	2	2	34	0	19
DDV66	548	304	468	220	188.4	2	2	84	0	44
DDV51	151			96	42.4	0	1			
DDV62	210	310	483	none	15.4	1	1			
DDV7 (destroyed)										

KOCH

KOCH HYDROCARBON LP

March 4, 2002

Dr. W. Lynn Watney
Kansas Geological Survey
1930 Constant Avenue
University of Kansas, West Campus
Lawrence, Kansas 66047-3726

HUTCHINSON TEST-1, API 15-155-21458-0000, SW NW NW 22-23S-6W, RENO COUNTY, KANSAS - ELECTRIC LOGS- NJF-02-006

Dear Dr. Watney:

Please find enclosed the electric log suite from the Koch Hydrocarbon, LP (KHLP) Hutchinson Test-1 Well, API15-155-21458-0000. By separate letter, we have requested that this information be held in confidential custody for a period of one (1) year as allowed by Kansas Corporation Commission (KCC), Conservation Division, Rule K.A.R. 82-3-107(e) (See letter from N. J. Fix, KHLP, to D. Williams, KCC, Subject "Hutchinson Test-1, API 15-155-21458-0000, SW NW NW 22-23S-6W, Reno County, Kansas - Request for Custodial Confidentiality- NJF-02-004). We did not request that electronic copies of the logs be made by the logging contractor.

If you have any questions or require additional information, please contact me at (620) 694.1723 or email fixa@kochind.com.

Sincerely,

N. J. Fix, Environmental Compliance Manager
Koch Hydrocarbon, LP

NJF

Attachments,
As stated

cc: (W/O Attach)
P. G. Baker - KHLP
D. Blankenship - RESPEC
S. Collier - KII
T. S. Oakleaf - KHLP
J. L. Ratigan - PB-KBB, Inc.
J. M. Reese - KHLP
L. H. Skelton - Kansas Geological Survey
File(2)/Hutch test well

1910 South Broadacres Road ▪ Hutchinson, Kansas 67501 ▪ 620/662-6691 ▪ FAX 620/662-0357

— DRAFT —

ASSESSMENT OF THE GEOMECHANICAL SUITABILITY OF THE KOCH HYDROCARBONS UNDERGROUND STORAGE CAVERNS AT HUTCHINSON, KANSAS

PROGRAM PLAN

Submitted to

Koch Hydrocarbons
1910 South Broadacres Road
Hutchinson, Kansas 67501

Submitted by

PB-KBB, Inc.
11757 Katy Freeway, Suite 600
Houston, Texas 77079

and

RESPEC
P.O. Box 725
Rapid City, South Dakota 57709

November 2001

PB-KBB
FENIX & SCISSON
ENGINEERING CONSTRUCTION OPERATIONS

RESPEC
An Integrated Consulting and Services Company

2.0 PROJECT OBJECTIVES

The objective of the proposed geomechanics study is to verify the suitability of the local salt and nonsalt formation for the storage of natural gas liquids (NGLs) in solution-mined caverns. PB-KBB has identified three tasks in the proposed study that are necessary to obtain this objective:

- **Task 1** – Develop a Program Plan for the study for submittal to the KDHE for review.
- **Task 2** – Execute the geomechanical field and laboratory testing program.
- **Task 3** – Document the tests results and the verification of formation suitability and report the results to KDHE for review.

This document has resulted from the execution of Task 1. The remaining two tasks in the project are described in the following chapter.

3.0 TECHNICAL APPROACH

The technical approach for this project consists of three tasks that are described below.

3.1 TASK 1 – DEVELOP A PROGRAM FOR THE STUDY FOR SUBMITTAL TO THE KDHE FOR COMMENT AND CONCURRENCE

This Program Plan that describes the cavern storage facility at Hutchinson and the proposed field and laboratory testing program planned to evaluate the compliance of the facility with generally accepted industry guidelines.

This draft version of the Program Plan will be submitted to KDHE for review.

A central feature of the Program Plan is the geomechanical field and laboratory testing program. The geomechanical testing program has the objective of (1) filling in *missing data* necessary to verify suitability of the salt formation for underground LPG storage caverns and (2) establishing a measure of safety (*Factor of Safety*) for the operating pressures and cavern geometries at the Koch Hutchinson facility.

3.2 TASK 2 – EXECUTE THE GEOMECHANICAL FIELD AND LABORATORY TESTING PROGRAM

3.2.1 Overview

The elements of the geomechanical field and laboratory testing program are reasonably well defined based on PB-KBB and RESPEC review of the Koch Hutchinson facility for the past several years. The essential elements of the field testing program are:

1. Contemporary well logging of a test hole to establish geomechanical parameters of the salt formation in which the caverns are constructed.
2. Hydraulic fracturing of the salt formation to determine the acceptable maximum operating pressures.

Core will be recovered from the test well and laboratory testing will be performed to determine detailed properties of the salt and nonsalt units in the formation.

3.2.2 Test Well Description

The test well will start with the installation of a 10-inch-diameter surface cased hold drilled from surface to 20 feet into bedrock (anticipated at 155 ft.), or 175 ft. The surface casing will be cemented and allowed to cure.

A 7-inch-diameter cased hole will be drilled to approximately 250 feet and cemented. The test well will be open hole from the bottom of the 7-inch casing to total depth (T.D.). The well will be cored from a depth of approximately 310 feet to approximately 900 feet. The core zone will include Upper Wellington Shale through the Hutchinson Salt. The upper zone of the core is being taken to assist the Kansas Geological Survey with their evaluation of the Hutchinson area geological formations.

The well will be drilled with a blowout preventer (BOP). Under some circumstances, this well could be drilled without a BOP. However, because of the possibility of encountering hydrocarbons, a BOP will be employed.

Once the testing in the well is complete, the well will be plugged and abandoned according to Kansas regulations.

3.2.3 Test Well Activities

The test well activities will include:

1. Well logging
2. Coring
3. Hydraulic fracture tests ("mini-fracs") for in situ fracture gradient.

Each of these activities is briefly described below.

3.2.3.1 Well Logging

Well logs will include (1) gamma, (2) bulk density, and (3) dipole sonic. The gamma log will enable a correlation of the geologic formations encountered in the test well with other logged wells at the South Hutchinson facility. The dipole sonic log will allow a determination of the shear wave and compressional wave travel time in the formations encountered in the drillhole. These two wave speeds and the bulk density will enable one to calculate the dynamic elastic moduli (Young's modulus and Poisson's ratio) for the formations encountered in the drillhole.

An additional induction log will be run to assist with the Kansas Geological Survey's evaluation of the Hutchinson-area geology.

The gamma, bulk density, and dipole sonic logs will be run after the surface casing has been cemented and the drillhole has been extended to T.D.

3.2.3.2 Coring

Continuous 4-inch-diameter core will be taken from a depth of about 310 feet to T.D. at about 900 feet. This is expected to be about 575 to 600 feet of core. The core will be logged on

site by a PB-KBB or RESPEC geologist or engineer, photographed, packaged, and selected core will be sent to the RESPEC rock mechanics laboratory in Rapid City, South Dakota. The remaining core will be packaged for on-site storage.

3.2.3.3 In Situ Mini-Fracs

The fracture gradient measurement mini-fracs will be performed in various isolated depth intervals in the Hutchinson salt. The objective of this test will be to determine the pressure that will "fracture" the salt formation. Such a measurement allows Koch to establish a maximum operating pressure for the storage cavern. It is expected that five or six mini-fracs will be performed in the test well. This mini-frac test consists of lowering a straddle packer into the well, pressurizing the packers to isolate a portion of the test well, and pressurizing the packed-off interval until fracture occurs. The occurrence of the fracture is detected from an instantaneous plot of measured pressure versus time and flow rate versus time. The fracture gradient will be determined essentially as a function of depth within the Hutchinson salt formation, so that a *Factor of Safety* can be established independently for the shallower and deeper caverns in the Hutchinson salt.

3.2.4 Core Testing

Four-inch-diameter core from the Upper Wellington shale and the Hutchinson salt will be tested in the RESPEC rock mechanics laboratory in Rapid City, South Dakota.

Tests on the Upper Wellington shale core will include (1) Brazilian indirect tensile strength and (2) confined triaxial compression tests. The Brazilian indirect tensile strength test will enable an assessment of the tensile strength of the shale in the roof of the proposed cavern. The confined triaxial compression tests will enable an assessment of the compressive strength of the roof of the proposed cavern as well as Young's modulus and Poisson's ratio.

Tests on the Hutchinson salt core will include (1) Brazilian indirect tensile strength, (2) confined triaxial compression tests, and (3) triaxial creep tests. The triaxial creep tests will define the time-dependent creep deformation characteristics of this salt.

The expected core test matrix is illustrated in Table 3-1. A significant number of tests are proposed for the Upper Wellington shale. It has been our experience that this shale can exhibit considerable variability, and a large number of tests are required to characterize the strength of this cavern roof rock.

Table 3-1. Core Test Matrix for Salt and Nonsalt Core From the Koch Medford Test Well

Rock Type	Test Type	Number of Tests
Upper Wellington Shale	Brazilian Indirect Tensile Strength	6
Upper Wellington Shale	Confined Triaxial Compression (Constant Strain Rate)	20
Hutchinson Salt	Brazilian Indirect Tensile Strength	6
Hutchinson Salt	Confined Triaxial Compression (Constant Strain Rate)	5
Hutchinson Salt	Confined Triaxial Creep Deformation	3

3.3 TASK 3 – DOCUMENT THE TEST RESULTS AND THE VERIFICATION OF FORMATION SUITABILITY AND REPORT THE RESULTS TO KDHE FOR CONCURRENCE

PB-KBB and RESPEC will develop a comprehensive report of the field and laboratory test results. This data will be incorporated into the Koch Hutchinson hydrocarbon storage cavern assessment that will be the deliverable in this task. The report will be delivered initially to Koch in draft for review and comment. Following incorporation of the Koch comments, the report will be presented to the KDHE in Topeka, Kansas (or Hutchinson), for comment and concurrence.

6.0 REFERENCES

Nelson, P. E. and J. L. Ratigan, 2000. *Geomechanical Assessment of the Liquid Hydrocarbon Storage Caverns at the Koch Terminal, Hutchinson, Kansas*, RSI-1387, prepared by RESPEC, Rapid City, SD, and Sofregaz US Inc., Houston, TX, for Koch Medford Company, Medford, OK.

KOCH HYDROCARBON, LP

Hutchinson, Kansas

Hutchinson Core Sample/Fracture Gradient Test Well

Drilling Plans

I. Surface Casing

Pratt Well Service will be installing the test well surface casing to a depth of approximately 175 ft. Surface casing will involve the following activities:

a. Start hauling water to mix drilling mud. Wed 1/16
b. Mix drilling mud. Thu 1/17
c. Start drilling. Fri 1/18. Pratt will drill on days, covering the hole overnight.
d. Drilling will take approximately 2 days. Once drilling is complete, Acid Services will come on site to cement casing (Sat 1/19, p.m.).
e. After cementing, Pratt will rig down and leave the site. The cement will cure a minimum of 12 hours. Sun 1/20

II. Drilling

Dynatec Drilling will be performing the drilling/logging operations, under the supervision of RESPEC. Drilling will consist of the following activities:

a. Dynatec crews on-site to rig up on Monday 1/21. Dynatec will have Trand crane on site to move equipment. Rig up will take approximately 1-1/2 days.
b. Mix mud. Tue 1/22
c. Start drilling Wed 1/23
d. Drill from 175-250 ft (should take one shift).
e. Set 7" casing from surface to 250 ft and cement. Acid Services will be on site to cement casing. Thu 1/24.
f. Clean up tanks and let cement cure for 12 hours.
g. Rig BOP and start drilling. Fri 1/25.
h. Drill from 250 to 310 ft. (few hours)
i. Trip out and switch to coring. Fri 1/25.

III. Coring

a. Mix brine/mud. Sat 1/26
b. Start coring. Sat 1/26 to Mon 1/28

IV. Logging

a. Schlumberger on site to log hole.
b. Log hole. Tue 1/29
c. Halliburton on site to perform hydro-fracs.
d. Perform hydro-fracs Tue 1/29 to Wed 1/30.

V. Closeout

a. Cement hole. Acid Services on site to pump cement. Wed 1/30 – Thu 1/31
b. Dynatec rig down. Thu 1/31
c. Dynatec load trucks and equipment off-site. Fri 2/1