552883

Sandia National Laboratories Compliance Monitoring Parameter Assessment For 2009

WBS 1.3.1

January 2010

Prepared for the United States Department of Energy
Carlsbad Field Office

Sandia National Laboratories

WIPP:1.3.1:CO:QA-L:pkg 510062

Sandia National Laboratories
Compliance Monitoring
Parameter Assessment for 2009

WBS 1.3.1
Pkg. No.

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Executive Summary

This document reports the tenth annual (2009) derivation and assessment of the Waste Isolation Pilot Plant (WIPP) Compliance Monitoring Parameters (COMPs). The COMPs program is designed to meet certain requirements of the U.S. Environmental Protection Agency's (EPA) long-term disposal regulations (EPA 1993 and 1996). The concept of deriving and assessing COMPs is explained in Sandia National Laboratories (SNL) Activity/Project Specific Procedure, SP 9-8, titled: *Monitoring Parameter Assessment Per 40 CFR 194.42* (SNL 2008a).

The WIPP has many monitoring programs, each designed to meet various regulatory and operational safety requirements. The comprehensive WIPP monitoring effort is not under the auspice of one program, but is comprised of many discrete elements, one of which was designed to fulfill the EPA's long-term disposal requirements found at 40 CFR Part 191 Subparts B and C, and the Certification Criteria at 40 CFR Part 194. Monitoring parameters that are related to the long-term performance of the repository were identified in a monitoring analysis.[1] Since these parameters fulfill a regulatory function, they were termed Compliance Monitoring Parameters so that they would not be confused with similar performance assessment (PA) input parameters.

The Department of Energy (DOE) uses PA to predict the radioactive waste containment performance of the WIPP. COMPs are used to indicate conditions that are not within the PA data ranges, conceptual model assumptions or expectations of the modelers and to alert the project of conditions not accounted for or anticipated. COMPs values and ranges were developed such that exceedance of an identified value indicates a condition that is potentially outside PA expectations. These values were appropriately termed "trigger values." Deriving COMPs trigger values (TVs) was the first step in assessing the monitoring data. TVs were derived in 1999 and are documented in the *Trigger Value Derivation Report* (SNL 2002a). In some instances, a COMP will not have a TV because sensitivity analysis has demonstrated that PA is insensitive to that parameter or because the parameter is subjective in nature and is not directly related to PA inputs.

This COMPs Report is the first derived after the WIPP's second recertification application was submitted to the EPA (the Compliance Recertification Application (CRA-2009; DOE 2009a) and prior to an expected EPA notification of continued compliance). The EPA requested a new PA in support of the second recertification called the Performance Assessment Baseline Calculation (PABC-2009). The PABC-2009 is in-process. The PABC-2009 when completed and approved through a recertification decision will represent the latest compliance baseline. However, this decision is not expected during this COMPs reporting cycle such that the current compliance baseline was used in this year's COMPs assessment (PABC-2004).

In the initial Certification Ruling (EPA 1998a), EPA approved 10 COMPs, 2 relating to human activities, 5 relating to geotechnical performance, 2 relating to regional hydrogeology

[1] Attachment MONPAR to Appendix MON in the CCA (DOE 1996) documents the analysis of monitoring parameters. The analysis was performed to fulfill 40 CFR § 194.42 requirements.

and 1 relating to the radioactive components of the waste. The requirements of 40 CFR 194.4(b)(3) require the DOE to report any condition that would indicate the repository would not function as predicted or a condition that is substantially different from the information contained in the most recent compliance application. The DOE complies with these EPA requirements by conducting periodic assessments of COMPs that monitor the predicted performance of the repository and report any condition adverse to the containment performance. This compliance monitoring program is described in greater detail in DOE's *40 CFR Parts 191 and 194 Compliance Monitoring Implementation Plan* (MIP; DOE 2005).

This 2009 COMPs assessment present the results and the recommendations based on the COMPs monitoring data gathered during the reporting cycle. This assessment concludes that the current COMP values do not indicate a condition for which the repository will perform in a manner other than that represented in the WIPP certification PAs.

1 Introduction

The WIPP is governed by the EPA's long-term radioactive waste disposal regulations at 40 CFR Part 191 Subparts B and C (EPA 1993) and the WIPP-specific certification criteria at 40 CFR Part 194 (EPA 1996). Monitoring WIPP performance is an "assurance requirement" of these regulations and is intended to provide assurances that the WIPP will protect the public and environment (see 40 CFR § 191.14). In the WIPP Compliance Certification Application (CCA; DOE 1996), the DOE made commitments to conduct a number of monitoring activities to comply with the criteria at 40 CFR § 194.42 and to ensure that deviations from the expected long-term performance of the repository are identified at the earliest possible time. These DOE commitments are represented by 10 COMPs, which are listed in Section 2.

The COMPs are an integral part of the overall WIPP monitoring strategy. The DOE's *40 CFR Part 191 and 194 Compliance Monitoring Implementation Plan* (MIP; DOE 2005) describes the overall monitoring program and responsibilities for COMPs derivation and assessment. This report documents the results of the reporting year 2009 COMPs assessment (July 1st 2008 to June 30th 2009). This period matches the reporting period of the annual report that addresses 40 CFR § 194.4(b)(4) requirements (EPA 2003). Each COMP is derived from data published in various WIPP project reports. The most recent available data is used however the reporting periods for these reports do not all correspond to the July 2008 to June 2009 period of this report. The data collection period used in each COMP is documented in this report. This COMPs assessment follows the program developed under the original certification baseline using data and performance assessment (PA) results from the current certified baseline, the 2004 recertification's Performance Assessment Baseline Calculation (PABC-2004).

1.1 Monitoring and Evaluation Strategy

The Compliance Monitoring Program is an integrated effort between the Management and Operating Contractor (M&OC), the Scientific Advisor (SA) and the DOE Carlsbad Field Office (CBFO). The CBFO oversees and directs the monitoring program to ensure compliance with the EPA monitoring and reporting requirements. The SA is responsible for the development and maintenance of the TVs. An observation beyond the acceptable range of TVs represents a condition that requires further actions, but does not necessarily indicate an out-of-compliance condition. This approach assures that conditions that are not consistent with expected repository performance are recognized as early as possible. These conditions may include data inconsistent with the conceptual models implemented in PA, or invalidation of assumptions and arguments used in the screening of Features, Events and Processes (FEPs) screened into PA.

1.2 Reporting Cycle

The types of changes that must be reported to EPA are defined in 40 CFR §194.4. Under 40 CFR §194.4, changes that differ from the activities or conditions outlined in the latest compliance application are defined as either significant or non-significant based on their potential impact on the compliance baseline and potential impact on containment performance. This part of the rule also identified the timeframe to which the DOE is required to report significant and non-significant changes to the EPA. As such, the CCA and the CRA-2004 state in Section 7.2.1 that the results of the monitoring program would be submitted annually (DOE 1996, DOE 2004). Additionally, the recertification requirements at 40 CFR §194.15(a)(2) also require inclusion of all additional monitoring data, analysis and results in the DOE's documentation of continued compliance as submitted in periodic CRAs. Monitoring data, the associated parameter values and monitoring information must be reported even if the assessment concludes there is no impact on the repository. The annual monitoring data will be compiled and provided to the DOE to fulfill DOE's monitoring reporting requirements to the EPA. The SA's role in the annual reporting task is to use the monitoring data to derive the COMPs (as necessary), compare the results to repository performance expectations in PA (annually), and to use the new and updated information to make any recommendations for modification to the Compliance Baseline, if merited.

2 Assessment of COMPs

The compliance monitoring program tracks the following 10 COMPs:

1. Probability of Encountering a Castile Brine Reservoir
2. Drilling Rate
3. Subsidence
4. Creep Closure
5. Extent of Deformation
6. Initiation of Brittle Deformation
7. Displacement of Deformation Features
8. Changes in Culebra Groundwater Flow
9. Change in Culebra Groundwater Composition
10. Waste Activity

A periodic review of these COMPs is necessary to meet the intent of 40 CFR §191.14 assurance requirements, which states:

> "(b) Disposal systems shall be monitored after disposal to detect substantial and detrimental deviations from expected performance. This monitoring shall be done with techniques that do not jeopardize the isolation of the wastes and shall be conducted until there are no significant concerns to be addressed by further monitoring."

This section summarizes the results of the 2009 calendar year assessment. In the following sections, each COMP is evaluated and compared to the applicable TV. This assessment is performed under Specific Procedure SP 9-8 (SNL 2008a). A table for each of the ten COMPs is used to summarize the evaluation and shows the COMP derivation, related PA parameters and FEPs, the current value for the COMPs as applicable and the TV.

2.1 Human Activities COMPs

The CCA identifies 10 COMPs that the DOE is required to monitor and assess during the WIPP operational period. Two of these parameters monitor "Human Activities" in the WIPP vicinity which include:

- Probability of Encountering a Castile Brine Reservoir
- Drilling Rate

2.1.1 Probability of Encountering a Castile Brine Reservoir

Table 2.1 summarizes PA, data and TV information relating to the COMP, Probability of Encountering a Castile Brine Encounter. Monitoring activities for Castile brine encounters have identified no new brine encounter during this reporting period. The total of encounters identified since the CCA is 7. These encounters are detailed in Table 2.2. Data used for the CCA PA to derive the probability of a drilling intrusion intersecting a Castile brine pocket were compiled from drilling record searches for the region surrounding the WIPP. A geostatistical analysis was used to derive this CCA PA parameter (CCA Appendix MASS, Attachment 18-6; DOE 1996). The results of this initial search recorded 27 drilling encounters with pressurized brine (water) in the Castile Formation. Of these encounters, 25 were hydrocarbon wells scattered over a wide area in the vicinity of the WIPP site; 2 wells, ERDA 6 and WIPP 12, were drilled in support of the WIPP site characterization effort (see DOE 2009b, Table 7 for a complete listing of brine encounters). The Delaware Basin Drilling Surveillance Program reviews the well files of all new wells drilled in the New Mexico portion of the Delaware Basin each year looking for instances of Castile brine encounters. The program also sends out an annual survey to operators of new wells to determine if pressurized brine was encountered. Since the CCA, data have been compiled through August 2009. During this reporting period, no pressurized Castile brine encounters have been reported in the official drilling records for wells drilled in the New Mexico portion of the Delaware Basin (DOE 2009b).

Of the 7 Castile brine encounters recorded since the 1996 CCA, 6 were identified when WIPP Site personnel performing field work talked to area drillers. The other encounter was reported by an operator in the annual survey of area drillers. All the new encounters are located in areas where Castile brine is expected to be encountered during the drilling process. Table 2.2 shows all known Castile brine encounters in the vicinity of the WIPP Site since the CCA.

The impacts of brine encounters are modeled in the PA. The CCA used a 0.08 probability of encountering a Castile brine reservoir. In the Performance Assessment Verification Test (PAVT), the EPA mandated a probability range of 0.01 to 0.60. The new range did not significantly influence the predicted performance of the repository. This range has been used in all PAs since the original WIPP certification. The EPA also determined in their first certification sensitivity analysis that this parameter (PBRINE) does not have a significant impact on PA results (EPA 1998b).

Table 2. 1. Probability of Encountering a Brine Reservoir - 2009:

Trigger Value Derivation

COMP Title:	Probability of Encountering a Castile Brine Reservoir
COMP Units:	Unitless

Related Monitoring Data

Monitoring Program	Monitoring Parameter ID	Characteristics (e.g., number, observation)	Compliance Baseline Value
DBMP(1)	NA	Driller's survey – Field observations	0.01 to .60

COMP Assessment Process

Analysis of encounters of pressurized brine recorded and reported by industry in the 9-township area centered on WIPP.

Year 2009 COMP Assessment Value - Reporting Period September 2008 to August 2009

No new data reported in State record during the reporting period; No new report from Field Observations. 34 Total Brine Encounters

27 CCA total occurrences before 1996
0 State Record occurrences since 1996
7 Site Personnel/ Drillers Survey occurrences since 1996

Related Performance and Compliance Elements

Element Title	Parameter Type & ID or Model Description	Derivation Procedure	Compliance Baseline	Impact of Change
Probability of Encountering Brine	Parameter PRBRINE	CCA MASS Attachment 18-6 geostatistical study based on area occurrences.	0.08	Not a sensitive parameter.
		EPA Technical Support Document justified the upper value in their range by rounding up the upper value interpreted from the Time Domain Electromagnetic survey, which suggested a 10 to 55% areal extent.	0.01 to 0.60	

Monitoring Data Trigger Values

Monitoring Parameter ID	Trigger Value	Basis
Probability of Encountering a Castile Brine Reservoir	None	After the DOE proposed the brine reservoir probability as potentially significant in the CCA Appendix MONPAR, the EPA conducted analyses that indicate a lack of significant effects on performance from changes in this parameter. For this reason and since the parameter is evaluated for significant changes at least once annually, no TV is needed.

(1) Delaware Basin Monitoring Program

Table 2. 2 Well Locations Encountering Brine since the CCA[2].

Number	Location	Well Name and Location	Spud Date	Well Information
1	T21S-R31E-Sec 35	Lost Tank "35" State #4	09/11/2000	Oil Well: Estimated several hundred barrels per hour. Continued drilling.
2	T21S-R31E-Sec 35	Lost Tank "35" State #16	02/06/2002	Oil Well: At 2,705 ft, encountered 1,000 barrels per hour. Shut-in to get room in reserve pit with pressure of 180 psi. and water flow of 450 barrels per hour. Two days later, no water flow/full returns.
3	T22S-R31E-Sec 2	Graham "AKB"State #8	04/12/2002	Oil Well: Estimated 105 barrels per hour. Continued drilling.
4	T23S-R30E-Sec 1	James Ranch Unit #63	12/23/1999	Oil Well: Sulfur water encountered at 2,900 ft. 35 ppm H_2S was reported but quickly dissipated to 3 ppm in a matter of minutes. Continued drilling.
5	T23S-R30E-Sec 1	Hudson "1" Federal #7	01/06/2001	Oil Well: Estimated initial flow at 400 to 500 barrels per hour with a total volume of 600 to 800 barrels. Continued drilling.
6	T22S-R30E-Sec 13	Apache "13" Federal #3	11/26/2003	Oil Well: Encountered strong water flow with blowing air at 2,850-3,315 ft. 362 ppm H_2S was reported. Continued drilling.
7	T21S-R31E-Sec 34	Jaque "AQJ" State #7	03/04/2005	Oil Well: Encountered 104 barrels per hour at 2,900 ft. No impact on drilling process.

[2] From DOE 2009b, Table 7

2.1.2 Drilling Rate

Table 2.3 summarizes PA, data and TV information relating to the COMP, Drilling Rate. The drilling rate COMP tracks deep drilling (boreholes that exceed the repository depth of 2,150 ft) activities relating to resource exploration and extraction. Boreholes relating to resources include potash and sulfur core-holes, hydrocarbon exploration wells, saltwater disposal wells and water wells drilled in the Delaware Basin. The first drilling rate, reported in the CCA, was determined using an equation provided in 40 CFR Part 194. The formula is as follows: number of deep boreholes greater than 2,150 ft deep times 10,000 years divided by 23,102 square kilometers (area of the Delaware Basin) divided by 100 years equals the number of boreholes per square kilometer per 10,000 years. The number of deep boreholes over the last 100 years is used in the equation (1896 – June 1995 for the CCA value). The rate reported in the CCA using this equation was 46.8 boreholes per square kilometer over 10,000 years. Including the time period after the CCA (June 1996 to June 2009) increases the rate to 61.3 boreholes per square kilometer per 10,000 years (DOE 2009b).

As shown in Table 2.4, the drilling rate has risen from 46.8 holes per square kilometer to 61.3 holes per square kilometer since 1996. The rate will continue to climb because of the method used to calculate the rate. Since the first well drilled in the area occurred in 1911, it will be 2011 before one well is dropped from the count and 2014 before the next well is dropped from the count. In the meantime, numerous wells will have been added, increasing the drilling rate.

When the TV report was written, it was thought that the drilling rate used in PA would not be changed for each recertification. However, each recertification updates the drilling rate parameter and effectively accounts for the change in rate. Because the change in the drilling rate is accounted for every 5 years, the concept of applying a TV is unnecessary. Although the drilling rate TV was exceeded in 2004, the exceedance was expected. As discussed in the Delaware Basin Monitoring Annual Report, the drilling rate will continue to rise with each new well drilled until the 100-year window moves to a point in time when there are more older wells removed from consideration than new wells are added. Studies have demonstrated that much higher drilling rates are needed to impact compliance (EEG 1998). For example, in response to a request from EPA (EPA 2004), the SA analyzed the impact of drilling rate on repository performance. This analysis shows that even if the drilling rate was doubled relative to that used for the CRA-2004 PA, the disposal system performance would be well within the release limits set by EPA regulations (Kanney and Kirchner 2004).

Table 2. 3 Drilling Rate - 2009:

COMP Title:	Drilling Rate			
COMP Units:	Deep boreholes (i.e., > 2,150 ft deep)/square kilometer/10,000 years			
Related Monitoring Data				
Monitoring Program	Monitoring Parameter ID	Characteristics (e.g., number, observation)		
DBMP	Deep hydrocarbon boreholes drilled	Integer per year		
COMP Assessment Process				
Number of deep boreholes greater than 2,150 ft deep that occurred over the last 100 years times 10,000 years divided by 23,102 square kilometers (area of the Delaware Basin) divided by 100 years, equals the number of boreholes per square kilometer per 10,000 years				
Year 2009 COMP Assessment Value - Reporting Period September 1, 2008 to August 31, 2009				
(14,173 boreholes on record for the Delaware Basin) Drilling Rate = 61.3 boreholes per square kilometer per 10,000 yrs.				
Related Performance and Compliance Elements				
Element Title	Parameter Type & ID or Model Description	Derivation Procedure	Compliance Baseline	Impact of Change
Drilling rate	Parameter LAMBDAD	COMP/10,000 years	5.98 E-03 per square kilometer per year (CRA-2004 PABC value)	Cuttings/cavings releases increase proportionally with the drilling rate. Doubling CRA drilling rate does not exceed compliance limit.
Monitoring Data Trigger Values				
Monitoring Parameter ID	Trigger Value	Basis		
Deep boreholes	NA.	Calculations have shown that doubling the drilling rate does not impact compliance with the EPA release limits (Kanney and Kirchner 2004).		

Table 2. 4 Drilling Rates for Each Year since the CCA.

Year	**Number of Boreholes Deeper than 2,150 ft**	**Drilling Rate (boreholes per square kilometer per 10,000 years)**
1996 (CCA Value)	10,804	46.8
1997	11,444	49.5
1998	11,616	50.3
1999	11,684	50.6
2000	11,828	51.2
2001	12,056	52.2
2002[3]	12,219	52.9
2002 (revised)	12,139	52.5
2003	12,316	53.3
2004	12,531	54.2
2005	12,819	55.5
2006	13,171	57.0
2007	13,520	58.5
2008	13,824	59.8
2009	14,173	61.3

[3] In Revision 3 of DOE 2009b (dated 2002), the drilling rate for 2002 was shown as 52.9, with 12,219 deep boreholes. It was later noted that 80 shallow wells in Texas were listed as being deep. Correcting the classification of the 80 boreholes resulted in a reduction of the drilling rate from 53.9 to 52.5 (DOE 2009b).

2.2 Geotechnical COMPs

The CCA lists 10 monitoring parameters that the DOE is required to monitor and assess during the WIPP operational period. Five of these parameters are considered "geotechnical" in nature and include:

- Creep Closure
- Extent of Deformation
- Initiation of Brittle Deformation
- Displacement of Deformation Features
- Subsidence

Data needed to derive and evaluate the geotechnical COMPs are available from the most recent annual Geotechnical Analysis Report (GAR; DOE 2009c) and the annual Subsidence Monument Leveling Survey (DOE 2008). Three of the geotechnical parameters lend themselves to quantification: creep closure, displacement of deformation features and subsidence. In contrast, the extent of deformation and initiation of brittle deformation are qualitative or observational parameters.

The WIPP GARs have been available since 1983 and are currently prepared by the M&OC on an annual basis. The purpose of the GAR is to present and interpret geotechnical data from the underground excavations. These data are obtained as part of a regular monitoring program and are used to characterize current conditions, to compare actual performance to the design assumptions, and to evaluate and forecast the performance of the underground excavations during operations. Additionally, the GAR fulfills various regulatory requirements and through the monitoring program, provides early detection of conditions that could affect operational safety, data to evaluate disposal room closure, and guidance for design changes. Data are presented for specific areas of the facilities including: (1) Shafts and Keys, (2) Shaft Stations, (3) Northern Experimental Area, (4) Access Drifts, and (5) Waste Disposal Areas. Data are acquired using a variety of instruments including convergence points and meters, multipoint borehole extensometers, rockbolt load cells, pressure cells, strain gauges, piezometers and joint meters. All of the geotechnical COMPs involve analyses of deformations/displacements, so the most pertinent data derived from the GAR are convergence and extensometer data. The most recent GAR (DOE 2009c) summarizes data collected from July 2007 through June 2008.

Subsidence monitoring survey reports are also prepared by the M&OC on an annual basis and present the results of leveling surveys performed in 2008 for 9 vertical control loops comprising approximately 15 linear miles traversed over the ground surface of the WIPP site. Elevations are determined for 48 current monuments and 14 National Geodetic Survey vertical control points using digital leveling techniques to achieve Second-Order Class II loop closures or better. The data are used to estimate total subsidence and subsidence rates in fulfillment of regulatory requirements. The most recent survey (DOE 2008) summarizes data collected between September and November of 2008.

Comparisons between available geotechnical COMP related data and the TVs allow evaluation of the most recent geotechnical observations for the COMPs program. The cited reports and programs provide a good evaluation of all observations where deviations from historical normal occurrences are recorded. This process, as engaged for COMPs assessments, not only focuses attention on monitored parameters, it allows for reassessment of the proposed TVs. Notable deviations are addressed in the GAR and other references, and are reexamined here in the context of COMPs and TVs.

Geotechnical COMPs can be derived from or related to the repository's operational safety monitoring program, which has been implemented to ensure worker and mine safety. By nature, changes in geotechnical conditions evolve slowly; however, they are monitored continuously and reported annually. Since pertinent data from the underground reflect slowly evolving conditions, relationships that correlate to geotechnical COMPs also evolve slowly. Therefore, geotechnical conditions warranting action for operational safety will become evident before such conditions would impact long-term waste isolation. Monitoring underground response allows continuing assessment of conceptual geotechnical models supporting certification. In effect, these annual comparisons of actual geotechnical response with expected response serve to validate or improve models.

2.2.1 Creep Closure

Table 2.5 summarizes PA, data and TV information relating to the COMP, Creep Closure. The GAR compiles all geotechnical operational safety data gathered from the underground. The most readily quantifiable geomechanical response in the WIPP underground is creep closure. The GAR routinely measures and reports creep deformation, either from rib-to-rib, roof-to-floor, or extensometer borehole measurements. With the exception of newly mined openings, rates of closure are relatively constant within each zone of interest and usually range from about 1-5 cm/yr. A closure rate in terms of cm/yr can be expressed as a global or nominal creep rate by dividing the displacement by the room dimension and converting time into seconds. Nominally these rates are of the order of $1x10^{-10}$ /s and are quite steady over significant periods. From experience, increases and decreases of rates such as these might vary by 20 percent without undue concern. Therefore, the "trigger value" for creep deformation was set as one order of magnitude increase in creep rate. Such a rate increase would alert the M&OC geotechnical staff to scrutinize the area exhibiting accelerating creep rates.

Extensive GAR data suggest that possible TV could be derived from creep rate changes. The WIPP underground is very stable, relative to most operating production mines, and deformation is steady for long periods. However, under certain conditions creep rates accelerate, indicating a change in the deformational processes. Arching of microfractures to an overlying clay seam might create the onset of the roof beam de-coupling and increase the measured closure rate. Phenomena of fracture coalescence and DRZ growth comprise important elements of PA assumption confirmation. Therefore, a measured creep rate change over a yearly period constitutes the COMP TV for creep closure. Rate changes are necessarily evaluated on a case-by-case basis since closure is related to many factors such as age of the opening, location in the room or drift, convergence history, recent excavations, and geometry of the excavations.

The creep deformation COMP is addressed by examining the deformations measured in specific regions of the underground including: (1) Shafts and Shaft Stations and (2) Access

Drifts and Waste Disposal Areas. Figure 2.1 shows the current configuration of the WIPP underground with specific elements and regions annotated for reference. Information used

Table 2. 5 Creep Closure - 2009:

COMP Title:	Creep Closure			
COMP Units:	Closure Rate (s^{-1})			
Related Monitoring Data				
Monitoring **Program**	Monitoring Parameter ID	Characteristics (e.g., number, observation)	Compliance Baseline Value	
Geotechnical	Closure	Instrumentation located throughout the underground.	Munson-Dawson (MD) Constitutive Model	
COMP Assessment Process - Reporting Period July 2007 through June 2008				
Evaluate GAR for centerline closure rates, compare to previous year's rate. Account for drift dimensions and convert to creep rate. If closure rate increases by greater than one order of magnitude, initiate technical review.				
Related Performance and Compliance Elements				
Element Title	Parameter Type & ID or Model Description	Derivation Procedure	Compliance Baseline	Impact of Change
Repository Fluid Flow	Creep Closure	Porosity Surface, waste compaction, characteristics, waste properties, evolution of underground setting	SANTOS, porosity surface calculations	Provides validation of the creep closure model.
Monitoring Data Trigger Values				
Monitoring Parameter ID	Trigger Value	Basis		
Creep Closure	Greater than one order of magnitude increase in closure rate.	The closure rate increase signals potential de-coupling of rock.		

for all geotechnical COMPs is derived from the GAR which has a reporting period ending June 30, 2008. For this reporting period, Panels 1 through 5 had been fully excavated. Figure 2.1 shows all areas mined as of June 30, 2008. At that time, waste was being emplaced in panel 4 while panels 1, 2 and 3 waste disposal operations had ceased and the entry drifts had been sealed to prevent access (please note that the reporting period for geotechnical information is through June 2008 such that the reported mining and emplacement activities depicted in Figure 2.1 from the GAR are not as current as the waste activity COMP information, which is through June 30, 2009).

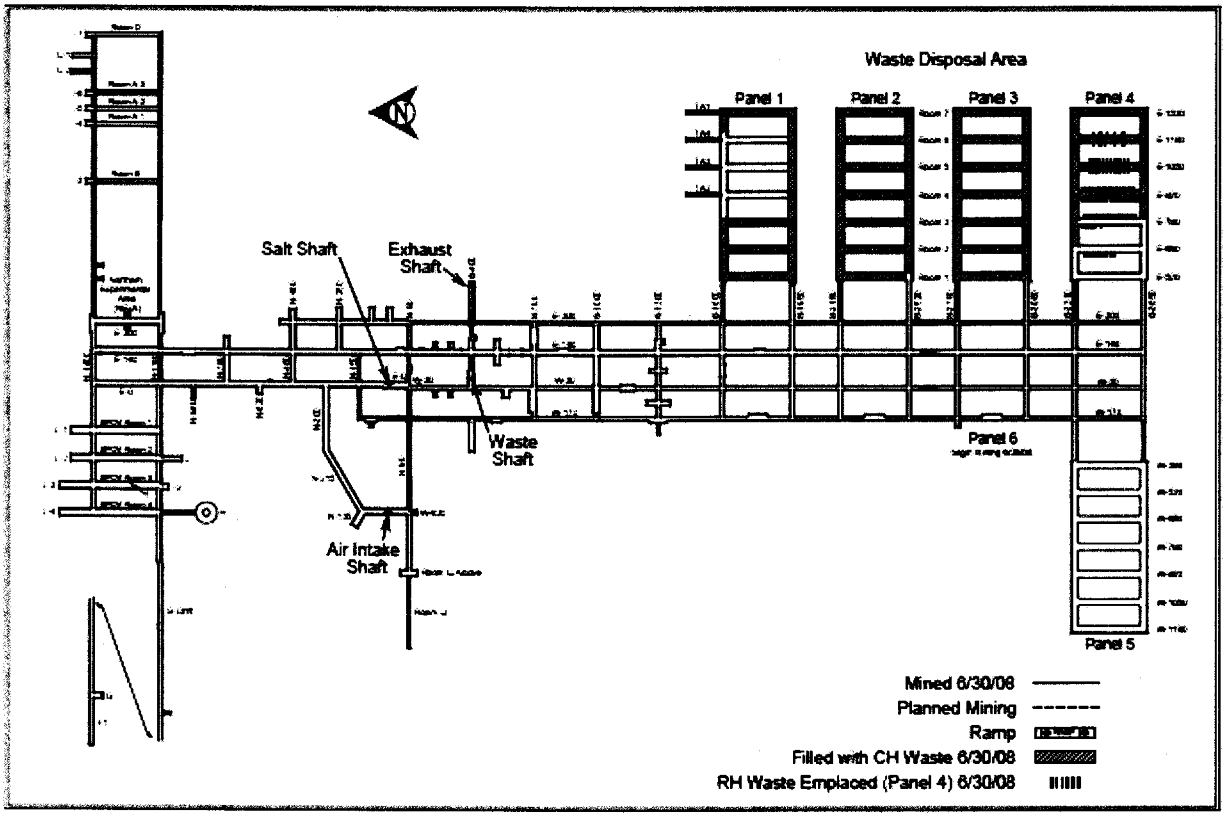

Figure 2.1 Configuration of the WIPP Underground for Geotechnical COMPs (after DOE 2009c; Reporting Period July 2007 through June 2008).

Shafts and Shaft Stations

The WIPP underground is serviced by 4 vertical shafts including the following: (1) Salt Handling Shaft, (2) Waste Shaft, (3) Exhaust Shaft, and (4) Air Intake Shaft. At the repository level (approximately 650 m below ground surface), enlarged rooms have been excavated around the Salt Handling and Waste Shafts to allow for movement of equipment, personnel, mined salt and waste into or out of the facility. The enlarged rooms are called shaft stations and assigned designations consistent with the shaft they service (e.g., Salt Handling Shaft Station).

<u>Shafts.</u> With the exception of the Salt Handling Shaft, the shafts are configured nearly identically. From the ground surface to the top of the Salado Formation, the shafts are lined with un-reinforced concrete. Reinforced concrete keys are cast at the Salado/Rustler interface with the shafts extending through the keys to the Salado. Below the keys, the shafts are essentially "open holes" through the Salado Formation and terminate either at the repository horizon or at sumps that extend approximately 40 m below the repository horizon. In the Salt Handling Shaft, a steel liner is grouted in place from the ground surface to the top of the Salado. Similar to the three other shafts, the Salt Handling Shaft is configured with a reinforced concrete key and is "open-hole" to its terminus. For safety purposes, the portions of the open shafts that extend through the Salado are typically supported using wire mesh anchored with rock bolts to contain rock fragments that may become detached from the shaft walls. Within the Salado Formation, the shaft diameters range from 3.65 m to 7.0 m.

Data available for assessing creep deformations in the salt surrounding the shafts are derived exclusively from routine inspections and extensometers extending radially from the shaft walls. These data are reported annually in the GAR. The Salt Handling Shaft, Waste Shaft, and Air Intake Shaft are inspected weekly by underground operations personnel. Although the primary purpose of these inspections is to assess the conditions of the hoisting and mechanical equipment, observations are also made to determine the condition of the shaft walls, particularly with respect to water seepage, loose rock, and sloughing. In contrast to the other three shafts, the Exhaust Shaft is inspected quarterly using remote-controlled video equipment. These inspections have focused on salt build-up in the Exhaust Shaft and the impacts this build-up has on power cabling in the shaft. Based on these visual observations, all four shafts are in satisfactory condition and have required only routine ground-control activities during this reporting period.

Shortly after its construction, each shaft was instrumented with extensometers to measure the inward movement of the salt at 3 levels within the Salado Formation. In addition to COMPs assessment, measurements of shaft closure are used periodically as a calibration of calculational models and have been used in shaft seal system design. The approximate depths corresponding to the 3 instrumented levels are 330 m, 480 m and 630 m. Three extensometers are emplaced at each level to form an array. The extensometers comprising each array extend radially outward from the shaft walls and are equally spaced around the perimeter of the shaft wall. Over the years, most of these extensometers have malfunctioned. As a result, reliable data are not available at some locations. The DOE currently has no plans to replace failed instrumentation installed in any of the shafts because monitoring data acquired to date have shown no unusual shaft movements or displacements.

Table 2.6 provides a summary of the current displacement rates of the shaft walls based on data reported in the GAR (DOE 2009c). It should be noted that no extensometer data was collected from the shafts during the reporting period because of a data logger failure. The type of extensometer is no longer manufactures nor is a compatible data logger. DOE does not plan to replace the logger with an alternate because of compatibility and interface issues. As such the rate information from the Waste Shaft is reported but was not used in this assessment.

<u>Shaft Station.</u> Shaft station openings are typically rectangular in cross-section with heights ranging from approximately 4 to 6 m and widths ranging from 6 to 10 m. Over the life-time of the individual shaft stations, modifications have been made that have altered the dimensions of the openings. In the past, portions of the Salt Handling Shaft Station have been enlarged by removing the roof beam that extended up to anhydrite "b". In the Waste Handling Shaft Station, the walls have been trimmed to enlarge the openings for operational purposes. No major modifications were performed at the shaft stations during this reporting period. Ground control, bolt replacement, bolt trimming and cable shoe anchor replacement were performed as routine maintenance.

The effects of creep on the shaft stations are assessed through visual observations and displacement measurements made using extensometers and convergence points. Because of the modifications made over the years, many of the original instrumentation has been removed or relocated. In addition, some instruments have malfunctioned or have been damaged and no longer provide reliable data. Displacement rates from existing and functional instrumentation listed in the GAR for the current reporting period (2007-2008) and the previous reporting period (2006-2007) are summarized in Table 2.6. Most of the measurements are for vertical closure. Based on convergence data, current vertical displacement rates range from 0.08 to 1.57 in/yr (0.20 to 3.99 cm/yr); current horizontal displacement rates range from 0.89 to 1.05 in/yr (2.26 to 2.67 cm/yr). Dividing convergence rates by the average room dimension (approximately 6 meters) and expressing the results in units of 1/s yields vertical and horizontal creep rates between approximately 1.06×10^{-11}/s to 2.11×10^{-10}/s. These rates are still low and represent typical creep rates for stable openings in salt. An examination of the percentage changes in displacement rates shown in Table 2.6 suggests the current shaft station displacement rates (where available) are essentially identical to those measured during the previous reporting period. Based on the extensometer and convergence data, as well as the limited maintenance required in the shaft stations during the last year, creep deformations associated with the WIPP shaft stations are considered acceptable and meet the TV requiring creep deformation rates to change by less than one order of magnitude in a one-year period.

Table 2. 6 Summary of Closure Rates for WIPP Shafts and Shaft Stations.

Location	Inst. Type[a]	Displacement Rate (in/yr)[c]		Change In Rate (%)
		2006–2007	2007–2008	
Salt Handling Shaft	No extensometers remain functional			
Waste Handling Shaft	No extensometers remain functional			
Exhaust Shaft	No extensometers remain functional			
Salt Handling Shaft Station				
E0 Drift – S18 (A-E)	CP	1.51	1.41	-7
E0 Drift – S18 (B-D)	CP	1.64	1.57	-4
E0 Drift – S18 (H-F)	CP	1.04	0.94	-10
E0 Drift – S30 (A-C)	CP	1.55	1.47	-5
E0 Drift – S65 (A-C)	CP	1.15	1.05	-9
Waste Shaft Station				
S400 Drift – W30 (Vert. CL)	Ext	0.25	0.32	28
Waste Shaft Brow (North)	Ext	0.08	0.08	0
Waste Shaft Brow (South)	Ext	0.20	0.32	60
S400 Drift – E30 (Horiz. CL)	CP	0.91	0.89	-2
S400 Drift – E90 (Horiz. CL)	CP	1.05	1.05	0
Air Intake Shaft Station				
S65 Drift – W620 (Vert CL)	Ext	0.26	0.32	26
N95 Drift – W620 (Vert CL)	Ext	0.34	0.42	24

(a) Instrument Type: Ext = extensometer; CP = convergence point.
(b) CL = Centerline
(c) nr = no reading available

Access Drifts and Waste Disposal Area

Access Drifts. The access drifts comprise the 4 major north-south drifts extending southward from near the Salt Handling Shaft to the entries into the waste disposal panels and several short cross-drifts intersecting these major drifts. The access drifts are typically rectangular in cross-section with heights ranging from 4.0 m to 6.4 m and widths ranging from 4.3 m to 9.2 m.

During the current reporting period (July 2007 to June 2008), excavation of Panel 5 was completed. Panels 3 and 4 were excavated at a slightly higher stratigraphic position (2.4 m) than either Panels 1 or 2. The roof of these panels coincides with Clay G. As such, Panels 1, 2, 7 and 8 will be at the original horizon and Panels 3, 4, 5 and 6 approximately 2.4 m higher in elevation (roof at Clay G). Trimming, scaling, floor milling and rock bolting operations were performed as necessary during the reporting period. During the reporting period, 21 convergence points were replaced and 4 new points were added because of new mining and ongoing trimming activities.

Assessment of creep deformations in the access drifts is made through the examination of extensometer and convergence point data reported annually in the GAR. Table 2.7 summarizes the vertical and horizontal displacement data reported in the most recent GAR (DOE 2009c). The table examines percentage changes between displacement rates measured during the current and previous annual reporting periods and breaks these percentage changes into ranges (e.g., <0% which includes negative values, 0 to 25%, 25 to 50%, etc.). The numbers shown in the tables represent the number of instrumented locations located on the drift centerline vertically or at the midpoint horizontally that fall within the range of the indicated percentage change. In general, convergence rate accelerations continue to be minor in most locations. Other areas that have shown an increase in closure rates can be directly attributed to mining in Panel 5 and associated drifts. The majority of the rate changes for the 2007 COMPs data were negative or near zero which demonstrates that displacements were slowing. For this 2009 and the 2008 COMP reports, the majority of the data are in the less than 0 range. Both convergence point data and extensometer data were combined in this year's report. The maximum displacement rates corresponding to these data for the current reporting period are given below:

Maximum Vertical Displacement Rates along Access Drift Centerlines:

6.40 cm/yr

Maximum Horizontal Displacement Rate along Access Drift Centerlines:

3.46 cm/yr

Using a typical average drift dimension of 5 m and the maximum displacement rates shown above, the inferred maximum creep rate is approximately 2.44×10^{-10}/s. This rate is based on the maximum displacement which is not representative of the behavior of the system.

Creep deformations associated with the Access Drifts are acceptable and meet the TV requiring creep deformation rates to change by less than one order of magnitude in a one-year period. High displacement rates observed at a few locations have little effect on safety as geotechnical engineering provides continuous ground-control monitoring and remediation on an as-needed basis.

Waste Disposal Area: The Waste Disposal Area is located at the extreme southern end of the WIPP facility and is serviced by the access drifts described above. Eventually, the Waste Disposal Area will include 8 disposal panels, each comprising 7 rooms (the major north-south access drifts servicing the 8 panels will also be used for waste disposal and will make up the ninth and tenth panels). Panel 1 was constructed in the late 1980s, Panel 2 constructed during the 1999-2000 time period, Panel 3 constructed during the 2002-2004 time period and the completion of Panel 4 during 2006. As of June 30, 2008 (for the GAR reporting period), waste emplacement operations were complete in Panels 1, 2 and 3. Panel 4 was currently being used for waste emplacement. Panel 5 mining was completed during this GAR reporting period. Figure 2.1 shows the state of waste emplacement and mining for the GAR reporting period.

The waste emplacement rooms are rectangular in cross-section with a height of 4 m and a width of 10 m. Entry drifts that provide access into the disposal rooms are also rectangular with a height of 3.65 m and a width of 4.3 m.

Table 2. 7 Summary of Changes in Vertical and Horizontal Displacement Rates Measured Along the Centerlines of the WIPP Access Drifts and Waste Disposal Area Openings.

Location	Number of Instrument Locations Where the Indicated Percentage Change has Occurred					
	Percentage Increase in Displacement Rate for Measurements Made During the 2006-2007 and 2007-2008 Reporting Periods					
	< 0%	0 – 25%	25 – 50%	50 – 75%	75 – 100%	100 – 200%
Access Drifts						
Vertical	105	129	19	6	3	6
Horizontal	98	34	0	2	2	1
Waste Disposal Area						
Panel 3:						
Vertical	0	4	1	2	2	2
Horizontal	2	0	0	0	0	0
Panel 4						
Vertical	37	6	0	0	0	0
Horizontal	7	0	0	0	0	0
Panel 5						
Vertical	33	2	0	0	0	0
Horizontal	49	0	0	0	0	0

Assessment of creep deformation in the waste disposal area is made through the examination of extensometer and convergence point data reported annually in the GAR. Tables 2.6 and 2.7 (presented previously) summarize, respectively, the vertical and horizontal displacement data reported in the most recent GAR (DOE 2009c) for Panel access drifts and Panels 3, 4 and 5. Panel 1, 2 and 3 are closed and are no longer accessible. Convergence points and extensometers were installed in Panel 5 and are currently monitored. Each table examines percentage changes between displacement rates measured during the current and previous reporting periods and breaks these percentage changes into ranges. Only data from instruments located along the drift centerlines are reported here. In addition, extensometer data are based only on displacements of the collar relative to the deepest anchor. The maximum displacement rates corresponding to these data are given below.

Maximum Vertical Displacement Rates along Waste Disposal Area Centerlines:

12.35 cm/yr

Maximum Horizontal Displacement Rates along Waste Disposal Area Centerlines:

2.99 cm/yr

Using a nominal disposal-area-opening dimension of 8 m and the maximum displacement rates shown above the inferred maximum creep rate is approximately 4.90×10^{-11}/s. This is a decrease from last year's rate of 1.11×10^{-10}/s. Maximum creep rates for the waste disposal areas are all associated with Panel 3, the oldest of the panels with at least two years of data. According to the GAR, Panel 3 (currently closed) closure rates indicate continued deformation and deteriorating ground conditions until no data could be obtained. Convergence rates for Panel 4 are generally decreasing due to a lesser influence from initial mining of the panel. Panel 5 was bolted and instrumented soon after mining, much sooner than Panels 3 and 4. Room beam deformation and room closure are trending lower than in Panel 4. This trend may be attributed to the early installation of the roof bolts.

2.2.2 Extent of Deformation

Table 2.8 summarizes PA, data and TV information relating to the COMP, Extent of Deformation. The extent of brittle deformation can have important implications to PA. As modeled in PA, the DRZ releases brine to the disposal room while properties of the DRZ control hydrologic communication between disposal panels. Therefore, extent of deformation relates directly to a conceptual model used in performance determinations. If characteristics could be tracked from inception, the spatial and temporal evolution of the DRZ would provide a validation benchmark for damage calculations.

Measurements in the GAR include borehole inspections, fracture mapping and borehole logging. These observations are linked closely to other monitoring requirements concerned with initiation of brittle deformation and displacement of deformation features. These monitoring requirements define the characteristics of the DRZ, which help validate the baseline conceptual model, and its flow characteristics. The extent of deformation quantifies the DRZ, a significant element of PA analyses.

The Geotechnical Engineering Department at WIPP has compiled back-fracturing data into a database. The supporting data for the GAR (Volume 2, DOE 2009c) consists of plan and isometric plots of fractures. Fracture development is most continuous parallel to the rooms and near the upper corners. These fractures are designated "low angle fractures" relative to the horizontal axis. The original excavation horizon results in a 2.4 m-thick beam of halite between the roof and Clay Seam G. Low-angle fractures arch over rooms and asymptotically connect with Clay Seam G. Although the preponderance of monitoring information derives from the roof (back), buckling extends into the floor to the base of Marker Bed 139, which is located about 2 m below the disposal room floors. Fracture mapping thus far is consistent with expectations and tracks stress trajectories derived from computational work. At this time, a comprehensive model and supporting data for model parameters for damage evolution has not been developed for PA.

Excavation of Panel 3 raises the waste disposal panels by 2.4 m such that the roof of the disposal rooms will be coincident with Clay Seam G and the floor will be an additional 2.4 m above Marker Bed 139. This change will likely alter the typical fracture patterns observed to date and may cause subtle changes in how the DRZ develops. Effects of excavation to Clay G have been evaluated by finite element analyses to assess possible impact to PA (Park and Holland 2003). Their modeling shows that the DRZ does not extend below MB139 at the new horizon, as it does at the original horizon. The rise in repository elevation otherwise causes no discernable change to the porosity surface used in PA. Data provided in the GAR suggest that brittle deformation extends at least 2.4 m (to Clay Seam G where present) and perhaps as much as 4.5 m (to Clay Seam H) above the roof of the WIPP openings. In addition, brittle deformation extends below the floor of the openings to at least the base of Marker Bed 139 (approximately 2 to 3 m).

Data provided in the 2009 GAR were compared to fracture maps in the previous year's report to determine if fractures exceed the 1 m/yr TV. Only Panel 4 maps were reviewed this reporting cycle. Most all fracture maps looked identical to last year's maps with the exception of the one for Panel 4, S3310, E500 to E 850. This map shows a roof fracture of approximately 30 feet in length that was not shown in the 2008 GAR. This fracture exceeds the 1 m/yr TV. As such, a more in-depth look at this area will be made during next year's COMPs assessment. No additional action is recommended at this time. Is should also be noted that access to Panel 3 was lost and Panel 5 was initially mapped during this reporting cycle.

Table 2. 8 Extent of Deformation - 2009:

COMP Title:	Extent of Deformation			
COMP Units:	Areal extent (length, direction)			
Related Monitoring Data				
Monitoring **Program**	Monitoring Parameter ID	Characteristics (e.g., number, observation)	Compliance Baseline Value	
Geotechnical	Displacement	Meters	Not Established	
COMP Assessment Process - Reporting Period July 2007 through June 2008				
Extent of deformation is deduced from visual inspections and mapping which are examined yearly for active cross sections. Anomalous growth is determined by yearly comparison.				
Related Performance and Compliance Elements				
Element Title	Parameter Type & ID or Model Description	Derivation Procedure	Compliance Baseline	Impact of Change
DRZ Conceptual Model	Micro- and macro-fracturing in the Salado Formation	Constitutive model from laboratory and field databases.	Permeability of DRZ was originally assigned a constant value of $10^{-15} m^2$ for the CCA; per EPA direction, a uniform distribution from 3.16×10^{-13} to $3.98 \times 10^{-20} m^2$ was used for all subsequent PAs	DRZ spatial and temporal properties have important PA implications for permeability to gas, brine, and two-phase flow.
Monitoring Data Trigger Values				
Monitoring Parameter ID	Trigger Value	Basis		
Fractures at depth	Growth of 1 m/y	Coalescence of fractures at depth in rock surrounding drifts will control panel closure functionality and design, as well as discretization of PA models.		

2.2.3 Initiation of Brittle Deformation

Table 2.9 summarizes PA, data and TV information relating to the COMP, Initiation of Brittle Deformation. Initiation of brittle deformation around WIPP openings is not directly measured and is therefore a qualitative observational parameter. By definition, qualitative COMPs can be subjective and are not prone to the development of well-defined TVs. This COMP is not directly related to a PA parameter. Brittle deformation eventually leads to features that are measured as part of geotechnical monitoring requirements, such as the extent and displacement of deformation features. Initiation of brittle deformation is expected to begin immediately upon creation of an opening. The ongoing geotechnical program will help quantify damage evolution around WIPP openings. Initiation and growth of damaged rock zones are important considerations to operational period panel closures as well as compliance PA calculations. As stated previously, this COMP is qualitative and is not directly related to PA parameters.

Table 2. 9 Initiation of Brittle Deformation - 2009:

COMP Title:	**Initiation of Brittle Deformation**			
COMP Units:	**Qualitative**			
Related Monitoring Data				
Monitoring **Program**	Monitoring Parameter ID	Characteristics (e.g., number, observation)	Compliance Baseline Value	
Geotechnical	Closure	Observational	Not Established	
COMP Assessment Process - Reporting Period July 2007 through June 2008				
Qualitative and pertinent to operational considerations. Captured qualitatively in association with other COMPs				
Performance and Compliance Elements				
Element Title	Parameter Type & ID or Model Descriptio n	Derivation Procedure	Compliance Baseline	Impact of Change
Not directly related to PA as currently measured	NA	NA	NA	NA
Monitoring Data Trigger Values				
Monitoring Parameter ID	Trigger Value	Basis		
Initiation of Brittle Deformation	None	Qualitative COMPs can be subjective and are not prone to the development of meaningful TVs.		

2.2.4 Displacement of Deformation Features

Table 2.10 summarizes PA, data and TV information relating to the COMP, Displacement of Deformation Features. The displacement of deformation features primarily focuses on those features located in the immediate vicinity of the underground openings, e.g., mining-induced fractures and lithological units within several meters of the roof and floor. As discussed previously, fracture development is most continuous parallel to the openings and near the upper corners. These fractures tend to propagate or migrate by arching over and under the openings and, thus are designated "low-angle fractures" relative to the horizontal axis. Typically, the fractures intersect or asymptotically approach lithologic units such as clay seams and anhydrite stringers. As a result, salt beams are formed. In the roof, the beams are de-coupled from the surrounding formation requiring use of ground support. In the floor, the beams sometimes buckle into the openings requiring floor milling and trimming. Lithologic units of primary interest are Clays G and H. These features are located approximately 2.4 m and 4.5 m respectively, above the roof of Panels 1, 2, 7 and 8. Marker Bed 139 (anhydrite) is located approximately 2 m below the floor of these panels. For Panels 3 through 6, the panels are mined up to Clay G. Clay H is therefore located 2.1 m above the roof of these panels and Marker Bed 139 is located approximately 4.4 m below the panel floors.

Table 2. 10 Displacement of Deformation Features - 2009:

COMP Title:	Displacement of Deformation Features			
COMP Units:	Length			
Related Monitoring Data				
Monitoring **Program**	Monitoring Parameter ID	Characteristics (e.g., number, observation)	Compliance Baseline Value	
Geotechnical	Delta D/D_o	Observational	Not established	
COMP Assessment Process - Reporting Period July 2007 through June 2008				
Observational – Lateral deformation across boreholes.				
Related Performance and Compliance Elements				
Element Title	Parameter Type & ID or Model Description	Derivation Procedure	Compliance Baseline	Impact of Change
Not directly related to PA	N/A	N/A	N/A	N/A
Monitoring Data Trigger Values				
Monitoring Parameter ID	Trigger Value	Basis		
Borehole diameter closure	Obscured observational borehole.	If lateral displacement is sufficient to close diameter of observational borehole, technical evaluation of consequences will be initiated.		

Monitoring of these deformation features is accomplished through visual inspection of observation boreholes (OBH) drilled from the openings through the feature of interest. In general, these boreholes are aligned vertically (normal to the roof and floor surfaces) because of the location and orientation of the fractures and lithological units of interest. All of the OBHs are 7.6 cm (3 in) in diameter, and many intersect more than one deformation feature. The ages of the OBHs vary from more than 20 years to recent.

The deformation features in OBHs are classified as: 1) offsets, 2) separations, 3) rough spots and 4) hang-ups. Of the 4 features, offsets are the principle metric for this COMP and are quantified by visually estimating the degree of borehole occlusion created by the offset. The direction of offset along displacement features is defined as the movement of the stratum nearer the observer relative to the stratum farther from the observer. Typically, the nearer stratum moves toward the center of the excavation. Based on previous observations in the underground, the magnitude of offset is usually greater in boreholes located near the ribs as compared to boreholes located along the centerline of openings.

All of the observation holes associated with Panels 1 through 3 are no longer monitored. There are a total of 164 OBHs monitored during this reporting period. These OBHs are located in the panels and access drifts. Only 9 OBH were accessible over this reporting period. There were 48 holes in Panel 4 in the last period. No OBHs are occluded in this panel. There are 47 OBHs in Panel 5 (6 more than the last reporting period). There were no occluded OBHs in Panel 5. In both Panels 4 and 5, the greatest separations were associated with Clay H and anhydrite "a". Eight holes in Panel 4 and 3 holes in Panel 5 had fractures associated with anhydrite stringers in the lower portion (first 3 feet) of the roof beam. There are 97 OBHs within the access drifts, 10 of which are fully occluded. Based on the current data available from the GAR, 5 OBHs (approx. 6% of the total) were fully occluded. The TV for displacement of deformation features is the observation of a fully occluded borehole. Exceedance of the TV is not a cause for concern given that no significant impact on safety or performance has occurred in those locations where the TV has been exceeded. However, to limit the formation of low-angle fractures and de-coupled beams over the roof, the elevation of Panels 3, 4, 5, and future Panel 6 have been raised approximately 2.4 m so the roof will then coincide with Clay G. This horizon change was implemented to improve ground control. As such, the horizon change will change the expected deformation and displacement behavior.

Displacement of deformation features has been useful for implementation of ground control alternatives (i.e., horizon change to Clay G). Displacement features complement observation of brittle deformation initiation and corroborate estimates of the extent of deformation.

2.2.5 Subsidence

Table 2.11 summarizes PA, data and TV information relating to the COMP, Subsidence. Subsidence is currently monitored via elevation determination of 48 existing monuments and 14 of the National Geodetic Survey's vertical control points. To address EPA monitoring requirements, the most recent survey results (DOE 2008) are reviewed and compared to derived TVs. Because of the low extraction ratio and the relatively deep emplacement horizon (650 m), subsidence over the WIPP is expected to be much lower and slower than over the local potash mines. Maximum observed subsidence over potash mines near the WIPP is 1.5 m, occurring over a time period of months to a few years after initial mining. In contrast, calculations show that the maximum subsidence predicted directly above the WIPP waste emplacement panels is 0.62 m assuming emplacement of CH-TRU waste and no backfill (Backfill Engineering Analysis Report [BEAR; WID 1994]). Further considerations, such as calculations of room closure, suggest that essentially all surface subsidence would occur during the first few centuries following construction of the WIPP, so the maximal vertical displacement rates would be approximately 0.002 m/yr (0.006 ft/yr). Obviously, these predicted rates could be higher or lower depending on mining activities as well as other factors such as time. Because the vertical elevation changes are very small, survey accuracy, expressed as the vertical closure of an individual loop times the square root of the loop length, is of primary importance. For the current subsidence surveys, a Second-Order Class II loop closure accuracy of 8 mm × $\sqrt{km}$ (or 0.033 ft × $\sqrt{mile}$) or better was achieved in all cases.

Three monuments have also been included in various annual surveys, but were not included in the current surveys because the monuments no longer exist (last surveyed in 2003, monuments S-17 & S-18 are under a salt pile) or have been physically disturbed (PT-31, last surveyed in 2003). Historically, the surveys were conducted by private companies under subcontract to DOE; however, since 1993, the WIPP M&OC has conducted the surveys using a set of standardized methods. Starting with the 2002 survey, the M&OC has been following WIPP procedure WP 09-ES4001 (WTS 2002).

Table 2. 11 Subsidence - 2009:

COMP Title:	Subsidence		
COMP Units:	Change in surface elevation in meters per year		
Related Monitoring Data			
Monitoring **Program**	Monitoring Parameter ID	Characteristics (e.g., number, observation)	Compliance Baseline Value
Subsidence Monitoring Leveling Survey (SMP)	Elevation of 62 original monitoring monuments	Decimal (meters)	Not Established
SMP	Change in elevation over year	Decimal (meters)	Not Established
COMP Assessment Process – 2009; Data acquired between September through December of 2008			
Survey data from annual WIPP Subsidence Monument Leveling are evaluated. Elevations of 48 monitoring monuments are compared to determine change.			

Related Performance and Compliance Elements

Element Title	Parameter Type & ID or Model Description	Derivation Procedure	Compliance Baseline	Impact of Change
Subsidence	FEP [W-23]	Predictions are of low consequence to the calculated performance of the disposal system – based on WID (1994) analysis and EPA treatment of mining.	Maximum total subsidence of 0.62 m above the WIPP.	Predicted subsidence will not exceed existing surface relief of 3 m – i.e., it will not affect drainage. Predicted subsidence may cause an order of magnitude rise in Culebra hydraulic conductivity (CRA Appendix PA Attachment SCR , Section SCR-6.3.1.4) – this is within range modeled in the PA. Predicted WIPP subsidence is below that predicted for the effects of potash mining (0.62 m vs.1.5 m; DOE 2004).

Monitoring Data Trigger Values

Monitoring Parameter ID	Trigger Value	Basis
Change in elevation per year	1.0×10^{-2} m (3.25×10^{-3} ft) per year subsidence	Based on the most conservative prediction by analyses referenced in the CCA.

The current surveys comprise 9 leveling loops containing as few as 5 to as many as 10 monuments/control points per loop as shown in Figure 2.2 (Surveys of Loop 1 benchmarks have been discontinued because only 2 benchmarks comprise this loop and these benchmarks are redundant to other survey loops). Elevations are referenced to Monument S-37 located approximately 7,700 ft north of the most northerly boundary of the WIPP underground excavation. This location is considered to be far enough from the WIPP facility to be unaffected by excavation-induced subsidence expected directly above and near the WIPP underground. The elevation of S-37 has been fixed at 3,423.874 feet for all of the subsidence leveling surveys conducted since 1993. Survey accuracy for all loops was within the allowable limits (DOE 2008). Adjusted elevations are determined for every monument/control point by proportioning the vertical closure error for each survey loop to the monuments/control points comprising the loop. The proportions are based on the number of instrument setups and distance between adjacent points within a survey loop.

The adjusted elevations for each monument/control point are plotted as functions of time to assess subsidence trends. Figures 2.3 through 2.7 provide, respectively, elevations for selected monuments including those located (1) directly above the first waste emplacement panel, (2) directly above the second waste emplacement panel, (3) directly above the north experimental area, (4) near the salt handling shaft, and (5) outside the repository footprint of the WIPP underground excavation. As expected, subsidence is occurring directly above the underground openings (Figures 2.3 through 2.6); however the magnitude of the subsidence above the openings is small ranging from about -0.10 ft to -0.20 ft. Most of the observed subsidence has occurred in the time period from 1987 to 1993, but as discussed above, consistent surveying practices were not implemented until 1993 so some of the observed elevation changes may be related to differences in methodology rather than subsidence.

Elevations of survey points located directly above waste emplacement Panel 1 were stable during the 1994 to 1998 surveys, as shown in Figure 2.3. However, when the excavation of Panel 2 was initiated in 1999, the elevations of the survey points above Panel 1 began to decrease with time in a nearly linear manner. These higher rates of subsidence were anticipated because the excavation of new panels caused a redistribution of stress in the salt around Panel 1, leading to higher creep rates in the salt and higher convergence rates of panel rooms. Based on three-dimensional modeling conducted by Patchet et al. (2001), the convergence rates within Panel 1 were predicted to increase by as much as 60 to 96 percent as a result of the mining of Panel 2. A manifestation of these higher convergence rates is higher subsidence rates at the surface. Higher subsidence rates were also expected directly above Panel 2 because of the excavation of the next consecutive panel. Figure 2.4 shows that the elevations of the survey points located above Panel 2 also began to decrease immediately following the initiation of Panel 2 excavation in 1999. With the completion of the Panel 2 excavation in October 2000, subsidence rates of survey points located above both Panel 1 and Panel 2 slowed as indicated by the 2002 survey results shown in Figures 2.3 and 2.4, but then accelerated again in 2003 (particularly above Panel 2) as a result of the excavation of Panel 3 and its access drifts. This general trend has continued as more panels were mined.

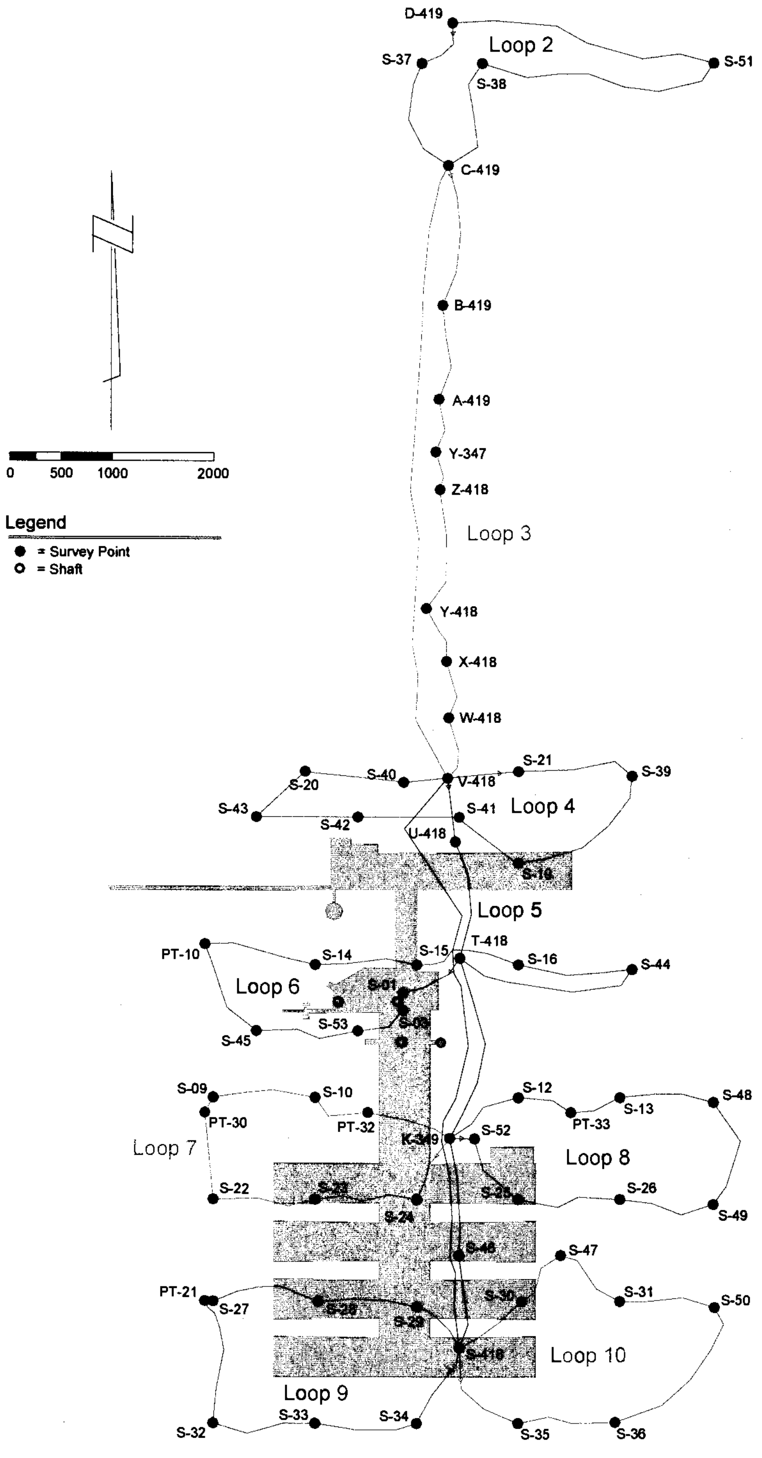

Figure 2. 2. Monuments and vertical control points comprising WIPP subsidence survey loops.

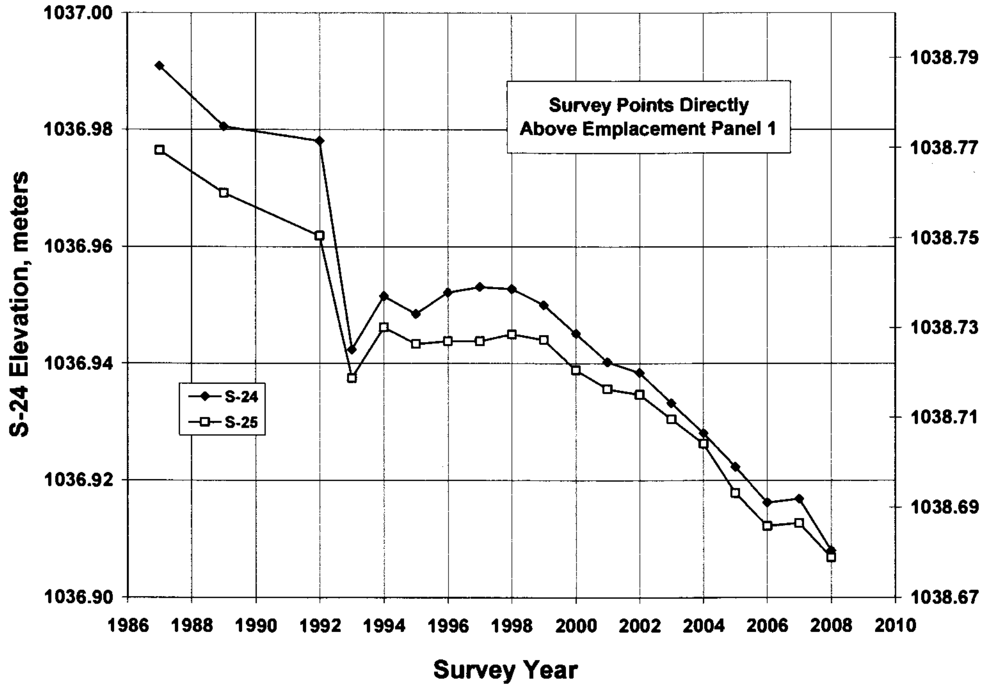

Figure 2. 3. Elevations of WIPP monuments S-24 and S-25 located directly above emplacement Panel 1.

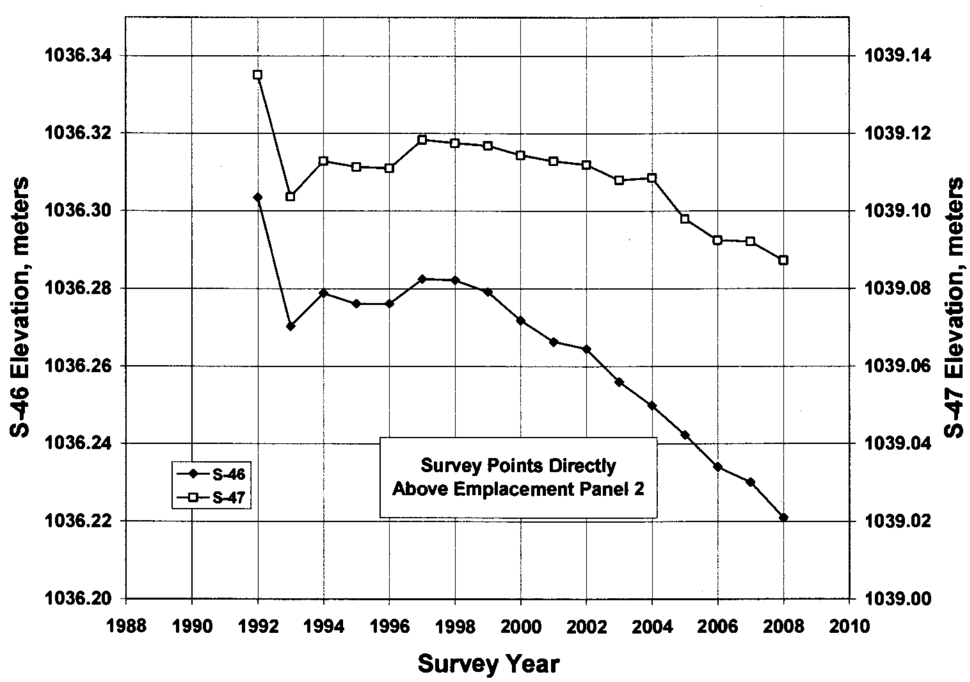

Figure 2. 4. Elevations of WIPP monuments S-46 and S-47 located directly above emplacement Panel 2.

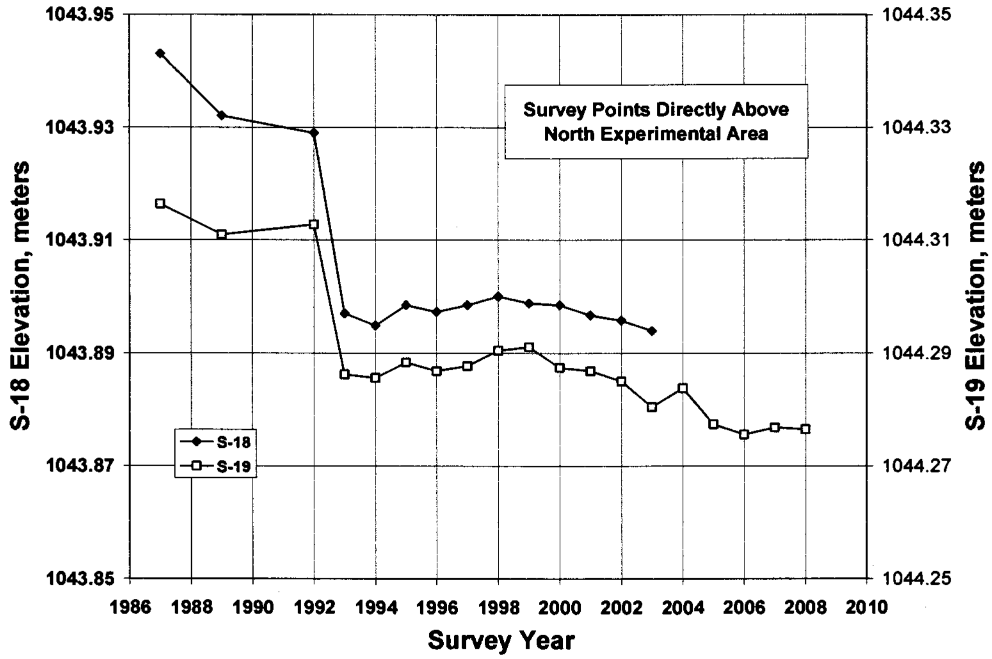

Figure 2. 5. Elevations of WIPP monuments S-18 and S-19 located directly above the north experimental area.

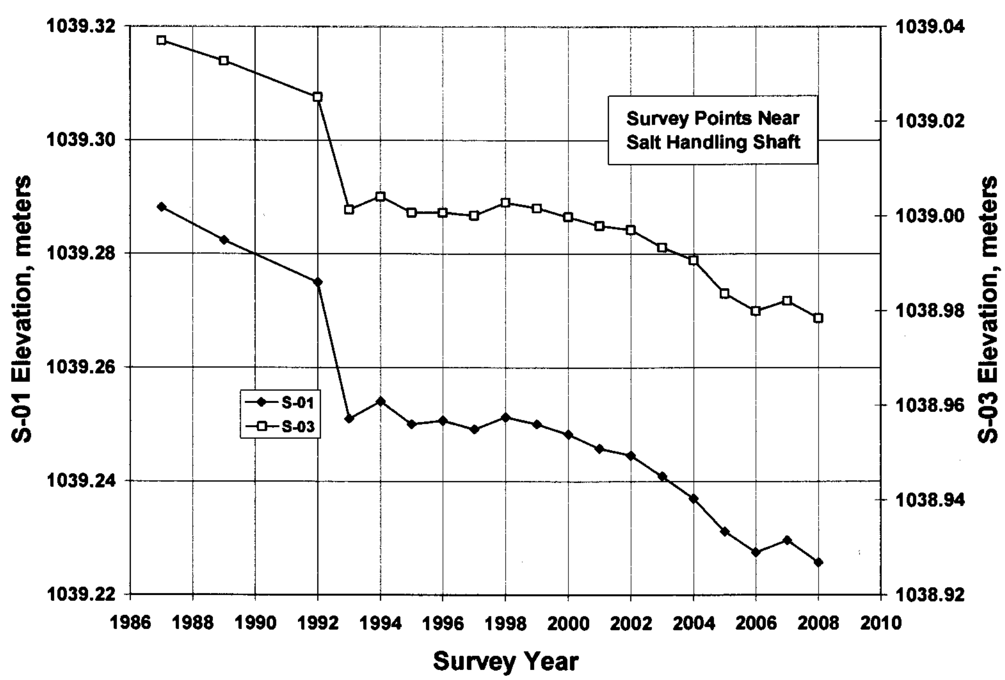

Figure 2. 6. Elevations of WIPP monuments S-01 and S-03 located near the Salt Handling Shaft.

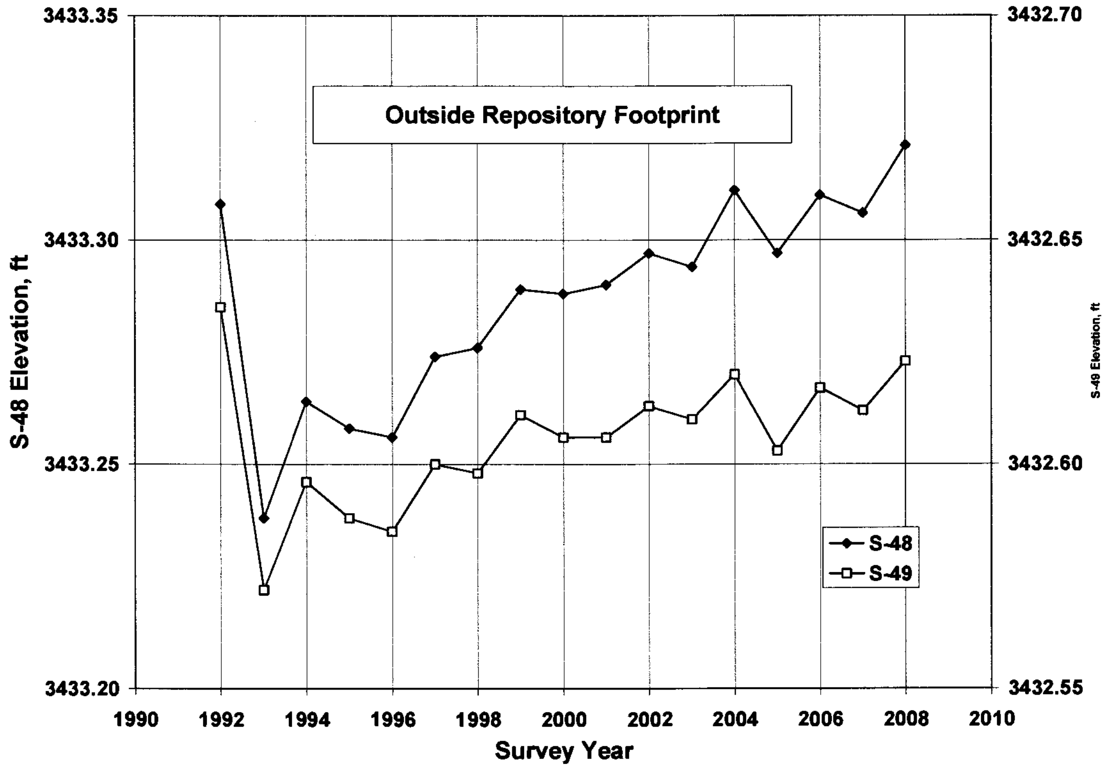

Figure 2. 7. Elevations of WIPP monuments S-48 and S-49 located outside the repository footprint.

As time passes, subsidence is expected to be most pronounced directly above the WIPP underground excavations and will be minimal away from the repository footprint. Early results suggest this pattern is already occurring, as shown in Figures 2.8 through 2.10 for the following subsidence profiles (shown in plan view in Figure 2.2):

- Section A-A′, North-South section extending through the WIPP site
- Section B-B′, North-South section extending from the north experimental area through the south emplacement panels
- Section C-C′, East-West section extending through Panel 1

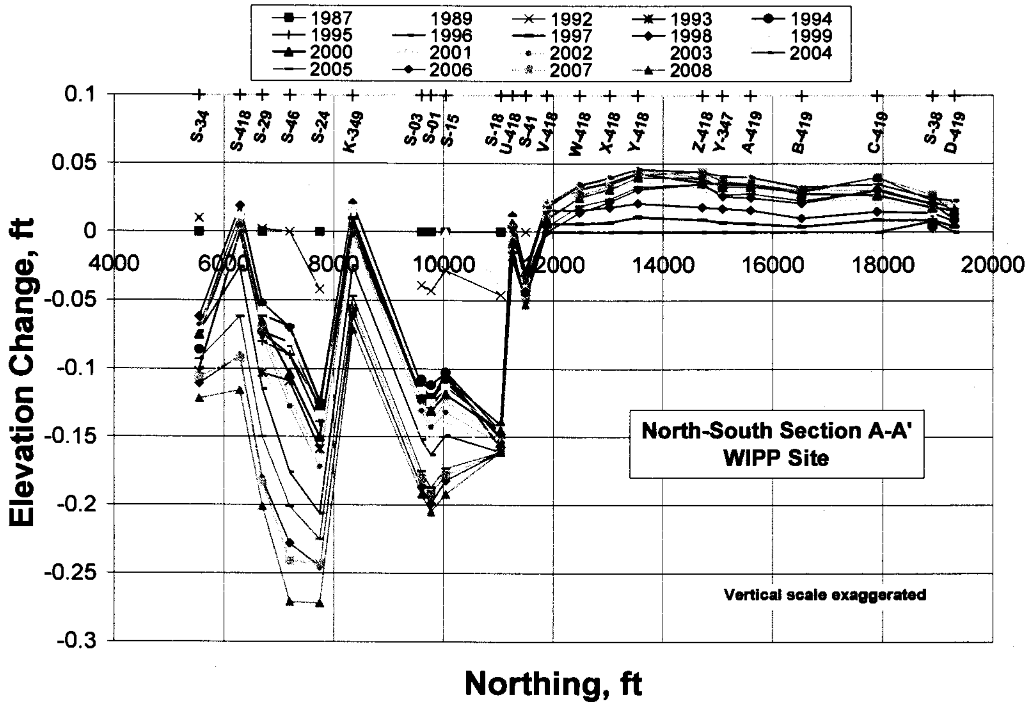

Figure 2. 8. North-South subsidence profile A-A'.

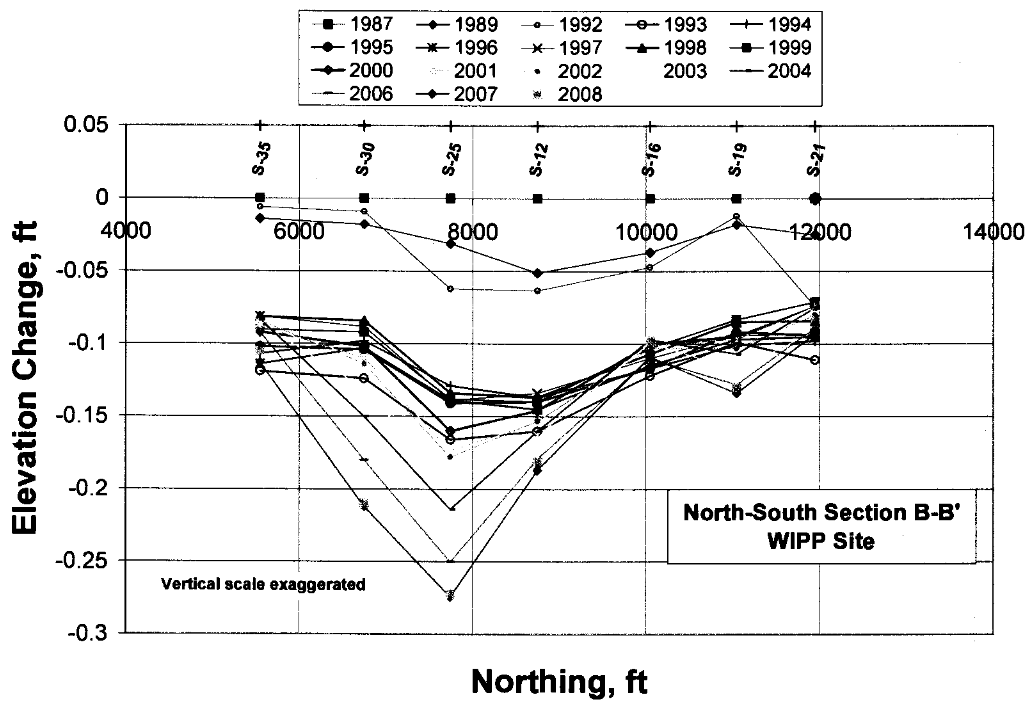

Figure 2. 9. North-South subsidence profile B-B'.

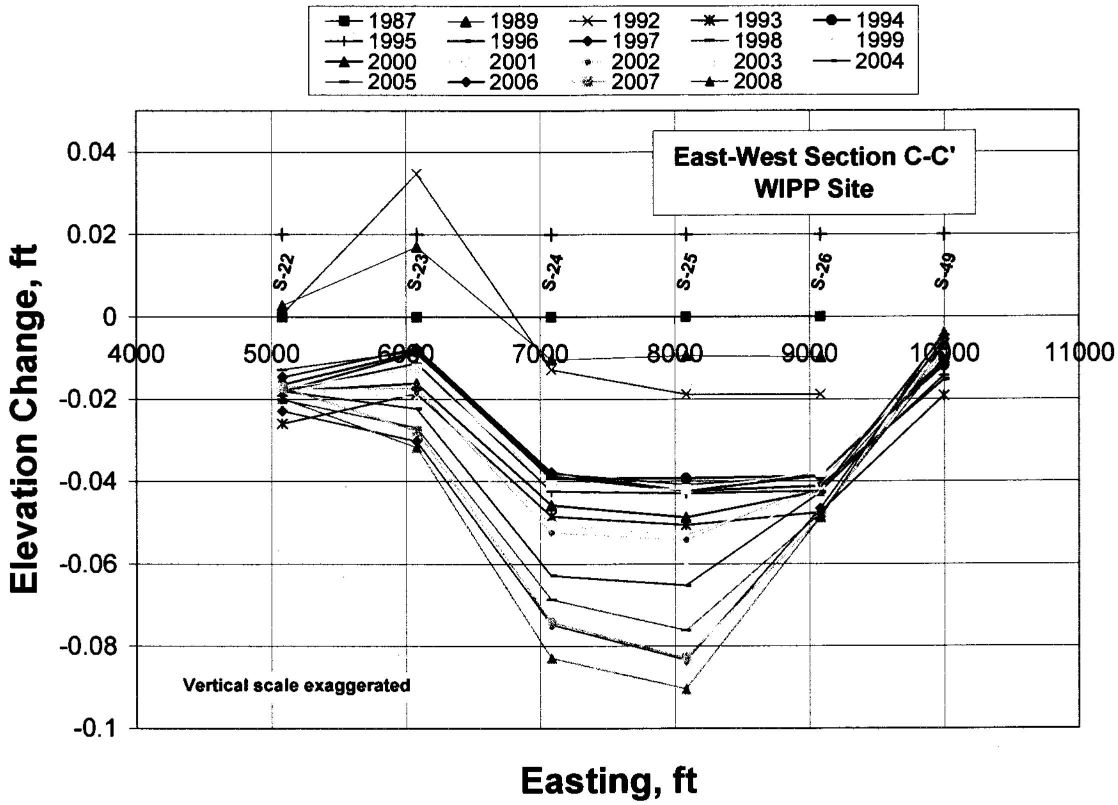

Figure 2. 10. East-West subsidence profile C-C′.

The elevation changes of individual monuments shown in these figures are referenced to the elevations determined from the annual surveys that first incorporated the monument so, in some cases, direct temporal comparisons between pairs of monuments cannot be made. For example, only 29 monuments were included in the 1987 survey, while 50 and 65 monuments were included in the 1992 and 1996 surveys, respectively. Although direct comparisons cannot always be made, several observations are possible including:

1. The most significant subsidence (greater than - 0.20 ft) occurs above the waste panels (Monuments PT-32, S-1, S-12, S-14, S-23, S-24, S-25, S-29, S-30 and S-46), with slightly less subsidence (-.20 to -0.18 ft) near the Shafts (Monuments S-1, S-15 and S-16). The maximum subsidence of 0.297 was over Panel 1 (S-25).
2. The highest subsidence rates measured for the 2007-2008 surveys correspond to benchmarks located over Panel 2 at marker S-46 which had a rate of approximately $9x10^{-3}$ m/yr. Markers S-24, S-25, S-28 through S-30, S-46 and S-47 located over the waste panels had rates of greater than $5x10^{-3}$ m/yr. Marker S-31, S35 and S-47 located near the waste panels had a rate of approximately $5x10^{-3}$ m/yr while S-45 located near the waste shafts had a rate of $6x10^{-3}$ m/yr. The most significant subsidence occurred over the waste panels.
3. The effects of subsidence extend away from the repository footprint approximately 1,000 to 1,500 ft (e.g., S-26, see Figures 2.2 and 2.10).

Furthermore, total subsidence and subsidence rates are small, and are approximately at the resolution level of the survey accuracy. The highest subsidence rates are seen above the mined panels and have increased since the mining of Panels 3, 4 and 5. Based on the latest survey data, subsidence rates of the ground surface at the WIPP have not exceeded the 1×10^{-2} m/yr TV. No additional activities are recommended at this time.

2.3 Hydrological COMPs

As stated in the previous sections, the Compliance Recertification Application (CRA) lists 10 monitoring parameters that the DOE is required to monitor and assess during the WIPP operational period (DOE 2009a). Two of these parameters are considered hydrological in nature and include:

- Changes in Culebra Water Composition
- Changes in Culebra Groundwater Flow

The SA has reviewed the data collected by the MOC during 2008 under the *Groundwater Monitoring Program Plan* (GMP; WTS 2003), which comprises two components:

- The Water Quality Sampling Program (WQSP)
- The Water-Level Monitoring Program (WLMP)

WQSP and WLMP data are reported in the Waste Isolation Pilot Plant Annual Site Environmental Report (ASER) for 2008 (DOE 2009d). Additionally, WLMP data are also reported in monthly memoranda from the MOC to the SA.

2.3.1 Changes in Culebra Water Composition

2.3.1.1 Water Quality Sampling Program (WQSP)

Table 2.12 summarizes PA, data and TV information relating to the COMP, Change in Culebra Water Composition.

Under the current WQSP, 7 wells are sampled by the MOC. Six of the wells (WQSP-1 through 6) are completed to the Culebra Dolomite Member of the Rustler Formation and the seventh (WQSP-6A) is completed to the Dewey Lake Formation (Figure 2.11). All the WQSP wells are located within the WIPP Land Withdrawal Boundary (LWB). WQSP-1, 2, and 3 are situated hydraulically up-gradient (north) of the WIPP surface facilities and WQSP-4, 5, and 6 are situated down-gradient (south) of the WIPP surface facilities. The Dewey Lake, to which WQSP-6A is completed, bears water only in the southwestern portion of the WIPP site and farther to the south.

The Culebra is modeled for PA because it is the most transmissive, lowest head, saturated water-bearing zone in the WIPP vicinity and, therefore, it is considered the most likely groundwater release pathway if inadvertent human intrusion of the repository were to occur in the future. The Culebra is not, however, a source of drinking water and water quality is

Table 2. 12 Change in Groundwater Composition - 2009:

Trigger Value Derivation

COMP Title:	Groundwater Composition
COMP Units:	mg/L

Related Monitoring Data

Monitoring Program	Monitoring Parameter ID	Characteristics (e.g., number, observation)	Compliance Baseline Value
Groundwater Monitoring	Composition	Semi-annual chemical analysis	RCRA Background Water Quality Baseline

COMP Derivation Procedure – Data acquired in two rounds, March-May (round 26) and September-November (round 27) 2008

Annually evaluate ASER data and compare to previous years and baseline information

Related Performance and Compliance Elements

Element Title	Type & ID	Derivation Procedure	Compliance Baseline	Impact of Change
Groundwater conceptual model, brine chemistry, actinide solubility	Indirect	Conceptual models	Indirect – The average Culebra brine composition is not used.	Provides validation of the various CCA models, potentially significant with respect to flow, transport, and solubility and redox assumptions.

Monitoring Data Trigger Values

Monitoring Parameter ID	Trigger Value	Basis
Change in Culebra groundwater composition	Both duplicate analyses for any major ion falling outside the 95% confidence interval (see Table 2.13) for three consecutive sampling periods	The 95% confidence interval for a particular analyte defines the range of concentrations that 19 out of 20 analyses, on average, should fall within. Therefore, TVs should not be set so that a single analysis falling outside the 95% confidence interval is significant. In addition, analysis of solutes in the concentrated brines of the Culebra is not a routine procedure, and occasional analytical errors are to be expected, particularly when a new laboratory is contracted to perform the analyses (SNL 2002b).

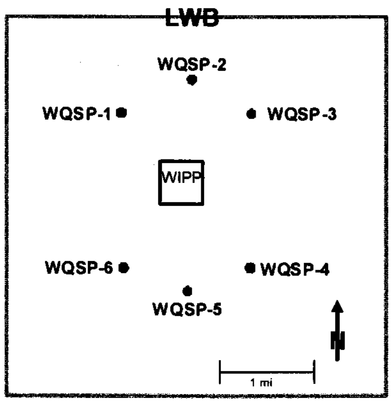

Figure 2. 11. Map showing locations of WQSP wells in relation to the WIPP surface facilities and the LWB. Note: WQSP-6A is on the same well pad as WQSP-6.

not of concern in a health sense. Instead, Culebra water quality is important because of what it implies about the nature of the flow system.

Solute concentrations for the Culebra differ widely among wells across the WIPP site, reflecting local equilibrium, diffusion, and, perhaps most importantly, slow transport rates. The conceptual model for the Culebra presented in the CRA-2004 (DOE 2004)[4] and implemented in PA numerical models is that of a confined aquifer with solute travel times across the WIPP site on the order of thousands to tens of thousands of years. In such a system, no changes in water quality at an individual well outside the range of normal analytical uncertainty and noise should be observed during the WIPP operational phase of a few decades duration. If sustained and statistically significant changes in the concentrations of major ionic species (Na^+, Ca^{2+}, Mg^{2+}, K^+, Cl^-, SO_4^{2-}, HCO_3^-) were observed, this would imply that water was moving faster through the Culebra than was consistent with PA models. Stability of major ion concentrations, on the other hand, is consistent with and supports the SA's Culebra transport conceptual model. Thus, this evaluation of the water-quality data focuses on the stability of major ion concentrations.

Flow and transport in the Dewey Lake are not modeled explicitly in PA because PA modeling shows no radionuclides reach the Dewey Lake, and even if this did occur, it is likely that the sorptive properties of the Dewey Lake would retard migration of radionuclides. Nevertheless, the Dewey Lake water quality is monitored because it increases our understanding of WIPP area hydrology.

[4] For this 2009 COMP report, the regulatory and PA baselines are based on the CRA-2004 and the 2004 PABC. DOE has since submitted the 2nd recertification application termed the CRA-2009. The EPA has not recertified the WIPP such that the regulatory and PA baselines have not changed as of the writing of this document. The CRA-2009 contains a revised groundwater conceptual model. However, the conclusions of this report are based on the EPA-approved baseline.

2.3.1.1.1 Water Quality Sampling

Two water samples (a primary and a duplicate) are collected from each WQSP well twice per year, in the spring and again in the fall. Water sampling procedures are outlined in the GMP (WTS 2003) and are summarized here.

Serial and final samples are collected using a submersible pump (each well has its own dedicated pump) that is set at the mid-formation level. Serial samples are taken at regular intervals while the well is being pumped and analyzed in a mobile field laboratory to determine when water chemistry has stabilized using the parameters of temperature, Eh, pH, alkalinity, chloride, divalent cations, and total iron. The final sample is collected when water quality has stabilized to within ±5% of the field parameter average. Final samples are collected in the appropriate containers (e.g., preserved versus unpreserved) for each particular analysis, placed in coolers, and delivered to the analytical laboratory within a day of collection.

2.3.1.1.2 Laboratory Analysis

The MOC collects samples to be analyzed for volatiles, total organic halogens, total organic carbon, semi-volatiles, metals, and general chemistry. For this report, only the results from the metals and general chemistry analyses are discussed, as they provide the necessary information for assessment of the COMP. In the field, the general chemistry samples are not preserved, metals samples are preserved with nitric acid, and neither sample is filtered. In the lab, samples are analyzed using a variety of published, lab-standard methods. Samples are analyzed for major cations (i.e., Na^+, Ca^{2+}, Mg^{2+}, K^+) and major anions (i.e., Cl^-, SO_4^{2-}, HCO_3^-), and other constituents that are not discussed here.

For sampling rounds 7 through 26, TraceAnalysis, Inc. of Lubbock, TX was responsible for analysis of the water samples submitted by the MOC. In 2008, the analytical contract was awarded to Hall Environmental Analysis Laboratory (HEAL) of Albuquerque, NM, who began analysis with round 27.

2.3.1.1.3 Data Analysis

The results of the WQSP analyses are compared to baseline results in order to determine stability, which is defined as a condition where the concentration of a given ion remains within its derived 95% confidence interval (CI; mean ± two standard deviations) established from the baseline measurements at a well, assuming a normal distribution of concentrations. The original baseline was defined by the initial 5 rounds of sampling in the WQSP wells conducted between July 1995 and September 1997 (Crawley and Nagy 1998). The baseline was revised in 2000, expanding from the first 5 rounds to the first 10 rounds of sampling, which were performed between July 1995 and May 2000, before the first receipt of RCRA-regulated waste at WIPP. The baseline data are presented in the WIPP Resource Conservation and Recovery Act Background Groundwater Quality Baseline Report (Crawley and Nagy 1998) and in Addendum 1 to that report (IT Corporation 2000). For the purposes of this evaluation, a small number of measurements have been eliminated from the baselines for WQSP-3, 5, 6, and 6A. The reasons for eliminating these values are discussed in detail in the COMPs assessment report for data collected in the year 2000 (SNL 2001). The elimination of these values is always conservative in that it reduces the "stable" range of concentrations for the affected parameters. The 95% CIs derived from the baseline data (SNL 2002a) are presented in Table 2.13.

Based on the baseline analysis described above, a Trigger Value (TV) for Culebra groundwater composition has been defined. A TV is defined as the condition where both primary and duplicate analyses for any major ion fall outside the 95% CI for 3 consecutive sampling periods. When and if this criterion is met, the project will evaluate the sampling

Table 2. 13 Rounds 26 and 27 major ion concentrations and charge-balance errors, with a baseline 95% CI defined for each major ion.

Well I.D.	Sample	Cl^- Conc. (mg/L)	SO_4^{2-} Conc. (mg/L)	HCO_3^- Conc. (mg/L)	Na^+ Conc. (mg/L)	Ca^{2+} Conc. (mg/L)	Mg^{2+} Conc. (mg/L)	K^+ Conc. (mg/L)	Charge-Balance Error (%)
WQSP-1	Round 26	37000/37800	5470/5560	50/50	**23500/23600**	1890/1800	**1220**/1160	**767**/701	2.6
	Round 27	***40500**/36000*	4490/4570	50/50	18000/17800	1490/1540	989/1020	477/475	**-10.6**
	95% C.I.	31100-39600	4060-5600	45-54	15900-21100	1380-2030	939-1210	322-730	
WQSP-2	Round 26	34200/33500	5810/6200	46/48	**24500/23800**	1590/1560	1080/1050	**701/651**	**6.6**
	Round 27	34000/35500	5500/5400	47/46	20300/19900	1490/1460	1020/996	482/487	-2.4
	95% C.I.	31800-39000	4550-6380	43-53	14100-22300	1230-1770	852-1120	318-649	
WQSP-3	Round 26	121000/122000	7190/7340	32/32	**91100/93900**	1510/1540	2430/2480	*2460/2190*	**9.9**
	Round 27	115000/**112000**	6910/7020	32/32	78800/81900	1360/1420	2200/2290	***1470/1640***	**6.2**
	95% C.I.	114000-145000	6420-7870	23-51	62600-82700[c]	1090-1620	1730-2500	2060-3150[a]	
WQSP-4	Round 26	56200/60300	5750/5850	40/38	36200/37400	1580/1610	1190/1210	*1060/916*	1.1
	Round 27	59700/59700	6870/6840	36/38	37000/36200	1540/1480	1200/1150	**750/744**	-1.2
	95% C.I.	53400-63000	5620-7720	31-46	28100-37800	1420-1790	973-1410	832-1550[b]	
WQSP-5	Round 26	14800/14500	4690/4660	***60**/50*	9880/9030	*1020/**1230***	451/454	387/352	0.3
	Round 27	17200/17100	5470/5420	46/44	9900/9800	980/960	450/440	300/300	**-6.8**
	95% C.I.	13400-17600	4060-5940	42-54	7980-10400[c]	902-1180	389-535	171-523	
WQSP-6	Round 26	**5030/5100**	4450/4580	52/50	4430/4150	672/659	205/198	184/167	0.7
	Round 27	**5340/5340**	4600/4570	46/46	4510/4160	673/680	211/202	157/143	-0.7
	95% C.I.	5470-6380[c]	4240-5120[c]	41-54	3610-5380[c]	586-777	189-233[c]	113-245	
WQSP-6A	Round 26	**378/388**	2090/2100	***116**/102*	253/256	638/649	171/175	6.3/5.3	1.2
	Round 27	**348/338**	2030/2010	105/105	**221/218**	590/607	158/156	3.9/3.9	-0.9
	95% C.I.	444-770[c]	1610-2440	97-111	253-354	554-718	146-185	1.8-9.2	

Bold denotes analyses returning values outside the 95% CI or a charge-balance error ≥5%
Italics denotes sample and duplicate analyses differ by >10%
[a] baseline defined from rounds 8-10 [b] baseline defined from rounds 7-10 [c] baseline definition excludes anomalous values

and analytical procedures to see if the apparent change in groundwater composition can be explained by procedural changes or irregularities. If the change appears to reflect conditions in the Culebra accurately, the SA will investigate what effects the changes might have on the conceptualization and modeling of the Culebra and, if appropriate, the model will be revised to be consistent with the new information.

In addition to the baseline comparison, a charge-balance error (CBE), defined as the difference between the positive and negative charges from the ions in solution divided by the sum of the positive and negative charges, was also calculated for each analysis using the average of the primary and duplicate sample. A CBE is useful in evaluating the reliability of an analysis because water must be electrically neutral. CBE is rarely zero because of inherent inaccuracy in analytical procedures, but a reliable analysis should not have a CBE exceeding ±5% (Freeze and Cherry 1979). A CBE in excess of ±5% implies either that the analysis of one or more ions is inaccurate (most likely) or that a significant ion has been overlooked (in the case of the WQSP wells, which have been sampled and analyzed in depth, this is highly unlikely). The variation between the results of primary and duplicate sample analysis for each individual ion is also considered. Generally speaking, this variation should be less than 10 percent. Greater variation indicates a potential problem with one or both analyses. Analytical results and CBE for rounds 26 and 27 are presented in Table 2.13.

2.3.1.2 Results

WQSP results for sampling rounds 26 and 27 conducted in 2008 are reported in the 2008 ASER (DOE 2009d). The reported major ion concentrations are listed in Table 2.13. Sampling round 26 was conducted between March and May and round 27 was conducted between September and November. Recall that the round 26 samples were analyzed by TraceAnalysis, Inc., and round 27 samples were analyzed by HEAL.

2.3.1.2.1 WQSP-1

Concentrations of most major ions were within their respective 95% CIs for round 26. Exceptions include the sodium concentrations measured in both samples and the magnesium and potassium values measured in the primary sample. The CBE was +2.6%.

For round 27, only the chloride value measured in the primary sample was outside its 95% CI; it was also >10% different from the duplicate sample. The CBE was -10.6%.

2.3.1.2.2 WQSP-2

For round 26, both primary and duplicate samples returned concentrations for sodium and potassium above their respective 95% CIs. All other analytes in both primary and duplicate samples were within their respective 95% CIs. The CBE was +6.6%.

Concentrations of all of the major ions in both the primary and duplicate samples were within their respective 95% CIs, and the CBE was -2.4%, for round 27.

2.3.1.2.3 WQSP-3

Sodium concentrations measured in both samples were above the upper threshold of the 95% CI for round 26. In addition, the potassium results showed a >10% difference between the primary and duplicate sample, but were within the 95% CI. The CBE was +9.9%.

For round 27, most concentrations measured in both samples were within their respective 95% CIs. Exceptions included the duplicate chloride concentration, which was below its lower 95% CI threshold, and the concentrations of potassium in both samples, which were also below their lower 95% CI threshold. Additionally, the potassium concentrations were >10% different between the two samples. The CBE was +6.2%.

2.3.1.2.4 WQSP-4

For round 26, all major ion concentrations measured in both the primary and duplicate samples were within their respective 95% CIs. Only potassium concentrations showed a >10% difference between primary and duplicate samples. The CBE was +1.1%.

The concentrations of most major ions for both the primary and duplicate samples were within their respective 95% CIs for round 27. The exception was potassium, which was below its lower 95% CI threshold in both samples. The CBE was -1.2%.

2.3.1.2.5 WQSP-5

Concentrations of most of the major ions were within their respective 95% CIs for round 26. Exceptions were the primary alkalinity and the duplicate calcium concentrations, both of which were >10% different from their other respective sample. The CBE was +0.3%.

For round 27, all of the major ion concentrations measured in the primary and duplicate samples were within their respective 95% CIs, and none showed a >10% difference. The CBE was -6.8%.

2.3.1.2.6 WQSP-6

For rounds 26 and 27, all major ions except chloride were within their 95% CIs; both primary and duplicate chloride concentrations were below the lower threshold. No analyses returned values with >10% difference between any of the primary or duplicate samples. The CBE was 0.7% for round 26 and -0.7% for round 27.

2.3.1.2.7 WQSP-6A

Most of the major ion concentrations were within their respective 95% CIs for round 26, except sodium concentrations in both samples, which were below the lower 95% CI threshold, and the alkalinity of the primary sample, which was above its respective 95% CI and >10% different from the duplicate sample. The CBE was +1.2%.

For round 27, most major ion concentrations were within their respective 95% CIs, with the exception of the sodium and chloride concentrations measured in both samples, which, in both cases, were below their respective lower 95% CI thresholds. The CBE was -0.9%.

2.3.1.3 Assessment of Water Quality Data

2.3.1.3.1 Culebra

Five of the 12 calculated CBEs for the two rounds were >±5%. Most of the CBEs >±5% are associated with analytes that have anomalously high or low concentrations. For example, the two highest CBEs observed at WQSP-1 (round 27) and WQSP-3 (round 26) can be linked to anomalously high concentrations of chloride and sodium, respectively. In the case of WQSP-1, if the anomalous chloride value (40,500 mg/L) was the same as the duplicate value (36,000 mg/L), the CBE would change to -7.8%, which represents a >3% improvement. For WQSP-3, if a more average, lower concentration of sodium were used (i.e., 80,000 mg/L, the average of round 27) the CBE would reduce to +3.2%. Similar arguments can be made for WQSP-2 (round 26) and WQSP-3 (round 27); if long-term, lower average concentrations were used (such as a sodium concentration of 20,000 mg/L in WQSP-2 and a chloride concentration of 120,000 mg/L in WQSP-3), CBEs would change to -1.3% and +3.5%, respectively. The only exception to this is the WQSP-5 (round 27) results, which show a CBE of -6.8%. No concentrations of any analytes are above/below their respective 95% CI threshold or show a >10% different between analyte pairs. Both the chloride and sulfate concentrations are toward the high end of their respective 95% CIs, and by inserting long-term average concentration values (16,000 and 5,000 mg/L, respectively) for each ion, CBE would be -3.2%, within the ±5% envelope.

Another method of assessing water-quality stability is through the use of trilinear (Piper) diagrams, which show relative ion concentrations. By plotting the ion ratios for every round, it can be determined if water quality of a given well is changing over time. Trilinear diagrams of Culebra water chemistry (Figure 2.12) over the course of the WQSP (now 13+ years) show that the groundwater is relatively stable, with results for each well continually plotting within relatively small envelopes.

Full assessment of the Culebra water-chemistry results shows that it is stable and that none of the Culebra wells has an analyte in violation of a TV. Based on review of CBEs calculated for each WQSP well sampled, the analytical results appear to be generally reliable. Any variability observed in the data suggesting instability can be attributable to analytical problems, with the possible exception of the WQSP-5 (round 27) results. As mentioned in the last year's COMPs report (SNL 2009), it is believed that the majority of analytical problems can be linked to the high salinity (i.e., TDS) observed in Culebra brines. The sensitive analytical equipment used in environmental labs requires that samples be diluted up to 10,000 times in order for samples to be run without harming the machine. Dilution of the samples introduces both human and analytical error, which can cause results to be less precise. For example, both round 26 and 27 CBEs for WQSP-3 were outside the desired ±5% envelope. The brine found inWQSP-3 also has the highest TDS concentrations of any WQSP well, averaging >200,000 mg/L. It has been shown in both cases that if the anomalous values were replaced with long-term averages, the CBEs would fall within the desired ±5% CBE range.

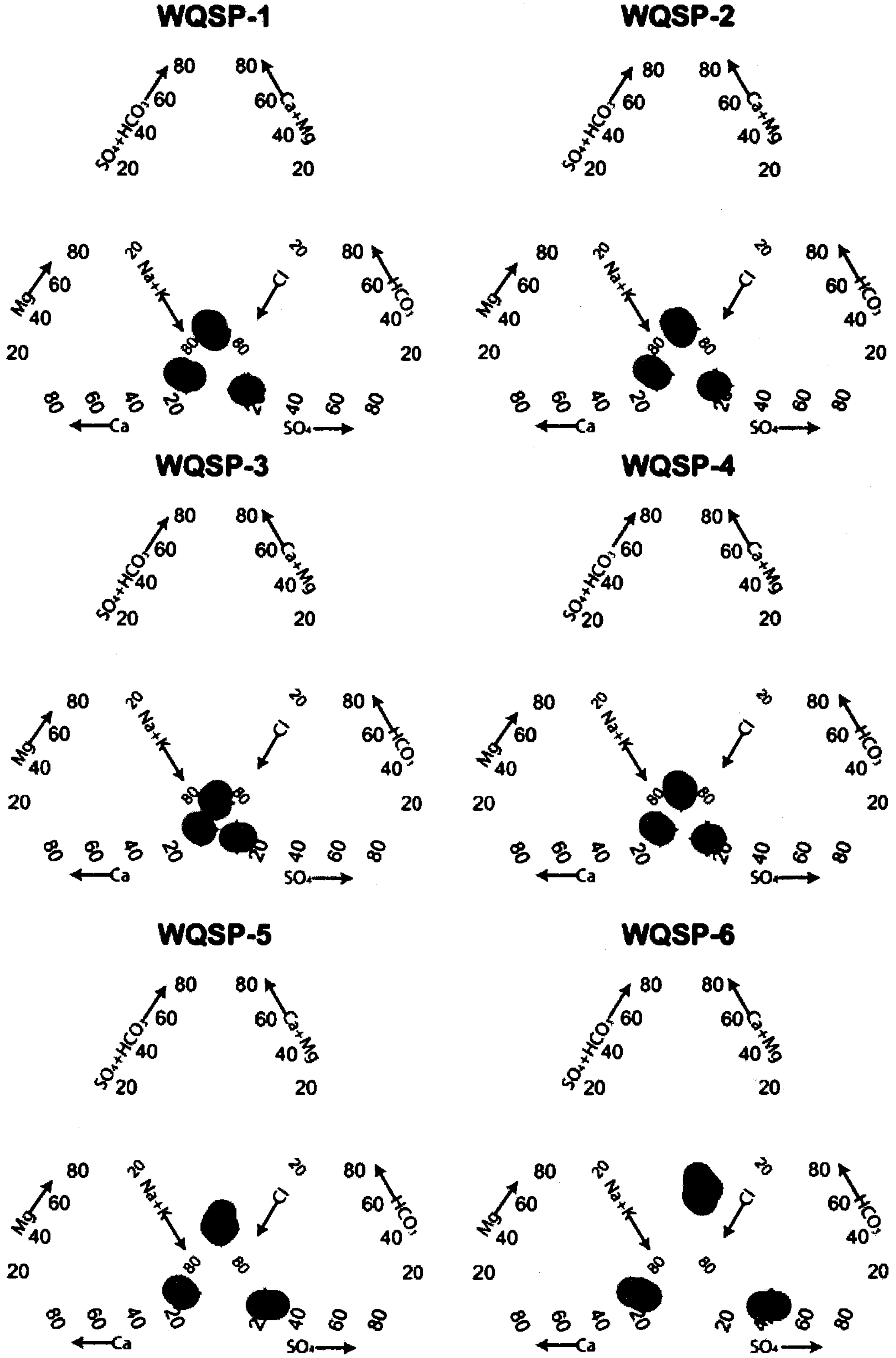

Figure 2. 12. Trilinear diagrams of data collected from WQSP-1 through WQSP-6. The plots show both historical data (gray areas) and results from rounds 26 (blue star) and 27 (red star).

2.3.1.3.2 Dewey Lake

Interpretation of the long-term data and the trilinear diagram for Dewey Lake well WQSP-6A (Figure 2.13) suggests that water chemistry is changing. Both sodium and chloride concentrations show declines in concentration relative to previous rounds. The concentrations for both ions, however, appear to be stabilizing over the last few rounds at concentrations below their respective 95% CIs. This suggests that the Dewey Lake, at least at WQSP-6A, has freshened slightly, which is reinforced by evaluation of specific conductance data, which has been gradually decreasing from round to round. In the future, the 95% CI should be re-evaluated and possibly adjusted.

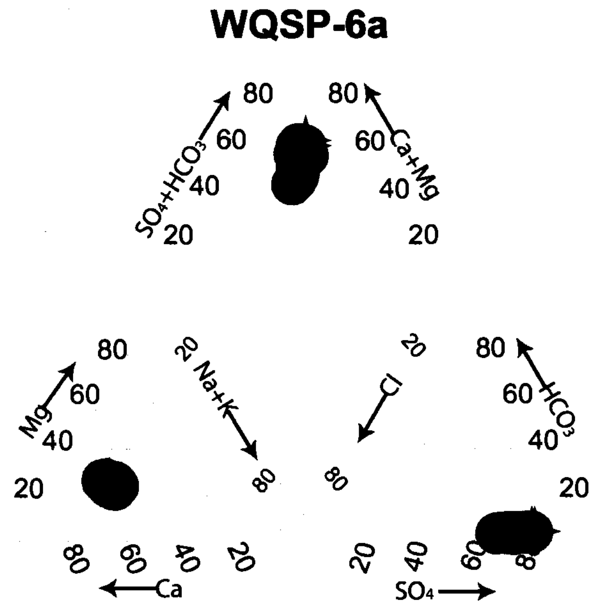

Figure 2. 13. Trilinear diagram of data collected from WQSP-6A. The plot shows both historical data (gray areas) and results from rounds 26 (blue star) and 27 (red star).

2.3.2 Changes in Groundwater Flow (Water Level)

Table 2.14 summarizes PA, data and TV information relating to the COMP, Change in Culebra Groundwater Flow. Assessment of the COMP "Changes in Groundwater Flow" involves TVs derived from the steady-state freshwater heads estimated for Culebra flow modeling in the CRA-2004 (DOE 2004). The Culebra transmissivity (T) fields that were used to simulate the transport of radionuclides through the Culebra were considered calibrated when, among other things, the modeled heads at 32 wells (23 of which still remained in 2008) fell within the ranges of uncertainty estimated for steady-state freshwater heads at those wells. If monitoring shows that heads at these wells are outside the ranges used for T-field calibration (hereafter called the "CRA-2004 range"), the cause(s) and ramifications of the deviations should be investigated.

The Dewey Lake, Magenta, and Bell Canyon are not currently monitored as COMPs and do not have TVs. The water-level measurements in these units do, however, provide information used in the development of the conceptual model of overall site hydrology.

Table 2. 14 Changes in Groundwater Flow - 2009:

Trigger Value Derivation				
COMP Title:	Changes in Groundwater Flow			
COMP Units:	Inferred from water-level data			
Related Monitoring Data				
Monitoring Program	**Monitoring Parameter ID**	**Characteristics (e.g., number, observation)**	**Compliance Baseline Value**	
Groundwater Monitoring	Head and Topography	Monthly water-level measurements.	Indirect	
COMP Derivation Procedure - Data acquired between December 2007 and December of 2008				
Annual assessment from ASER data.				
Related PA Elements				
Element Title	**Type & ID**	**Derivation Procedure**	**Compliance Baseline**	**Impact of Change**
Groundwater conceptual model, Transmissivity fields	T-Fields - groundwater conceptual models	Compare groundwater monitoring data with compliance baseline	Water level ranges used in the latest compliance baseline calculation	Provides validation of the various CCA/CRA models - T-field assumptions and groundwater basin model.
Monitoring Data Trigger Values				
Monitoring Parameter ID	**Trigger Value**	**Basis**		
Change in Culebra Groundwater Flow	CRA-2004 range; see Table 2.15	Annual comparisons with ranges of undisturbed steady-state freshwater heads used to calibrate Culebra T fields for CRA.		

2.3.2.1 Water Level Monitoring Program (WLMP)

In 2008, the MOC made monthly water-level measurements in all of the WIPP monitoring network wells (Figure 2-14), or quarterly in any redundant wells (i.e., six of the seven H-19 wells). Some wells have limited measurements (noted in Tables 2.15 and 2.16) due to SA well testing activities, maintenance issues, and/or well plugging and abandonment activities conducted during 2008. As of December 2008, the WIPP monitoring network consisted of 64 wells (including 3 dual-completion Magenta-Culebra wells): 50 wells with completions to the Culebra Member of the Rustler Formation, 14 to the Magenta Member of the Rustler Formation, 2 to the Bell Canyon Formation, and 1 to the Dewey Lake Formation.

2.3.2.2 Culebra Groundwater Flow Results and Assessment

Assessment of Culebra data involves the interpretation of water-level data. If water levels change significantly, flow direction and/or velocity in the Culebra may also change. The SA has determined that if the water level in a well changes by > 2.0 ft in a calendar year, it will be noted and investigated to determine the cause of the change.

A comparison of Culebra water levels, in feet above mean sea level (ft amsl), from December 2007 to December 2008 is presented in Table 2.15. Water-level changes in the 44 Culebra wells (the 6 redundant H-19 wells are not included in this assessment) ranged from -157.90 ft to +34.66 ft, with 16 of the wells experiencing water-level changes of ≥ 2.0 ft. The large changes observed at AEC-7 (-157.90 ft), SNL-6 (+24.99 ft), and SNL-15 (+34.66 ft), as well as smaller changes at C-2737 (-3.91 ft) and H-15 (-3.38 ft), are due to either SA well testing or MOC well workover activities. The water-level change in AEC-7 is due to well recompletion work conducted in February and March of 2008, and was discussed in depth in last year's COMPs report (SNL 2009). The changes observed in C-2737 and H-15 represent re-establishment of equilibrium after post-testing reconfiguration activities were completed, as noted in Table 2.15. SNL-6 and SNL-15 are located east of the margin where the Culebra is cemented with halite (Hart et al. 2008). This results in the Culebra having very low transmissivity ($\log_{10} T$ (m^2/s) = -13 to -11), which prevents water levels from reaching equilibrium quickly. Both wells are recovering from post-drilling well development and SA well testing activities, and are not expected to reach equilibrium in this century. Therefore, water levels in these two wells are expected to rise for the foreseeable future.

In general, the Culebra water levels declined across the WIPP area during 2008. The largest declines, typically between 2 and 3.5 ft, were observed in wells located north of the WIPP site, while wells located at or near to the WIPP site experienced declines that ranged from 0.5 to 2 ft. Wells positioned south of the site showed little to no change in water level.

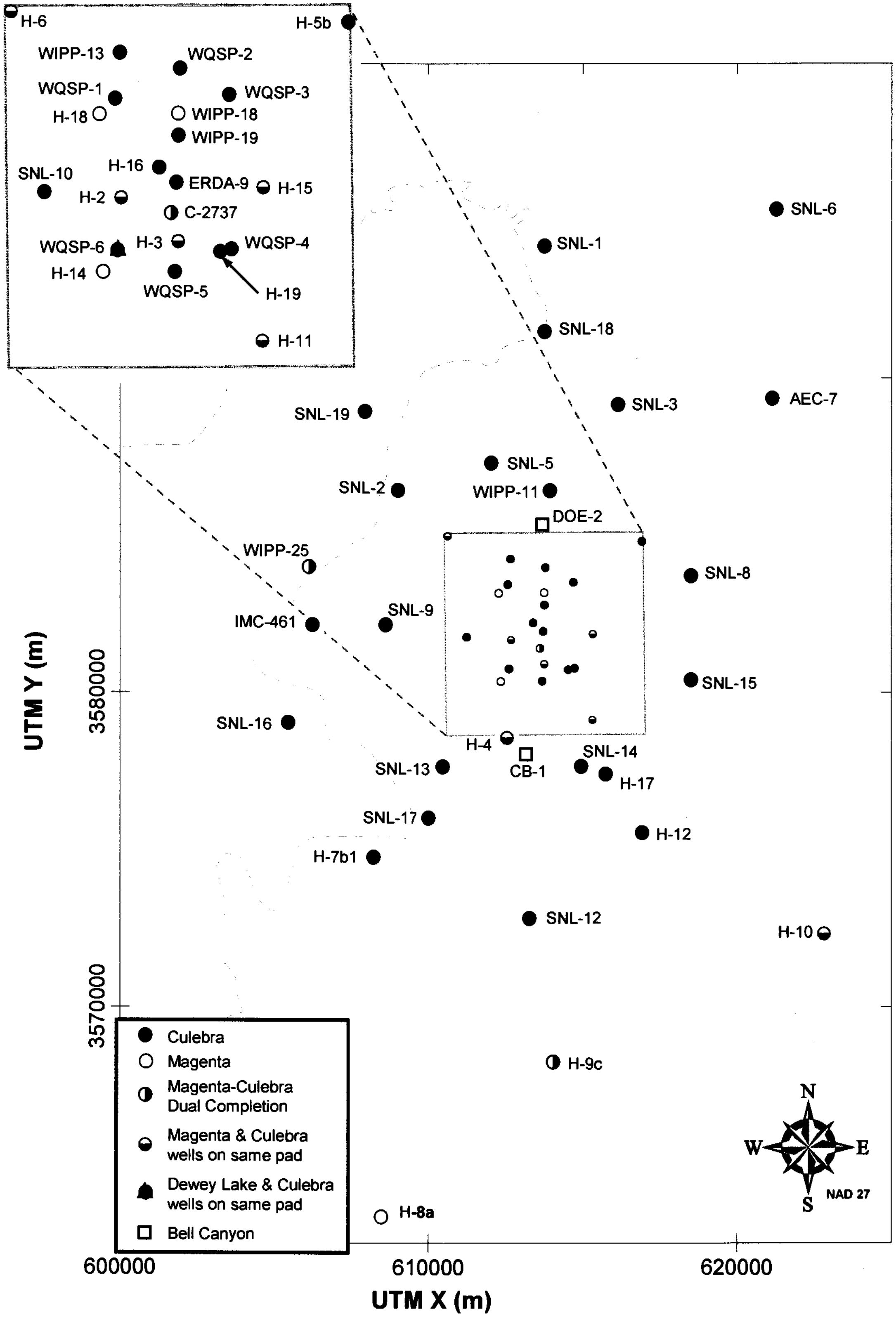

Figure 2. 14. Map of the WIPP area showing well locations discussed in this section.

2.3.2.3 Culebra Freshwater-Head Results and Assessment

Table 2.15 shows a comparison of the December 2008 FWH to the ranges of FWH used in the calibration of the CRA-2004 T fields for the 23 remaining wells used in that calibration. These ranges were calculated by Beauheim (2002) based on data from 2000. The December 2008 FWH as well as the fluid densities used to calculate them are reported in the 2008 ASER (DOE 2009d). FWH values in 17 of the 23 wells used in this assessment are now outside the upper limit of the CRA-2004 ranges. In almost all cases, this is independent of any density uncertainties, as no physically reasonable density (i.e., 1.0 to 1.25 g/cm^3) would result in calculated FWH within each well's respective CRA-2004 range.

The number of wells outside of the CRA-2004 range is unchanged from the previous COMPs assessment (SNL 2009), other than that well WIPP-30 was plugged and abandoned in March 2008. The fact that 17 of 23 wells are above the CRA-2004 range does not affect the SA's conceptual understanding of the WIPP hydrologic system(s). It does, however, lead the SA to investigate the possible reasons for Culebra water-level change (Beauheim 2003; Hillesheim et al. 2006; 2007). Additional Culebra water-level change scenario development and evaluation using the new Culebra flow model developed for CRA-2009 may be warranted (Hart et al. 2009).

Table 2. 15 Summary of 2008 Culebra water-level changes and freshwater heads.

Well I.D.	12/07 W.L. (ft amsl)	12/08 W.L. (ft amsl)	2007 Change (ft)	12/08 FWH (ft amsl)	CRA-2004 FWH Range (ft amsl)	Outside CRA-2004 Range?
AEC-7	3201.95	3044.05[a]	**-157.90**	3064.29	3057.1-3066.2	N
C-2737	3018.69	3014.78	**-3.91**	3023.63	N/A	-
ERDA-9	3013.32	3012.44	-0.88	3033.82[b]	3018.6-3028.6	Y
H-2b2	3046.53	3046.31	-0.22	3050.56	3036.8-3043.4	Y
H-3b2	3002.49	3002.59	0.10	3015.21	3004.2-3013.9	Y
H-4b	3004.71	3004.40	-0.31	3007.02	3000.2-3007.3	N
H-5b	3039.59	3040.21	0.62	3080.59	3065.5-3077.9	Y
H-6b	3060.84	3060.38[c]	-0.46	3071.57	3059.9-3070.0	Y
H-6bR	N/A	3063.86[d]	-	3074.94	N/A	-
H-7b1	3000.30	2998.93	-1.37	2996.18	2996.4-3001.0	N
H-9c	2996.32	2996.37	0.05	2996.62	2987.7-2993.8	Y
H-10c	3024.13	3023.58	0.55	3029.24	N/A	-
H-11b4	2988.25	2988.17	-0.08	3010.12	2998.6-3008.5	Y
H-12	2970.31	2970.95[e]	0.64	3008.01	2993.3-3008.4	N
H-15	2997.94	2994.56[f]	**-3.38**	3014.99	3012.5-3023.4	N
H-15R	N/A	2972.76[fg]	-	3045.09	N/A	-
H-16	N/A	3036.45[h]	-	3049.74	N/A	-
H-17	2967.18	2967.36	0.18	3007.60	2999.8-3006.6	Y
H-19b0	2993.40	2993.41	0.01	3015.78	3005.5-3012.4	Y
IMC-461	3047.46	3045.92	-1.54	3046.61	N/A	-
SNL-1	3084.72	3079.89	**-4.83**	3085.83	N/A	-
SNL-2	3075.46	3073.07	**-2.39**	3075.66	N/A	-
SNL-3	3076.46	3073.19	**-3.27**	3081.23	N/A	-
SNL-5	3077.46	3074.50	**-2.96**	3077.94	N/A	-
SNL-6[i]	2769.69	2794.59	**24.99**	2914.32	N/A	-
SNL-8	3014.34	3011.41	**-2.93**	3055.23	N/A	-
SNL-9	3053.20	3051.85	-1.35	3058.04	N/A	-
SNL-10	3054.28	3053.09	-1.19	3056.27	N/A	-
SNL-12	3002.68	3002.31	-0.37	3003.48	N/A	-
SNL-13	3009.63	3009.63	0.00	3012.78	N/A	-
SNL-14	2992.42	2992.29	-0.13	3006.37	N/A	-
SNL-15[i]	2816.48	2851.14	**34.66**	2918.18	N/A	-
SNL-16	3011.11	3009.83	-1.28	3010.66	N/A	-
SNL-17A	3007.35	3006.53	-0.82	3007.24	N/A	-
SNL-18	3077.76	3075.72	**-2.04**	3082.76	N/A	-
SNL-19	3076.52	3073.65	**-2.87**	3074.27	N/A	-
WIPP-11	3068.75	3066.07	**-2.68**	3084.92	N/A	-
WIPP-13	3064.89	3062.17	**-2.72**	3081.88	3062.7-3073.6	Y
WIPP-19	3047.74	3046.36	-1.38	3063.14	3054.3-3065.5	N
WIPP-25	3067.59[j]	3066.91	0.38	3070.37	3055.2-3064.9	Y
WQSP-1	3063.69	3060.92	**-2.77**	3077.98	3067.0-3072.4	Y
WQSP-2	3068.82	3066.17	**-2.65**	3086.68	3077.2-3083.0	Y
WQSP-3	3018.84	3017.34	-1.50	3075.31	3067.4-3073.6	Y
WQSP-4	2990.91	2990.92	0.01	3016.32	3007.8-3012.4	Y
WQSP-5	3006.44	3006.73	0.29	3013.76	3006.3-3012.2	Y
WQSP-6	3021.56	3022.07	0.51	3025.63	3016.2-3020.7	Y

All measurements made in December, except as noted

[a] AEC-7 was plugged back to 30 ft below Culebra and re-perforated in February and March 2008

[b] The FWH value reported in the 2008 ASER is incorrect; it was calculated using the 2007 fluid density value for ERDA-9. The value reported here is corrected with the 2008 fluid density value reported for ERDA-9 (DOE 2009d).

[c] 02/14/08 - Last measurement before well was plugged and abandoned in February 2008

[d] 07/08/08 - First measurement after well was drilled in June 2008

[e] 11/05/08 - Well worked over on 11/21/08 and the December measurement indicated that water level was still recovering

[f] 02/14/08 - Last measurement before well was plugged and abandoned in March 2008

[g] 08/15/08 - First measurement after well was drilled in May 2008

[h] 12/04/08 - First measurement after well was reconfigured in July 2008

[i] SNL-6 and SNL-15 are recovering from post-drilling development and SA well testing activities

[j] 01/15/08 - No measurement was made in December 2007, due to SA testing activities

N/A = not applicable (data from well not used in CRA-2004 T-field calibration) or not available (data do not exist)

Bold = changes in water level ≥2.0 ft

2.3.2.4 Interpretation/Summary of the 2008 Culebra Data

As mentioned previously, change in Culebra groundwater flow would be manifested as a change in gradient and/or flow velocity. In general, the potentiometric gradient of the Culebra is and has been from north to south and flow velocities are low across the WIPP modeling domain (Hart et al. 2009). In this year's assessment of the groundwater flow COMP, we are including a potentiometric surface map of the Culebra (Figure 2.15; DOE 2009d). The map was generated using the Culebra flow model developed by the SA for performance baseline calculations associated with CRA-2009 and Culebra heads from September 2008. The model is a single-layer groundwater flow model that incorporates information about aquifer parameters (e.g., transmissivity (T), storativity (S), and anisotropy (A)) and Culebra geology. The model is calibrated to both steady-state and transient head data, with the ensemble average of 100 realizations being used to generate the Culebra potentiometric contour map. The contour map shown in Figure 2.15 shows the area immediately around the WIPP land withdrawal boundary, and indicates that flow is generally from north to south, which is consistent with previous results, and that the gradient is steepest across the WIPP site, caused by a band of low Culebra T that passes through the site.

The observed pattern of water-level decline (discussed above) indicates a very slight decrease in the potentiometric gradient of the Culebra. At this time, it is unclear whether this decline is a short-term transient superimposed on a longer term trend of rising water levels or if it is the beginning of a new long-term trend of falling water levels. Additional observations are needed to assess whether the decline is a transient event in the system or not.

2.3.2.5 Results and Assessment of Data from Other Units

Assessment of water-level changes from other hydrologic units present in the WIPP vicinity (Table 2.16) is important for confirming the conceptual model of overall site hydrology. Water-level measurements for the Magenta Member of the Rustler Formation provide information about confinement of and connectivity to the underlying Culebra Member. Water-level changes in the Magenta ranged from -9.62 to 3.32 ft, with only three wells experiencing water-level changes of ≥ 2.0 ft. In general, water levels in the Magenta fell during 2008, reversing the long-term trend. The Magenta wells that experienced a change of ≥ 2.0 ft were all subjects of SA well testing activities during 2007 and 2008.

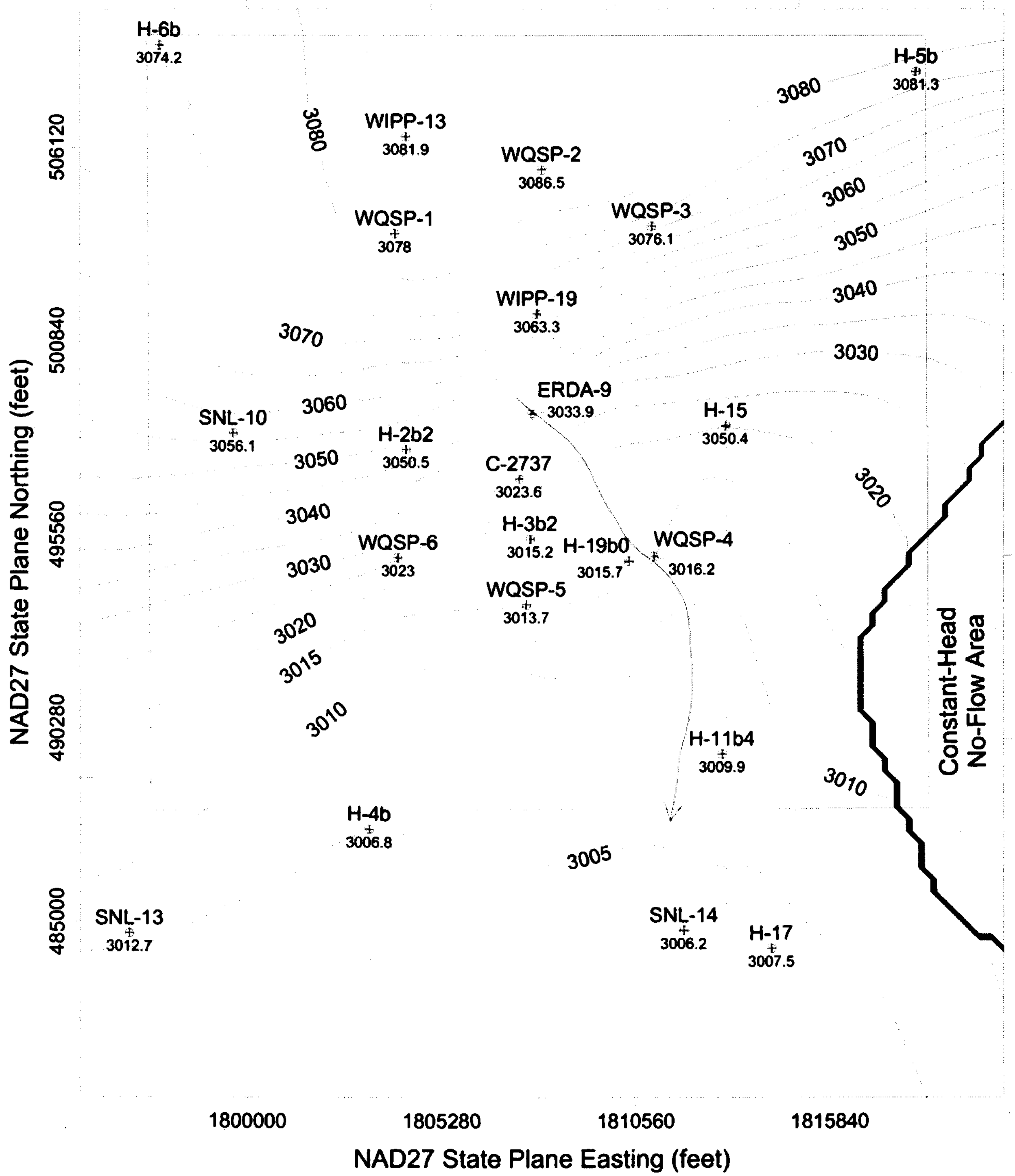

Figure 2. 15. September 2008 modeled Culebra potentiometric surface of the immediate WIPP vicinity (DOE 2009d) generated using ensemble average distributed aquifer parameters from the SNL Culebra flow model used in performance assessment baseline calculation for CRA-2009 (from Hart et al. 2009).

The water level was stable in WQSP-6A, the well completed to the middle of the Dewey Lake Formation (Table 2.16). During the summer of 2008, the 2 wells (DOE-2 and CB-1) completed to the Bell Canyon Formation were swabbed repeatedly to remove foreign water left in the wellbore during reconfiguration activities conducted in 2004. This work resulted in significant decreases in fluid density in both wells, which is reflected in much higher water-level elevations (Table 2.16).

Table 2. 16 Summary of 2008 water-level changes in units other than the Culebra.

Well I.D.	12/07 W.L. (ft AMSL)	12/08 W.L. (ft AMSL)	2008 Change (ft)
Magenta Wells			
C-2737	3145.85	3144.14	-1.71
H-2b1	3142.99	3143.37	0.38
H-3b1	3146.91	3146.66	-0.25
H-4c	3146.66	3147.43	0.77
H-6c	3069.63	3069.63	0.00
H-8a	3027.28	3027.28	0.00
H-9c	3136.88	3137.93	1.05
H-10a	3223.28	3222.33	-0.95
H-11b2	3139.41[a]	3137.96	-1.45
H-14	3138.39[b]	3128.77	**-9.62**
H-15[c]	3123.46	3125.82	**2.36**
H-18	3146.89	3150.21	**3.32**
WIPP-18	3149.69	3149.76	0.07
WIPP-25	3068.29[d]	3066.84	-1.45
Dewey Lake Well			
WQSP-6A	3196.97	3197.01	0.04
Bell Canyon Wells			
CB-1[e]	2731.95	3004.11	**272.16**
DOE-2[f]	2694.29	3065.66	**371.37**

All measurements made in December, except as noted

[a] 10/15/07 - No measurement due to SA well testing activities (pump in 11/09/07, pump out 06/26/08)

[b] 11/14/07 - No measurement due to SA well testing activities (pump in 11/15/07, pump out 03/07/08)

[c] Well was recompleted between March 5 and April 3, 2008

[d] 01/15/08 - No measurement was made in December 2007, due to SA testing activities

[e] Well swabbed repeatedly between March 15 and June 15, 2008

[f] Well swabbed repeatedly between March 17 and June 30, 2008

Bold = changes in water level ≥ 2.0 ft

2.4 Waste Activity

Table 2.17 summarizes PA, data and TV information relating to the COMP, Waste Activity. The reporting period for the waste activity COMP started at first waste receipt and ended on June 30, 2009. A comparison of the tracked actinides and the total repository inventory used in the PABC-2004 is detailed in Table 2.18. No other activity-related assessment has been made at this time.

There are no TVs for CH activity, only RH. The TV for RH is the regulatory limit of 5.1 million Curies. This is the first reporting period for RH waste. The total curies of RH waste for the period ending June 30, 2009 is 1.831×10^3 Curies, well below the TV. There are no recognized reportable issues associated with this COMP. No changes to the monitoring program are recommended at this time. A detailed waste inventory assessment has been provided in the CRA-2009 (DOE 2009a).

Table 2. 17 Waste Activity - 2009:

COMP Title:	Waste Activity		
COMP Units:	Curies		
Related Monitoring Data			
Monitoring Program	Monitoring Parameter ID	Characteristics (e.g., number, observation)	Compliance Baseline Value
WWIS, BIR	Radionuclide activity per container and volume	Curies per container. Container volume.	TRU Waste Inventory for the 2004 Compliance Recertification Application Performance Assessment Baseline Calculation (Leigh et al. 2005a)
COMP Assessment Process - Reporting Period July 1, 2008 to June 30, 2009			
Total curie content of emplaced CH-TRU and RH-TRU waste. *[Total radionuclide inventories reported by WWIS]*			
Year 2009 COMP Assessment Value			
A comparison of emplaced and PA waste parameters is found in Table 2.18.			

Element Title	**Type and ID**	**Derivation Procedure**	**Compliance Baseline**	**Impact of Change**
Radionuclide inventories	Parameter	Product of waste stream content and volume scaled up to the Land Withdrawal Act limits. (U.S. Congress 1992)	Table 14 in Leigh et al. 2005a.	May affect direct brine releases for those radionuclides that become inventory-limited during a PA simulation.
Activity of waste intersected for cuttings and cavings releases.	Parameter	Function of waste stream volumes and activities	Figure 6-30 of the CRA-2004 (DOE 2004)	Cuttings are a significant contributor to releases. An increase in activity of intersected waste is potentially significant.
WIPP-scale average activity for spallings releases	Parameter	Average of all CH-TRU waste only.	NA	Spallings are a significant contributor to releases. An increase in average activity of intersected waste is potentially significant.

Monitoring Data Trigger Values		
Monitoring Parameter ID	**Trigger Value**	**Basis**
Waste emplacement records	Panel half-full	Check that PA assumptions about waste activity will remain valid as remainder of panel is filled and verify random emplacement assumptions.
Total emplaced RH-TRU waste activity	5.1 million curies	LWA emplacement limit reached. Administrative controls address these limits.

Table 2. 18 Comparison of tracked radionuclide inventory to the PABC Inventory (from WRES 2009 and Leigh et al. 2005a).

Radionuclide (CCA Table 4-10)	Non-Decayed Total Activity as of June 30, 2008	Non-Decayed CH Inventory as of June 30, 2009	Non-Decayed RH Inventory as of June 30, 2009	Non-Decayed Total Activity as of June 30, 2009	PABC Total Inventory at Closure (2033)
^{241}Am	1.876×10^{5}	1.913×10^{5}	4.841×10^{1}	1.914×10^{5}	5.17×10^{5}
^{137}Cs	3.813×10^{2}	2.035	9.523×10^{2}	9.543×10^{2}	2.07×10^{5}
^{238}Pu	1.608×10^{5}	2.131×10^{5}	3.144×10^{1}	2.131×10^{5}	1.13×10^{6}
^{239}Pu	2.744×10^{5}	2.802×10^{5}	6.130×10^{1}	2.802×10^{5}	5.82×10^{5}
^{240}Pu	6.667×10^{4}	6.811×10^{4}	3.510×10^{1}	6.815×10^{4}	9.54×10^{4}
^{242}Pu	1.041×10^{1}	1.149×10^{1}	3.470×10^{-2}	1.152×10^{1}	12.70
^{90}Sr	2.846×10^{2}	3.352	7.024×10^{2}	7.058×10^{2}	1.76×10^{5}
^{233}U	3.258	3.679	9.838×10^{-2}	3.777	1.23×10^{3}
^{234}U	2.704×10^{1}	3.573×10^{1}	1.891×10^{-1}	3.592×10^{1}	3.44×10^{2}
^{238}U	1.063×10^{1}	1.099×10^{1}	2.649×10^{-3}	1.099×10^{1}	2.17×10^{2}
Total	**6.901×10^{5}**	**7.527×10^{5}**	**1.831×10^{3}**	**7.546×10^{5}**	**2.71×10^{6}**

3 COMPs Assessment Conclusion

The operational period monitoring program designed to meet the Assurance Requirements of 40 CFR §191.14 and the terms of WIPP certification was initiated in 1999. This monitoring program is useful to further validate the assumptions and conceptual models that were used to predict WIPP performance and identify conditions that could potentially cause radioactive release above the limits established in 40 CFR §191.13. Since releases above these limits cannot occur during the operational period of WIPP, the monitoring program looks at other potential performance indicators of the disposal system and compares these data to PA performance expectations. Specifically, 10 monitoring parameters are assessed and compared to PA expectations and assumptions. The PABC-2004 (Leigh et al. 2005b) and later the CRA-2009 (DOE, 2009a) contain the results of updated PAs submitted to the EPA for compliance purposes. The PABC-2004 was used in EPA's 2006 certification decision and became the new compliance baseline PA. The CRA-2009 used the same inventory information as the PABC-2004. The DOE will provide another PA using a more current inventory during the PABC-2009 which was not completed prior to the reporting period of this year's COMPs report. Therefore, results of this year's COMP assessment used the baseline documented in the CRA-2004 (and subsequently the PABC-2004) and conclude that there are no COMPs data or results that indicate a reportable event or condition adverse to predicted performance. In instances where TVs have been exceeded, further investigations or activities will be pursued as described in previous sections. The operational period monitoring program will continue to seek to identify conditions that could indicate deviations from the expected disposal system performance.

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Slwagner 1/20/10

Wagner, Steve

From: Chavez, Mario Joseph

Sent: Wednesday, January 20, 2010 10:15 AM

To: Trone, Janis R

Cc: Wagner, Steve

Subject: Signature Authority for 2009 COMPS Report

I give Janis Trone authority to sign the 2009 COMPS report on my behalf.

Mario Chavez

SW 1/13/10

Wagner, Steve

From: Beauheim, Richard L

Sent: Wednesday, January 13, 2010 12:58 PM

To: Wagner, Steve

Subject: RE: Signature authority for COMPs title page

I hereby delegate signature authority for the COMPs report to Steve Wagner.

Rick Beauheim

From: Wagner, Steve
Sent: Wednesday, January 13, 2010 12:56 PM
To: Beauheim, Richard L
Subject: Signature authority for COMPs title page

Rick,
I finally have all the DRCs signed off and need your signature on the report. Can you give me signature authority for this report?
Thanks,
Steve