Two-Component Swelling Tests Operated for Three, Nine and Twenty-Seven Months

NWMO TR-2011-15 January 2011

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ABSTRACT

Title: **Two-Component Swelling Tests Operated for Three, Nine and Twenty-Seven Months**
Report No.: **NWMO TR-2011-15**
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Company: Atomic Energy of Canada Limited
Date: January 2011

Abstract

The Backfilling and Closure of the Deep Repository (BACLO) project was a co-operative international effort that involved a variety of activities supported by SKB and Posiva, as well as a limited scope of in-kind contributions from Nuclear Waste Management Organization (NWMO). This project ended in 2009 and was superseded by the BASE (Backfill and Sealing) project, which continued the work begun prior to that date. From 2008 onwards the contribution from NWMO to this work involved laboratory tests that have been done for NWMO by Atomic Energy of Canada Limited (AECL) to examine the mechanical (strain) interactions between dissimilar components of the clay-based sealing system. Specifically, this ongoing work has been investigating the manner in which water supplied from the rock will be taken up by densely compacted backfill blocks and bentonite pellets configured to represent the tunnel fill in a placement room of a deep geological repository using the In-Floor Borehole placement method.

In this testing program, a total of 17 testing cells were installed at AECL's geotechnical laboratory in order to examine the process of water uptake and volumetric equilibration of backfill clay blocks in contact with clay pellets. These tests consisted of two different assemblies (i.e., Friedland clay blocks-bentonite pellets and Asha clay blocks-bentonite pellets) and two different groundwater compositions (1.0% and 3.5% of 50% Sodium Chloride (NaCl) and 50% of Calcium Chloride ($CaCl_2$) by mass). The replicated cells were scheduled to be dismantled at intervals of 3, 9 and 27 months with associated measurement of gravimetric water content and volume changes of the components installed (expansion or compression).

This report presents a summary of the results obtained by dismantling the test cells after 3, 9 and 27 months of operation. Data obtained during dismantling include measurement of the distribution of internal gravimetric water content and density, as well as a measure of how these change with time. The test results show that a system consisting of two similar mineralogical materials, will come to a homogeneous density state and two different pore fluid salinities (1.0% and 3.5%) had little effect on the apparent rate of system equilibration. This information will be useful to provide a means of better understanding the role of both time and groundwater salinity on the short-term evolution of clay-based sealing materials.

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1. BACKGROUND

The Backfilling and Closure of the Deep Repository (BACLO) project that was followed by the BASE (Backfill and Sealing) in 2009, was one of the co-operative international efforts supported by Swedish Nuclear Fuel and Waste Management Company (SKB) and Posiva Oy, as well as a limited scope of in-kind contributions from NWMO. The contribution from NWMO to this work involved laboratory tests (done for NWMO by AECL) to examine the mechanical (strain) interactions between two dissimilar components of the clay-based sealing system.

The two-component testing has been investigating the tunnel fill in a placement room where water supplied to the material that would be closest to the rock (pellets) will be taken up by an assembly of densely compacted backfill blocks and bentonite pellets. In this study it was assumed that the blocks fill approximately 80% of the tunnel volume and pellets fill the remaining 20%. The pellets are intended to be used to fill the spaces between the block assembly and the surrounding rock walls, floor and roof. Inflow of water from the surrounding rock into a backfilled section of tunnel will result in the initiation of saturation and subsequent swelling of the pellet-filled volume.

A total of 17 testing cells were commissioned to examine the role of groundwater salinity on water uptake; and the process of water uptake and development of volumetric equilibrium in backfill clay blocks in contact with clay pellets. These cells are slightly modified large-volume compaction/permeability cells and were monitored at AECL's geotechnical laboratory. While most of these cells were ~100 mm in height and 94 mm in diameter, five (5) shorter cells (~40 mm height) were included in order to evaluate the effects of test dimensions as well as filling efficiency (one 9-month test for 60 and 70% block-filling efficiency were evaluated in addition to the 15 tests completed for 80% block-filling efficiency) on the strains of the components installed. For the 80-20 tests, two (2) different pore fluid concentrations were evaluated (1.0% and 3.5% of Na-Ca-Cl by mass) to assess the role of groundwater salinity on water uptake and system strain. In addition, the cumulative amount of water uptake by each cell was monitored by measuring change in cell mass over time, without externally restricting the uptake rate. The 17 cells were dismantled at intervals of 3, 9 and 27 months with associated measurement of gravimetric water content and volume changes of the components installed (expansion or compression).

This report presents the results obtained through dismantling the cells after 3, 9 and 27 months of operation. Data on the evolution of the internal gravimetric water content and density will provide a better understanding of the role of both time and groundwater salinity on the evolution of this clay-based backfilling system.

2. TESTING PROGRAM

2.1 TEST APPARATUS

A slight modification to conventional large-diameter permeameter cells has been made by AECL by adding a split wall. The modified cells have an approximate internal diameter of 94 mm and a height of ~100 mm as shown in Figure 1. The cells are split down one side and bolts are installed along the side in order to allow release of the lateral restraint of the specimens without disturbing them. Rather than compacting the specimen directly into the permeameter, precompacted bentonite blocks and pellets were installed in a thin-walled Plexiglas sleeve, which was subsequently installed in the split mould, providing both a water-tight assembly and sufficient mechanical confinement to the sleeve to prevent it from cracking due to swelling pressure development. This geometry facilitates specimen removal at the end of the test and the cylinder can be accurately cut into sections for moisture and density measurement

The cells were filled with 80% by volume of compacted bentonite block material and 20% of bentonite pellets. A porous disk and filter paper were placed at the top of the specimens and glass plate spacers were placed at the bottom of several specimens. The cell contained top and bottom plates with a fluid inlet and outlet, respectively. The fluid solution was supplied to the cell through a constant-head reservoir. Due to the potential for leakage in the modified cell, the maximum water inflow pressure ranged from 20 to 30 kPa. The cumulative amount of water uptake of each cell was monitored by measuring change in mass with time, without restricting uptake rate. This method eliminates the need for evaluating cell leakage since only the amount actually taken into the specimen is recorded (mass change). This method does not attempt to simulate a field situation where swelling and subsequent increase in resistance to inflow occurs; rather it is intended to simulate a system where water is passively supplied to the pellet contact. Any additional water (or increase in hydraulic head) associated with the geometry is assumed to have been diverted to another location either via the EDZ or the fracture network from which the water is supplied.

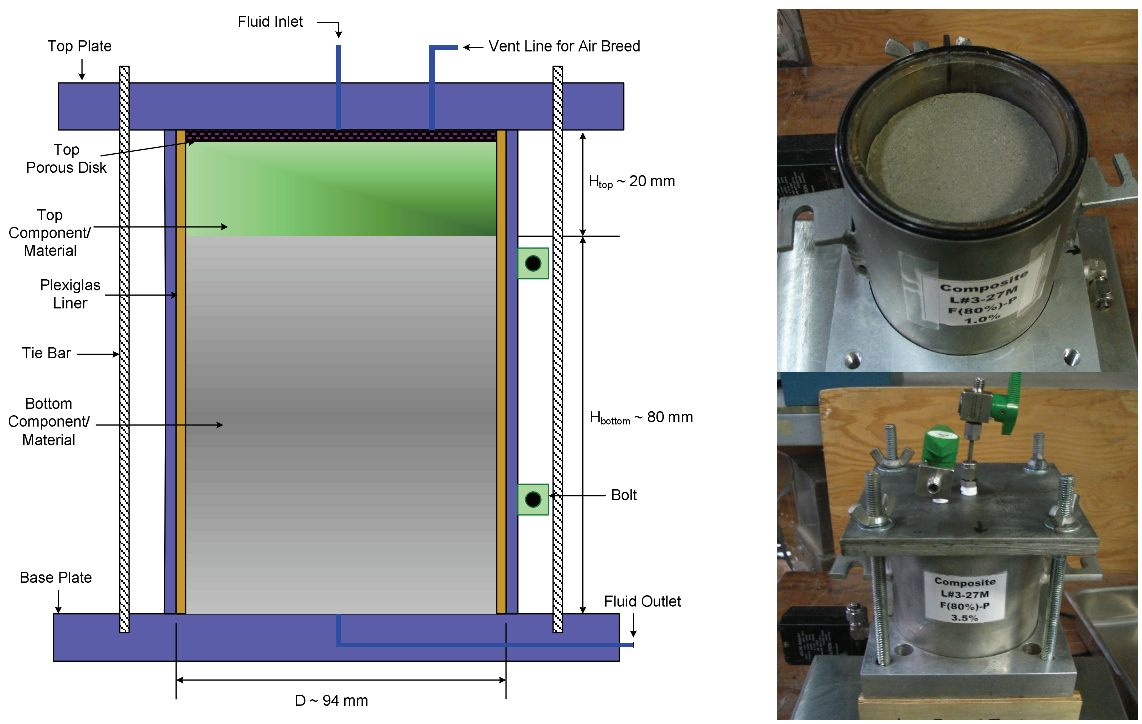


Figure 1: Backfill Clay Block-Bentonite Pellet Assembly in the Modified Cell

2.2 TESTING MATERIALS

The materials tested in this program are identical to those being evaluated in the backfill testing programs at Äspö and elsewhere in Sweden and Finland during 2007 and 2008. This testing program consists of the following material groups: (1) assemblies of Friedland blocks and Cebogel pellets in 1.0% and 3.5% saline solutions, and (2) assemblies of Asha blocks and Cebogel pellets in 1.0% and 3.5% saline solutions (equal TDS contributions of NaCl and $CaCl_2$).

Clay Block Material

The clay block materials used in these tests are prepared from Friedland and Asha clay. These two types of clay were provided to AECL by SKB and Posiva and represent well-characterised reference materials. Some physical processing of the materials was undertaken prior to the start of testing in order to produce materials at the reference densities and water saturation of the SKB backfill block concept. This processing included compaction of Friedland or Asha clays into blocks (cylinders) of the desired dry densities of 2.0 and 1.7 Mg/m^3 at target gravimetric water contents of 11% and 17%, respectively (achieving approximately 75-85% water saturation). The blocks are then placed as double-lift layers in each cell. Table 1 summarizes initial (as supplied) water content and target properties of these two clay materials.

Pellet Material

Cebogel pellets were used in the testing program. Cebogel pellets were provided by SKB and have dimensions of approximately 5 mm diameter and 10 mm length. The pellet layer is compacted to achieve the desired as-placed dry density of 1.1 Mg/m^3 as also shown in Table 1.

Table 1: Summary of Clay Based Testing Material Properties

Type	Water Content as Supplied, %	Target Water Content, %	Target Dry Density, Mg/m^3
Friedland	~11.0	11.0%	2.0
Asha	~2.0	17.0%	1.7
Cebogel*	~19.0	N/A	1.1

* The individual pellets have a dry density of ~1.8 Mg/m^3, the poured volume occupied by these pellets had an average dry density of 1.1 Mg/m^3

Saline Solutions

The fluids used in this testing program are artificial groundwaters with salt concentrations of 1.0% and 3.5%. The saline solution consists of 50% of Sodium Chloride (NaCl) and 50% of Calcium Chloride ($CaCl_2$) by mass, which is consistent with the groundwater salinities of interest to SKB and Posiva.

2.3 INSTALLATION

A testing cell is an assembly of the base plate, Plexiglas sleeve between the cell wall and the specimen, top filter paper and porous stone, and top plate. Figure 2 shows the installation process of a testing cell. The clay block was first compacted in two equal layers and then placed in the Plexiglas sleeve within the modified cell (Figures 2A, 2B and 2C). Pre-weighed pellets were placed and lightly compacted on the top of the clay block and saline solution was poured into the assembly (Figures 2D and 2E) in order to remove any trapped air in the cell prior to installing the top lid. The filter paper and porous stone were placed on top of the pellets before the top lid was put on and the cell was then bolted closed (Figure 2F).

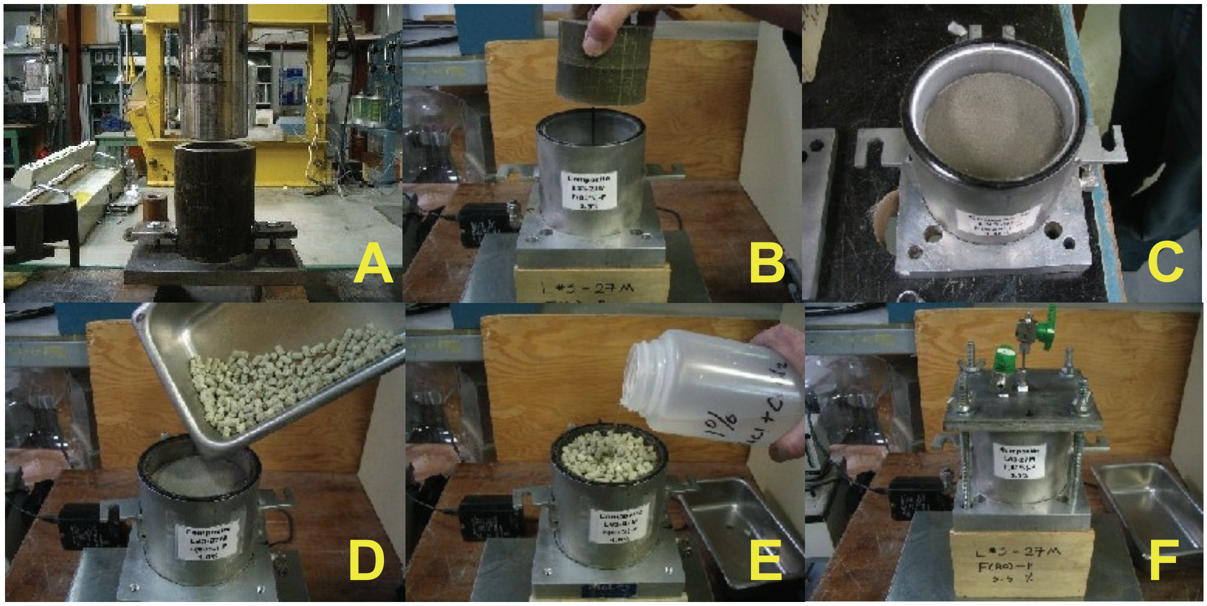


Figure 2: Installation of a Testing Cell

A listing of the tests installed is provided in Table 2. Eleven (11) testing cells containing Friedland clay blocks and Cebogel pellets were installed between March and April 2008. The remaining six (6) cells contained Asha clay blocks and Cebogel pellets were installed in June 2008.

Table 2: Test Matrix for Tests Commissioned

Types	Friedland Block-Pellets					Asha Block-Pellets	
Saline Fluids, %	1.0	3.5	3.5			1.0	3.5
Specimen Height, mm	~100	~100	~40			~100	~100
Target Percentage of Cell Filled with Clay Block, %	80	80	80	70	60	80	80
Duration, Months	3	3	3	-	-	3	3
	9	9	9	9	9	9	9
	27	27	27	-	-	27	27
Total Number of Test	3	3	3	1	1	3	3

Table 3: Summary of Test Status

Type	Duration, (month)	Specimen Length, (mm)	Salinity, (%)	Installation Date	Date Dismantled
Friedland Clay - Cebogel Pellets	3	~100	1.0	March 17-08	Dismantled July 2008
	9	~100	1.0	March 24-08	Dismantled January 2009
	27	~100	1.0	April 01-08	Dismantled June 2010
	3	~100	3.5	March 31-08	Dismantled July 2008
	9	~100	3.5	March 27-08	Dismantled January 2009
	27	~100	3.5	April 01-08	Dismantled June 2010
	3	~40	3.5	March 31-08	Dismantled July 2008
	9	~40	3.5	March 18-08	Dismantled January 2009
	27	~40	3.5	March 31-08	Dismantled June 2010
	9	~40	3.5	March 18-08	Dismantled January 2009
	9	~40	3.5	March 19-08	Dismantled January 2009
Asha Clay - Cebogel Pellets	3	~100	1.0	June 09-08	Dismantled September 2008
	9	~100	1.0	June 09-08	Dismantled March 2009
	27	~100	1.0	June 10-08	Dismantled August 2010
	3	~100	3.5	June 10-08	Dismantled September 2008
	9	~100	3.5	June 10-08	Dismantled March, 2009
	27	~100	3.5	June 09-08	Dismantled August 2010

2.4 DISMANTLING AND SAMPLING

At the end of each test, the thin-walled Plexiglas sleeve containing the specimen was removed by loosening the side bolts on the cell as shown in Figures 3A and 3B. After removal from the main cell, visual observation of each sample was undertaken and dimensions such as thickness and weight were measured. The Plexiglas sleeve was then cut into horizontal and vertical slices using an electric saw (Figures 3C, 3D, 3E and 3F) in order to minimize sampling disturbance.

Sampling to determine the density and gravimetric water content was conducted on each test. Figure 4 shows cutting layers for the specimens confined by Plexiglas. The 100 mm long specimens were cut into four (4) equal clay block layers and a single pellet layer. The 40 mm long tests had three (3) equal clay block layers and a pellet layer. Dividing the sample in this manner increased accuracy in determining changes in gravimetric water content, volumetric strain and density changes with sample length. Figure 5 shows the sampling layout of the pellet layer to measure gravimetric water content and bulk density. In each clay block layer, samples were taken at eight (8) different locations and were then divided into two sections (i.e., centre and outside) as shown in Figure 6. The test method for determining bulk density and volume of solid refractories by wax immersion (ASTM Standard C914-95) was used to determine bulk density of samples. Gravimetric water content was measured using the technique defined by ASTM Standard D2216-05.

In the course of dismantling of these tests, mechanical shortcomings in the apparatus setup were identified. Some tests that contained glass plates as spacers at the cell base and in others an uneven contact existed between the porous stone and the cell lid. This resulted in unplanned internal volume changes due to breakage of the glass or stone components as shown in Figure 7. This change in volume made comparison of the individual tests difficult. In order to evaluate the effects of such volume changes and analyze the test data, it is assumed that (1) the clay blocks were rigid masses farther away from the water supply and were initially pushed down as a relatively uniform mass by the hydrated pellets that generated swelling pressure, and/or (2) the hydrated pellets swelled and caused mechanical failure of the porous stone under the uneven top lid of the cell. Therefore in the analysis of the results where an increase in internal volume occurred, it is assumed to have occurred within the pellet-filled volume (the initial pellet volume in some tests was greater than it was supposed to be).

Figure 3: Dismantling of a Testing Cell

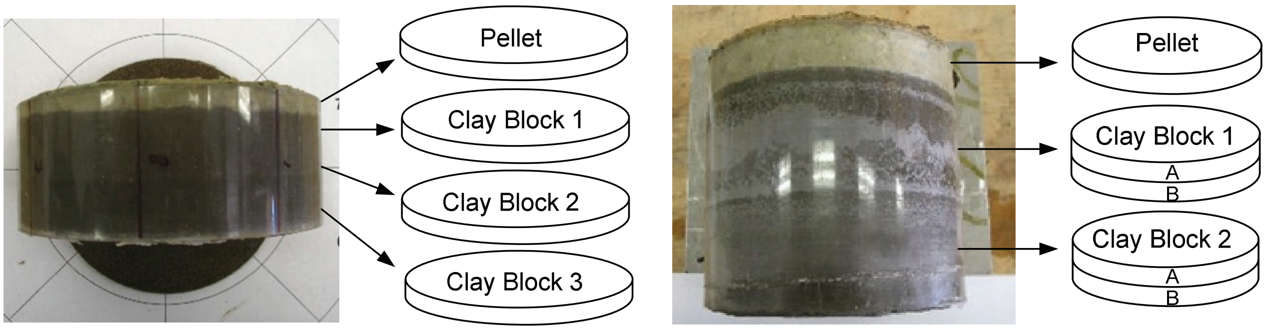


Figure 4: Sampling Layers of Short (left) and Long (right) Specimens Surrounded by Plexiglas Sleeves

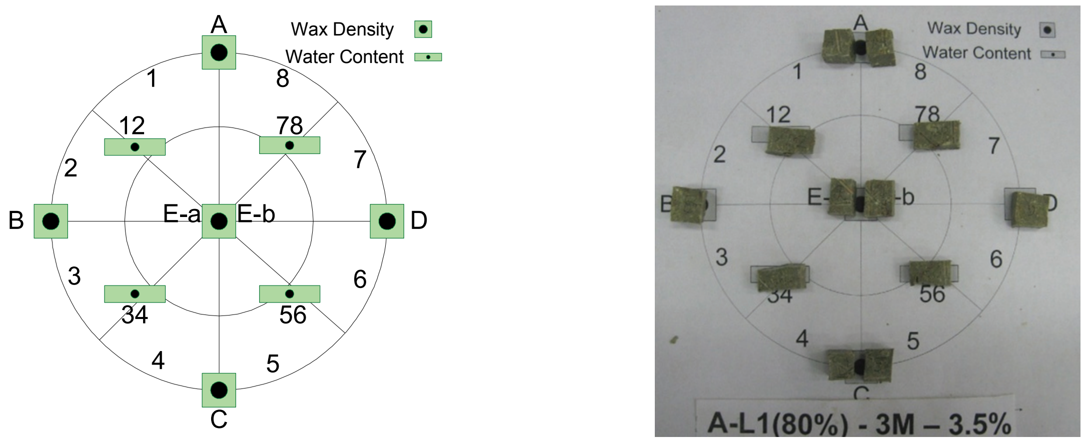


Figure 5: Layout of Pellet Samples for Measuring Wax Density (WD) and Water Content (WC)

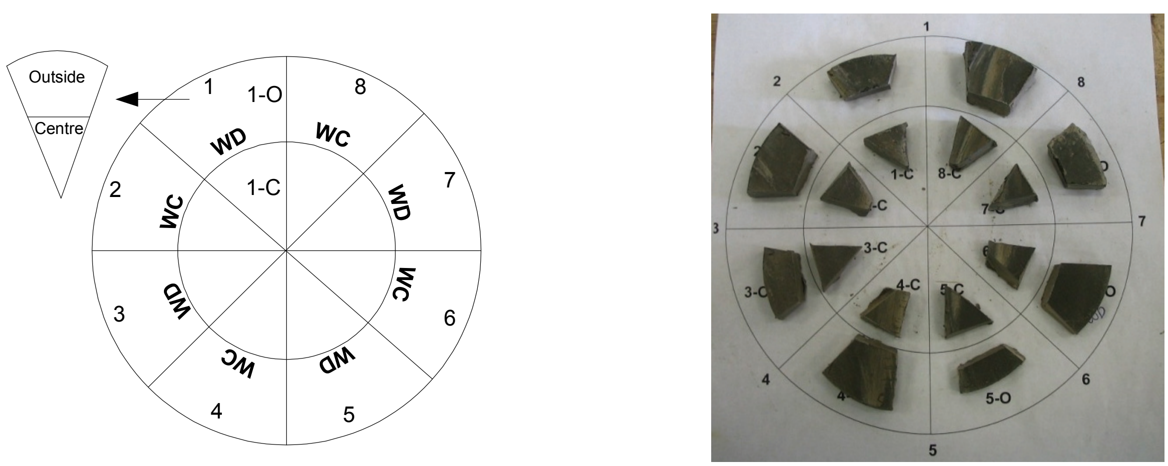


Figure 6: Layout of Clay Block Samples for Measuring Wax Density (WD) and Water Content (WC)

Figure 7: Samples Showing Mechanical Failure at the Top (Left) and Bottom (Right)

3. TEST RESULTS AND DISCUSSIONS

The measured gravimetric water content and bulk densities were used to calculate dry density, Effective Montmorillonite Dry Density (EMDD), degree of fluid saturation and volumetric strain. This section presents a comparison of test results in terms of the cumulative amount of water uptake, changes in gravimetric water content, dry density and EMDD including volumetric strain, and degree of fluid saturation.

3.1 CUMULATIVE WATER UPTAKE

The amount of water uptake into the cell was monitored by measuring changes in mass of the cell with time. The cumulative amount of water uptake in each test was different and difficult to directly compare with other tests due to the differences in the amount of solution that was initially used to fill the pellet-filled region and remove trapped air during installation. The water added for initial wetting of the pellets tends to overwhelm subsequent water uptake quantities and only small variations in the quantity of pellets installed greatly affect initial system evolution. Mechanical failure of the top and bottom spacer-plates also contributed to variability in the amounts of water entering in each test. For these reasons, it is better to compare the cumulative water uptake pattern of each test rather than the absolute volume of water taken in.

Figures 8 through 11 show the cumulative water uptake into assemblies of Friedland clay blocks and Cebogel pellets at 1.0% and 3.5% saline solutions for 3, 9 and 27 month operations. Figures 8 and 9 show that most fluid uptake occurred within the first 60 days (about 1500 hours) at both 1.0% and 3.5% pore fluid salinity and then the water uptake rates stabilized after that time.

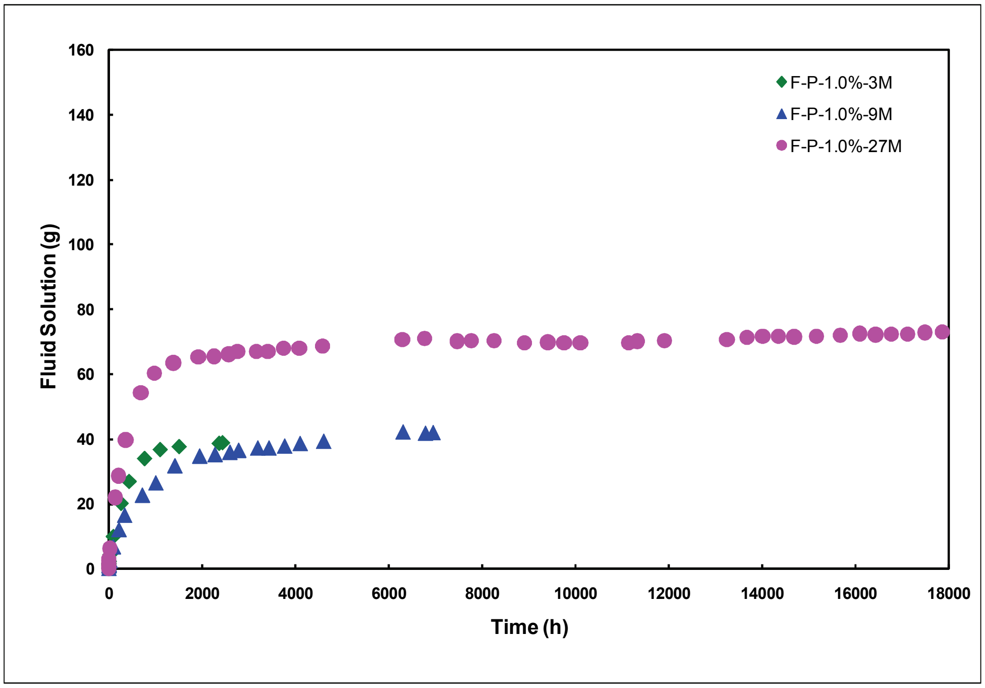


Figure 8: Cumulative Water Uptake into Friedland Clay Blocks - Cebogel Pellets at 1.0% Salinity at 3, 9 and 27 Months (Note: F (Friedland Clay) / A (Asha Clay) – P (Cebogel Pellet) – 3M (Operated time))

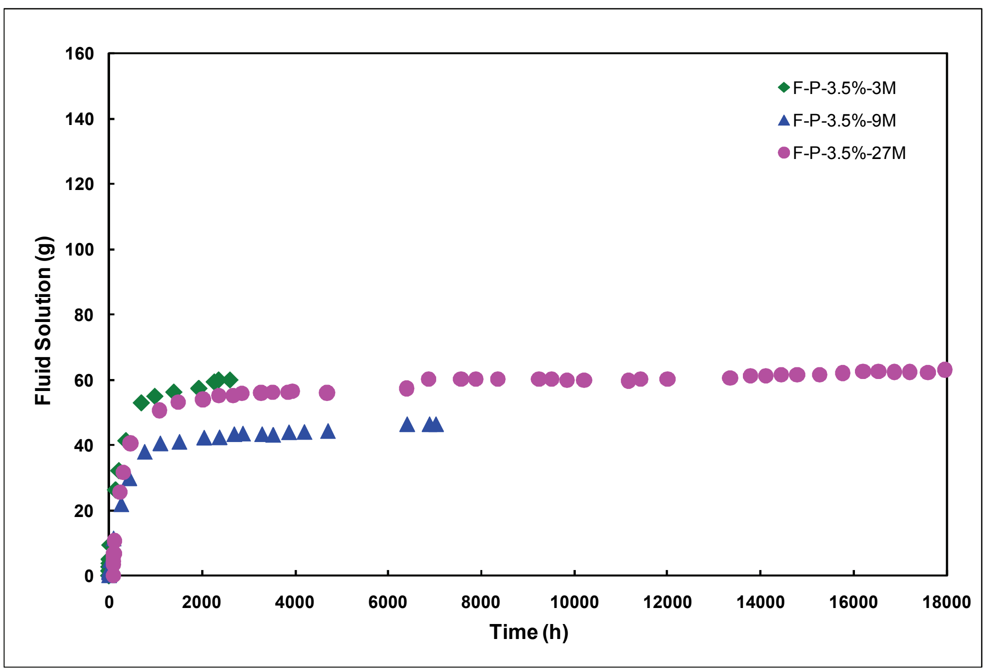


Figure 9: Cumulative Water Uptake into Friedland Clay Blocks - Cebogel Pellets at 3.5% Salinity at 3, 9 and 27 Months

Figures 10 and 11 show the cumulative water uptake into the shorter assemblies (~40 mm lengths) of Friedland clay blocks and Cebogel pellets. These cells were supposed to be filled to 80%, 70% and 60% by volume with clay blocks, however due to mechanical difficulty in the design, the 9 month tests targeted to be 60% and 80% were actually 50% and 70% clay block filling respectively. The 27 month test targeted to be 80% block filling was actually only 75% clay block filling. The significance of these deviations from the target condition is discussed below. Most fluid uptake in the 40 mm high tests occurred within approximately 17 days (400 hours). As would be expected, the time for inflow rate to equilibrate was quicker for the short specimens than that in the tests with longer (~100 mm) lengths. In assemblies of Asha clay blocks and Cebogel pellets, most fluid uptake occurred within 90 days (~2200 hours) at both 1.0% and 3.5% salinity as shown in Figures 12 and 13.

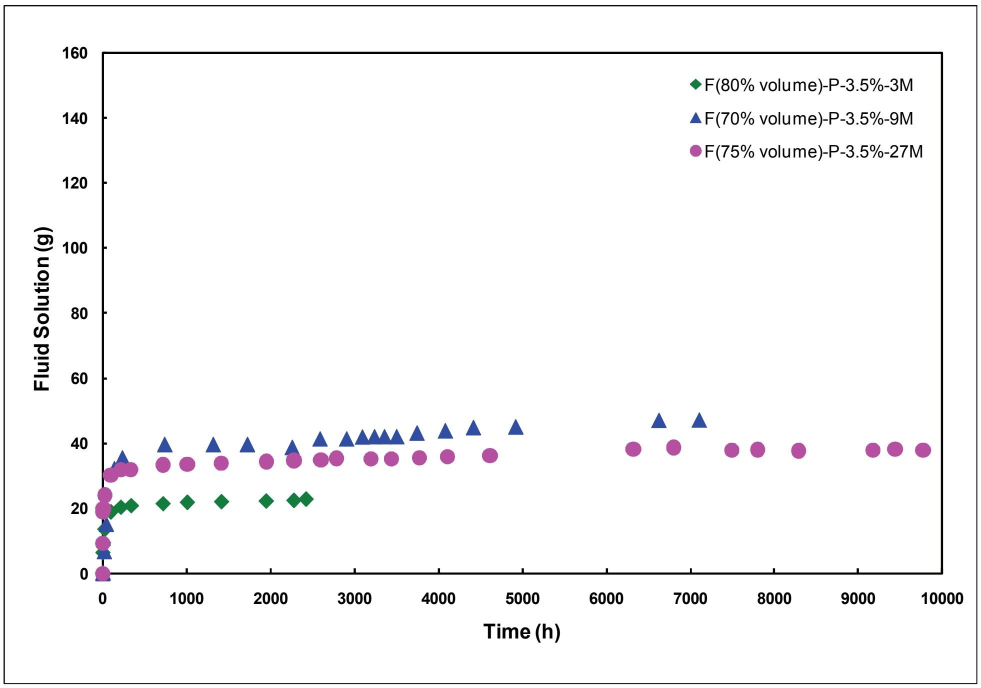


Figure 10: Cumulative Water Uptake into Short Friedland Clay Blocks - Cebogel Pellets at 3.5% Salinity (3 months-80%, 9 months-70% and 27 months-75% clay blocks by volume)

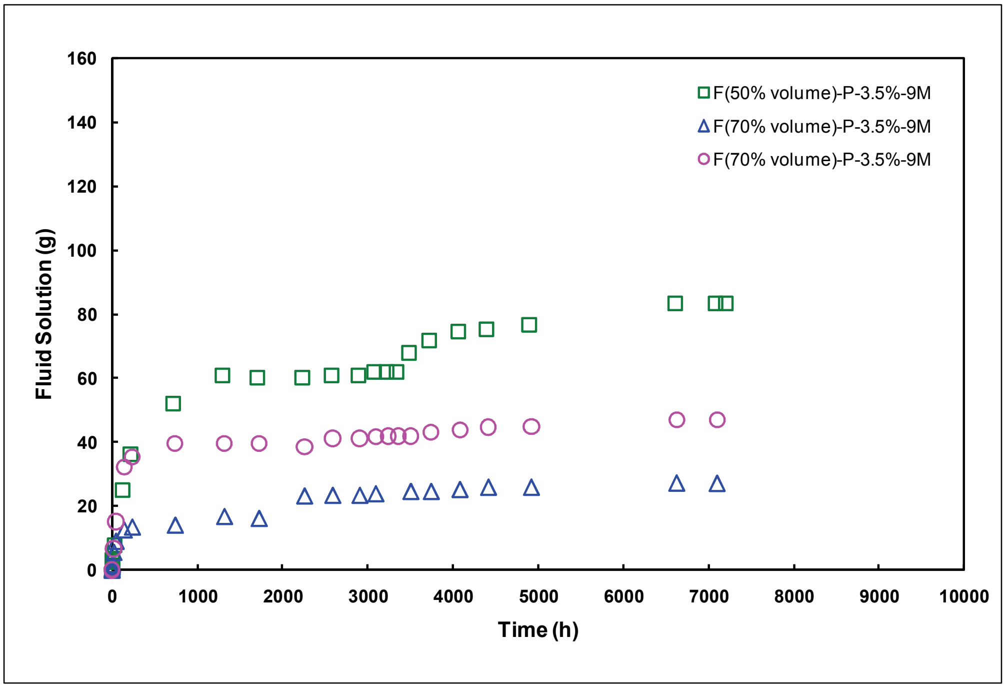


Figure 11: Cumulative Water Uptake into Short Friedland Clay Blocks - Cebogel Pellets with Different Clay Filling Efficiency at 3.5% Salinity at 9 Months

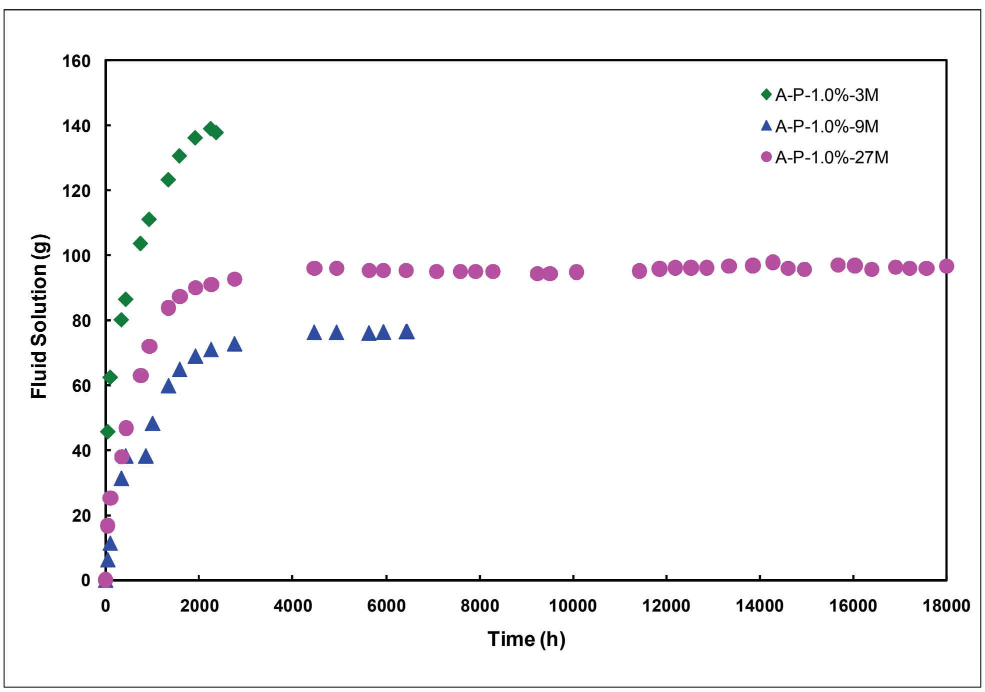


Figure 12: Cumulative Water Uptake into Asha Clay Blocks - Cebogel Pellets at 1.0% Salinity at 3, 9 and 27 Months

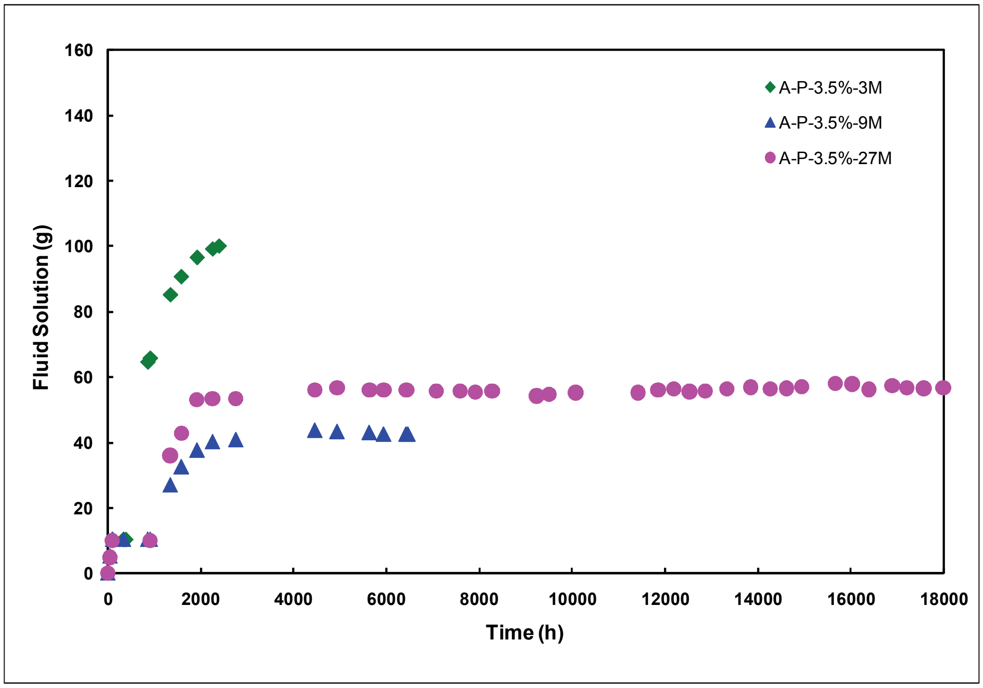


Figure 13: Cumulative Water Uptake into Asha Clay Blocks - Cebogel Pellets at 3.5% Salinity at 3, 9 and 27 Months

3.2 GRAVIMETRIC WATER CONTENT

At the time of installation and at the end of testing, gravimetric water content was measured for each specimen. The average gravimetric water content was calculated from samples taken at different locations on each layer (see Figures 5 and 6). For the 40 mm high specimens, the clay blocks had three (3) individual average values, one representing each layer sampled, and for the 100 mm high specimens, the clay blocks had four average water content values, one for each layer. In calculation of gravimetric water content, the soluble salt content was taken into account in order to correct the masses measured (based on ASTM D 4542-07). Table 5 provides a summary of values measured at the time of installation and the end of testing.

Plots of gravimetric water content measured from assemblies of Friedland clay blocks and Cebogel pellets with 1.0% and 3.5% pore fluid salinity after 3, 9 and 27 months of water uptake are shown in Figures 14 and 15. In the 3 and 9 month tests with both 1.0% and 3.5% pore fluid salinity, the gravimetric water content in the clay blocks increased with time and the clay blocks immediately adjacent to the pellets had relatively high gravimetric water contents due to their locations close to the water supply. The gravimetric water content in the pellets increased and then started to decrease with time. The reason for this is likely due to the increase in swelling pressure exerted by the clay blocks with time, as this layer became more hydrated. This caused the pellets to be compressed, decreasing their void volume and the gravimetric water content. In both 27 month tests at 1.0% and 3.5% salinity, a similar pattern was present with the clay blocks closer to the pellets having higher gravimetric water contents. Slight changes in gravimetric water content were observed between the 27 and 9 month tests. These figures also illustrate that the clay blocks were coming close to water content equilibrium with increasing time, showing that the water content gradients became slightly weaker. However there was little change between 9 months and 27 months tests at both 1.0% and 3.5% pore fluid salinity.

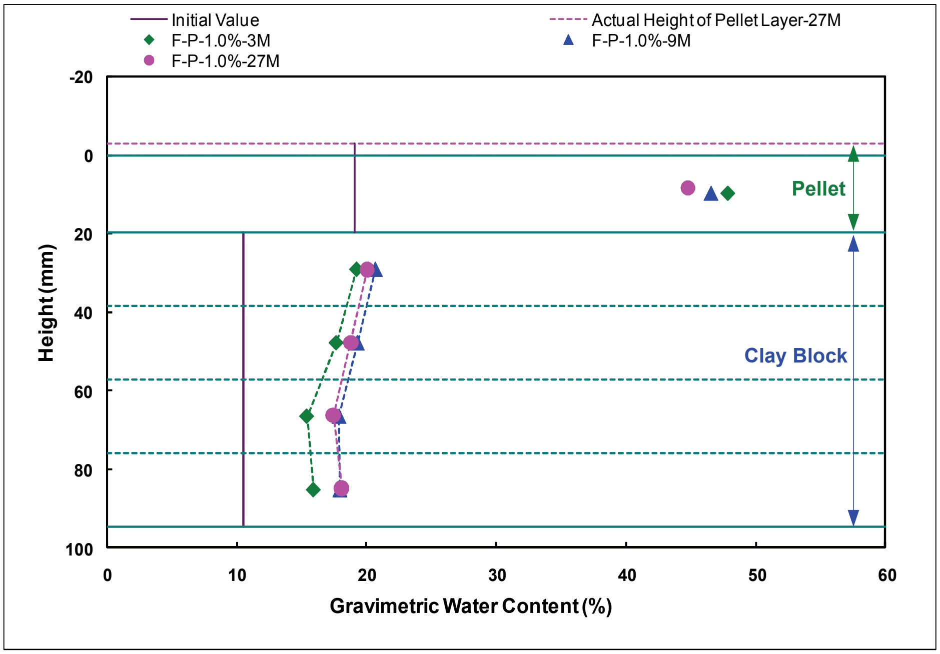


Figure 14: Gravimetric Water Content of Friedland Clay Blocks - Cebogel Pellets at 1.0% Salinity at 3, 9 and 27 Months

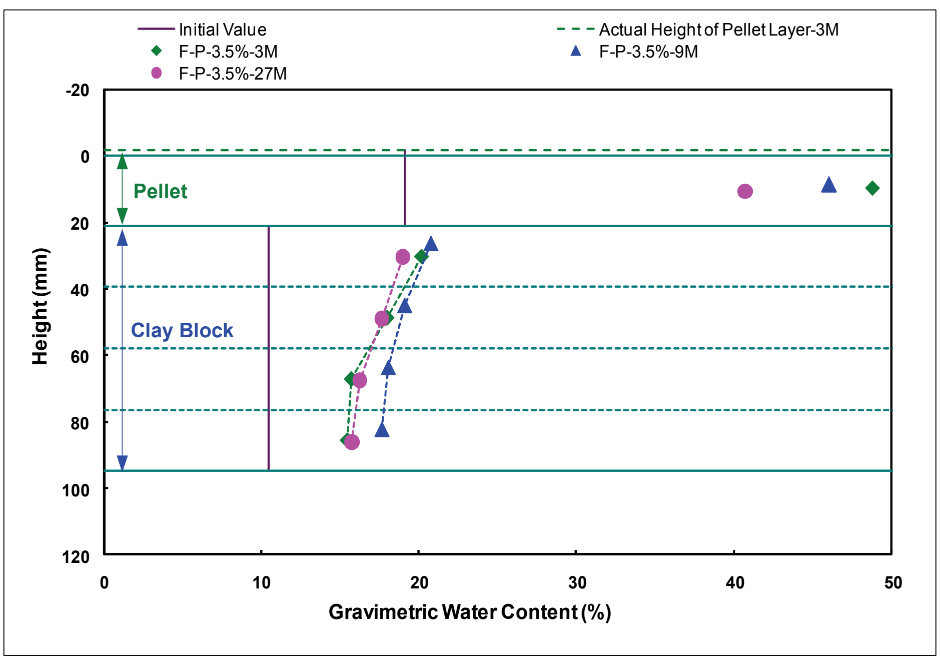
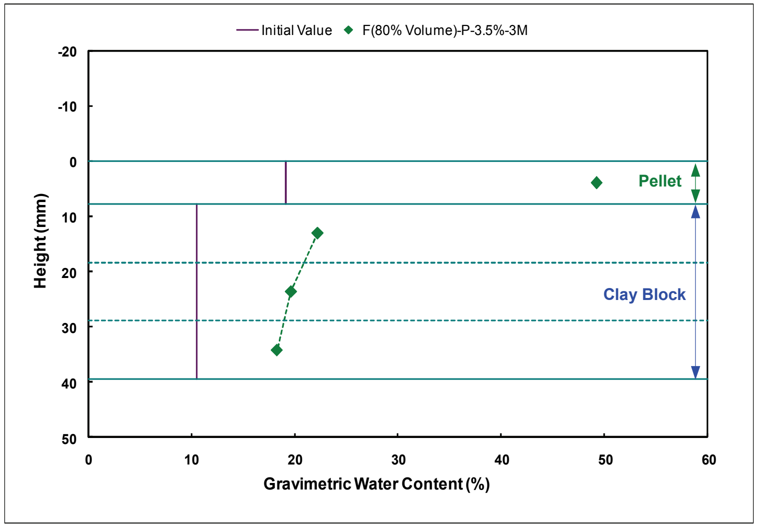


Figure 15: Gravimetric Water Content of Friedland Clay Blocks - Cebogel Pellets at 3.5% Salinity at 3, 9 and 27 Months

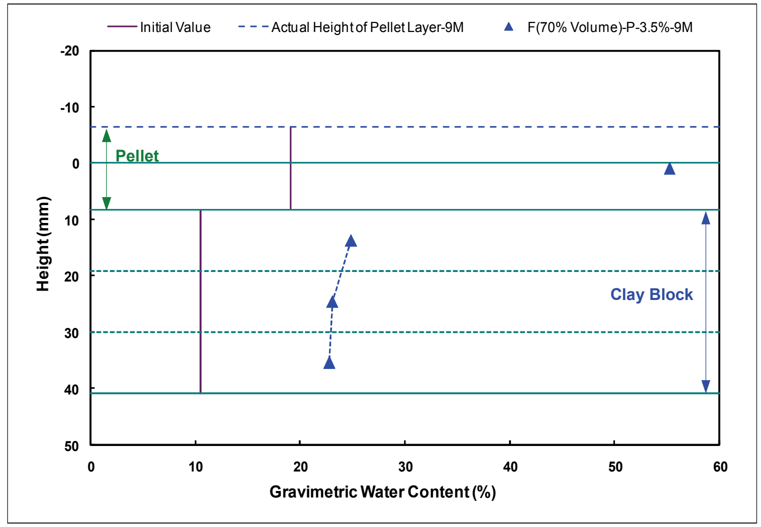
Test results from short assemblies (~40 mm length) of Friedland clay blocks and Cebogel pellets at 3.5% salinity after 3, 9 and 27 months are shown in Figures 16 and 17.

Figure 16 illustrates that in the 9 and 27 month tests, the gravimetric water contents increased by approximately 6% in the pellets and 3% in the clay blocks from the 3-month test. This indicates that the unexpected internal volume increase in the pellet-filled volume allowed both pellets and the clay blocks to absorb more water than would otherwise have occurred.

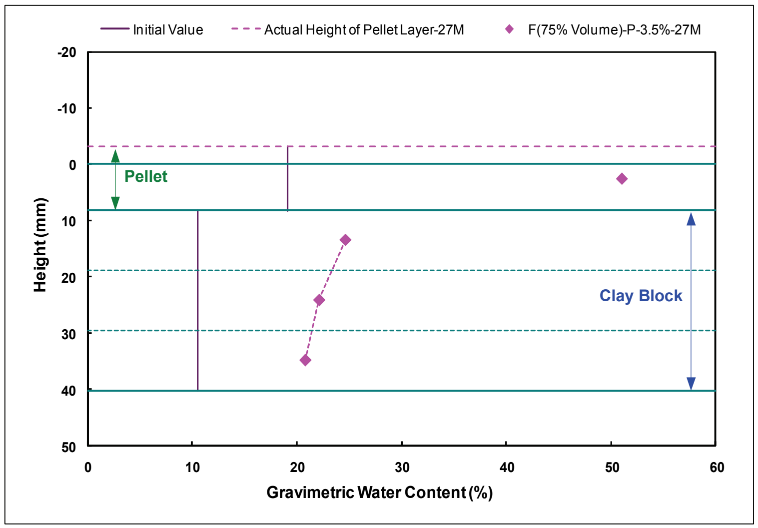
Figure 17 shows a comparison of the tests filled with 70% (original target 80%), 70%, and 50% (original target 60%) of clay blocks by volume for a 9 month test duration. As would be expected, the test with 50% clay block filling had apparently reached water content uniformity after 9 months due to the shorter distance needed for water movement into the clay blocks and the larger volume of pellet fill (and hence larger initial supply of water). The tests 70% filled with clay blocks (original target 70% and 80%) show almost straight vertical lines indicating they were very close to water content equilibrium after 9 months. This figure also indicates that internal volume increase in the pellet-filled region caused by incomplete confinement of the specimen induced an increase in the gravimetric water content in the clay blocks once density equilibrium was achieved.



(a) 3 Months



(b) 9 Months



(c) 27 Months

Figure 16: Gravimetric Water Content of Short Assemblies of Friedland Clay Blocks - Cebogel Pellets at 3.5% Salinity at (a) 3 Months-80% clay block volume, (b) 9 Months-70% clay block volume and (c) 27 Months-75% clay block volume

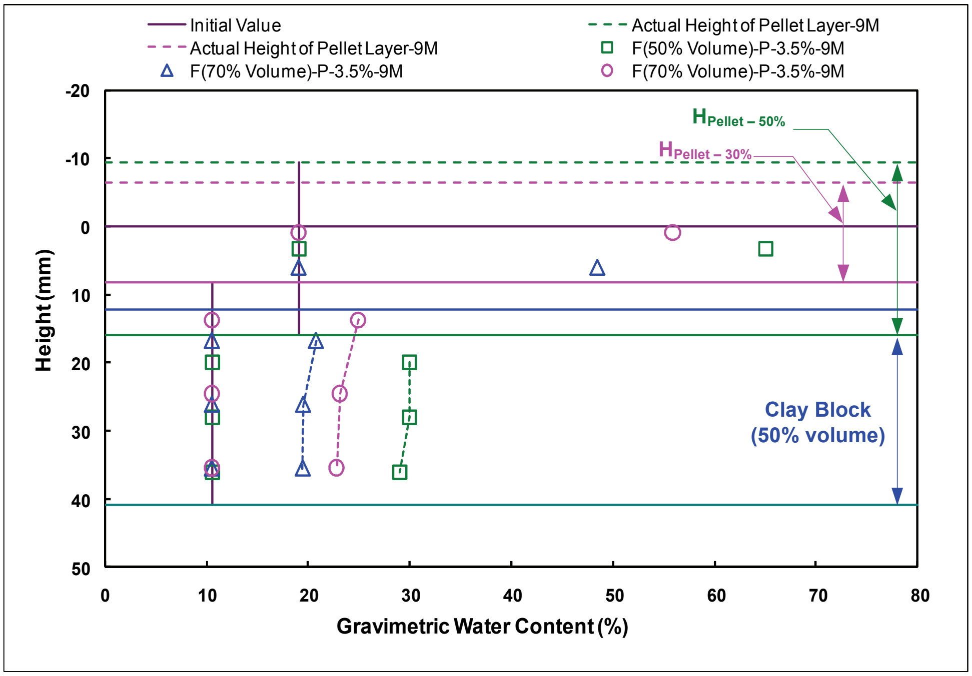


Figure 17: Gravimetric Water Content of Short Assemblies of Friedland Clay Blocks - Cebogel Pellets at 3.5% Salinity at 9 Months with Different Clay Filling Efficiencies

Figures 18 and 19 show plots of gravimetric water content for assemblies (~100 mm length) of Asha clay blocks and Cebogel pellets at 1.0% and 3.5% salinity after 3, 9 and 27 months of water uptake. Figure 18 shows the conditions at the end of the 3 month test with 1.0% salinity. The gravimetric water content of the pellets increased approximately 16% from their initial (pre-wetted) condition and then for the 9 and 27 month tests, the pellets showed a slight reduction from their 3 month conditions. The gravimetric water content in clay blocks increased approximately 20% at the top layer and 15% at the bottom layers. Figure 19 shows about 12% increase of gravimetric water content in pellets, and 17% at the top and 15% at the bottom of the clay blocks at the end of 3 and 9 month tests. The 27 month test with 3.5% salinity shows slightly higher gravimetric water content likely due to internal volume increase in the pellet-filled volume, which allowed both material layers to absorb more water.

The clay blocks tested using 1.0% and 3.5% salinity were not at equilibrium with respect to water content with depth but there were only slight changes observed between the results of the 9 and 27 month tests. The middle and bottom parts of the clay blocks were moving slowly toward water content equilibrium, indicating a more uniform water distribution with depth.

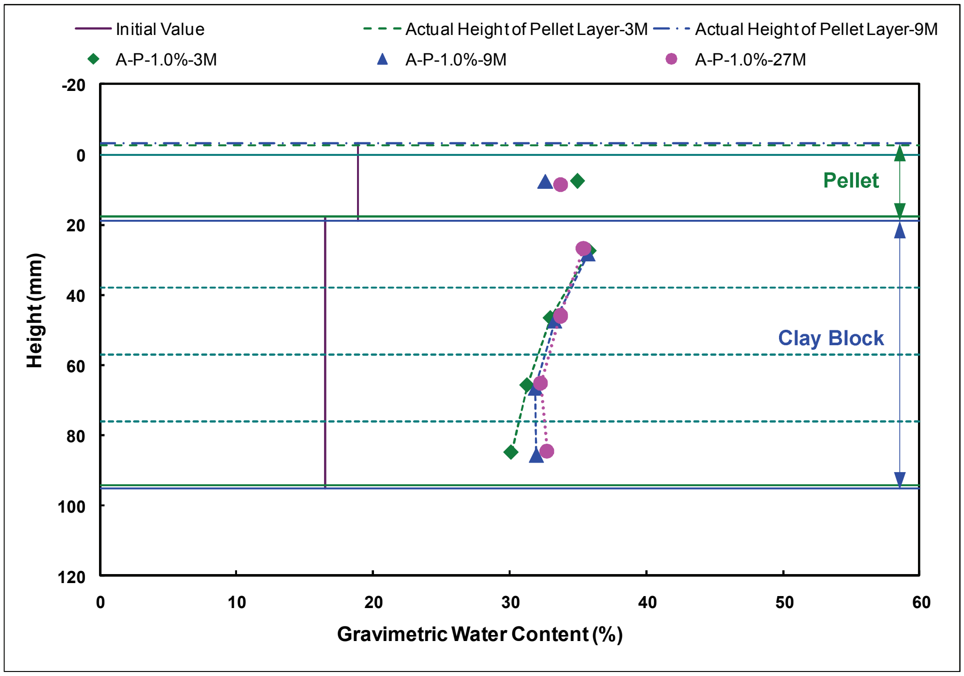


Figure 18: Gravimetric Water Content of Asha Clay Blocks - Cebogel Pellets at 1.0% Salinity at 3, 9 and 27 Months

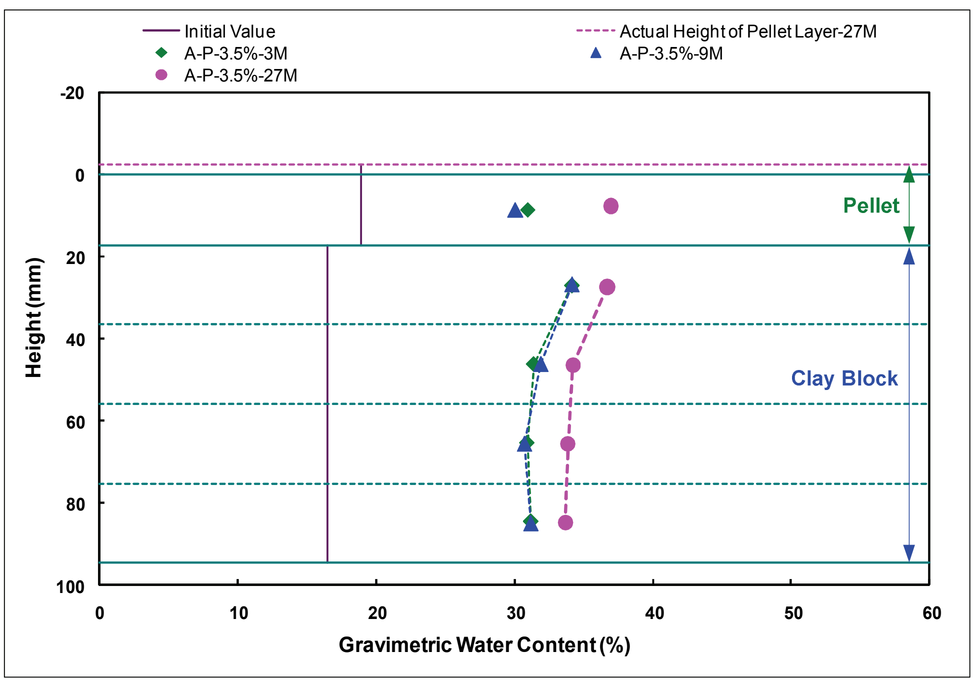


Figure 19: Gravimetric Water Content of Asha Clay Blocks - Cebogel Pellets at 3.5% Salinity at 3, 9 and 27 Months

3.3 DRY DENSITY AND EMDD (Effective Montmorillonite Dry Density)

Dry density was calculated from bulk density and gravimetric water contents measured for samples recovered during specimen dismantling. These dry density values are the average values of each layer. Figures 20 through 25 show plots of dry density from assemblies of clay blocks and pellets at the time of installation and at the end of testing at various locations (see Figures 5 and 6). These figures also present (1) values of EMDD (Effective Montmorillonite Dry Density), as bracketed numbers, (2) interface changes (vertical volume changes) between two materials after 3, 9 and 27 month of operation, and (3) estimated EMDD values at stress or density equilibriums.

There are three possibilities related to ultimate equilibration of these systems.

1. The system will come into a density equilibrium based on the EMDD of dissimilar materials (e.g., Friedland clay and bentonite pellets).
2. The system will come to a homogenized density (EMDD) situation as the result of similar mineralogical and textural materials being used in the pellets and blocks (e.g., HCB blocks and bentonite pellets)
3. The system will come into equilibrium somewhere between the states of items 1 and 2 above as the result of textural differences between the materials.

These possibilities are based on the following assumptions (1) the salinity is assumed to be homogeneous throughout the specimens, and (2) in order to reach homogenization of two different clay-based sealing materials, swelling pressure is assumed to be hydrostatic (an elastic shear modulus of these materials at saturation equal to zero) (Chandler 2009).

In many of the initial repository performance assessments it was assumed that the backfill would completely homogenize with respect to density and that the backfill in the tunnel would behave based on the average backfill density. This situation is not however considered to be representative of a system where very different materials are used in the backfilling of the tunnel. The tests completed in the study and described in this document are part of a process of physically testing the actual evolution of the backfill system so as to provide a robust basis for modelling system evolution.

Evaluation of the test results based on determination of EMDD values for stress equilibrium is carried out by determining the strains (volumetric expansion/compression) that would occur based upon the assumption that the materials in a fixed-volume cell will come to a stress equilibrium, which is defined by EMDD, not by density. If there is stress equilibrium in a cell consisting of different materials, densities are different but EMDD will be the same. Similarly, if the system contains similar materials, the EMDD equilibration will also be evidenced by dry density uniformity. Table 4 shows relative densities and solid fractions of clay-based sealing materials used in calculation of EMDD and degree of water saturation. It should be noted that the Gs values in Table 4 are subject to some uncertainty and use of slightly different values would result in slight changes in the calculated degree of saturation of specimens (a value of slightly more than 100% is therefore potentially obtainable). Tables 5 and 6 summarize all values calculated and estimated and the significance of some of these values is discussed in Section 3.4. The values for vertical volume change shown in Table 5 were calculated based on changes in density between the two materials at the time of installation and at the end of tests. In Table 6, the values for total required change in height were estimated by altering vertical volumetric height in the system in order to find the same EMDD values of the two materials.

Table 4: Relative Densities and Solid Fractions of Clay-Based Sealing Material (after Karnland et al. 2006)

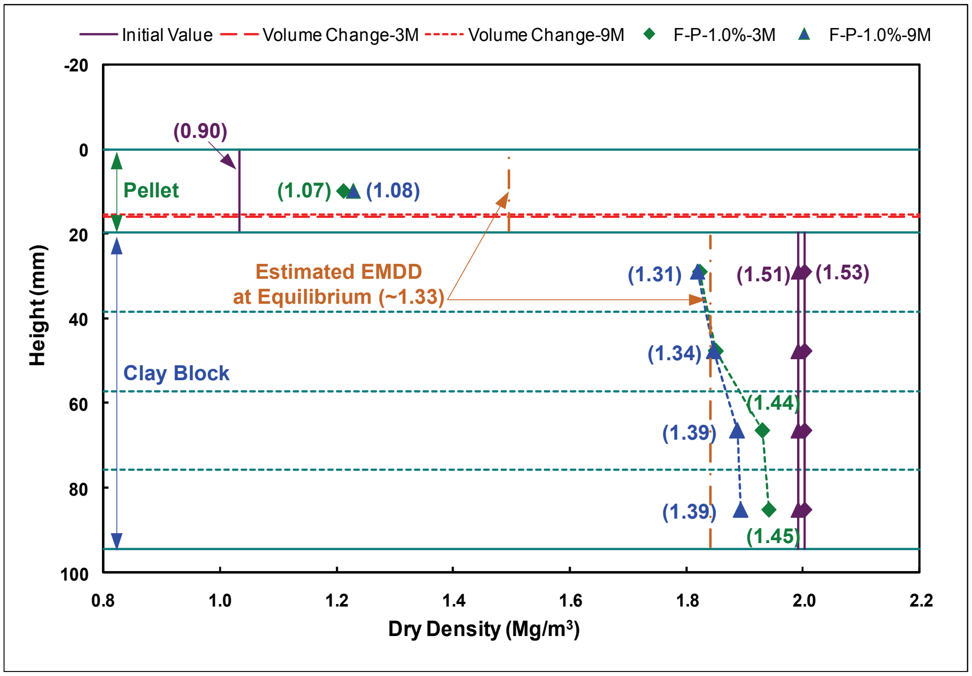
Material Type		G_s	G_n	f_c	f_m
Clay Block	Friedland	2.760	2.684	100%	45%
	Asha	2.780	2.650	100%	80%
Pellet	Cebogel	2.780	2.650	100%	80%

Note:
G_s – Relative density of solid
G_n – Relative density of non-montmorillonite component in clay
f_c – Mass fraction of clay in dry solids
f_m – Mass fraction of montmorillonite in clay fraction

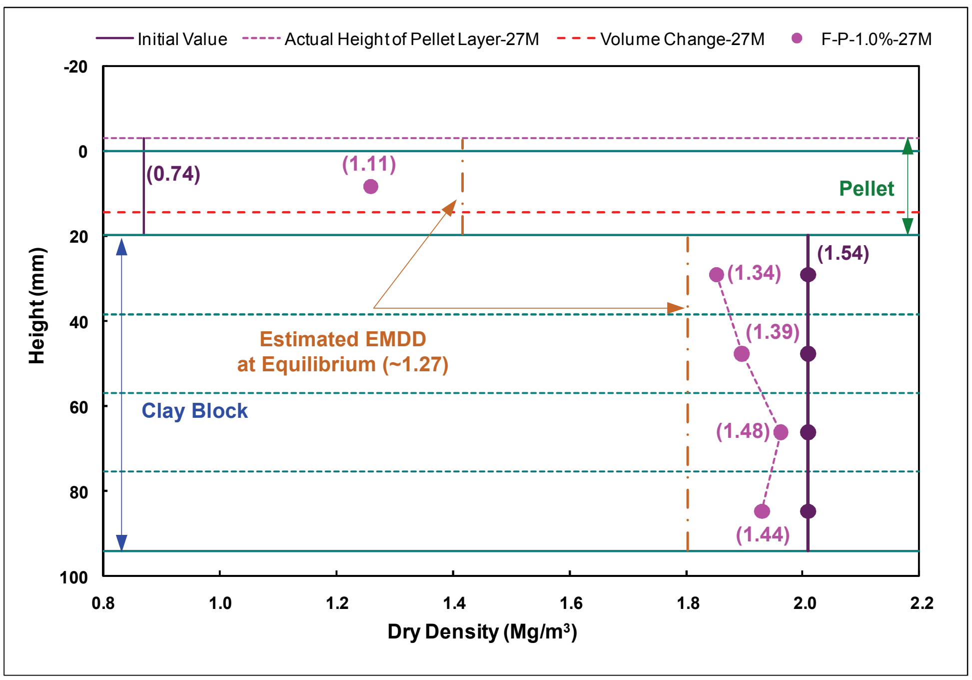
3.3.1 Behaviour of Fill Composed of Mineralogically Dissimilar Materials

Figure 20 shows a plot of Friedland clay-Cebogel pellet assemblies at 1.0% salinity after 3, 9 and 27 months. In Figure 20 (a), the dry density in the pellet-filled region continued to increase with time (about 20%) while the dry density in the clay blocks at the bottom continued to decrease. The wetter clay blocks at the top experienced only small change in dry density beyond the first 3 months of testing. This pattern indicates that the top two clay blocks may have reached stress equilibrium after 3 months due to their close proximity to the water supply. However the bottom two clay blocks were still moving toward the stress equilibrium, marked as a red dashed line in the figure. In the 27 month test (Figure 20 (b)), the dry density in the pellets had increased about 50% from their as-placed condition. This is in-part attributable to the lower-than-planned initial dry density of the pellet-filled region due to a ~3 mm increase in specimen height resulting from breakage of the bottom disk of the cell. This initial dry density change allowed the pellet layer to be more compressible and less resistant to swelling pressure generated by clay blocks.

Vertical volume changes at the interface between these materials were approximately 4.0 mm at 3 months, 4.0 mm at 9 months and 5.5 cm at 27 months in each test. The major volume change seemed to occur during the initial 3-month period because it was controlled by swelling pressure, mainly generated by the uppermost hydrated clay block. The estimated EMDD at stress equilibrium in both the pellets and the clay blocks is ~1.33 Mg/m^3 for the 3 and 9 month tests, and ~1.27 Mg/m^3 for the 27 month test. The lowermost clay blocks in the 9 and 27 month tests will ultimately generate higher swelling pressure with concurrent compression of the pellet regions if stress equilibrium, as defined by EMDD, is to be reached. The density distribution based on EMDD equilibration in the Friedland blocks and the bentonite pellets is shown in red in Figure 20.



(a) 3 and 9 months

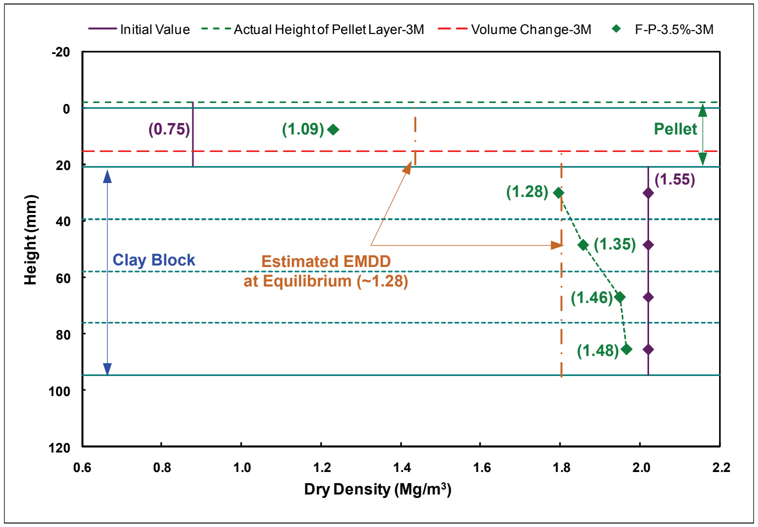


(b) 27 months

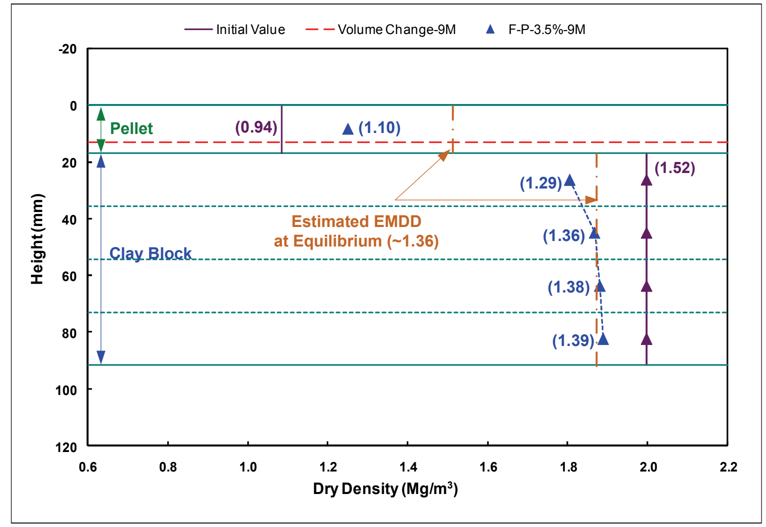
Figure 20: Dry Density of Friedland Clay Blocks - Cebogel Pellets at 1.0% Salinity at 3, 9 and 27 Months (EMDD values in brackets)

Plots of the same type of assemblies as shown in Figure 20, but at 3.5% salinity for the supplied water are shown in Figure 21. The initial dry density of the pellet-filled region in the 3 month test was slightly lower than targeted value due to the ~2 mm increase in specimen height. As shown in Figure 21 (a), the pellet-filled region after 3 months was compressed more than was observed for the 9 and 27 month tests (Figure (b) and (c)), indicating that the hydrated upper clay block at the top of the 3 month setup had more space for the clay to swell into. The hydrated clay block at the top of the 3 month test seemed to be at equilibrium while the middle and bottom parts of the clay block were not. In the 3 month test the estimated EMDD at stress equilibrium is ~1.28 Mg/m^3 as can be seen in Figure 21 (a). If the system is to evolve to EMDD-determined density equilibrium, the pellets and the top clay block layer will need to be further compressed by swelling pressure generated by the denser middle and bottom parts of the block.

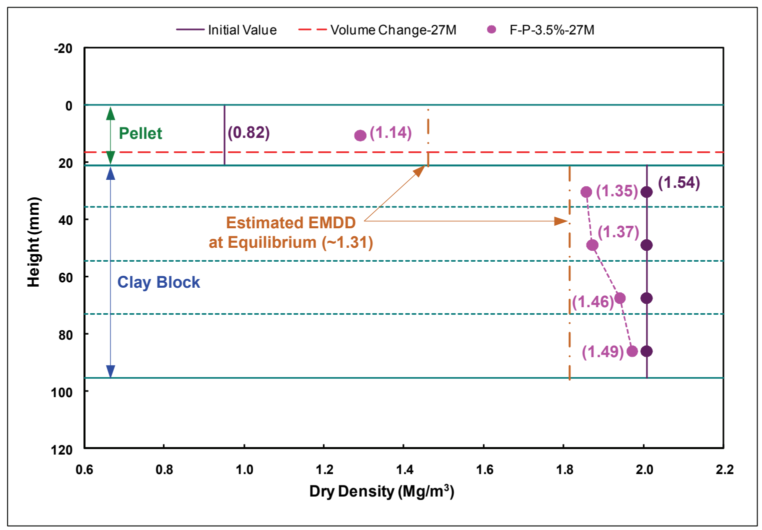
In contrast to the 3 month test, the estimated EMDD values at stress equilibrium for the 9 and 27 month tests are 1.36 Mg/m^3 and ~1.31 Mg/m^3, respectively (Figure 21 (b) and (c)). The lowermost clay blocks in the 9 month test have almost reached stress equilibrium as shown in the bottom portion of Figure 21 (b). In the 27 month test (Figure 21 (c)) having a similar initial condition to that in the 3 month test, the uppermost clay blocks in the 27 month test were almost reaching stress equilibrium, as compared to those in the 3 month test. Vertical volume changes at the interface between these materials were approximately 6 mm for 3 months, 4 mm for 9 months, and 5 mm for 27 months. The vertical volume change in the 3 month test was greater than that in the 9 month test due to the initial internal volume change resulting from the uneven contact between the pellets and the top lid.



(a) 3 Months



(b) 9 Months



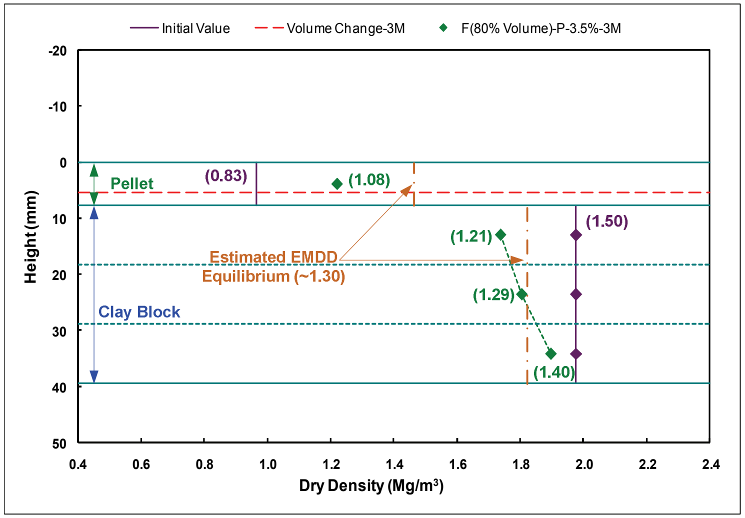
(c) 27 Months

Figure 21: Dry Density of Friedland Clay Blocks - Cebogel Pellets at 3.5% Salinity at 3, 9 and 27 Months. (EMDD values in brackets)

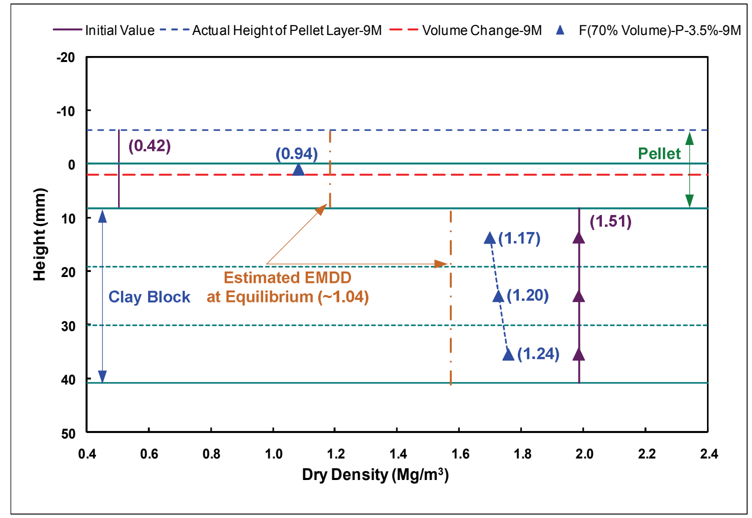
Plots for shorter assemblies of Friedland clay blocks and Cebogel pellets are shown in Figures 22 and 23. Figure 22 shows three short assembly tests for 3, 9 and 27 months at 3.5% salinity. The 3 month test was filled with 80% clay block by volume, the 9-month test was filled with 70% clay block (original target 80%) and the 27 month test was filled with 75% clay block (original target 80%). In Figure 22 (a), the system for 3 months was not at water content, density or stress equilibrium. The wetter uppermost clay blocks had swelled and compressed the pellets and the bottom clay block still needed to generate sufficient swelling pressure to compress the upper layers and reach density equilibrium. In order to reach the estimated average EMDD of ~1.30 Mg/m^3 corresponding to dry density of 1.46 Mg/m^3 for equilibrium, the pellets would have to strain (compress) about 34% in total. The 9 month test filled with 70% clay block by volume (Figure 22 (b)) required much more strain for equilibrium, about 58% in total, due to the internal volume increase, which causes the pellet-filled region to be less dense than initially intended. The 27 months test filled with 75% clay block by volume (Figure 22 (c)) shows that the pellets were compressed mainly by the wetter uppermost clay block and the middle and lower parts of the clay block still needed to swell, but were gradually moving towards density (and stress) equilibrium.

Figure 23 shows a plot of dry density calculated from assemblies with different clay block filling efficiencies after 9 months of passive water uptake. In the upper part of Figure 23, for the test filled with 50% clay block by volume, the pellet-filled region and clay blocks were already showing moisture, density and likely at stress equilibrium, but they were not showing the same EMDD values for the two materials. The process to reach the moisture and density equilibrium for each component was much quicker in these tests than in the 100 mm-long tests because it had lower initial dry density and very short distance required for water movement. The estimated EMDD for full system equilibrium in these cells is in a range of ~0.9 Mg/m^3.

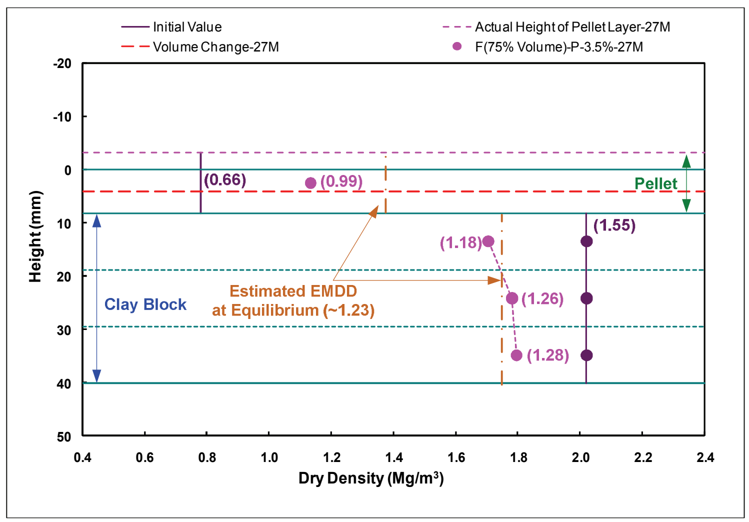
In the test filled with 70% by volume of clay blocks, Figure 23 (b), the dry density of the pellet-filled region had increased as the dry density of the clay blocks decreased in the 9 month test. The hydrated clay at the top had begun to swell and but sufficient water had not yet reached the middle and bottom parts of the clay block, resulting in the continued presence of a strong density gradient. This test shows a slower process of swelling, compression and equilibration as compared to the test containing 50% by volume of clay blocks. The difference in rate can in part be attributed to different initial dry densities in the pellets (1.05 Mg/m^3 for the test with 70% clay block filling and 0.63 Mg/m^3 for the test with 50% clay block filling). This denser pellet-filled region had more resistance to compression from the clay blocks and so the vertical change of the system was about 2 mm, compared to other two tests (Figure 22(b) and Figure 23(b)) where about 8.5 mm for the test with 50% clay filling and about 6.5 mm for 70% clay filling (original target 80% clay filling) were observed.



(a) 3 Months

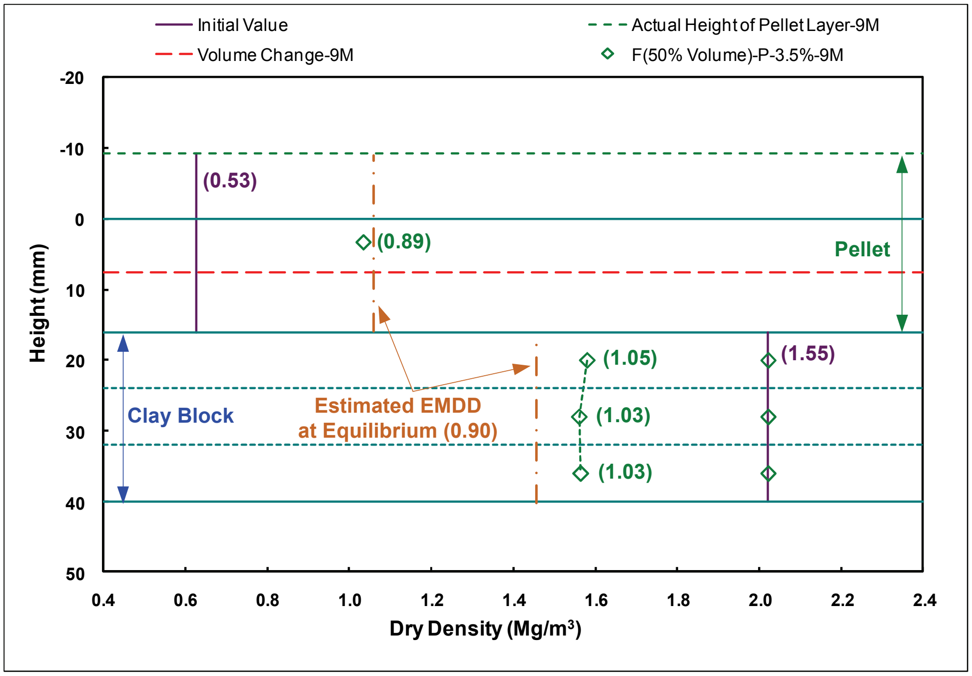


(b) 9 Months

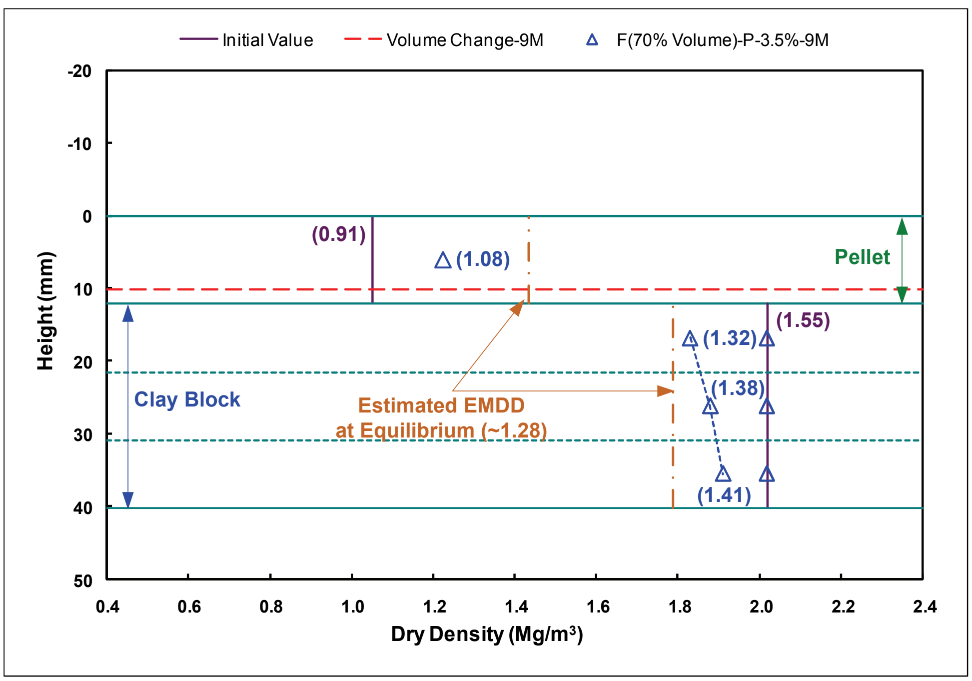


(c) 27 Months

Figure 22: Dry Density of Short Assemblies of Friedland Clay Blocks - Cebogel Pellets at 3.5% Salinity at 3 Months ((a)-80% clay block volume), 9 Months((b)-70% clay block volume) and 27 month((c)-75% clay block volume) (EMDD values in brackets)



(a) F(50% Volume)-9M



(b) F(70% Volume)-9M

Figure 23: Dry Density of Short Assemblies of Friedland Clay Blocks - Cebogel Pellets at 3.5% Salinity at 9 Months ((a)-50% and (b)-70% clay blocks by volume)(EMDD values in brackets)

3.3.2 Behaviour of Fill Composed of Mineralogically Similar Materials

The behaviour of Asha clay-Cebogel pellet assemblies, as shown in Figures 24 and 25, is very different to what was observed for Friedland clay-Cebogel pellet assemblies. This is because Asha clay and Cebogel pellets are very similar mineralogically (montmorillonite content of 80-85%) as described by Keto et al. (2009). Since they are similar materials with only different initial dry densities, they should move towards a closer density (and swelling pressure depending on only EMDD) equilibrium than for dissimilar materials (e.g., Friedland clay and Cebogel pellets).

Figure 24 shows Asha clay-Cebogel pellet assemblies at 1.0% salinity after 3 and 9 months. Both tests had approximately 3 mm extra height added to the initial as-built pellet thickness to account for volume change in the test cell. Although the initial dry densities in the pellets and clay blocks were slightly different, they showed the same pattern with the same estimated final EMDD of ~1.35 Mg/m^3 for density equilibrium.

In the 3 month tests (Figure 24 (a)), the top clay block layers were already at the anticipated EMDD equilibrium for the system, however the pellets and the middle and bottom parts of the clay block were still evolving towards this equilibrium. In Figure 24 (b) (the 9 month tests), it can be seen that the pellets have reached the anticipated equilibrium density and the middle and bottom parts of the clay block were much closer to that value than was observed in the 3 month test. Figure 24(c) (27 month tests) shows a similar density distribution to that observed in the 9 month test, except for that the upper regions of the clay block were at equilibrium, indicated by straighter vertical line parallel and closer to the estimated equilibrium line.

Figure 25 shows how the Asha clay blocks-pellet assemblies at 3.5% salinity had similar behaviour in terms of dry density change. It should be noted that the clay blocks in the 3.5% salinity tests were much closer to density equilibrium after 3, 9 and 27 months than in the test at 1.0% salinity. Both materials were however moving toward the density equilibrium (estimated EMDD of ~1.41 Mg/m^3). In the 3 month test (Figure 25 (a)) the pellets and most parts of the clay block except the lowermost section were at equilibrium while in the 9 month test (Figure 25 (b)) the pellets and the bottom clay block were still moving toward the equilibrium line. The 27 month test in Figure 25 (c) shows a much more straight line toward estimated equilibrium line in the clay blocks, however the pellets and the lower region of the clay block were still not at full equilibrium.

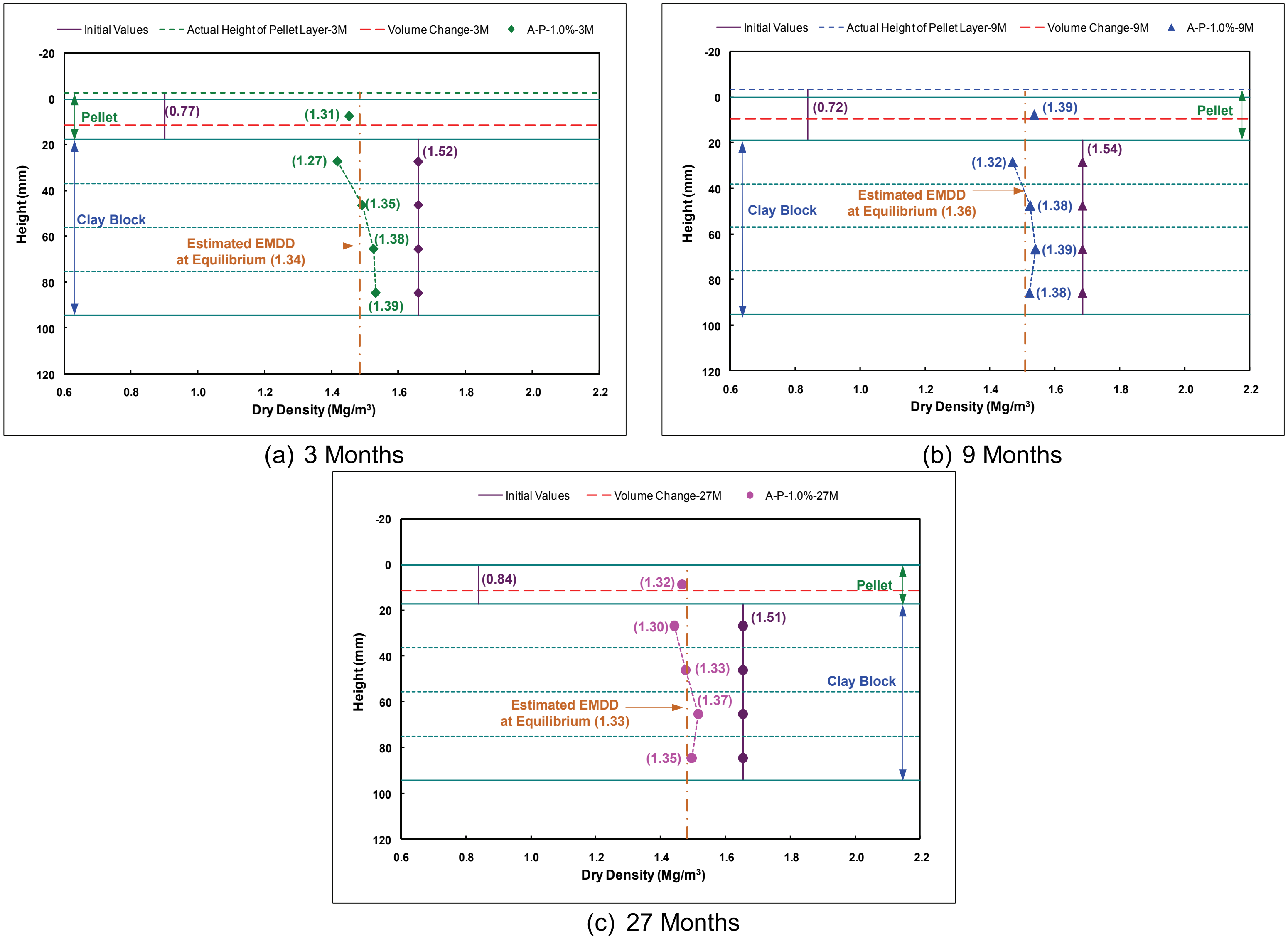
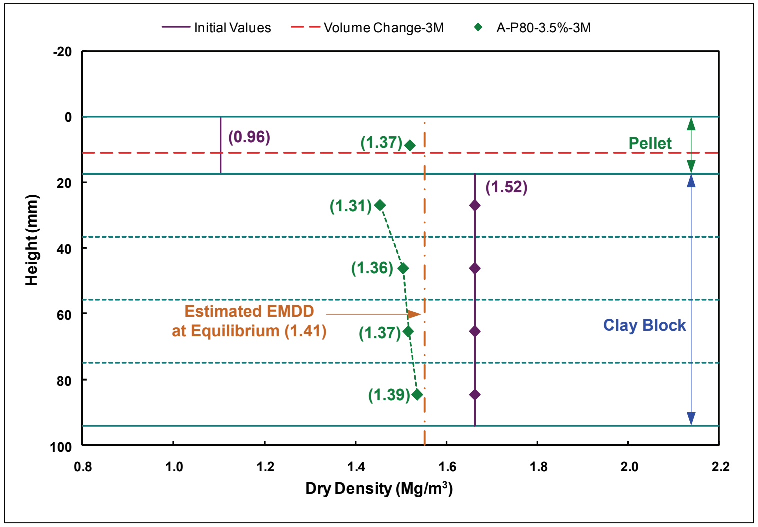
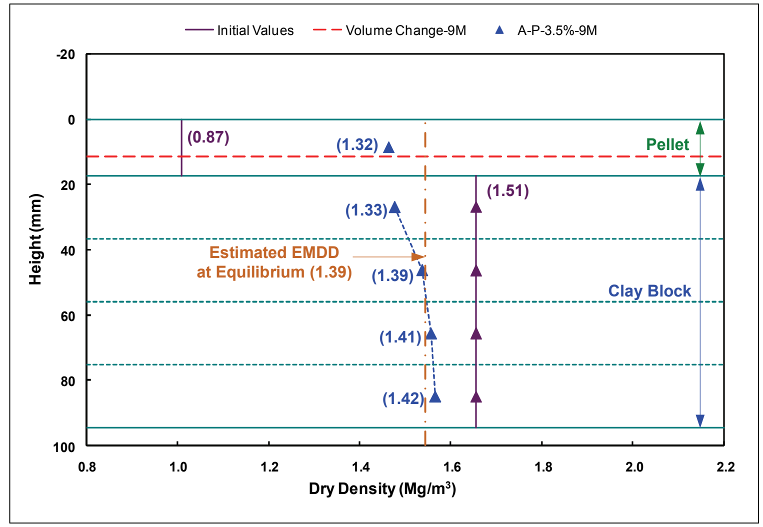


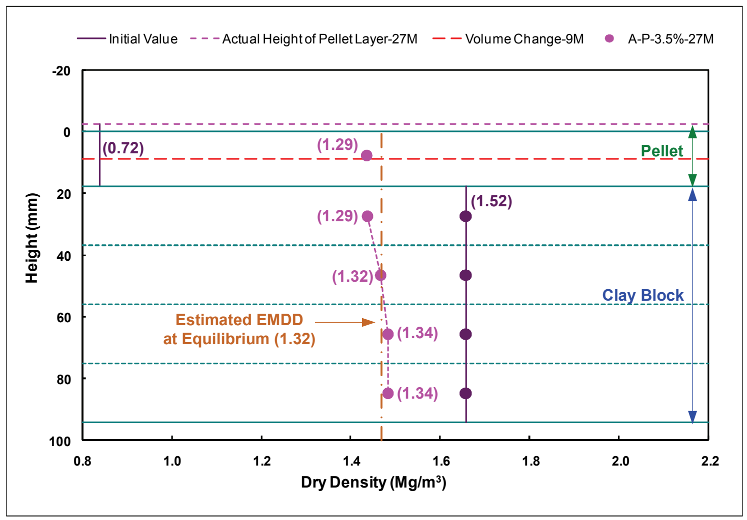
Figure 24: Dry Density of Asha Clay Blocks - Cebogel Pellets at 1.0% Salinity at 3, 9 and 27 Months (EMDD values in brackets)



(a) 3 Months



(b) 9 Months



(c) 27 Months

Figure 25: Dry Density of Asha Clay Blocks - Cebogel Pellets at 3.5% Salinity at 3, 9 and 27 Months(EMDD values in brackets)

Table 5: Summary of Test Material Properties

Test	At the Time of Installation				At the End of Test				
	Gravimetric Water Content	Dry Density	EMDD	Degree of Saturation	Gravimetric Water Content	Dry Density	EMDD	Degree of Saturation	Vertical Volume Change
	(%)	(Mg/m^3)	(Mg/m^3)	(%)	(%)	(Mg/m^3)	(Mg/m^3)	(%)	(mm)
F-P-1.0%-3M									3.80
Pellet	19.08	1.03	0.90	93.80	47.83	1.21	1.07	99.10	
CB 1 – T	10.53	2.00	1.53	76.93	19.23	1.82	1.31	98.83	
CB 1 – B	10.53	2.00	1.53	76.93	17.67	1.85	1.34	96.83	
CB 2 – T	10.53	2.00	1.53	76.93	15.41	1.93	1.44	94.82	
CB 2 – B	10.53	2.00	1.53	76.93	15.92	1.94	1.45	97.55	
F-P-1.0%-9M									4.20
Pellet	19.08	1.03	0.89	93.90	46.56	1.23	1.08	99.98	
CB 1 – T	10.53	1.99	1.51	75.30	20.71	1.82	1.31	103.83	
CB 1 – B	10.53	1.99	1.51	75.30	19.31	1.85	1.34	103.53	
CB 2 – T	10.53	1.99	1.51	75.30	17.89	1.89	1.39	102.21	
CB 2 – B	10.53	1.99	1.51	75.30	17.96	1.89	1.39	102.17	
*F-P-1.0%-27M									5.50
Pellet	19.08	0.87	0.74	95.20	44.80	1.26	1.11	99.77	
CB 1 – T	10.53	2.01	1.54	77.72	20.03	1.85	1.34	102.65	
CB 1 – B	10.53	2.01	1.54	77.72	18.79	1.90	1.39	100.96	
CB 2 – T	10.53	2.01	1.54	77.72	17.43	1.96	1.48	101.49	
CB 2 – B	10.53	2.01	1.54	77.72	18.08	1.93	1.44	102.44	

Note:
F (Friedland), P (Pellet), CB (Clay Block), T (Top), B (Bottom), and M (months, e.g., 3M is 3 Months), * Initial volume change in the pellet.

Test	At the Time of Installation				At the End of Test				
	Gravimetric Water Content	Dry Density	EMDD	Degree of Saturation	Gravimetric Water Content	Dry Density	EMDD	Degree of Saturation	Vertical Volume Change
	(%)	(Mg/m^3)	(Mg/m^3)	(%)	(%)	(Mg/m^3)	(Mg/m^3)	(%)	(mm)
*F-P-3.5%-3M									5.80
Pellet	19.12	0.88	0.75	94.50	48.81	1.23	1.09	98.33	
CB 1 – T	10.49	2.02	1.55	79.18	20.20	1.80	1.28	97.42	
CB 1 – B	10.49	2.02	1.55	79.18	18.01	1.86	1.35	97.07	
CB 2 – T	10.49	2.02	1.55	79.18	15.73	1.95	1.46	99.23	
CB 2 – B	10.49	2.02	1.55	79.18	15.49	1.97	1.48	95.35	
F-P-3.5%-9M									3.90
Pellet	19.08	1.08	0.94	93.30	46.05	1.25	1.10	101.07	
CB 1 – T	10.53	2.00	1.52	75.98	20.76	1.80	1.29	106.00	
CB 1 – B	10.53	2.00	1.52	75.98	19.12	1.87	1.36	104.62	
CB 2 – T	10.53	2.00	1.52	75.98	18.08	1.88	1.38	101.91	
CB 2 – B	10.53	2.00	1.52	75.98	17.68	1.89	1.39	102.69	
F-P-3.5%-27M									4.70
Pellet	19.08	0.95	0.82	94.60	40.72	1.29	1.14	97.92	
CB 1 – T	10.53	2.01	1.54	77.36	18.97	1.86	1.35	99.29	
CB 1 – B	10.53	2.01	1.54	77.36	17.67	1.87	1.37	100.37	
CB 2 – T	10.53	2.01	1.54	77.36	16.26	1.95	1.46	100.88	
CB 2 – B	10.53	2.01	1.54	77.36	15.76	1.97	1.49	102.05	

Note:
F (Friedland), P (Pellet), CB (Clay Block), T (Top), B (Bottom), M (months, e.g., 3M is 3 Months), * Initial volume change in the pellet.

Test	At the Time of Installation				At the End of Test				
	Gravimetric Water Content	Dry Density	EMDD	Degree of Saturation	Gravimetric Water Content	Dry Density	EMDD	Degree of Saturation	Vertical Volume Change
	(%)	(Mg/m^3)	(Mg/m^3)	(%)	(%)	(Mg/m^3)	(Mg/m^3)	(%)	(mm)
F80-P-3.5%-3M									2.20
Pellet	19.08	0.97	0.83	94.50	49.60	1.22	1.08	101.09	
CB – T	10.53	1.98	1.50	73.07	22.20	1.74	1.21	98.13	
CB – Mi	10.53	1.98	1.50	73.07	19.60	1.81	1.29	95.36	
CB – B	10.53	1.98	1.50	73.07	18.20	1.90	1.40	99.37	
*F70-P-3.5%-9M									6.40
Pellet	19.08	0.50	0.42	95.10	55.90	1.08	0.94	100.49	
CB – T	10.53	1.99	1.51	76.68	24.90	1.70	1.17	101.90	
CB – Mi	10.53	1.99	1.51	76.68	23.10	1.73	1.20	103.26	
CB – B	10.53	1.99	1.51	76.68	22.80	1.76	1.24	104.41	
*F75-P-3.5%-27M									4.10
Pellet	19.08	0.78	0.66	95.90	51.06	1.13	0.99	98.72	
CB – T	10.53	2.02	1.55	82.15	24.64	1.71	1.18	100.69	
CB – Mi	10.53	2.02	1.55	82.15	22.13	1.78	1.26	100.17	
CB – B	10.53	2.02	1.55	82.15	20.80	1.80	1.28	101.64	

Note:
F80 (short cell - 80% Friedland clay volume), P (Pellet), CB (Clay Block), T (Top), Mi (Middle), B (Bottom), M (months, e.g., 3M is 3 Months, * Initial volume change in the pellet.

Test	At the Time of Installation				At the End of Test				
	Gravimetric Water Content	Dry Density	EMDD	Degree of Saturation	Gravimetric Water Content	Dry Density	EMDD	Degree of Saturation	Vertical Volume Change
	(%)	(Mg/m^3)	(Mg/m^3)	(%)	(%)	(Mg/m^3)	(Mg/m^3)	(%)	(mm)
*F50-P-3.5%-9M									8.50
Pellet	19.08	0.63	0.53	94.30	65.09	1.03	0.89	98.23	
CB – T	10.53	2.02	1.55	79.70	30.03	1.58	1.05	101.40	
CB – Mi	10.53	2.02	1.55	79.70	29.99	1.56	1.03	103.02	
CB – BT	10.53	2.02	1.55	79.70	29.05	1.56	1.03	101.67	
F70-P-3.5%-9M									2.00
Pellet	19.08	1.05	0.91	93.70	48.46	1.22	1.08	100.92	
CB – T	10.53	2.02	1.55	79.20	20.79	1.83	1.32	102.38	
CB – Mi	10.53	2.02	1.55	79.20	19.49	1.88	1.38	105.35	
CB – B	10.53	2.02	1.55	79.20	19.47	1.91	1.42	105.44	

Note:
F50 (short cell - 50% Friedland clay volume), P (Pellet), CB (Clay Block), T (Top), Mi (Middle), B (Bottom), M (months, e.g., 3M is 3 Months), * Initial volume change in the pellet.

Test	At the Time of Installation				At the End of Test				
	Gravimetric Water Content	Dry Density	EMDD	Degree of Saturation	Gravimetric Water Content	Dry Density	EMDD	Degree of Saturation	Vertical Volume Change
	(%)	(Mg/m^3)	(Mg/m^3)	(%)	(%)	(Mg/m^3)	(Mg/m^3)	(%)	(mm)
*A-P-1.0%-3M									6.10
Pellet	18.92	0.90	0.77	93.60	35.00	1.45	1.31	101.56	
CB 1 – T	16.49	1.66	1.52	67.93	35.83	1.42	1.27	99.81	
CB 1 – B	16.49	1.66	1.52	67.93	33.00	1.49	1.35	102.74	
CB 2 – T	16.49	1.66	1.52	67.93	31.29	1.53	1.38	101.24	
CB 2 – B	16.49	1.66	1.52	67.93	30.12	1.53	1.39	101.99	
*A-P-1.0%-9M									9.30
Pellet	18.92	0.84	0.72	94.00	32.59	1.54	1.39	96.79	
CB 1 – T	16.49	1.69	1.54	70.61	35.77	1.47	1.32	102.71	
CB 1 – B	16.49	1.69	1.54	70.61	33.32	1.52	1.38	102.99	
CB 2 – T	16.49	1.69	1.54	70.61	31.89	1.54	1.39	104.38	
CB 2 – B	16.49	1.69	1.54	70.61	31.97	1.52	1.38	103.45	
A-P-1.0%-27M									5.80
Pellet	18.92	0.97	0.84	92.40	33.74	1.47	1.32	100.18	
CB 1 – T	16.49	1.65	1.51	67.30	35.40	1.44	1.30	104.34	
CB 1 – B	16.49	1.65	1.51	67.30	33.71	1.48	1.33	105.08	
CB 2 – T	16.49	1.65	1.51	67.30	32.26	1.52	1.37	106.06	
CB 2 – B	16.49	1.65	1.51	67.30	32.72	1.50	1.35	106.26	

Note:
A (Asha), P (Pellet), CB (Clay Block), T (Top), B (Bottom), M (months, e.g., 3M is 3 Months), * Initial volume change in the pellet.

Test	At the Time of Installation				At the End of Test				
	Gravimetric Water Content	Dry Density	EMDD	Degree of Saturation	Gravimetric Water Content	Dry Density	EMDD	Degree of Saturation	Vertical Volume Change
	(%)	(Mg/m^3)	(Mg/m^3)	(%)	(%)	(Mg/m^3)	(Mg/m^3)	(%)	(mm)
A-P-3.5%-3M									6.50
Pellet	18.92	1.10	0.96	93.60	30.95	1.52	1.37	99.70	
CB 1 – T	16.49	1.66	1.52	68.20	34.15	1.46	1.31	97.58	
CB 1 – B	16.49	1.66	1.52	68.20	31.40	1.51	1.36	101.29	
CB 2 – T	16.49	1.66	1.52	68.20	30.91	1.52	1.37	101.46	
CB 2 – B	16.49	1.66	1.52	68.20	31.20	1.54	1.39	103.14	
A-P-3.5%-9M									5.80
Pellet	18.92	1.01	0.87	94.00	30.04	1.46	1.32	96.61	
CB 1 – T	16.49	1.66	1.51	67.49	34.18	1.48	1.33	101.61	
CB 1 – B	16.49	1.66	1.51	67.49	31.91	1.54	1.39	103.60	
CB 2 – T	16.49	1.66	1.51	67.49	30.71	1.56	1.41	104.96	
CB 2 – B	16.49	1.66	1.51	67.49	31.17	1.57	1.42	104.49	
*A-P-3.5%-27M									9.00
Pellet	18.92	0.84	0.72	92.40	37.00	1.44	1.29	103.90	
CB 1 – T	16.49	1.66	1.52	67.69	36.70	1.44	1.29	107.53	
CB 1 – B	16.49	1.66	1.52	67.69	34.22	1.47	1.32	108.39	
CB 2 – T	16.49	1.66	1.52	67.69	33.86	1.48	1.34	107.78	
CB 2 – B	16.49	1.66	1.52	67.69	33.67	1.48	1.34	106.85	

Note:
A (Asha), P (Pellet), CB (Clay Block), T (Top), B (Bottom), M (months, e.g., 3M is 3 Months), * Initial volume change in the pellet.

Table 6: Estimated EMDD Values at Stress Equilibrium

Test	Total Required Change in Height (mm)	Total Required Change in Height (%)	Dry Density (Mg/m^3)	EMDD (Mg/m^3)
F-P-1.0%-3M				
Pellet	6.00	30.30	1.49	1.33
Clay Block		8.04	1.85	1.33
F-P-1.0%-9M				
Pellet	6.00	30.15	1.48	1.32
Clay Block		8.00	1.85	1.32
F-P-1.0%-27M				
Pellet	8.90	38.86	1.42	1.27
Clay Block		11.99	1.80	1.26
*F-P-3.5%-3M				
Pellet	8.80	38.43	1.43	1.27
Clay Block		11.92	1.81	1.28
F-P-3.5%-9M				
Pellet	4.70	27.65	1.51	1.36
Clay Block		6.28	1.88	1.36
*F-P-3.5%-27M				
Pellet	7.50	34.88	1.46	1.31
Clay Block		10.09	1.82	1.30
F80-P-3.5%-3M				
Pellet	2.60	33.77	1.46	1.30
Clay Block		8.18	1.83	1.30
*F70-P-3.5%-9M				
Pellet	8.50	57.82	1.19	1.04
Clay Block		26.07	1.57	1.04
*F75-P-3.5%-27M				
Pellet	4.90	43.36	1.38	1.23
Clay Block		15.36	1.75	1.22
*F50-P-3.5%-9M				
Pellet	10.00	39.53	1.04	0.90
Clay Block		41.67	1.43	0.90
F70-P-3.5%-9M				
Pellet	3.30	26.83	1.43	1.28
Clay Block		11.74	1.80	1.27
A-P-1.0%-3M				
Pellet	8.10	39.90	1.50	1.34
Clay Block		10.55	1.50	1.34
*A-P-1.0%-9M				
Pellet	8.90	40.27	1.51	1.36
Clay Block		11.63	1.51	1.36

Test	Total Required Change in Height (mm)	Total Required Change in Height (%)	Dry Density (Mg/m^3)	EMDD (Mg/m^3)
A-P-1.0%-27M				
Pellet	5.70	33.14	1.48	1.33
Clay Block		7.39	1.48	1.33
A-P-3.5%-3M				
Pellet	5.10	28.98	1.56	1.41
Clay Block		6.68	1.56	1.41
A-P-3.5%-9M				
Pellet	5.80	33.53	1.54	1.39
Clay Block		7.49	1.54	1.39
A-P-3.5%-27M				
Pellet	6.10	34.27	1.48	1.32
Clay Block		7.96	1.48	1.32

3.4 DEGREE OF FLUID SATURATION

Degree of fluid saturation was calculated based upon bulk density determined by the wax immersion method (ASTM Standard C914-95). Dry density calculated from bulk density was used to determine the void ratio (e). The relative densities of the soil solids (G_s) and gravimetric water contents (w) were used to calculate the degree of fluid saturation. Table 4 shows the relative densities used for the three materials used in the test series.

The degree of fluid saturation calculated in the tests was in many cases slightly greater than 100%. Possible reasons for such a situation are attributable to:

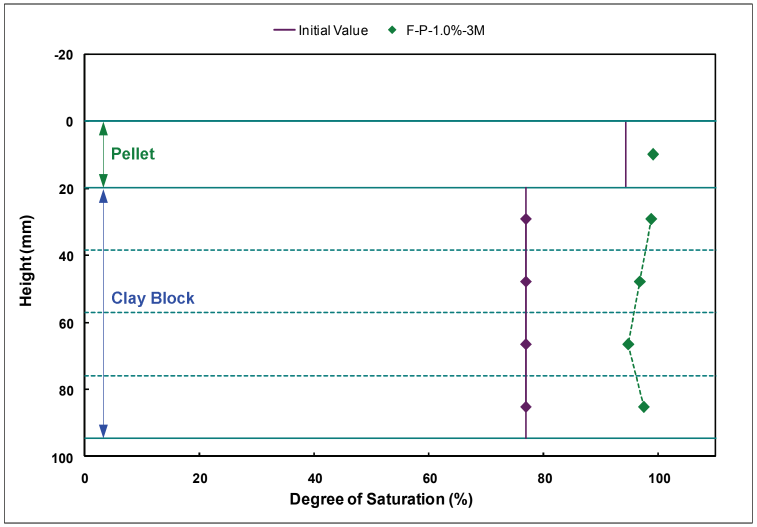
1. the relative density (G_s) values used for soils, which attribute slight inaccuracies to subsequent calculations (see Table 4);
2. the very small sample sizes associated with dismantling mean that only slight inaccuracies in measurements will result in large variations in the calculated degree of saturation; and
3. assumptions used in defining the density of the water component could also contribute to higher than unity degrees of saturation. For example, diffuse-double layer and absorbed water make up significant proportions of the water in these clay-based materials (Mitchell 1976). These water components may have densities different from that of free liquid water, resulting in calculated degrees of saturation that exceed 100%.

However, for the purpose of this study these slight variations are not considered to be significant and hence calculated degree of saturation that slightly exceed 100% are considered as being saturated in the conduct of dry density analysis.

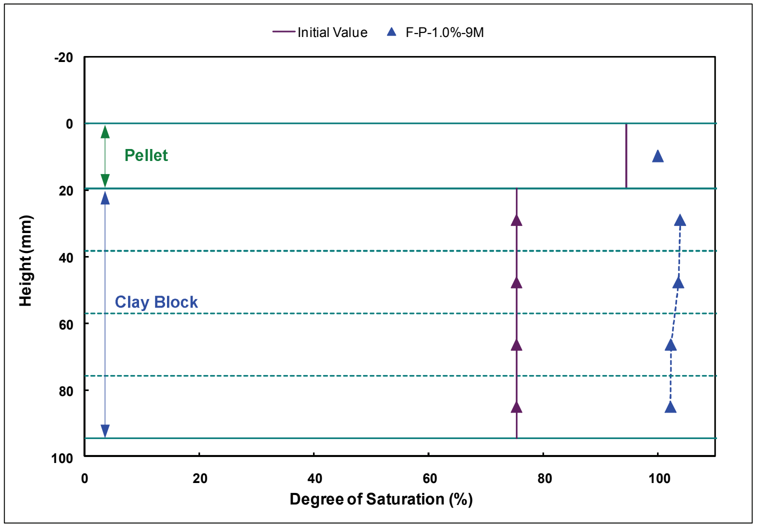
Figure 26 shows the degree of fluid saturation calculated from assemblies of Friedland clay blocks-Cebogel pellets at 1.0% after 3, 9 and 27 months. For the 3 month test all materials but the middle parts of the clay block were saturated. The 9 and 27 month tests show these materials were fully saturated (the overall degree of saturation calculated was ~102%). A plot of the degree of saturation for the same assemblies at 3.5% salinity after 3, 9 and 27 months is shown in Figure 27. In the 3 month test both the pellets and the clay blocks can also be assumed to be saturated, with overall degree of saturation close to 100%. Similarly the materials from the 9 and 27 month tests were also fully saturated. The distributions of the saturation from the tests with both 1.0% and 3.5% pore fluid salinity were not much different, indicating that there was little effect of different pore fluid salinities on the saturation achieved in the Friedland clay blocks-Cebogel pellets assemblies.

Figure 28 (a) shows that in the 3 month test of the short assemblies of Friedland clay blocks-Cebogel pellets with 3.5% pore fluid salinity, all materials except the middle parts of the clay block were saturated while the 9 and 27 month tests showed all materials were fully saturated (Figures (b) and (c)). The degree of saturation of the pellets in the 27 month test decreased, compared to that observed in the 9 month test. This may be due to the approximately 5% higher filling efficiency in the clay blocks in the 27 month test relative to the 9 month test. As a result of this difference, the pellets were being compressed at a higher block-generate swelling pressure. Both tests filled with 50% and 70% clay block by volume after 9 months showed degrees of saturation of approximately 100% in the pellets and between 100% and 105% in the clay blocks (Figure 29 (a) and (b)).

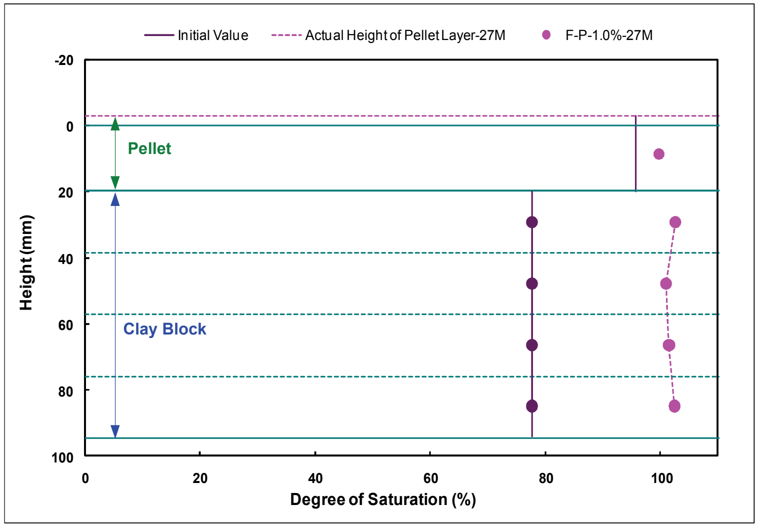
Figures 30 and 31 show plots of the degree of fluid saturation for Asha clay-Cebogel pellet assemblies at 1.0 and 3.5% pore fluid salinity. In both tests the clay blocks were 100% saturated while the degree of saturation of the pellets decreased slightly by about 4% and 3% after 9 months at 1.0% and 3.5% salinity, respectively (see also Table 5). This may be because the pellets were being compressed by swelling pressure generated by clay blocks, however the 27 month tests did not show further decrease in the pellet fluid saturation from that indicated at 9 month.



(a) 3 Months

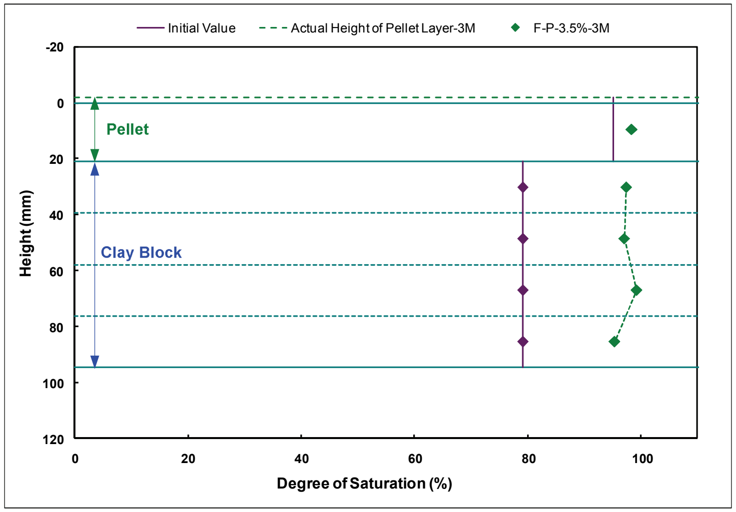


(b) 9 Months

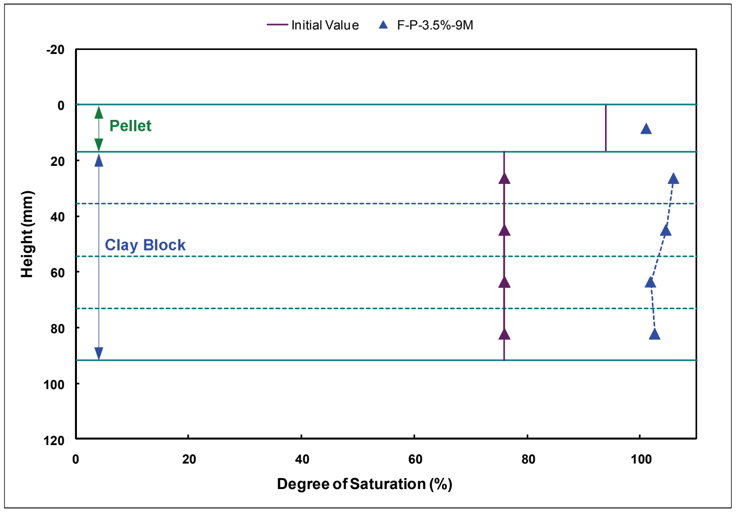


(c) 27 Months

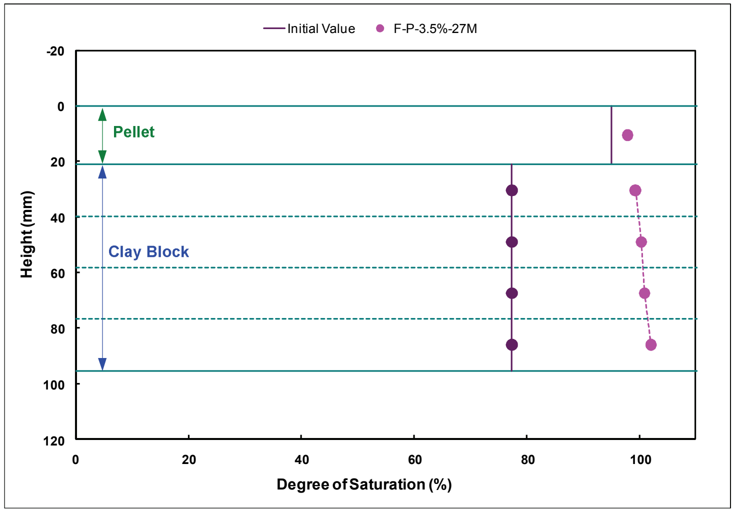
Figure 26: Degree of Fluid Saturation of Friedland Clay Blocks - Cebogel Pellets at 1.0% Salinity at 3, 9 and 27 Months



(a) 3 Months

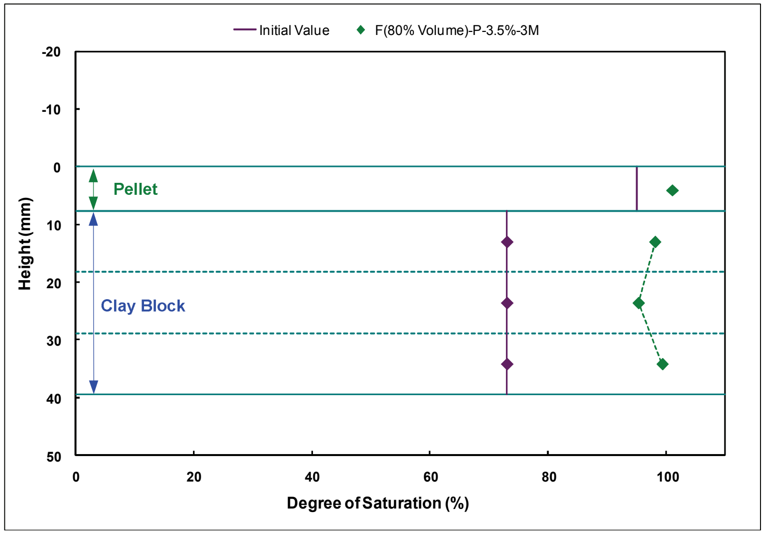


(b) 9 Months

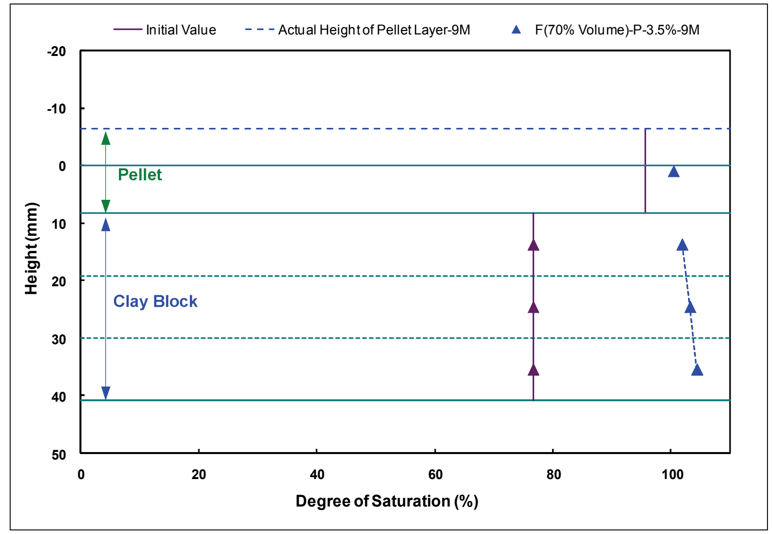


(c) 27 Months

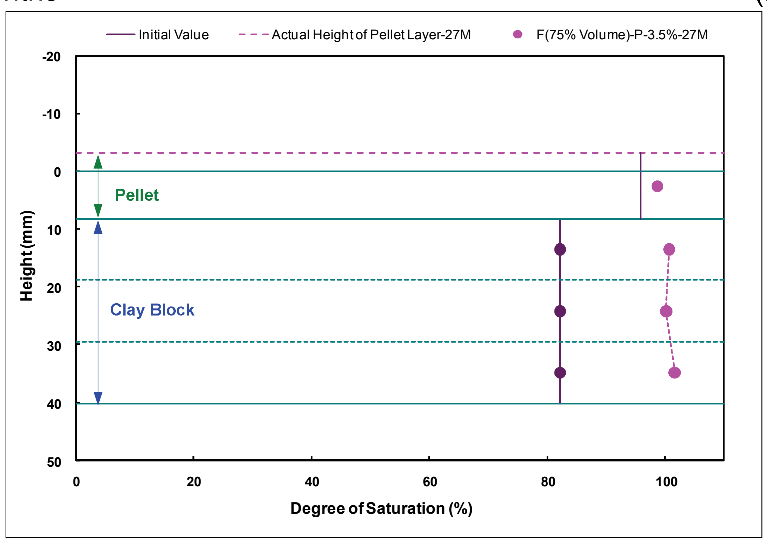
Figure 27: Degree of Fluid Saturation of Friedland Clay Blocks - Cebogel Pellets at 3.5% Salinity at 3, 9 and 27 Months



(a) 3 Months

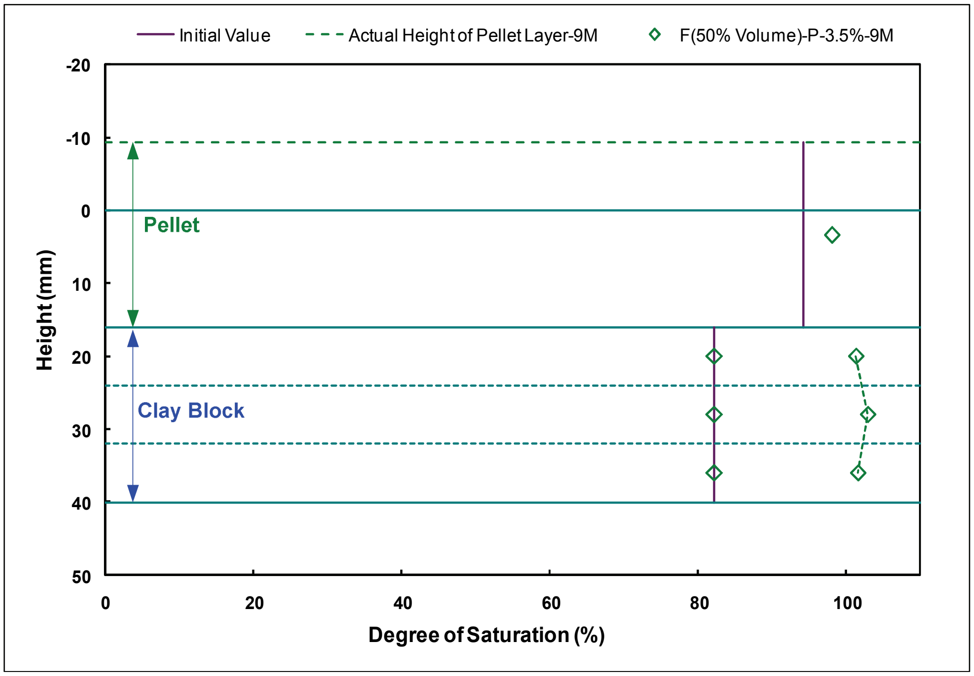


(b) 9 Months

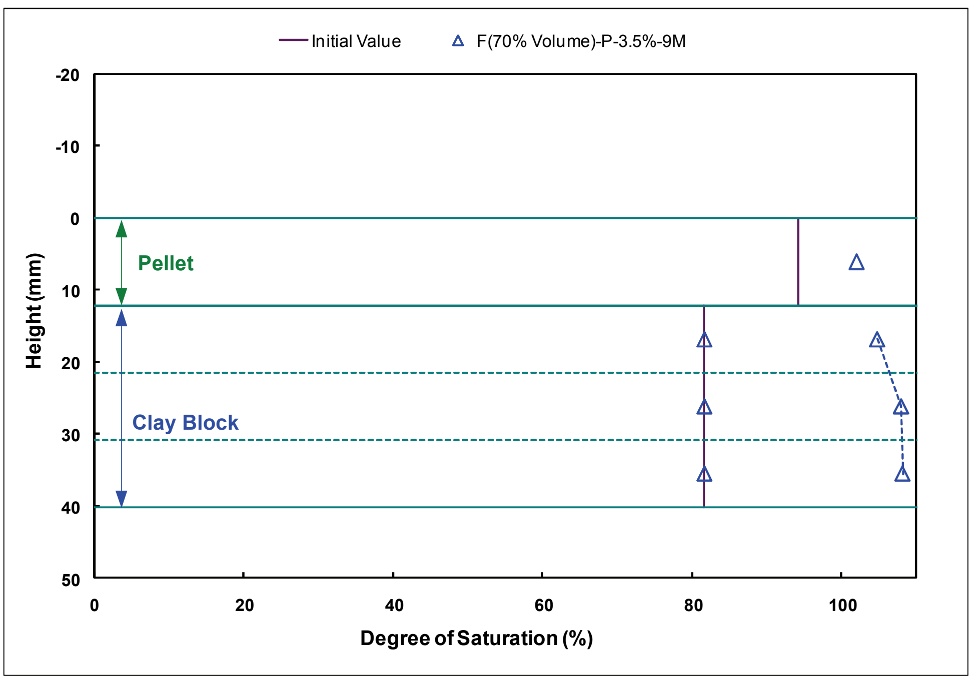


(c) 27 Months

Figure 28: Degree of Fluid Saturation of Short Assemblies of Friedland Clay Blocks - Cebogel Pellets at 3.5% Salinity at 3 Months ((a)-80% clay block volume), 9 Months ((b)-70% clay block volume) and 27 months ((c)-75% clay block volume)

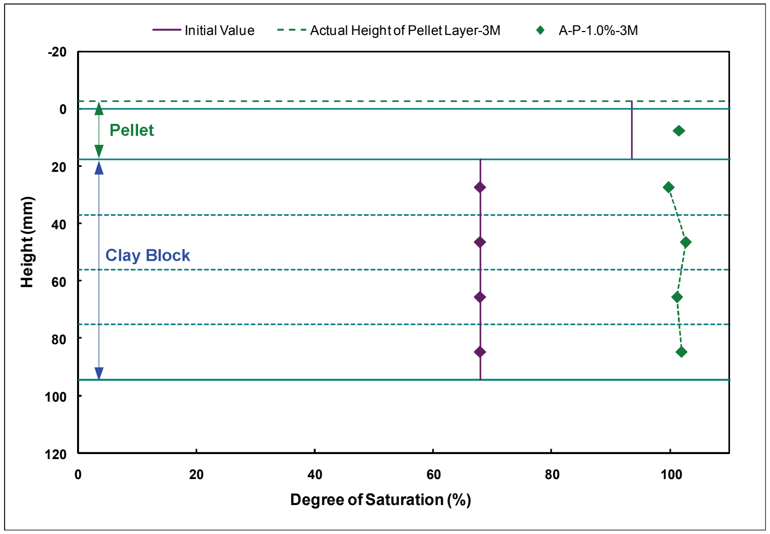


(a) F(50% Volume)-9 Months

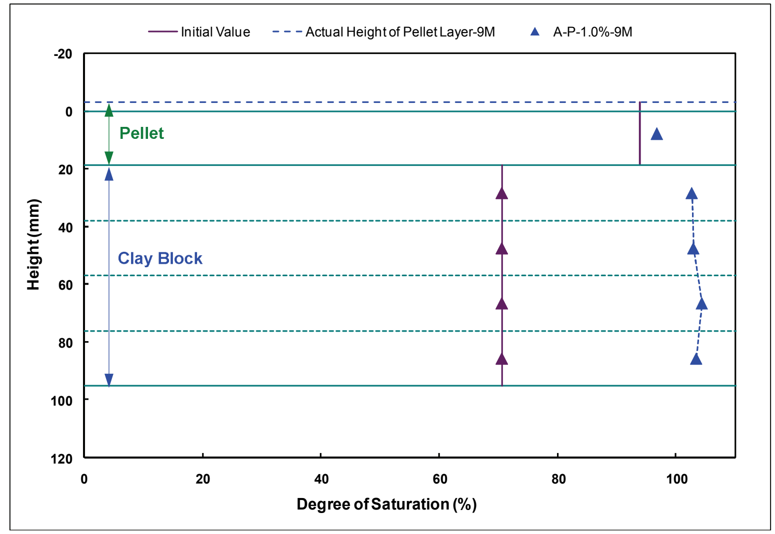


(b) F(70% Volume)-9 Months

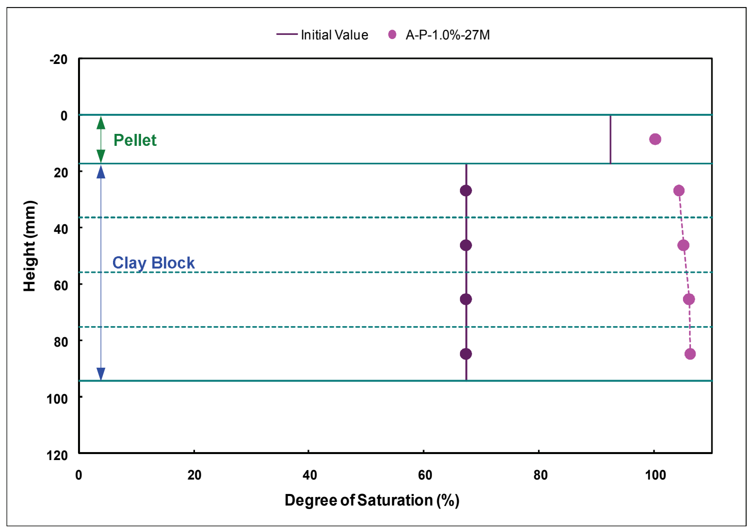
Figure 29: Degree of Fluid Saturation of Short Assemblies of Friedland Clay Blocks - Cebogel Pellets at 3.5% Salinity at 9 Months ((a)-50% and (b)-70% clay block volume)



(a) 3 Months

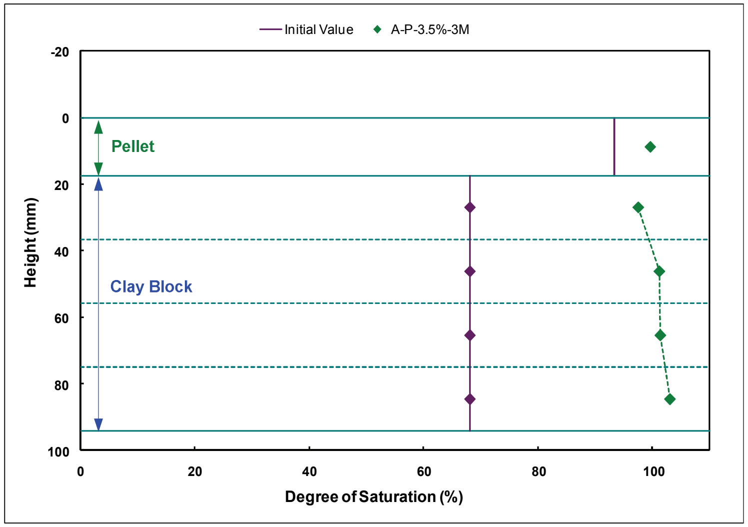


(b) 9 Months

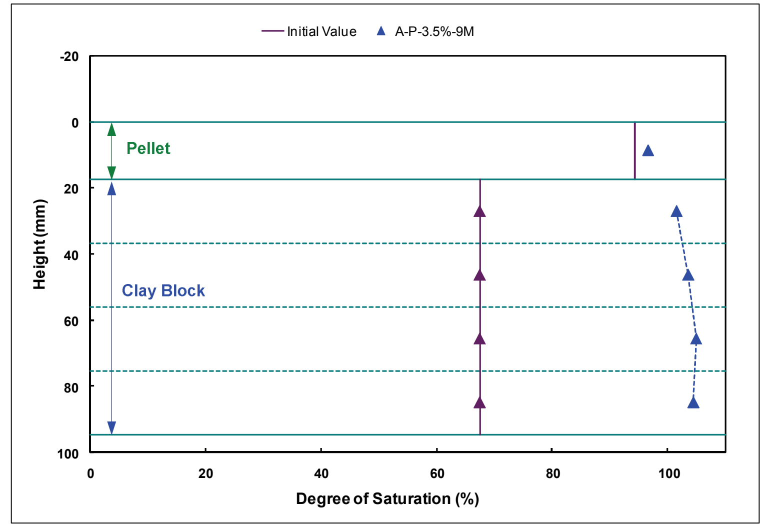


(c) 27 Months

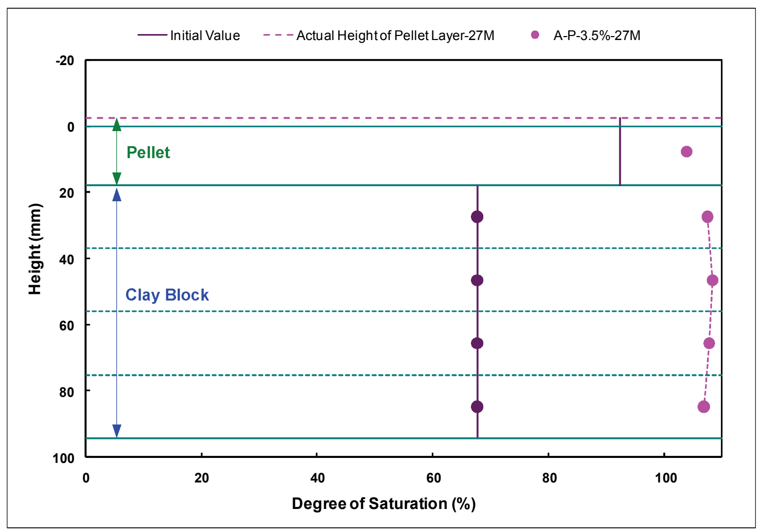
Figure 30: Degree of Fluid Saturation of Asha Clay Blocks - Cebogel Pellets at 1.0% Salinity at 3, 9 and 27 Months



(a) 3 Months



(b) 9 Months



(c) 27 Months

Figure 31: Degree of Fluid Saturation of Asha Clay Blocks - Cebogel Pellets at 3.5% Salinity at 3, 9 and 27 Months

4. CONCLUSIONS

The objectives of this testing program were to examine: (1) the role of groundwater salinity on water uptake; (2) the role of groundwater salinity on development of stress equilibrium; and (3) the effects of test dimension with different filling efficiencies. The results obtained are considered to be indicative of what would be observed for a range of similar swelling clay products and so are not considered to be unique to the materials used in this project. In this study, a total of 17 tests were undertaken with careful measurement of gravimetric water content and volume strains of the components installed in each. The results provide an indication of what manner of volume change would be encountered in an environment where dissimilar filling materials are used and from these parameters can be extracted for use in modelling larger-scale system behaviours.

Based upon the testing data collected through completion of this study, the following material-specific conclusions can be made.

Friedland clay-Cebogel pellet assemblies

- This system, consisting of two dissimilar but still fine-textured materials, will likely come to a stress equilibrium based on EMDD of these dissimilar materials. This may mean that each different component will exhibit different hydraulic behaviour. After 27 months of unrestricted, passive water uptake, the swelling clay materials examined had moved closer to density equilibrium. However, when different clay types are used, textural differences can result in a system developing where it is unlikely that backfill equilibrium will involve an end-state where a uniform dry density or EMDD exists. In this situation these two materials may still retain different hydraulic conductivities and also different mechanical behaviour.

- The process to reach equilibrium will be much quicker in a system with a lower initial density of the pellet-filled region, which allows for easier initial water uptake by the system.

- The 40 mm-long tests had a much quicker process of the moisture and density equilibrium for each component than in the 100 mm-long tests. The test filled with 70% by volume of clay blocks had a slower process of swelling, compression and equilibration than the test containing 50% by volume of clay blocks.

- Two different pore fluid salinities (1.0% and 3.5%) had little effect on the apparent rate of system equilibration.

Asha clay-Cebogel pellet assemblies

- This system, consisting of two similar mineralogical materials, will come to a homogeneous state (i.e., the same EMDD and dry density).

- Between 9 months and 27 months, the evolution of the system proceeds very slowly. At the end of 27 months, tests undertaken using 1.0% and 3.5% pore fluid salinity showed only slight changes/movements towards further equilibration relative to what was observed at 9 months. This is attributed to the low permeability of the materials and as a result achieving of full equilibration will be a long-term process.

- Two different pore fluid salinities (1.0% and 3.5%) had little effect on the apparent rate of system homogenization. Hence, slight variations in the groundwater conditions are unlikely to substantively affect the rate or system equilibration.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the financial support of NWMO and participation of staff from AECL's Geotechnical Science and Engineering Branch in this work, especially Bill Evenden.

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APPENDIX A: MEASUREMENT AND CALCULATION OF MECHANICAL PROPERTIES

Table A1. Friedland Clay – Cebogel Pellet at 1.0% Salinity for 3 months – Installation

Sample	Location	$W.C._{gravimetric}$ (%)	Bulk density (Mg/m^3)	Dry density (Mg/m^3)	Void Ratio	EMDD (Mg/m^3)	Degree of Saturation, S (%)
Pellets	A	19.08	1.23	1.03	1.69	0.90	93.80
	B	19.08	1.23	1.03	1.69	0.90	93.80
	C	19.08	1.23	1.03	1.69	0.90	93.80
	D	19.08	1.23	1.03	1.69	0.90	93.80
	E-a	19.08	1.23	1.03	1.69	0.90	93.80
	E-b	19.08	1.23	1.03	1.69	0.90	93.80
Clay Block 1	1	10.53	2.21	2.00	0.38	1.53	76.93
Top Block	1	10.53	2.21	2.00	0.38	1.53	76.93
	3	10.53	2.21	2.00	0.38	1.53	76.93
	3	10.53	2.21	2.00	0.38	1.53	76.93
	5	10.53	2.21	2.00	0.38	1.53	76.93
	5	10.53	2.21	2.00	0.38	1.53	76.93
	7	10.53	2.21	2.00	0.38	1.53	76.93
	7	10.53	2.21	2.00	0.38	1.53	76.93
Clay Block 1	1	10.53	2.21	2.00	0.38	1.53	76.93
Bottom	1	10.53	2.21	2.00	0.38	1.53	76.93
Block	3	10.53	2.21	2.00	0.38	1.53	76.93
	3	10.53	2.21	2.00	0.38	1.53	76.93
	5	10.53	2.21	2.00	0.38	1.53	76.93
	5	10.53	2.21	2.00	0.38	1.53	76.93
	7	10.53	2.21	2.00	0.38	1.53	76.93
	7	10.53	2.21	2.00	0.38	1.53	76.93
Clay Block 2	1	10.53	2.21	2.00	0.38	1.53	76.93
Top Block	1	10.53	2.21	2.00	0.38	1.53	76.93
	3	10.53	2.21	2.00	0.38	1.53	76.93
	3	10.53	2.21	2.00	0.38	1.53	76.93
	5	10.53	2.21	2.00	0.38	1.53	76.93
	5	10.53	2.21	2.00	0.38	1.53	76.93
	7	10.53	2.21	2.00	0.38	1.53	76.93
	7	10.53	2.21	2.00	0.38	1.53	76.93
Clay Block 2	1	10.53	2.21	2.00	0.38	1.53	76.93
Bottom	1	10.53	2.21	2.00	0.38	1.53	76.93
Block	3	10.53	2.21	2.00	0.38	1.53	76.93
	3	10.53	2.21	2.00	0.38	1.53	76.93
	5	10.53	2.21	2.00	0.38	1.53	76.93
	5	10.53	2.21	2.00	0.38	1.53	76.93
	7	10.53	2.21	2.00	0.38	1.53	76.93
	7	10.53	2.21	2.00	0.38	1.53	76.93

Table A2. Friedland Clay – Cebogel Pellet at 1.0% Salinity for 3 months – End of Test

Sample	Location	Fluid Content	Bulk density	Dry density	Void Ratio	EMDD	Degree of Saturation, S
		(%)	(Mg/m^3)	(Mg/m^3)		(Mg/m^3)	(%)
Pellets	A	46.92	1.77	1.20	1.31	1.06	99.43
	B	47.45	1.76	1.19	1.33	1.05	99.43
	C	45.79	1.77	1.21	1.29	1.07	98.39
	D	46.92	1.76	1.20	1.32	1.06	98.97
	E-a	45.46	1.78	1.23	1.27	1.08	99.76
	E-b	44.41	1.78	1.23	1.25	1.09	98.64
Clay Block 1	1	18.69	2.18	1.84	0.50	1.33	102.78
Top Block	1	18.43	2.17	1.84	0.50	1.32	100.98
	3	18.45	2.14	1.81	0.53	1.29	96.67
	3	19.08	2.13	1.79	0.54	1.27	97.22
	5	18.09	2.16	1.83	0.51	1.32	98.71
	5	18.32	2.17	1.83	0.51	1.32	99.91
	7	17.39	2.16	1.84	0.50	1.33	95.61
	7	18.64	2.15	1.81	0.52	1.30	98.79
Clay Block 1	1	17.02	2.20	1.88	0.47	1.38	100.93
Bottom	1	17.36	2.19	1.87	0.48	1.36	99.93
Block	3	17.03	2.15	1.84	0.50	1.32	93.23
	3	17.58	2.17	1.84	0.50	1.33	97.35
	5	16.64	2.16	1.85	0.49	1.35	94.02
	5	17.11	2.17	1.85	0.49	1.34	96.38
	7	16.63	2.17	1.86	0.48	1.36	95.32
	7	18.60	2.14	1.81	0.53	1.29	97.50
Clay Block 2	1	14.30	2.20	1.92	0.44	1.43	90.32
Top Block	1	14.51	2.24	1.95	0.41	1.47	97.05
	3	15.37	2.21	1.92	0.44	1.42	96.65
	3	14.87	2.23	1.94	0.42	1.45	97.29
	5	14.47	2.21	1.93	0.43	1.43	92.61
	5	14.95	2.22	1.93	0.43	1.44	96.40
	7	14.51	2.18	1.90	0.45	1.40	88.73
	7	15.03	2.24	1.95	0.42	1.46	99.51
Clay Block 2	1	14.20	2.26	1.98	0.39	1.50	99.45
Bottom	1	15.32	2.23	1.94	0.42	1.45	99.51
Block	3	14.48	2.25	1.96	0.41	1.48	98.61
	3	15.94	2.21	1.90	0.45	1.41	97.94
	5	14.22	2.23	1.95	0.41	1.47	94.97
	5	15.30	2.23	1.93	0.43	1.44	98.19
	7	14.40	2.22	1.94	0.42	1.45	94.70
	7	15.32	2.22	1.92	0.44	1.43	97.03

Table A3. Friedland Clay – Cebogel Pellet at 1.0% Salinity for 9 months – Installation

Sample	Location	W.C.gravimetric (%)	Bulk density (Mg/m^3)	Dry density (Mg/m^3)	Void Ratio	EMDD (Mg/m^3)	Degree of Saturation, S (%)
Pellets	A	19.08	1.23	1.03	1.70	0.89	93.90
	B	19.08	1.23	1.03	1.70	0.89	93.90
	C	19.08	1.23	1.03	1.70	0.89	93.90
	D	19.08	1.23	1.03	1.70	0.89	93.90
	E-a	19.08	1.23	1.03	1.70	0.89	93.90
	E-b	19.08	1.23	1.03	1.70	0.89	93.90
Clay Block 1	1	10.53	2.20	1.99	0.39	1.51	75.30
TB	1	10.53	2.20	1.99	0.39	1.51	75.30
	3	10.53	2.20	1.99	0.39	1.51	75.30
	3	10.53	2.20	1.99	0.39	1.51	75.30
	5	10.53	2.20	1.99	0.39	1.51	75.30
	5	10.53	2.20	1.99	0.39	1.51	75.30
	7	10.53	2.20	1.99	0.39	1.51	75.30
	7	10.53	2.20	1.99	0.39	1.51	75.30
Clay Block 1	1	10.53	2.20	1.99	0.39	1.51	75.30
BB	1	10.53	2.20	1.99	0.39	1.51	75.30
	3	10.53	2.20	1.99	0.39	1.51	75.30
	3	10.53	2.20	1.99	0.39	1.51	75.30
	5	10.53	2.20	1.99	0.39	1.51	75.30
	5	10.53	2.20	1.99	0.39	1.51	75.30
	7	10.53	2.20	1.99	0.39	1.51	75.30
	7	10.53	2.20	1.99	0.39	1.51	75.30
Clay Block 2	1	10.53	2.20	1.99	0.39	1.51	75.30
TB	1	10.53	2.20	1.99	0.39	1.51	75.30
	3	10.53	2.20	1.99	0.39	1.51	75.30
	3	10.53	2.20	1.99	0.39	1.51	75.30
	5	10.53	2.20	1.99	0.39	1.51	75.30
	5	10.53	2.20	1.99	0.39	1.51	75.30
	7	10.53	2.20	1.99	0.39	1.51	75.30
	7	10.53	2.20	1.99	0.39	1.51	75.30
Clay Block 2	1	10.53	2.20	1.99	0.39	1.51	75.30
BB	1	10.53	2.20	1.99	0.39	1.51	75.30
	3	10.53	2.20	1.99	0.39	1.51	75.30
	3	10.53	2.20	1.99	0.39	1.51	75.30
	5	10.53	2.20	1.99	0.39	1.51	75.30
	5	10.53	2.20	1.99	0.39	1.51	75.30
	7	10.53	2.20	1.99	0.39	1.51	75.30
	7	10.53	2.20	1.99	0.39	1.51	75.30

Table A4. Friedland Clay – Cebogel Pellet at 1.0% Salinity for 9 months – End of Test

Sample	Location	Fluid Content (%)	Void Ratio	Bulk density (Mg/m^3)	Dry density (Mg/m^3)	EMDD (Mg/m^3)	Degree of Saturation, S (%)
Pellets	A	45.39	1.26	1.79	1.23	1.09	100.21
	B	45.45	1.28	1.77	1.22	1.07	98.61
	C	46.00	1.28	1.78	1.22	1.07	99.99
	D	46.18	1.29	1.78	1.21	1.07	99.66
	E-a	44.90	1.24	1.80	1.24	1.10	100.79
	E-b	44.39	1.23	1.80	1.25	1.10	100.62
Clay Block 1	1	19.12	0.51	2.18	1.83	1.31	103.26
TB	1	19.20	0.51	2.17	1.82	1.31	103.14
	3	19.49	0.52	2.17	1.81	1.30	103.31
	3	19.22	0.51	2.18	1.83	1.31	103.90
	5	19.28	0.51	2.17	1.82	1.31	103.55
	5	19.77	0.53	2.17	1.81	1.29	103.74
	7	19.86	0.52	2.17	1.81	1.30	104.91
	7	19.49	0.51	2.18	1.82	1.31	104.79
Clay Block 1	1	18.00	0.48	2.20	1.86	1.36	103.37
BB	1	18.21	0.49	2.19	1.85	1.35	102.84
	3	18.54	0.49	2.20	1.85	1.34	104.36
	3	18.76	0.50	2.18	1.84	1.32	102.83
	5	18.49	0.49	2.19	1.85	1.34	103.68
	5	18.76	0.50	2.18	1.84	1.33	103.19
	7	18.55	0.49	2.20	1.85	1.34	104.48
	7	18.85	0.50	2.18	1.84	1.33	103.48
Clay Block 2	1	16.84	0.46	2.22	1.90	1.40	101.97
TB	1	16.91	0.46	2.21	1.89	1.39	101.37
	3	17.19	0.46	2.21	1.89	1.38	102.49
	3	17.33	0.47	2.20	1.87	1.37	100.97
	5	17.34	0.46	2.21	1.88	1.38	102.94
	5	17.33	0.47	2.20	1.88	1.37	101.75
	7	17.13	0.46	2.22	1.90	1.39	103.57
	7	16.90	0.45	2.22	1.90	1.40	102.65
Clay Block 2	1	16.15	0.44	2.22	1.91	1.41	100.37
BB	1	16.85	0.46	2.21	1.89	1.39	101.01
	3	16.95	0.46	2.22	1.89	1.39	102.44
	3	17.49	0.47	2.20	1.88	1.37	102.33
	5	16.87	0.45	2.22	1.90	1.40	103.33
	5	17.41	0.47	2.20	1.88	1.37	101.90
	7	16.58	0.44	2.23	1.91	1.41	103.15
	7	17.13	0.46	2.21	1.89	1.39	102.86

Table A5. Friedland Clay – Cebogel Pellet at 1.0% Salinity for 27 months – Installation

Sample	Location	$W.C._{gravimetric}$ (%)	Bulk density (Mg/m^3)	Dry density (Mg/m^3)	Void Ratio	EMDD (Mg/m^3)	Degree of Saturation, S (%)
Pellets	A	19.08	1.04	0.87	2.20	0.74	95.20
	B	19.08	1.04	0.87	2.20	0.74	95.20
	C	19.08	1.04	0.87	2.20	0.74	95.20
	D	19.08	1.04	0.87	2.20	0.74	95.20
	E-a	19.08	1.04	0.87	2.20	0.74	95.20
	E-b	19.08	1.04	0.87	2.20	0.74	95.20
Clay Block 1	1	10.53	2.22	2.01	0.37	1.54	77.72
TB	1	10.53	2.22	2.01	0.37	1.54	77.72
	3	10.53	2.22	2.01	0.37	1.54	77.72
	3	10.53	2.22	2.01	0.37	1.54	77.72
	5	10.53	2.22	2.01	0.37	1.54	77.72
	5	10.53	2.22	2.01	0.37	1.54	77.72
	7	10.53	2.22	2.01	0.37	1.54	77.72
	7	10.53	2.22	2.01	0.37	1.54	77.72
Clay Block 1	1	10.53	2.22	2.01	0.37	1.54	77.72
BB	1	10.53	2.22	2.01	0.37	1.54	77.72
	3	10.53	2.22	2.01	0.37	1.54	77.72
	3	10.53	2.22	2.01	0.37	1.54	77.72
	5	10.53	2.22	2.01	0.37	1.54	77.72
	5	10.53	2.22	2.01	0.37	1.54	77.72
	7	10.53	2.22	2.01	0.37	1.54	77.72
	7	10.53	2.22	2.01	0.37	1.54	77.72
Clay Block 2	1	10.53	2.22	2.01	0.37	1.54	77.72
TB	1	10.53	2.22	2.01	0.37	1.54	77.72
	3	10.53	2.22	2.01	0.37	1.54	77.72
	3	10.53	2.22	2.01	0.37	1.54	77.72
	5	10.53	2.22	2.01	0.37	1.54	77.72
	5	10.53	2.22	2.01	0.37	1.54	77.72
	7	10.53	2.22	2.01	0.37	1.54	77.72
	7	10.53	2.22	2.01	0.37	1.54	77.72
Clay Block 2	1	10.53	2.22	2.01	0.37	1.54	77.72
BB	1	10.53	2.22	2.01	0.37	1.54	77.72
	3	10.53	2.22	2.01	0.37	1.54	77.72
	3	10.53	2.22	2.01	0.37	1.54	77.72
	5	10.53	2.22	2.01	0.37	1.54	77.72
	5	10.53	2.22	2.01	0.37	1.54	77.72
	7	10.53	2.22	2.01	0.37	1.54	77.72
	7	10.53	2.22	2.01	0.37	1.54	77.72

Table A6. Friedland Clay – Cebogel Pellet at 1.0% Salinity for 27 months – End of Test

Sample	Location	Fluid Content (%)	Void Ratio	Bulk density (Mg/m^3)	Dry density (Mg/m^3)	EMDD (Mg/m^3)	Degree of Saturation, S (%)
Pellets	A	43.57	1.22	1.80	1.25	1.11	99.24
	B	43.46	1.21	1.81	1.26	1.11	100.23
	C	43.39	1.20	1.81	1.26	1.12	100.20
	D	44.94	1.26	1.79	1.23	1.09	99.53
	E-a	41.80	1.16	1.82	1.28	1.14	99.76
	E-b	42.87	1.20	1.81	1.27	1.12	99.66
Clay Block 1	1	17.98	0.49	2.19	1.86	1.35	102.04
TB	1	18.24	0.49	2.20	1.86	1.35	103.50
	3	18.23	0.49	2.19	1.85	1.34	102.32
	3	18.66	0.50	2.19	1.84	1.33	103.78
	5	18.21	0.50	2.18	1.84	1.33	101.18
	5	18.81	0.50	2.19	1.84	1.33	103.89
	7	17.50	0.48	2.20	1.87	1.37	101.61
	7	18.30	0.49	2.19	1.85	1.34	102.83
Clay Block 1	1	15.86	0.44	2.22	1.91	1.42	99.01
BB	1	16.72	0.46	2.21	1.90	1.39	101.23
	3	16.57	0.45	2.22	1.90	1.40	101.22
	3	17.09	0.46	2.21	1.89	1.39	102.02
	5	16.60	0.45	2.21	1.90	1.40	101.10
	5	17.09	0.46	2.21	1.89	1.38	101.74
	7	16.29	0.45	2.21	1.90	1.40	99.52
	7	17.30	0.47	2.20	1.88	1.37	101.83
Clay Block 2	1	15.64	0.43	2.23	1.93	1.44	100.57
TB	1	15.23	0.41	2.25	1.95	1.47	101.87
	3	15.19	0.41	2.26	1.96	1.47	102.41
	3	15.02	0.41	2.26	1.96	1.47	101.69
	5	14.90	0.41	2.25	1.95	1.47	99.69
	5	14.77	0.40	2.27	1.97	1.49	102.53
	7	14.49	0.39	2.27	1.98	1.50	101.82
	7	14.26	0.39	2.27	1.99	1.51	101.35
Clay Block 2	1	15.07	0.41	2.25	1.96	1.47	101.75
BB	1	16.67	0.45	2.23	1.91	1.41	103.07
	3	15.54	0.42	2.24	1.94	1.45	101.95
	3	16.66	0.44	2.23	1.91	1.41	103.40
	5	15.53	0.42	2.25	1.95	1.46	102.36
	5	16.16	0.43	2.23	1.92	1.43	102.56
	7	15.29	0.42	2.25	1.95	1.46	101.51
	7	16.83	0.45	2.22	1.90	1.40	102.87

Table A7. Friedland Clay – Cebogel Pellet at 3.5% Salinity for 3 months – Installation

Sample	Location	W.C.$_{gravimetric}$ (%)	Bulk density (Mg/m^3)	Dry density (Mg/m^3)	Void Ratio	EMDD (Mg/m^3)	Degree of Saturation, S (%)
Pellets	A	19.12	1.05	0.88	2.16	0.75	94.50
	B	19.12	1.05	0.88	2.16	0.75	94.50
	C	19.12	1.05	0.88	2.16	0.75	94.50
	D	19.12	1.05	0.88	2.16	0.75	94.50
	E-a	19.12	1.05	0.88	2.16	0.75	94.50
	E-b	19.12	1.05	0.88	2.16	0.75	94.50
Clay Block 1	1	10.49	2.23	2.02	0.37	1.55	79.18
TB	1	10.49	2.23	2.02	0.37	1.55	79.18
	3	10.49	2.23	2.02	0.37	1.55	79.18
	3	10.49	2.23	2.02	0.37	1.55	79.18
	5	10.49	2.23	2.02	0.37	1.55	79.18
	5	10.49	2.23	2.02	0.37	1.55	79.18
	7	10.49	2.23	2.02	0.37	1.55	79.18
	7	10.49	2.23	2.02	0.37	1.55	79.18
Clay Block 1	1	10.49	2.23	2.02	0.37	1.55	79.18
BB	1	10.49	2.23	2.02	0.37	1.55	79.18
	3	10.49	2.23	2.02	0.37	1.55	79.18
	3	10.49	2.23	2.02	0.37	1.55	79.18
	5	10.49	2.23	2.02	0.37	1.55	79.18
	5	10.49	2.23	2.02	0.37	1.55	79.18
	7	10.49	2.23	2.02	0.37	1.55	79.18
	7	10.49	2.23	2.02	0.37	1.55	79.18
Clay Block 2	1	10.49	2.23	2.02	0.37	1.55	79.18
TB	1	10.49	2.23	2.02	0.37	1.55	79.18
	3	10.49	2.23	2.02	0.37	1.55	79.18
	3	10.49	2.23	2.02	0.37	1.55	79.18
	5	10.49	2.23	2.02	0.37	1.55	79.18
	5	10.49	2.23	2.02	0.37	1.55	79.18
	7	10.49	2.23	2.02	0.37	1.55	79.18
	7	10.49	2.23	2.02	0.37	1.55	79.18
Clay Block 2	1	10.49	2.23	2.02	0.37	1.55	79.18
BB	1	10.49	2.23	2.02	0.37	1.55	79.18
	3	10.49	2.23	2.02	0.37	1.55	79.18
	3	10.49	2.23	2.02	0.37	1.55	79.18
	5	10.49	2.23	2.02	0.37	1.55	79.18
	5	10.49	2.23	2.02	0.37	1.55	79.18
	7	10.49	2.23	2.02	0.37	1.55	79.18
	7	10.49	2.23	2.02	0.37	1.55	79.18

Table A8. Friedland Clay – Cebogel Pellet at 3.5% Salinity for 3 months – End of Test

Sample	Location	Fluid Content (%)	Bulk density (Mg/m^3)	Dry density (Mg/m^3)	Void Ratio	EMDD (Mg/m^3)	Degree of Saturation, S (%)
Pellets	A	45.89	1.75	1.20	1.32	1.06	96.96
	B	47.70	1.75	1.18	1.35	1.04	98.23
	C	44.20	1.78	1.23	1.25	1.09	98.15
	D	45.08	1.77	1.22	1.28	1.08	98.18
	E-a	42.15	1.82	1.28	1.18	1.13	99.54
	E-b	42.48	1.81	1.27	1.19	1.12	98.95
Clay Block 1	1	19.09	2.13	1.79	0.54	1.27	96.98
TB	1	19.36	2.15	1.80	0.53	1.29	100.57
	3	19.00	2.13	1.79	0.54	1.27	96.37
	3	19.49	2.14	1.79	0.54	1.27	98.94
	5	18.45	2.13	1.80	0.53	1.28	95.32
	5	18.79	2.15	1.81	0.52	1.30	98.98
	7	18.14	2.12	1.80	0.53	1.28	93.63
	7	19.24	2.14	1.79	0.54	1.28	98.55
Clay Block 1	1	16.84	2.19	1.87	0.47	1.37	98.46
BB	1	17.76	2.18	1.85	0.49	1.35	100.50
	3	16.63	2.16	1.85	0.49	1.35	93.93
	3	17.87	2.17	1.84	0.50	1.33	98.93
	5	16.33	2.17	1.87	0.48	1.36	94.34
	5	17.44	2.17	1.85	0.49	1.34	97.45
	7	16.62	2.18	1.87	0.48	1.37	96.53
	7	17.21	2.17	1.85	0.49	1.34	96.44
Clay Block 2	1	14.53	2.23	1.94	0.42	1.46	95.69
TB	1	14.88	2.25	1.96	0.41	1.48	100.90
	3	14.63	2.25	1.96	0.41	1.47	98.67
	3	14.96	2.24	1.95	0.42	1.46	98.96
	5	15.16	2.25	1.95	0.41	1.47	101.27
	5	15.29	2.23	1.93	0.43	1.44	98.84
	7	14.81	2.25	1.96	0.41	1.47	99.46
	7	15.30	2.24	1.94	0.42	1.45	100.04
Clay Block 2	1	13.60	2.25	1.98	0.39	1.50	95.53
BB	1	14.58	2.25	1.96	0.41	1.48	99.08
	3	13.46	2.25	1.98	0.39	1.50	94.13
	3	14.49	2.24	1.96	0.41	1.47	97.32
	5	13.08	2.22	1.97	0.40	1.48	89.62
	5	15.38	2.23	1.94	0.43	1.44	99.76
	7	12.91	2.25	1.99	0.38	1.52	92.57
	7	14.15	2.23	1.95	0.41	1.47	94.78

Table A9. Friedland Clay – Cebogel Pellet at 3.5% Salinity for 9 months – Installation

Sample	Location	$W.C._{gravimetric}$ (%)	Bulk density (Mg/m^3)	Dry density (Mg/m^3)	Void Ratio	EMDD (Mg/m^3)	Degree of Saturation, S (%)
Pellets	A	19.12	1.29	1.08	1.56	0.94	93.30
	B	19.12	1.29	1.08	1.56	0.94	93.30
	C	19.12	1.29	1.08	1.56	0.94	93.30
	D	19.12	1.29	1.08	1.56	0.94	93.30
	E-a	19.12	1.29	1.08	1.56	0.94	93.30
	E-b	19.12	1.29	1.08	1.56	0.94	93.30
Clay Block 1	1	10.49	2.21	2.00	0.38	1.52	75.98
TB	1	10.49	2.21	2.00	0.38	1.52	75.98
	3	10.49	2.21	2.00	0.38	1.52	75.98
	3	10.49	2.21	2.00	0.38	1.52	75.98
	5	10.49	2.21	2.00	0.38	1.52	75.98
	5	10.49	2.21	2.00	0.38	1.52	75.98
	7	10.49	2.21	2.00	0.38	1.52	75.98
	7	10.49	2.21	2.00	0.38	1.52	75.98
Clay Block 1	1	10.49	2.21	2.00	0.38	1.52	75.98
BB	1	10.49	2.21	2.00	0.38	1.52	75.98
	3	10.49	2.21	2.00	0.38	1.52	75.98
	3	10.49	2.21	2.00	0.38	1.52	75.98
	5	10.49	2.21	2.00	0.38	1.52	75.98
	5	10.49	2.21	2.00	0.38	1.52	75.98
	7	10.49	2.21	2.00	0.38	1.52	75.98
	7	10.49	2.21	2.00	0.38	1.52	75.98
Clay Block 2	1	10.49	2.21	2.00	0.38	1.52	75.98
TB	1	10.49	2.21	2.00	0.38	1.52	75.98
	3	10.49	2.21	2.00	0.38	1.52	75.98
	3	10.49	2.21	2.00	0.38	1.52	75.98
	5	10.49	2.21	2.00	0.38	1.52	75.98
	5	10.49	2.21	2.00	0.38	1.52	75.98
	7	10.49	2.21	2.00	0.38	1.52	75.98
	7	10.49	2.21	2.00	0.38	1.52	75.98
Clay Block 2	1	10.49	2.21	2.00	0.38	1.52	75.98
BB	1	10.49	2.21	2.00	0.38	1.52	75.98
	3	10.49	2.21	2.00	0.38	1.52	75.98
	3	10.49	2.21	2.00	0.38	1.52	75.98
	5	10.49	2.21	2.00	0.38	1.52	75.98
	5	10.49	2.21	2.00	0.38	1.52	75.98
	7	10.49	2.21	2.00	0.38	1.52	75.98
	7	10.49	2.21	2.00	0.38	1.52	75.98

Table A10. Friedland Clay – Cebogel Pellet at 3.5% Salinity for 9 months – End of Test

Sample	Location	Fluid Content (%)	Bulk density (Mg/m^3)	Dry density (Mg/m^3)	Void Ratio	EMDD (Mg/m^3)	Degree of Saturation, S (%)
Pellets	A	43.83	1.82	1.26	1.20	1.12	101.32
	B	44.66	1.81	1.25	1.22	1.11	101.82
	C	44.80	1.81	1.25	1.22	1.11	101.92
	D	45.99	1.79	1.23	1.27	1.08	100.86
	E-a	43.50	1.82	1.27	1.20	1.12	101.17
	E-b	44.16	1.79	1.24	1.24	1.10	99.33
Clay Block 1	1	20.44	2.17	1.80	0.53	1.28	105.52
TB	1	20.08	2.17	1.81	0.53	1.29	105.02
	3	20.60	2.17	1.80	0.53	1.28	106.61
	3	20.23	2.17	1.81	0.53	1.29	105.92
	5	20.00	2.18	1.82	0.52	1.30	106.28
	5	20.08	2.17	1.81	0.52	1.30	105.63
	7	20.50	2.17	1.80	0.53	1.29	106.76
	7	20.64	2.17	1.80	0.54	1.28	106.29
Clay Block 1	1	18.02	2.21	1.87	0.47	1.37	105.32
BB	1	18.29	2.21	1.87	0.48	1.36	105.83
	3	18.02	2.19	1.86	0.49	1.35	102.49
	3	18.27	2.21	1.87	0.48	1.36	105.45
	5	17.64	2.21	1.88	0.47	1.38	104.43
	5	17.90	2.21	1.87	0.48	1.37	103.97
	7	18.26	2.21	1.86	0.48	1.36	104.99
	7	18.39	2.20	1.86	0.49	1.35	104.50
Clay Block 2	1	17.06	2.20	1.88	0.47	1.38	100.56
TB	1	17.03	2.21	1.89	0.46	1.39	102.08
	3	16.59	2.21	1.89	0.46	1.39	100.25
	3	17.24	2.21	1.88	0.46	1.38	102.35
	5	17.40	2.20	1.88	0.47	1.37	101.98
	5	17.54	2.21	1.88	0.47	1.38	103.37
	7	17.69	2.20	1.87	0.47	1.37	102.96
	7	17.42	2.20	1.87	0.47	1.37	101.75
Clay Block 2	1	16.87	2.22	1.90	0.45	1.40	103.19
BB	1	17.00	2.21	1.89	0.46	1.39	102.45
	3	16.82	2.22	1.90	0.45	1.40	102.20
	3	17.43	2.21	1.88	0.47	1.38	103.20
	5	17.04	2.22	1.90	0.46	1.39	103.11
	5	17.64	2.20	1.87	0.47	1.37	102.54
	7	17.06	2.22	1.89	0.46	1.39	102.92
	7	17.16	2.21	1.88	0.46	1.38	101.91

Table A11. Friedland Clay – Cebogel Pellet at 3.5% Salinity for 27 months – Installation

Sample	Location	W.C.$_{gravimetric}$ (%)	Bulk density (Mg/m^3)	Dry density (Mg/m^3)	Void Ratio	EMDD (Mg/m^3)	Degree of Saturation, S (%)
Pellets	A	19.12	1.13	0.95	1.92	0.82	94.60
	B	19.12	1.13	0.95	1.92	0.82	94.60
	C	19.12	1.13	0.95	1.92	0.82	94.60
	D	19.12	1.13	0.95	1.92	0.82	94.60
	E-a	19.12	1.13	0.95	1.92	0.82	94.60
	E-b	19.12	1.13	0.95	1.92	0.82	94.60
Clay Block 1	1	10.49	2.22	2.01	0.37	1.54	77.36
TB	1	10.49	2.22	2.01	0.37	1.54	77.36
	3	10.49	2.22	2.01	0.37	1.54	77.36
	3	10.49	2.22	2.01	0.37	1.54	77.36
	5	10.49	2.22	2.01	0.37	1.54	77.36
	5	10.49	2.22	2.01	0.37	1.54	77.36
	7	10.49	2.22	2.01	0.37	1.54	77.36
	7	10.49	2.22	2.01	0.37	1.54	77.36
Clay Block 1	1	10.49	2.22	2.01	0.37	1.54	77.36
BB	1	10.49	2.22	2.01	0.37	1.54	77.36
	3	10.49	2.22	2.01	0.37	1.54	77.36
	3	10.49	2.22	2.01	0.37	1.54	77.36
	5	10.49	2.22	2.01	0.37	1.54	77.36
	5	10.49	2.22	2.01	0.37	1.54	77.36
	7	10.49	2.22	2.01	0.37	1.54	77.36
	7	10.49	2.22	2.01	0.37	1.54	77.36
Clay Block 2	1	10.49	2.22	2.01	0.37	1.54	77.36
TB	1	10.49	2.22	2.01	0.37	1.54	77.36
	3	10.49	2.22	2.01	0.37	1.54	77.36
	3	10.49	2.22	2.01	0.37	1.54	77.36
	5	10.49	2.22	2.01	0.37	1.54	77.36
	5	10.49	2.22	2.01	0.37	1.54	77.36
	7	10.49	2.22	2.01	0.37	1.54	77.36
	7	10.49	2.22	2.01	0.37	1.54	77.36
Clay Block 2	1	10.49	2.22	2.01	0.37	1.54	77.36
BB	1	10.49	2.22	2.01	0.37	1.54	77.36
	3	10.49	2.22	2.01	0.37	1.54	77.36
	3	10.49	2.22	2.01	0.37	1.54	77.36
	5	10.49	2.22	2.01	0.37	1.54	77.36
	5	10.49	2.22	2.01	0.37	1.54	77.36
	7	10.49	2.22	2.01	0.37	1.54	77.36
	7	10.49	2.22	2.01	0.37	1.54	77.36

Table A12. Friedland Clay – Cebogel Pellet at 3.5% Salinity for 27 months – End of Test

Sample	Location	Fluid Content (%)	Bulk density (Mg/m^3)	Dry density (Mg/m^3)	Void Ratio	EMDD (Mg/m^3)	Degree of Saturation, S (%)
Pellets	A	41.10	1.81	1.29	1.16	1.14	98.24
	B	41.85	1.81	1.28	1.17	1.13	99.06
	C	40.67	1.81	1.29	1.16	1.14	97.65
	D	41.48	1.80	1.28	1.18	1.13	97.77
	E-a	39.91	1.82	1.30	1.13	1.16	98.08
	E-b	38.64	1.83	1.32	1.11	1.17	96.73
Clay Block 1	1	17.23	2.18	1.86	0.49	1.35	97.63
TB	1	17.56	2.17	1.85	0.49	1.34	98.40
	3	17.22	2.18	1.86	0.49	1.35	97.68
	3	17.69	2.18	1.85	0.49	1.34	99.81
	5	17.22	2.20	1.88	0.47	1.37	100.96
	5	18.06	2.18	1.84	0.50	1.33	100.39
	7	17.23	2.19	1.87	0.48	1.36	99.44
	7	17.63	2.18	1.86	0.49	1.35	99.98
Clay Block 1	1	16.77	2.20	1.88	0.47	1.38	99.30
BB	1	17.56	2.19	1.86	0.48	1.35	100.30
	3	16.69	2.20	1.89	0.46	1.38	99.45
	3	17.19	2.19	1.87	0.48	1.36	99.78
	5	16.68	2.20	1.89	0.46	1.39	99.81
	5	17.34	2.19	1.87	0.48	1.36	99.74
	7	17.65	2.20	1.87	0.48	1.36	102.02
	7	18.07	2.19	1.86	0.49	1.35	102.54
Clay Block 2	1	15.00	2.24	1.95	0.42	1.46	99.78
TB	1	15.36	2.25	1.95	0.41	1.46	102.46
	3	15.16	2.25	1.95	0.42	1.46	100.66
	3	15.12	2.24	1.95	0.42	1.46	100.07
	5	15.34	2.24	1.94	0.42	1.45	100.90
	5	15.42	2.24	1.94	0.42	1.45	100.74
	7	15.09	2.25	1.95	0.41	1.46	100.48
	7	15.28	2.25	1.95	0.41	1.46	101.98
Clay Block 2	1	14.44	2.28	1.99	0.39	1.51	102.65
BB	1	15.30	2.25	1.95	0.41	1.47	102.57
	3	14.44	2.28	1.99	0.39	1.51	102.88
	3	14.79	2.26	1.97	0.40	1.49	102.30
	5	14.59	2.26	1.97	0.40	1.49	100.91
	5	15.39	2.25	1.95	0.41	1.47	102.82
	7	14.25	2.27	1.98	0.39	1.50	100.52
	7	14.88	2.26	1.97	0.40	1.48	101.72

Table A13. Friedland Clay (80% clay block by volume-short sample) – Cebogel Pellet at 3.5% Salinity for 3 months – Installation

Sample	Location	W.C.$_{gravimetric}$	Bulk density	Dry density	Void Ratio	EMDD	Degree of Saturation, S
		(%)	(Mg/m^3)	(Mg/m^3)		(Mg/m^3)	(%)
Pellets	A	19.12	1.15	0.97	1.88	0.83	94.50
	B	19.12	1.15	0.97	1.88	0.83	94.50
	C	19.12	1.15	0.97	1.88	0.83	94.50
	D	19.12	1.15	0.97	1.88	0.83	94.50
	E-a	19.12	1.15	0.97	1.88	0.83	94.50
	E-b	19.12	1.15	0.97	1.88	0.83	94.50
Clay Block	1	10.49	2.18	1.98	0.40	1.50	73.07
Top	1	10.49	2.18	1.98	0.40	1.50	73.07
	3	10.49	2.18	1.98	0.40	1.50	73.07
	3	10.49	2.18	1.98	0.40	1.50	73.07
	5	10.49	2.18	1.98	0.40	1.50	73.07
	5	10.49	2.18	1.98	0.40	1.50	73.07
	7	10.49	2.18	1.98	0.40	1.50	73.07
	7	10.49	2.18	1.98	0.40	1.50	73.07
Clay Block	1	10.49	2.18	1.98	0.40	1.50	73.07
Middle	1	10.49	2.18	1.98	0.40	1.50	73.07
	3	10.49	2.18	1.98	0.40	1.50	73.07
	3	10.49	2.18	1.98	0.40	1.50	73.07
	5	10.49	2.18	1.98	0.40	1.50	73.07
	5	10.49	2.18	1.98	0.40	1.50	73.07
	7	10.49	2.18	1.98	0.40	1.50	73.07
	7	10.49	2.18	1.98	0.40	1.50	73.07
Clay Block	1	10.49	2.18	1.98	0.40	1.50	73.07
Bottom	1	10.49	2.18	1.98	0.40	1.50	73.07
	3	10.49	2.18	1.98	0.40	1.50	73.07
	3	10.49	2.18	1.98	0.40	1.50	73.07
	5	10.49	2.18	1.98	0.40	1.50	73.07
	5	10.49	2.18	1.98	0.40	1.50	73.07
	7	10.49	2.18	1.98	0.40	1.50	73.07
	7	10.49	2.18	1.98	0.40	1.50	73.07

Table A14. Friedland Clay (80% clay block by volume-short sample) – Cebogel Pellet at 3.5% Salinity for 3 months – End of Test

Sample	Location	Fluid Content	Bulk density	Dry density	Void Ratio	EMDD	Degree of Saturation, S
		(%)	(Mg/m^3)	(Mg/m^3)		(Mg/m^3)	(%)
Pellets	A	48.89	1.78	1.19	1.332	1.05	98.92
	B	48.25	1.76	1.19	1.339	1.04	97.14
	C	48.09	1.76	1.19	1.340	1.04	96.77
	D	51.56	1.82	1.20	1.319	1.05	105.14
	E-a	47.28	1.80	1.23	1.269	1.08	100.49
	E-b	44.58	1.90	1.31	1.115	1.17	108.06
Clay Block	1	21.43	2.09	1.72	0.605	1.20	95.72
Top	1	22.08	2.09	1.72	0.609	1.19	97.90
	3	21.56	2.12	1.74	0.586	1.22	99.45
	3	21.93	2.11	1.73	0.596	1.21	99.43
	5	20.56	2.13	1.76	0.565	1.24	98.34
	5	20.68	2.13	1.77	0.564	1.24	99.23
	7	20.90	2.12	1.75	0.573	1.23	98.54
	7	21.95	2.08	1.71	0.614	1.18	96.47
Clay Block	1	17.56	2.17	1.84	0.496	1.33	96.16
Middle	1	19.16	2.11	1.77	0.556	1.25	93.36
	3	18.30	2.14	1.81	0.525	1.29	94.54
	3	18.57	2.14	1.81	0.529	1.29	95.21
	5	17.97	2.18	1.85	0.494	1.34	98.76
	5	18.32	2.17	1.83	0.508	1.32	97.77
	7	18.77	2.13	1.79	0.541	1.27	94.05
	7	20.00	2.09	1.75	0.582	1.22	93.04
Clay Block	1	15.83	2.20	1.90	0.451	1.40	95.58
Bottom	1	17.13	2.18	1.86	0.481	1.36	96.79
	3	16.38	2.22	1.91	0.449	1.41	99.29
	3	17.11	2.20	1.88	0.467	1.38	99.43
	5	15.57	2.24	1.94	0.423	1.45	100.25
	5	15.53	2.25	1.95	0.416	1.46	101.82
	7	17.44	2.21	1.88	0.466	1.38	101.60
	7	17.56	2.20	1.87	0.476	1.36	100.19

Table A15. Friedland Clay (70% clay block by volume – target 80%) – Cebogel Pellet at 3.5% Salinity for 9 months – Installation

Sample	Location	W.C.$_{gravimetric}$	Bulk density	Dry density	Void Ratio	EMDD	Degree of Saturation, S
		(%)	(Mg/m^3)	(Mg/m^3)		(Mg/m^3)	(%)
Pellets	A	19.12	0.60	0.50	4.53	0.42	95.10
	B	19.12	0.60	0.50	4.53	0.42	95.10
	C	19.12	0.60	0.50	4.53	0.42	95.10
	D	19.12	0.60	0.50	4.53	0.42	95.10
	E-a	19.12	0.60	0.50	4.53	0.42	95.10
	E-b	19.12	0.60	0.50	4.53	0.42	95.10
Clay Block	1	10.49	2.19	1.99	0.39	1.51	74.23
Top	1	10.49	2.19	1.99	0.39	1.51	74.23
	3	10.49	2.19	1.99	0.39	1.51	74.23
	3	10.49	2.19	1.99	0.39	1.51	74.23
	5	10.49	2.19	1.99	0.39	1.51	74.23
	5	10.49	2.19	1.99	0.39	1.51	74.23
	7	10.49	2.19	1.99	0.39	1.51	74.23
	7	10.49	2.19	1.99	0.39	1.51	74.23
Clay Block	1	10.49	2.19	1.99	0.39	1.51	74.23
Middle	1	10.49	2.19	1.99	0.39	1.51	74.23
	3	10.49	2.19	1.99	0.39	1.51	74.23
	3	10.49	2.19	1.99	0.39	1.51	74.23
	5	10.49	2.19	1.99	0.39	1.51	74.23
	5	10.49	2.19	1.99	0.39	1.51	74.23
	7	10.49	2.19	1.99	0.39	1.51	74.23
	7	10.49	2.19	1.99	0.39	1.51	74.23
Clay Block	1	10.49	2.19	1.99	0.39	1.51	74.23
Bottom	1	10.49	2.19	1.99	0.39	1.51	74.23
	3	10.49	2.19	1.99	0.39	1.51	74.23
	3	10.49	2.19	1.99	0.39	1.51	74.23
	5	10.49	2.19	1.99	0.39	1.51	74.23
	5	10.49	2.19	1.99	0.39	1.51	74.23
	7	10.49	2.19	1.99	0.39	1.51	74.23
	7	10.49	2.19	1.99	0.39	1.51	74.23

Table A16. Friedland Clay (70% clay block by volume – target 80%) – Cebogel Pellet at 3.5% Salinity for 9 months – End of Test

Sample	Location	Fluid Content	Bulk density	Dry density	Void Ratio	EMDD	Degree of Saturation, S
		(%)	(Mg/m^3)	(Mg/m^3)		(Mg/m^3)	(%)
Pellets	A	59.78	1.70	1.07	1.61	0.93	99.71
	B	59.70	1.68	1.05	1.65	0.91	97.16
	C	61.80	1.71	1.06	1.63	0.92	101.33
	D	58.77	1.71	1.08	1.58	0.94	99.86
	E-a	59.16	1.75	1.10	1.53	0.96	103.30
	E-b	56.03	1.75	1.12	1.48	0.98	101.61
Clay Block	1	22.54	2.11	1.72	0.61	1.19	100.52
	1	23.05	2.10	1.71	0.61	1.18	101.26
	3	23.52	2.12	1.71	0.61	1.19	103.86
	3	24.51	2.09	1.68	0.64	1.15	102.74
	5	23.61	2.11	1.70	0.62	1.18	102.64
	5	24.00	2.10	1.70	0.63	1.17	103.09
	7	24.04	2.09	1.68	0.64	1.16	101.08
	7	23.67	2.08	1.69	0.64	1.16	100.03
Clay Block	1	21.94	2.14	1.75	0.57	1.23	103.16
	1	22.12	2.13	1.74	0.58	1.22	102.52
	3	23.46	2.11	1.71	0.61	1.19	103.22
	3	22.69	2.12	1.73	0.60	1.21	102.70
	5	23.57	2.12	1.71	0.61	1.19	103.79
	5	23.65	2.12	1.71	0.61	1.19	104.38
	7	23.10	2.12	1.73	0.60	1.20	103.93
	7	22.98	2.11	1.72	0.61	1.19	102.36
Clay Block	1	20.48	2.17	1.80	0.53	1.28	103.89
	1	22.05	2.15	1.76	0.57	1.24	104.57
	3	21.28	2.17	1.79	0.54	1.27	106.34
	3	22.78	2.11	1.72	0.60	1.20	101.88
	5	21.60	2.16	1.78	0.55	1.26	105.43
	5	23.55	2.12	1.72	0.61	1.19	104.60
	7	21.51	2.16	1.78	0.55	1.26	105.28
	7	23.19	2.12	1.72	0.61	1.19	103.28

Table A17. Friedland Clay (75% clay block by volume – target 80%) – Cebogel Pellet at 3.5% Salinity for 27 months – Installation

Sample	Location	$W.C._{gravimetric}$ (%)	Bulk density (Mg/m^3)	Dry density (Mg/m^3)	Void Ratio	EMDD (Mg/m^3)	Degree of Saturation, S (%)
Pellets	A	19.12	0.93	0.78	2.56	0.66	94.30
	B	19.12	0.93	0.78	2.56	0.66	94.30
	C	19.12	0.93	0.78	2.56	0.66	94.30
	D	19.12	0.93	0.78	2.56	0.66	94.30
	E-a	19.12	0.93	0.78	2.56	0.66	94.30
	E-b	19.12	0.93	0.78	2.56	0.66	94.30
Clay Block	1.00	10.49	2.23	2.02	0.36	1.55	79.34
Top	1.00	10.49	2.23	2.02	0.36	1.55	79.34
	3.00	10.49	2.23	2.02	0.36	1.55	79.34
	3.00	10.49	2.23	2.02	0.36	1.55	79.34
	5.00	10.49	2.23	2.02	0.36	1.55	79.34
	5.00	10.49	2.23	2.02	0.36	1.55	79.34
	7.00	10.49	2.23	2.02	0.36	1.55	79.34
	7.00	10.49	2.23	2.02	0.36	1.55	79.34
Clay Block	1.00	10.49	2.23	2.02	0.36	1.55	79.34
Middle	1.00	10.49	2.23	2.02	0.36	1.55	79.34
	3.00	10.49	2.23	2.02	0.36	1.55	79.34
	3.00	10.49	2.23	2.02	0.36	1.55	79.34
	5.00	10.49	2.23	2.02	0.36	1.55	79.34
	5.00	10.49	2.23	2.02	0.36	1.55	79.34
	7.00	10.49	2.23	2.02	0.36	1.55	79.34
	7.00	10.49	2.23	2.02	0.36	1.55	79.34
Clay Block	1.00	10.49	2.23	2.02	0.36	1.55	79.34
Bottom	1.00	10.49	2.23	2.02	0.36	1.55	79.34
	3.00	10.49	2.23	2.02	0.36	1.55	79.34
	3.00	10.49	2.23	2.02	0.36	1.55	79.34
	5.00	10.49	2.23	2.02	0.36	1.55	79.34
	5.00	10.49	2.23	2.02	0.36	1.55	79.34
	7.00	10.49	2.23	2.02	0.36	1.55	79.34
	7.00	10.49	2.23	2.02	0.36	1.55	79.34

Table A18. Friedland Clay (75% clay block by volume – target 80%) – Cebogel Pellet at 3.5% Salinity for 27 months – End of Test

Sample	Location	Fluid Content	Bulk density	Dry density	Void Ratio	EMDD	Degree of Saturation, S
		(%)	(Mg/m^3)	(Mg/m^3)		(Mg/m^3)	(%)
Pellets	A	50.78	1.70	1.13	1.46	0.99	93.20
	B	50.51	1.68	1.12	1.49	0.98	94.72
	C	51.05	1.67	1.11	1.51	0.97	96.37
	D	50.61	1.72	1.14	1.43	1.00	101.53
	E-a	49.25	1.73	1.16	1.40	1.01	103.56
	E-b	50.49	1.74	1.15	1.41	1.01	102.96
Clay Block	1	23.42	2.09	1.70	0.63	1.17	100.62
Top	1	24.64	2.07	1.66	0.66	1.13	100.46
	3	23.05	2.10	1.71	0.62	1.18	100.52
	3	23.99	2.09	1.69	0.64	1.16	101.67
	5	22.16	2.11	1.73	0.60	1.20	100.00
	5	22.78	2.11	1.72	0.61	1.19	101.37
	7	21.49	2.12	1.74	0.58	1.22	99.69
	7	23.23	2.10	1.70	0.62	1.18	101.15
Clay Block	1	20.24	2.14	1.78	0.55	1.26	98.87
Middle	1	20.90	2.14	1.77	0.56	1.25	100.89
	3	20.37	2.13	1.77	0.56	1.25	98.97
	3	21.00	2.14	1.77	0.56	1.25	100.96
	5	19.44	2.15	1.80	0.53	1.29	99.28
	5	19.97	2.16	1.80	0.53	1.28	101.04
	7	20.30	2.14	1.78	0.55	1.26	99.56
	7	20.47	2.15	1.79	0.54	1.27	101.83
Clay Block	1	20.70	2.14	1.78	0.55	1.26	101.10
Bottom	1	20.05	2.16	1.80	0.53	1.29	102.14
	3	20.11	2.15	1.79	0.54	1.27	100.47
	3	20.34	2.16	1.79	0.54	1.27	101.93
	5	20.35	2.16	1.79	0.54	1.27	101.91
	5	19.94	2.17	1.81	0.53	1.29	102.57
	7	20.15	2.15	1.79	0.54	1.27	100.44
	7	19.71	2.17	1.82	0.52	1.30	102.58

Table A19. Friedland Clay (70% clay block by volume) – Cebogel Pellet at 3.5% Salinity for 9 months – Installation

Sample	Location	W.C.$_{gravimetric}$ (%)	Bulk density (Mg/m^3)	Dry density (Mg/m^3)	Void Ratio	EMDD (Mg/m^3)	Degree of Saturation, S (%)
Pellets	A	19.08	1.25	1.05	1.648	0.91	93.70
	B	19.08	1.25	1.05	1.648	0.91	93.70
	C	19.08	1.25	1.05	1.648	0.91	93.70
	D	19.08	1.25	1.05	1.648	0.91	93.70
	E-a	19.08	1.25	1.05	1.648	0.91	93.70
	E-b	19.08	1.25	1.05	1.648	0.91	93.70
Clay Block	1	10.53	2.23	2.02	0.367	1.55	79.20
Top	1	10.53	2.23	2.02	0.367	1.55	79.20
	3	10.53	2.23	2.02	0.367	1.55	79.20
	3	10.53	2.23	2.02	0.367	1.55	79.20
	5	10.53	2.23	2.02	0.367	1.55	79.20
	5	10.53	2.23	2.02	0.367	1.55	79.20
	7	10.53	2.23	2.02	0.367	1.55	79.20
	7	10.53	2.23	2.02	0.367	1.55	79.20
Clay Block	1	10.53	2.23	2.02	0.367	1.55	79.20
Middle	1	10.53	2.23	2.02	0.367	1.55	79.20
	3	10.53	2.23	2.02	0.367	1.55	79.20
	3	10.53	2.23	2.02	0.367	1.55	79.20
	5	10.53	2.23	2.02	0.367	1.55	79.20
	5	10.53	2.23	2.02	0.367	1.55	79.20
	7	10.53	2.23	2.02	0.367	1.55	79.20
	7	10.53	2.23	2.02	0.367	1.55	79.20
Clay Block	1	10.53	2.23	2.02	0.367	1.55	79.20
Bottom	1	10.53	2.23	2.02	0.367	1.55	79.20
	3	10.53	2.23	2.02	0.367	1.55	79.20
	3	10.53	2.23	2.02	0.367	1.55	79.20
	5	10.53	2.23	2.02	0.367	1.55	79.20
	5	10.53	2.23	2.02	0.367	1.55	79.20
	7	10.53	2.23	2.02	0.367	1.55	79.20
	7	10.53	2.23	2.02	0.367	1.55	79.20

Table A20. Friedland Clay (70% clay block by volume) – Cebogel Pellet at 3.5% Salinity for 9 months – End of Test

Sample	Location	Fluid Content	Bulk density	Dry density	Void Ratio	EMDD	Degree of Saturation, S
		(%)	(Mg/m^3)	(Mg/m^3)		(Mg/m^3)	(%)
Pellets	A	50.98	1.78	1.18	1.364	1.03	100.57
	B	48.68	1.80	1.21	1.291	1.07	101.63
	C	45.59	1.82	1.25	1.220	1.11	100.92
	D	48.22	1.79	1.21	1.299	1.06	100.04
	E-a	47.02	1.83	1.24	1.239	1.10	102.36
	E-b	46.06	1.81	1.24	1.244	1.09	99.97
Clay Block	1	18.96	2.19	1.84	0.497	1.33	103.49
Top	1	19.67	2.17	1.82	0.519	1.30	102.60
	3	18.97	2.18	1.83	0.505	1.32	101.78
	3	19.06	2.18	1.83	0.506	1.32	101.99
	5	18.38	2.20	1.86	0.487	1.35	102.27
	5	19.09	2.18	1.83	0.508	1.32	101.83
	7	19.35	2.18	1.83	0.510	1.31	102.65
	7	19.95	2.17	1.81	0.527	1.29	102.40
Clay Block	1	17.98	2.22	1.88	0.466	1.38	104.70
	1	18.68	2.20	1.85	0.489	1.34	103.52
	3	17.84	2.24	1.90	0.451	1.40	107.34
	3	18.41	2.23	1.88	0.468	1.38	106.76
	5	17.62	2.23	1.89	0.459	1.39	104.30
	5	17.26	2.22	1.90	0.455	1.40	102.97
	7	18.57	2.23	1.88	0.470	1.37	107.14
	7	18.87	2.21	1.86	0.482	1.36	106.06
Clay Block	1	17.08	2.24	1.91	0.446	1.41	104.17
	1	17.69	2.22	1.89	0.462	1.39	104.04
	3	16.90	2.24	1.91	0.443	1.42	103.81
	3	17.35	2.24	1.90	0.449	1.41	105.02
	5	16.37	2.27	1.95	0.417	1.46	106.96
	5	16.91	2.25	1.92	0.435	1.43	105.58
	7	17.48	2.26	1.92	0.436	1.43	108.96
	7	17.86	2.23	1.89	0.462	1.39	104.98

Table A21. Friedland Clay (60% clay block by volume) – Cebogel Pellet at 3.5% Salinity for 9 months – Installation

Sample	Location	W.C.$_{gravimetric}$	Bulk density	Dry density	Void Ratio	EMDD	Degree of Saturation, S
		(%)	(Mg/m^3)	(Mg/m^3)		(Mg/m^3)	(%)
Pellets	A	19.08	0.75	0.63	3.44	0.53	94.30
	B	19.08	0.75	0.63	3.44	0.53	94.30
	C	19.08	0.75	0.63	3.44	0.53	94.30
	D	19.08	0.75	0.63	3.44	0.53	94.30
	E-a	19.08	0.75	0.63	3.44	0.53	94.30
	E-b	19.08	0.75	0.63	3.44	0.53	94.30
Clay Block Top	1.00	10.53	2.23	2.02	0.36	1.55	79.70
	1.00	10.53	2.23	2.02	0.36	1.55	79.70
	3.00	10.53	2.23	2.02	0.36	1.55	79.70
	3.00	10.53	2.23	2.02	0.36	1.55	79.70
	5.00	10.53	2.23	2.02	0.36	1.55	79.70
	5.00	10.53	2.23	2.02	0.36	1.55	79.70
	7.00	10.53	2.23	2.02	0.36	1.55	79.70
	7.00	10.53	2.23	2.02	0.36	1.55	79.70
Clay Block Middle	1.00	10.53	2.23	2.02	0.36	1.55	79.70
	1.00	10.53	2.23	2.02	0.36	1.55	79.70
	3.00	10.53	2.23	2.02	0.36	1.55	79.70
	3.00	10.53	2.23	2.02	0.36	1.55	79.70
	5.00	10.53	2.23	2.02	0.36	1.55	79.70
	5.00	10.53	2.23	2.02	0.36	1.55	79.70
	7.00	10.53	2.23	2.02	0.36	1.55	79.70
	7.00	10.53	2.23	2.02	0.36	1.55	79.70
Clay Block Bottom	1.00	10.53	2.23	2.02	0.36	1.55	79.70
	1.00	10.53	2.23	2.02	0.36	1.55	79.70
	3.00	10.53	2.23	2.02	0.36	1.55	79.70
	3.00	10.53	2.23	2.02	0.36	1.55	79.70
	5.00	10.53	2.23	2.02	0.36	1.55	79.70
	5.00	10.53	2.23	2.02	0.36	1.55	79.70
	7.00	10.53	2.23	2.02	0.36	1.55	79.70
	7.00	10.53	2.23	2.02	0.36	1.55	79.70

Table A22. Friedland Clay (60% clay block by volume) – Cebogel Pellet at 3.5% Salinity for 9 months – End of Test

Sample	Location	Fluid Content	Bulk density	Dry density	Void Ratio	EMDD	Degree of Saturation, S
		(%)	(Mg/m^3)	(Mg/m^3)		(Mg/m^3)	(%)
Pellets	A	61.86	1.68	1.04	1.68	0.90	98.62
	B	61.68	1.69	1.05	1.66	0.91	99.42
	C	64.45	1.64	1.00	1.78	0.86	96.58
	D	62.72	1.66	1.02	1.72	0.89	97.39
	E-a	63.75	1.66	1.02	1.73	0.88	98.18
	E-b	59.85	1.70	1.06	1.62	0.92	99.19
Clay Block	1	30.36	2.01	1.54	0.79	1.01	103.03
Top	1	26.41	2.06	1.63	0.69	1.10	102.45
	3	30.05	1.99	1.53	0.80	1.01	100.67
	3	26.86	2.05	1.62	0.71	1.09	102.18
	5	31.04	1.98	1.51	0.82	0.99	101.09
	5	27.45	2.03	1.59	0.73	1.06	100.48
	7	28.76	2.01	1.56	0.77	1.03	100.38
	7	25.65	2.06	1.64	0.68	1.11	100.90
Clay Block	1	30.08	2.03	1.56	0.77	1.03	104.74
Middle	1	27.14	2.06	1.62	0.70	1.09	103.48
	3	32.47	2.01	1.52	0.82	0.99	106.15
	3	29.31	2.03	1.57	0.76	1.04	103.32
	5	30.88	1.98	1.51	0.82	0.99	100.40
	5	28.63	2.04	1.58	0.74	1.05	103.18
	7	31.26	1.99	1.52	0.82	0.99	101.99
	7	27.37	2.03	1.60	0.73	1.07	100.91
Clay Block	1	28.09	2.05	1.60	0.73	1.07	103.65
Bottom	1	25.85	2.07	1.65	0.67	1.12	103.13
	3	31.38	2.00	1.52	0.82	0.99	102.98
	3	29.44	2.02	1.56	0.77	1.03	102.12
	5	31.96	1.97	1.49	0.85	0.97	100.40
	5	28.97	2.00	1.55	0.78	1.02	99.98
	7	29.41	1.99	1.54	0.79	1.01	99.32
	7	27.68	2.04	1.59	0.73	1.07	101.75

Table A23. Asha Clay – Cebogel Pellet at 1.0% Salinity for 3 months – Installation

Sample	Location	W.C.$_{gravimetric}$	Bulk density	Dry density	Void Ratio	EMDD	Degree of Saturation, S
		(%)	(Mg/m^3)	(Mg/m^3)		(Mg/m^3)	(%)
Pellets	A1	18.92	1.07	0.90	2.09	0.77	93.60
	B	18.92	1.07	0.90	2.09	0.77	93.60
	C4	18.92	1.07	0.90	2.09	0.77	93.60
	D	18.92	1.07	0.90	2.09	0.77	93.60
	E-a	18.92	1.07	0.90	2.09	0.77	93.60
	E-b	18.92	1.07	0.90	2.09	0.77	93.60
Clay Block 1	1.00	16.49	1.93	1.66	0.67	1.52	67.93
TB	1.00	16.49	1.93	1.66	0.67	1.52	67.93
	3.00	16.49	1.93	1.66	0.67	1.52	67.93
	3.00	16.49	1.93	1.66	0.67	1.52	67.93
	5.00	16.49	1.93	1.66	0.67	1.52	67.93
	5.00	16.49	1.93	1.66	0.67	1.52	67.93
	7.00	16.49	1.93	1.66	0.67	1.52	67.93
	7.00	16.49	1.93	1.66	0.67	1.52	67.93
Clay Block 1	1.00	16.49	1.93	1.66	0.67	1.52	67.93
BB	1.00	16.49	1.93	1.66	0.67	1.52	67.93
	3.00	16.49	1.93	1.66	0.67	1.52	67.93
	3.00	16.49	1.93	1.66	0.67	1.52	67.93
	5.00	16.49	1.93	1.66	0.67	1.52	67.93
	5.00	16.49	1.93	1.66	0.67	1.52	67.93
	7.00	16.49	1.93	1.66	0.67	1.52	67.93
	7.00	16.49	1.93	1.66	0.67	1.52	67.93
Clay Block 2	1.00	16.49	1.93	1.66	0.67	1.52	67.93
TB	1.00	16.49	1.93	1.66	0.67	1.52	67.93
	3.00	16.49	1.93	1.66	0.67	1.52	67.93
	3.00	16.49	1.93	1.66	0.67	1.52	67.93
	5.00	16.49	1.93	1.66	0.67	1.52	67.93
	5.00	16.49	1.93	1.66	0.67	1.52	67.93
	7.00	16.49	1.93	1.66	0.67	1.52	67.93
	7.00	16.49	1.93	1.66	0.67	1.52	67.93
Clay Block 2	1.00	16.49	1.93	1.66	0.67	1.52	67.93
BB	1.00	16.49	1.93	1.66	0.67	1.52	67.93
	3.00	16.49	1.93	1.66	0.67	1.52	67.93
	3.00	16.49	1.93	1.66	0.67	1.52	67.93
	5.00	16.49	1.93	1.66	0.67	1.52	67.93
	5.00	16.49	1.93	1.66	0.67	1.52	67.93
	7.00	16.49	1.93	1.66	0.67	1.52	67.93
	7.00	16.49	1.93	1.66	0.67	1.52	67.93

Table A24. Asha Clay – Cebogel Pellet at 1.0% Salinity for 3 months – End of Test

Sample	Location	Fluid Content	Bulk density	Dry density	Void Ratio	EMDD	Degree of Saturation, S
		(%)	(Mg/m^3)	(Mg/m^3)		(Mg/m^3)	(%)
Pellets	A1	34.04	1.94	1.45	0.92	1.30	102.84
	B	34.04	1.91	1.42	0.95	1.28	99.49
	C4	31.52	1.95	1.48	0.87	1.34	100.32
	D	32.00	1.94	1.47	0.89	1.32	99.61
	E-a	34.67	1.93	1.44	0.94	1.29	103.05
	E-b	34.00	1.95	1.46	0.91	1.31	104.02
Clay Block 1	1	34.98	1.91	1.41	0.97	1.26	100.43
TB	1	34.56	1.93	1.43	0.94	1.29	102.21
	3	34.65	1.89	1.41	0.98	1.26	98.67
	3	35.07	1.91	1.41	0.97	1.27	101.02
	5	33.41	1.87	1.40	0.99	1.25	94.11
	5	33.50	1.91	1.43	0.95	1.28	98.28
	7	34.43	1.92	1.43	0.95	1.28	101.03
	7	35.20	1.92	1.42	0.95	1.28	102.73
Clay Block 1	1	31.13	1.96	1.49	0.86	1.34	100.12
BB	1	31.71	1.97	1.49	0.86	1.35	102.33
	3	31.64	1.96	1.49	0.87	1.34	101.39
	3	32.55	1.96	1.48	0.88	1.33	102.92
	5	31.75	1.97	1.50	0.85	1.35	103.28
	5	32.40	1.96	1.48	0.88	1.33	102.66
	7	31.78	1.98	1.51	0.85	1.36	104.43
	7	32.12	1.98	1.50	0.85	1.35	104.76
Clay Block 2	1	29.48	2.00	1.55	0.80	1.40	102.54
TB	1	29.89	1.97	1.51	0.84	1.37	99.43
	3	29.81	2.00	1.54	0.80	1.39	103.03
	3	30.44	1.97	1.51	0.84	1.36	100.43
	5	29.63	1.95	1.51	0.85	1.36	97.22
	5	30.78	1.98	1.52	0.83	1.37	102.86
	7	29.56	1.99	1.53	0.81	1.39	100.99
	7	29.53	2.01	1.55	0.79	1.40	103.44
Clay Block 2	1	29.30	1.98	1.53	0.81	1.39	100.24
BB	1	30.08	1.98	1.52	0.83	1.37	101.00
	3	29.31	1.99	1.54	0.81	1.39	100.91
	3	30.30	1.99	1.53	0.82	1.38	103.11
	5	29.26	2.00	1.55	0.79	1.40	102.48
	5	30.42	1.98	1.52	0.83	1.37	101.80
	7	29.22	2.01	1.55	0.79	1.41	102.99
	7	30.82	1.99	1.52	0.83	1.37	103.41

Table A25. Asha Clay – Cebogel Pellet at 1.0% Salinity for 9 months – Installation

Sample	Location	W.C.$_{gravimetric}$	Bulk density	Dry density	Void Ratio	EMDD	Degree of Saturation, S
		(%)	(Mg/m^3)	(Mg/m^3)		(Mg/m^3)	(%)
Pellets	A1	18.92	1.00	0.84	2.31	0.72	94.00
	B	18.92	1.00	0.84	2.31	0.72	94.00
	C4	18.92	1.00	0.84	2.31	0.72	94.00
	D	18.92	1.00	0.84	2.31	0.72	94.00
	E-a	18.92	1.00	0.84	2.31	0.72	94.00
	E-b	18.92	1.00	0.84	2.31	0.72	94.00
Clay Block 1	1	16.49	1.96	1.69	0.65	1.54	70.61
TB	1	16.49	1.96	1.69	0.65	1.54	70.61
	3	16.49	1.96	1.69	0.65	1.54	70.61
	3	16.49	1.96	1.69	0.65	1.54	70.61
	5	16.49	1.96	1.69	0.65	1.54	70.61
	5	16.49	1.96	1.69	0.65	1.54	70.61
	7	16.49	1.96	1.69	0.65	1.54	70.61
	7	16.49	1.96	1.69	0.65	1.54	70.61
Clay Block 1	1	16.49	1.96	1.69	0.65	1.54	70.61
BB	1	16.49	1.96	1.69	0.65	1.54	70.61
	3	16.49	1.96	1.69	0.65	1.54	70.61
	3	16.49	1.96	1.69	0.65	1.54	70.61
	5	16.49	1.96	1.69	0.65	1.54	70.61
	5	16.49	1.96	1.69	0.65	1.54	70.61
	7	16.49	1.96	1.69	0.65	1.54	70.61
	7	16.49	1.96	1.69	0.65	1.54	70.61
Clay Block 2	1	16.49	1.96	1.69	0.65	1.54	70.61
TB	1	16.49	1.96	1.69	0.65	1.54	70.61
	3	16.49	1.96	1.69	0.65	1.54	70.61
	3	16.49	1.96	1.69	0.65	1.54	70.61
	5	16.49	1.96	1.69	0.65	1.54	70.61
	5	16.49	1.96	1.69	0.65	1.54	70.61
	7	16.49	1.96	1.69	0.65	1.54	70.61
	7	16.49	1.96	1.69	0.65	1.54	70.61
Clay Block 2	1	16.49	1.96	1.69	0.65	1.54	70.61
BB	1	16.49	1.96	1.69	0.65	1.54	70.61
	3	16.49	1.96	1.69	0.65	1.54	70.61
	3	16.49	1.96	1.69	0.65	1.54	70.61
	5	16.49	1.96	1.69	0.65	1.54	70.61
	5	16.49	1.96	1.69	0.65	1.54	70.61
	7	16.49	1.96	1.69	0.65	1.54	70.61
	7	16.49	1.96	1.69	0.65	1.54	70.61

Table A26. Asha Clay – Cebogel Pellet at 1.0% Salinity for 9 months – End of Test

Sample	Location	Fluid Content	Bulk density	Dry density	Void Ratio	EMDD	Degree of Saturation, S
		(%)	(Mg/m^3)	(Mg/m^3)		(Mg/m^3)	(%)
Pellets	A1	26.76	1.99	1.57	0.77	1.42	96.52
	B	28.70	1.97	1.53	0.82	1.38	97.58
	C4	27.57	1.97	1.54	0.80	1.40	95.71
	D	29.40	1.95	1.51	0.84	1.36	96.84
	E-a	27.78	1.98	1.55	0.79	1.41	97.70
	E-b	28.45	1.96	1.53	0.82	1.38	96.39
Clay Block 1	1	32.08	1.95	1.47	0.88	1.33	100.79
TB	1	32.74	1.96	1.47	0.89	1.33	102.56
	3	32.98	1.96	1.47	0.89	1.33	103.24
	3	33.14	1.95	1.46	0.90	1.32	102.31
	5	33.01	1.96	1.47	0.89	1.32	103.12
	5	32.89	1.95	1.47	0.89	1.32	102.76
	7	33.24	1.95	1.47	0.89	1.32	103.28
	7	33.38	1.96	1.47	0.90	1.32	103.63
Clay Block 1	1	30.31	1.99	1.53	0.82	1.38	102.96
BB	1	32.01	1.99	1.51	0.85	1.36	105.30
	3	30.17	1.99	1.53	0.82	1.38	102.05
	3	31.03	1.99	1.52	0.83	1.37	103.91
	5	29.88	1.99	1.54	0.81	1.39	102.48
	5	31.41	1.99	1.51	0.84	1.37	104.26
	7	28.75	1.99	1.54	0.80	1.40	99.77
	7	30.51	1.99	1.53	0.82	1.38	103.17
Clay Block 2	1	30.48	2.02	1.55	0.80	1.40	106.02
TB	1	30.75	2.02	1.54	0.80	1.40	106.52
	3	29.91	1.99	1.53	0.81	1.39	102.09
	3	30.71	2.00	1.53	0.82	1.38	104.49
	5	30.50	2.00	1.53	0.82	1.38	103.74
	5	30.44	2.01	1.54	0.81	1.39	104.68
	7	28.91	2.01	1.56	0.78	1.42	102.97
	7	29.86	2.01	1.55	0.79	1.40	104.56
Clay Block 2	1	30.56	1.99	1.53	0.82	1.38	103.47
BB	1	31.12	1.99	1.51	0.84	1.37	103.47
	3	30.43	1.99	1.53	0.82	1.38	103.12
	3	31.22	1.99	1.52	0.83	1.37	104.31
	5	30.00	2.01	1.54	0.80	1.40	104.08
	5	31.16	1.99	1.52	0.83	1.37	104.31
	7	30.37	1.97	1.51	0.84	1.37	100.96
	7	31.23	1.99	1.51	0.84	1.37	103.87

Table A27. Asha Clay – Cebogel Pellet at 1.0% Salinity for 27 months – Installation

Sample	Location	W.C.$_{gravimetric}$ (%)	Bulk density (Mg/m^3)	Dry density (Mg/m^3)	Void Ratio	EMDD (Mg/m^3)	Degree of Saturation, S (%)
Pellets	A1	18.92	1.16	0.97	1.86	0.84	92.40
	B	18.92	1.16	0.97	1.86	0.84	92.40
	C4	18.92	1.16	0.97	1.86	0.84	92.40
	D	18.92	1.16	0.97	1.86	0.84	92.40
	E-a	18.92	1.16	0.97	1.86	0.84	92.40
	E-b	18.92	1.16	0.97	1.86	0.84	92.40
Clay Block 1	1	16.49	1.93	1.65	0.68	1.51	67.30
TB	1	16.49	1.93	1.65	0.68	1.51	67.30
	3	16.49	1.93	1.65	0.68	1.51	67.30
	3	16.49	1.93	1.65	0.68	1.51	67.30
	5	16.49	1.93	1.65	0.68	1.51	67.30
	5	16.49	1.93	1.65	0.68	1.51	67.30
	7	16.49	1.93	1.65	0.68	1.51	67.30
	7	16.49	1.93	1.65	0.68	1.51	67.30
Clay Block 1	1	16.49	1.93	1.65	0.68	1.51	67.30
BB	1	16.49	1.93	1.65	0.68	1.51	67.30
	3	16.49	1.93	1.65	0.68	1.51	67.30
	3	16.49	1.93	1.65	0.68	1.51	67.30
	5	16.49	1.93	1.65	0.68	1.51	67.30
	5	16.49	1.93	1.65	0.68	1.51	67.30
	7	16.49	1.93	1.65	0.68	1.51	67.30
	7	16.49	1.93	1.65	0.68	1.51	67.30
Clay Block 2	1	16.49	1.93	1.65	0.68	1.51	67.30
TB	1	16.49	1.93	1.65	0.68	1.51	67.30
	3	16.49	1.93	1.65	0.68	1.51	67.30
	3	16.49	1.93	1.65	0.68	1.51	67.30
	5	16.49	1.93	1.65	0.68	1.51	67.30
	5	16.49	1.93	1.65	0.68	1.51	67.30
	7	16.49	1.93	1.65	0.68	1.51	67.30
	7	16.49	1.93	1.65	0.68	1.51	67.30
Clay Block 2	1	16.49	1.93	1.65	0.68	1.51	67.30
BB	1	16.49	1.93	1.65	0.68	1.51	67.30
	3	16.49	1.93	1.65	0.68	1.51	67.30
	3	16.49	1.93	1.65	0.68	1.51	67.30
	5	16.49	1.93	1.65	0.68	1.51	67.30
	5	16.49	1.93	1.65	0.68	1.51	67.30
	7	16.49	1.93	1.65	0.68	1.51	67.30
	7	16.49	1.93	1.65	0.68	1.51	67.30

Table A28. Asha Clay – Cebogel Pellet at 1.0% Salinity for 27 months – End of Test

Sample	Location	Fluid Content	Bulk density	Dry density	Void Ratio	EMDD	Degree of Saturation, S
		(%)	(Mg/m^3)	(Mg/m^3)		(Mg/m^3)	(%)
Pellets	A1	32.53	1.93	1.46	0.90	1.31	99.93
	B	32.38	1.94	1.46	0.90	1.32	99.92
	C4	32.01	1.94	1.47	0.89	1.33	100.20
	D	32.38	1.93	1.46	0.90	1.31	99.77
	E-a	32.09	1.94	1.47	0.89	1.32	100.10
	E-b	32.28	1.95	1.47	0.89	1.33	101.13
Clay Block 1	1	34.37	1.95	1.45	0.92	1.30	103.92
TB	1	35.29	1.94	1.43	0.94	1.28	104.31
	3	35.04	1.95	1.44	0.93	1.29	105.01
	3	34.45	1.95	1.45	0.92	1.30	104.02
	5	34.96	1.94	1.44	0.93	1.29	104.21
	5	35.15	1.94	1.43	0.94	1.29	104.21
	7	34.24	1.95	1.46	0.91	1.31	104.60
	7	34.85	1.94	1.44	0.93	1.29	104.41
Clay Block 1	1	33.41	1.97	1.47	0.89	1.33	104.93
BB	1	33.87	1.97	1.47	0.89	1.33	105.99
	3	32.87	1.95	1.47	0.89	1.32	102.66
	3	33.59	1.97	1.48	0.88	1.33	105.87
	5	32.72	1.97	1.48	0.87	1.34	103.98
	5	33.31	1.98	1.48	0.87	1.34	105.95
	7	33.27	1.97	1.48	0.88	1.33	105.26
	7	33.70	1.97	1.48	0.88	1.33	106.02
Clay Block 2	1	32.47	2.02	1.52	0.83	1.38	109.13
TB	1	32.34	1.99	1.50	0.85	1.36	105.85
	3	32.23	1.99	1.51	0.85	1.36	105.96
	3	31.54	2.00	1.52	0.83	1.38	106.12
	5	31.17	2.00	1.52	0.82	1.38	105.04
	5	30.81	2.00	1.53	0.82	1.38	104.40
	7	32.11	1.99	1.51	0.84	1.36	105.92
	7	31.61	2.00	1.52	0.83	1.37	106.05
Clay Block 2	1	31.79	1.99	1.51	0.84	1.37	105.47
BB	1	33.09	1.98	1.49	0.86	1.34	106.46
	3	31.99	1.99	1.51	0.84	1.36	105.40
	3	32.75	1.99	1.50	0.86	1.35	106.13
	5	32.47	1.99	1.50	0.85	1.35	105.68
	5	32.60	1.99	1.50	0.85	1.36	106.66
	7	33.64	1.98	1.48	0.88	1.33	106.24
	7	34.25	1.98	1.48	0.88	1.33	108.06

Table A29. Asha Clay – Cebogel Pellet at 3.5% Salinity for 3 months – Installation

Sample	Location	W.C.$_{gravimetric}$ (%)	Bulk density (Mg/m^3)	Dry density (Mg/m^3)	Void Ratio	EMDD (Mg/m^3)	Degree of Saturation, S (%)
Pellets	A1	18.92	1.31	1.10	1.52	0.96	93.60
	B	18.92	1.31	1.10	1.52	0.96	93.60
	C4	18.92	1.31	1.10	1.52	0.96	93.60
	D	18.92	1.31	1.10	1.52	0.96	93.60
	E-a	18.92	1.31	1.10	1.52	0.96	93.60
	E-b	18.92	1.31	1.10	1.52	0.96	93.60
Clay Block 1	1	16.49	1.94	1.66	0.67	1.52	68.20
TB	1	16.49	1.94	1.66	0.67	1.52	68.20
	3	16.49	1.94	1.66	0.67	1.52	68.20
	3	16.49	1.94	1.66	0.67	1.52	68.20
	5	16.49	1.94	1.66	0.67	1.52	68.20
	5	16.49	1.94	1.66	0.67	1.52	68.20
	7	16.49	1.94	1.66	0.67	1.52	68.20
	7	16.49	1.94	1.66	0.67	1.52	68.20
Clay Block 1	1	16.49	1.94	1.66	0.67	1.52	68.20
BB	1	16.49	1.94	1.66	0.67	1.52	68.20
	3	16.49	1.94	1.66	0.67	1.52	68.20
	3	16.49	1.94	1.66	0.67	1.52	68.20
	5	16.49	1.94	1.66	0.67	1.52	68.20
	5	16.49	1.94	1.66	0.67	1.52	68.20
	7	16.49	1.94	1.66	0.67	1.52	68.20
	7	16.49	1.94	1.66	0.67	1.52	68.20
Clay Block 2	1	16.49	1.94	1.66	0.67	1.52	68.20
TB	1	16.49	1.94	1.66	0.67	1.52	68.20
	3	16.49	1.94	1.66	0.67	1.52	68.20
	3	16.49	1.94	1.66	0.67	1.52	68.20
	5	16.49	1.94	1.66	0.67	1.52	68.20
	5	16.49	1.94	1.66	0.67	1.52	68.20
	7	16.49	1.94	1.66	0.67	1.52	68.20
	7	16.49	1.94	1.66	0.67	1.52	68.20
Clay Block 2	1	16.49	1.94	1.66	0.67	1.52	68.20
BB	1	16.49	1.94	1.66	0.67	1.52	68.20
	3	16.49	1.94	1.66	0.67	1.52	68.20
	3	16.49	1.94	1.66	0.67	1.52	68.20
	5	16.49	1.94	1.66	0.67	1.52	68.20
	5	16.49	1.94	1.66	0.67	1.52	68.20
	7	16.49	1.94	1.66	0.67	1.52	68.20
	7	16.49	1.94	1.66	0.67	1.52	68.20

Table A30. Asha Clay – Cebogel Pellet at 3.5% Salinity for 3 months – End of Test

Sample	Location	Fluid Content	Bulk density	Dry density	Void Ratio	EMDD	Degree of Saturation, S
		(%)	(Mg/m^3)	(Mg/m^3)		(Mg/m^3)	(%)
Pellets	A1	29.22	1.95	1.51	0.84	1.36	96.75
	B	31.10	1.94	1.48	0.88	1.33	98.39
	C4	28.36	2.00	1.56	0.78	1.41	100.43
	D	28.12	1.96	1.53	0.82	1.38	95.34
	E-a	31.77	1.99	1.51	0.84	1.36	104.81
	E-b	29.85	1.99	1.54	0.81	1.39	102.49
Clay Block 1	1	30.47	1.92	1.47	0.89	1.32	95.22
TB	1	31.63	1.92	1.45	0.91	1.31	96.56
	3	32.06	1.90	1.44	0.93	1.29	95.88
	3	33.18	1.93	1.45	0.92	1.30	100.33
	5	29.22	1.95	1.51	0.84	1.36	96.80
	5	32.18	1.91	1.45	0.92	1.30	97.13
	7	33.23	1.92	1.44	0.93	1.29	99.34
	7	33.47	1.92	1.44	0.94	1.29	99.40
Clay Block 1	1	29.89	1.98	1.52	0.83	1.37	100.36
BB	1	31.40	1.98	1.50	0.85	1.36	102.96
	3	29.98	1.98	1.53	0.82	1.38	101.29
	3	31.02	1.96	1.50	0.85	1.35	100.99
	5	30.22	1.95	1.50	0.86	1.35	98.12
	5	31.57	1.96	1.49	0.87	1.34	101.35
	7	30.71	1.98	1.51	0.84	1.37	102.24
	7	31.23	1.98	1.51	0.84	1.36	103.00
Clay Block 2	1	29.73	1.99	1.54	0.81	1.39	102.08
TB	1	29.53	1.98	1.53	0.82	1.39	100.71
	3	30.16	1.97	1.52	0.83	1.37	100.74
	3	30.25	1.97	1.51	0.84	1.36	100.04
	5	30.44	1.98	1.51	0.84	1.37	101.32
	5	30.88	1.98	1.51	0.84	1.36	101.98
	7	30.56	1.97	1.51	0.84	1.36	100.79
	7	30.83	1.99	1.52	0.82	1.38	104.04
Clay Block 2	1	29.15	2.01	1.56	0.79	1.41	103.06
BB	1	29.61	1.99	1.54	0.81	1.39	101.58
	3	29.61	1.99	1.54	0.81	1.39	101.99
	3	30.32	1.99	1.53	0.82	1.38	102.92
	5	29.86	2.00	1.54	0.80	1.40	103.32
	5	30.58	2.00	1.54	0.81	1.39	104.83
	7	29.78	2.01	1.55	0.80	1.40	103.62
	7	30.55	2.00	1.53	0.82	1.38	103.82

Table A31. Asha Clay – Cebogel Pellet at 3.5% Salinity for 9 months – Installation

Sample	Location	W.C.$_{gravimetric}$	Bulk density	Dry density	Void Ratio	EMDD	Degree of Saturation, S
		(%)	(Mg/m^3)	(Mg/m^3)		(Mg/m^3)	(%)
Pellets	A1	18.92	1.20	1.01	1.76	0.87	94.00
	B	18.92	1.20	1.01	1.76	0.87	94.00
	C4	18.92	1.20	1.01	1.76	0.87	94.00
	D	18.92	1.20	1.01	1.76	0.87	94.00
	E-a	18.92	1.20	1.01	1.76	0.87	94.00
	E-b	18.92	1.20	1.01	1.76	0.87	94.00
Clay Block 1	1	16.49	1.93	1.66	0.68	1.51	67.49
TT	1	16.49	1.93	1.66	0.68	1.51	67.49
	3	16.49	1.93	1.66	0.68	1.51	67.49
	3	16.49	1.93	1.66	0.68	1.51	67.49
	5	16.49	1.93	1.66	0.68	1.51	67.49
	5	16.49	1.93	1.66	0.68	1.51	67.49
	7	16.49	1.93	1.66	0.68	1.51	67.49
	7	16.49	1.93	1.66	0.68	1.51	67.49
Clay Block 1	1	16.49	1.93	1.66	0.68	1.51	67.49
TB	1	16.49	1.93	1.66	0.68	1.51	67.49
	3	16.49	1.93	1.66	0.68	1.51	67.49
	3	16.49	1.93	1.66	0.68	1.51	67.49
	5	16.49	1.93	1.66	0.68	1.51	67.49
	5	16.49	1.93	1.66	0.68	1.51	67.49
	7	16.49	1.93	1.66	0.68	1.51	67.49
	7	16.49	1.93	1.66	0.68	1.51	67.49
Clay Block 2	1	16.49	1.93	1.66	0.68	1.51	67.49
BT	1	16.49	1.93	1.66	0.68	1.51	67.49
	3	16.49	1.93	1.66	0.68	1.51	67.49
	3	16.49	1.93	1.66	0.68	1.51	67.49
	5	16.49	1.93	1.66	0.68	1.51	67.49
	5	16.49	1.93	1.66	0.68	1.51	67.49
	7	16.49	1.93	1.66	0.68	1.51	67.49
	7	16.49	1.93	1.66	0.68	1.51	67.49
Clay Block 2	1	16.49	1.93	1.66	0.68	1.51	67.49
BB	1	16.49	1.93	1.66	0.68	1.51	67.49
	3	16.49	1.93	1.66	0.68	1.51	67.49
	3	16.49	1.93	1.66	0.68	1.51	67.49
	5	16.49	1.93	1.66	0.68	1.51	67.49
	5	16.49	1.93	1.66	0.68	1.51	67.49
	7	16.49	1.93	1.66	0.68	1.51	67.49
	7	16.49	1.93	1.66	0.68	1.51	67.49

Table A32. Asha Clay – Cebogel Pellet at 3.5% Salinity for 9 months – End of Test

Sample	Location	Fluid Content	Bulk density	Dry density	Void Ratio	EMDD	Degree of Saturation, S
		(%)	(Mg/m^3)	(Mg/m^3)		(Mg/m^3)	(%)
Pellets	A1	32.53	1.93	1.46	0.91	1.31	99.38
	B	31.81	1.93	1.46	0.90	1.31	98.12
	C4	31.08	1.93	1.47	0.89	1.33	97.52
	D	31.70	1.94	1.48	0.88	1.33	99.84
	E-a	30.29	1.90	1.46	0.90	1.31	93.13
	E-b	30.05	1.89	1.45	0.91	1.31	91.67
Clay Block 1	1	31.16	1.95	1.49	0.87	1.34	99.98
TB	1	32.54	1.96	1.48	0.88	1.33	102.79
	3	31.20	1.97	1.50	0.85	1.35	101.46
	3	31.91	1.90	1.44	0.93	1.29	95.00
	5	31.66	1.97	1.50	0.86	1.35	102.69
	5	32.40	1.97	1.48	0.87	1.34	103.28
	7	33.34	1.95	1.46	0.90	1.32	103.13
	7	33.10	1.97	1.48	0.88	1.33	104.55
Clay Block 1	1	29.13	2.01	1.56	0.79	1.41	102.97
BB	1	30.76	2.00	1.53	0.82	1.38	104.18
	3	29.77	2.00	1.54	0.81	1.39	102.79
	3	30.70	2.00	1.53	0.82	1.38	104.02
	5	28.84	2.01	1.56	0.78	1.41	102.48
	5	30.58	2.00	1.53	0.82	1.38	104.20
	7	29.77	2.00	1.54	0.80	1.40	103.31
	7	30.70	2.00	1.53	0.81	1.39	104.85
Clay Block 2	1	29.15	2.01	1.56	0.79	1.41	103.02
TB	1	30.00	2.02	1.55	0.79	1.41	105.37
	3	29.64	2.02	1.56	0.78	1.41	105.17
	3	29.67	2.02	1.56	0.78	1.42	105.56
	5	29.62	2.02	1.56	0.79	1.41	104.80
	5	29.05	2.03	1.57	0.77	1.42	104.69
	7	29.85	2.02	1.56	0.78	1.41	105.87
	7	29.60	2.02	1.56	0.78	1.41	105.24
Clay Block 2	1	28.61	2.03	1.58	0.76	1.43	104.66
BB	1	29.68	2.02	1.56	0.78	1.41	105.29
	3	28.45	2.03	1.58	0.76	1.44	104.36
	3	29.98	2.02	1.55	0.79	1.41	105.28
	5	28.36	2.02	1.58	0.76	1.43	103.38
	5	29.03	2.01	1.56	0.78	1.41	103.12
	7	28.99	2.04	1.58	0.76	1.44	106.42
	7	29.28	2.01	1.56	0.79	1.41	103.42

Table A33. Asha Clay – Cebogel Pellet at 3.5% Salinity for 27 months – Installation

Sample	Location	$W.C._{gravimetric}$	Bulk density	Dry density	Void Ratio	EMDD	Degree of Saturation, S
		(%)	(Mg/m^3)	(Mg/m^3)		(Mg/m^3)	(%)
Pellets	A1	18.92	1.00	0.84	2.32	0.72	92.40
	B	18.92	1.00	0.84	2.32	0.72	92.40
	C4	18.92	1.00	0.84	2.32	0.72	92.40
	D	18.92	1.00	0.84	2.32	0.72	92.40
	E-a	18.92	1.00	0.84	2.32	0.72	92.40
	E-b	18.92	1.00	0.84	2.32	0.72	92.40
Clay Block 1	1	16.49	1.93	1.66	0.68	1.52	67.69
TB	1	16.49	1.93	1.66	0.68	1.52	67.69
	3	16.49	1.93	1.66	0.68	1.52	67.69
	3	16.49	1.93	1.66	0.68	1.52	67.69
	5	16.49	1.93	1.66	0.68	1.52	67.69
	5	16.49	1.93	1.66	0.68	1.52	67.69
	7	16.49	1.93	1.66	0.68	1.52	67.69
	7	16.49	1.93	1.66	0.68	1.52	67.69
Clay Block 1	1	16.49	1.93	1.66	0.68	1.52	67.69
BB	1	16.49	1.93	1.66	0.68	1.52	67.69
	3	16.49	1.93	1.66	0.68	1.52	67.69
	3	16.49	1.93	1.66	0.68	1.52	67.69
	5	16.49	1.93	1.66	0.68	1.52	67.69
	5	16.49	1.93	1.66	0.68	1.52	67.69
	7	16.49	1.93	1.66	0.68	1.52	67.69
	7	16.49	1.93	1.66	0.68	1.52	67.69
Clay Block 2	1	16.49	1.93	1.66	0.68	1.52	67.69
TB	1	16.49	1.93	1.66	0.68	1.52	67.69
	3	16.49	1.93	1.66	0.68	1.52	67.69
	3	16.49	1.93	1.66	0.68	1.52	67.69
	5	16.49	1.93	1.66	0.68	1.52	67.69
	5	16.49	1.93	1.66	0.68	1.52	67.69
	7	16.49	1.93	1.66	0.68	1.52	67.69
	7	16.49	1.93	1.66	0.68	1.52	67.69
Clay Block 2	1	16.49	1.93	1.66	0.68	1.52	67.69
BB	1	16.49	1.93	1.66	0.68	1.52	67.69
	3	16.49	1.93	1.66	0.68	1.52	67.69
	3	16.49	1.93	1.66	0.68	1.52	67.69
	5	16.49	1.93	1.66	0.68	1.52	67.69
	5	16.49	1.93	1.66	0.68	1.52	67.69
	7	16.49	1.93	1.66	0.68	1.52	67.69
	7	16.49	1.93	1.66	0.68	1.52	67.69

Table A34. Asha Clay – Cebogel Pellet at 3.5% Salinity for 27 months – End of Test

Sample	Location	Fluid Content	Bulk density	Dry density	Void Ratio	EMDD	Degree of Saturation, S
		(%)	(Mg/m^3)	(Mg/m^3)		(Mg/m^3)	(%)
Pellets	A1	35.17	1.93	1.43	0.95	1.28	103.13
	B	35.42	1.93	1.43	0.95	1.28	104.03
	C4	34.76	1.95	1.45	0.92	1.30	104.85
	D	35.72	1.94	1.43	0.95	1.28	104.69
	E-a	34.63	1.92	1.43	0.95	1.28	101.87
	E-b	34.31	1.95	1.46	0.91	1.31	104.81
Clay Block 1	1	36.73	1.93	1.41	0.97	1.26	105.03
TB	1	36.34	1.95	1.43	0.94	1.28	107.23
	3	36.64	1.94	1.42	0.96	1.27	105.77
	3	35.50	1.97	1.45	0.91	1.31	107.99
	5	36.24	1.95	1.43	0.94	1.29	107.37
	5	35.81	1.97	1.45	0.92	1.30	108.49
	7	36.03	1.96	1.44	0.93	1.29	108.04
	7	35.70	1.99	1.46	0.90	1.32	110.33
Clay Block 1	1	34.83	1.97	1.46	0.91	1.31	106.83
BB	1	35.32	1.98	1.46	0.90	1.31	108.87
	3	34.88	1.97	1.46	0.91	1.31	107.11
	3	34.80	1.98	1.47	0.90	1.32	107.94
	5	35.01	1.98	1.47	0.89	1.32	108.97
	5	34.89	1.99	1.47	0.89	1.33	109.21
	7	34.71	1.99	1.48	0.88	1.33	109.26
	7	34.80	1.99	1.47	0.89	1.33	108.97
Clay Block 2	1	34.13	1.99	1.48	0.88	1.33	108.23
TB	1	33.84	1.99	1.49	0.87	1.34	107.92
	3	34.12	1.99	1.48	0.88	1.33	108.02
	3	33.79	2.00	1.50	0.86	1.35	109.37
	5	33.79	1.99	1.49	0.87	1.34	108.14
	5	33.45	1.99	1.49	0.86	1.35	107.93
	7	34.00	1.95	1.46	0.91	1.31	104.24
	7	33.94	1.99	1.49	0.87	1.34	108.44
Clay Block 2	1	33.88	1.98	1.48	0.88	1.33	107.09
BB	1	34.65	1.98	1.47	0.89	1.32	107.77
	3	33.27	1.96	1.47	0.89	1.33	104.38
	3	33.82	1.99	1.49	0.87	1.34	108.36
	5	32.83	1.98	1.49	0.87	1.34	105.21
	5	33.13	1.99	1.49	0.86	1.35	107.03
	7	33.55	1.99	1.49	0.87	1.34	107.60
	7	33.62	1.99	1.49	0.87	1.34	107.32