University of Southern Queensland
Faculty of Engineering and Surveying

Quantifying the Reduction in Hydraulic Conductivity of Disturbed Soil Columns as a Function of the Salinity and Sodicity of Applied Water

A dissertation submitted by

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Abstract

In recent years there has been increased concern within Australia’s agricultural industry regarding water availability and quality for irrigation. Prolonged droughts and dwindling water storages have put the nation’s water resources under increased pressure. As a result, Australia’s coal seam gas industry has been investigating the utility of coal seam gas (CSG) by-product water for irrigation. However, CSG by-product water comprises of high sodicity and salinity concentrations which are potentially harmful to crops and soil structure if used for irrigation.

The aim of this project was to investigate the physical and chemical characteristics involved with the determination of the electrolyte thresholds in soils, and their interrelationships, with regard to the effects of sodium. This project also investigated these characteristics and their significance to Australia’s Coal Seam Gas mining industry, with the ultimate aim of determining the utility of CSG by-product water for irrigation.

The methodology for determining the threshold electrolyte concentration (TEC) in soils was found to be appropriate for identifying differences between soils. In the present study, soils subjected to water with high sodium concentrations were generally found to have a substantial reduction in hydraulic conductivity compared to soils leached with calcium-dominated water. However, the hydraulic conductivities for two soils with low clay content were not affected by the application of saline-sodic water.

A substantial variation in the TEC was found between soils and there was no clear relationship between the TEC and the soil chemical or physical properties of the soils. This suggests that there is a need to individually measure the TEC for each soil and that it may not be possible to identify surrogate indicators of structural stability to saline-sodic water application. While the TEC measurement methodology appeared appropriate for the soils evaluated in this study, further research is required to validate the utility of this methodology for use across a broader range of soils.

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ENG4111 Research Project Part 1 & ENG4112 Research Project Part 2

Certification

I certify that the ideas, designs and experimental work, results, analyses and conclusions set out in this dissertation are entirely my own effort, except where otherwise indicated and acknowledged.

I further certify that the work is original and has not been previously submitted for assessment in any other course or institution, except where specifically stated.

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______________________________________Signature

______________________________________Date

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1. Introduction

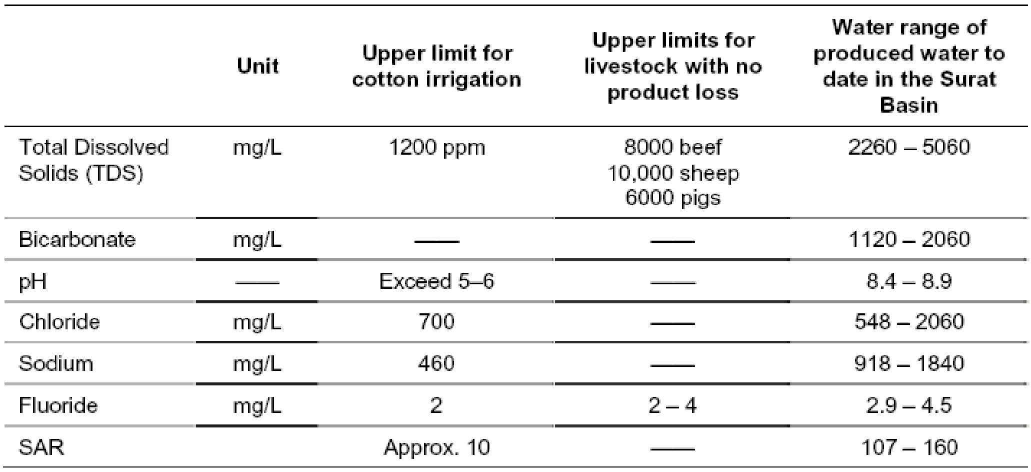
The aim of this project was to investigate the physical and chemical characteristics involved with the determination of the electrolyte threshold in soils and their interrelationships, with particular interest in effects of sodium. This project also investigates these characteristics and their significance to the Australia's Coal Seam Gas mining industry and irrigation.

In recent years there has been increased concern within Australia's agricultural industry regarding water availability and quality for irrigation. Prolonged droughts and dwindling water storages have put the nation's water resources under increased pressure. Australia's coal seam gas industry has been investigating the use of coal seam gas (CSG) by-product water for irrigation. However, CSG by-product water has high sodicity and salinity concentrations which are potentially harmful to crops and soil structure if used for irrigation.

Coal Seam Gas also commonly known as Coal Bed Methane is a naturally occurring methane (CH_4) gas is created through geological processes during the formation of coal. Usually the methane is mixed with carbon dioxide, other hydrocarbons and nitrogen. The methane that is produced during coalification is later extracted for industrial and commercial use. Water is produced as a by-product to coal seam gas production but its reuse is limited by the water quality and cost of treatment. Often this water is poor quality and must be contained in storage ponds.

Extraction of coal seam gas has and continues to generate global controversy. Phenomenal volumes of water are pumped from coal seams to release entrapped methane within the saturated coal seam. The water quality and volume discarded from each seam varies regionally, however, it can be expected to extract 20 to 80L per minute of water. Generally the water quality is satisfactory for domestic purposes and livestock watering, however high sodium levels threaten soil stability when utilized for irrigation. Adversely, the application of coal seam gas water could change the physical and chemical properties within the soil profile, inducing prolonged degradation of soil.

Controversy has surrounded the disposal/beneficial use of coal seam gas product water, a potentially viable irrigation source. The quality of CSG is highly variable and can only be quantified after exploration and appraisal testing. However, total dissolved salts from water extracted in the Surat Basin are typically 2260-5060 mg/L, whereas the upper limit for cotton salt tolerance is 1200 ppm as illustrated by Figure 1. The apparent salinity of CSG water limits its potential uses.



	Unit	Upper limit for cotton irrigation	Upper limits for livestock with no product loss	Water range of produced water to date in the Surat Basin
Total Dissolved Solids (TDS)	mg/L	1200 ppm	8000 beef 10,000 sheep 6000 pigs	2260 – 5060
Bicarbonate	mg/L	——	——	1120 – 2060
pH	——	Exceed 5–6	——	8.4 – 8.9
Chloride	mg/L	700	——	548 – 2060
Sodium	mg/L	460	——	918 – 1840
Fluoride	mg/L	2	2 – 4	2.9 – 4.5
SAR		Approx. 10	——	107 – 160

Figure 1 Comparison of produced water with Guideline values for irrigation and stock watering

The Queensland Government is moving towards implementing legislation that forces mining companies to discontinue use of evaporation ponds. The development of the CSG water policy was initiated when in 2007, 12.5 GL of by-product water was produced in Queensland (Department of Infrastructure and Planning 2009). Due to industry expansion it has been projected to reach 200-500 GL of by-product water per year. The managing director of Queensland Gas Company has disclosed to the media that the company has the capacity to produce up to 17 ML of water every day in the Surat basin.

This new legislation has forced mining industries to investigate alternate ways of using disposed CSG water. The most viable option is treating the water for irrigation.

However, the soil tolerance to sodium is governed by the soil chemistry and physical structural properties and is typically characterized by a reduction in the soil hydraulic conductivity. The structural degradation is a function of both the salinity (i.e. electrolyte concentration) and sodicity of the applied water.

The reuse of CSG water requires complete understanding of the physical and chemicals of the soils before irrigation. However, there is currently no standardized method for the routine determination of electrolyte thresholds to minimize structural degradation in soils. Hence, this project developed a strategy for the routine measurement of threshold electrolyte concentrations (TEC) and evaluated the differences in TEC across a range of soils.

Correct management of this mining by-product could potentially supplement farmers with an alternative resource base for water. Where available water from dams, creeks, rivers, and underground aquifers are scarce, extraction of water saturating coal seams may be utilized as an irrigable source of water. This would revolutionize irrigation management practices in Australia.

For the application of coal seam gas water further research is required to determine universal standards and regulations for appropriate treatment methods and mixing rates with coal seam gas water and irrigation water.

2. Literature Review

Salt affected soils occur both naturally and as a results of interference by man. This interference by manipulating hydraulic process induces the accumulation of salts within the soil profile. There are significantly large areas in Australia that are salt affected by natural causes. However, there is an increasing landmass area that is becoming influenced by man’s activities. There are two broad classifications of salinity. The first is saline soils which contain high levels of any salt, and the second is sodic soils which contain high proportions of sodium ions relative to other cations in the soil. This project primarily investigates the effects of sodium on the hydraulic conductivity.

Sodic soils can be susceptible to clay dispersion especially when they have high levels of exchangeable sodium and low levels of total soluble salts. As a results sodic soils can seal, crust and have induced low permeability. Moreover, the dispersion of sodic soils increases their susceptibility to erosion. Hence, it is imperative that professionals working with irrigation of CSG water have familiarity of the chemical and physical process involved with the degradation of sodic soils.

The objectives to this project are outlined below:

1. Evaluate the reduction in Ksat for nine soils across a range of EC/SAR water combinations

- Prepare soils by crushing and sieving the samples to the recommended standard size.
- Conduct short column saturated hydraulic conductivity tests on soils by preparing water solutions at varying concentrations of sodium and calcium and treat each soil column (five columns per soil). Each soil column has a Pre-Treatment (stable concentration) and Treatment water applied to it.
- Analyse data determining the relative hydraulic conductivity of each soil.

2. Evaluate the factors influencing the reduction in Ksat within the soil columns

- Perform a particle size analysis on the selected soils to identify relationships with the saturated hydraulic conductivity

- Conduct long column saturated hydraulic conductivity tests on selected soils using selected water quality treatments;
- Analyse data and model the results for each soil. Compare results to short column tests identifying any discrepancies;
- If appropriate, evaluate the soil chemistry at different locations in the columns.

2.1 Salinity and Sodicity

Saline soils are simply soils containing a large amount of soluble salts. These salts are predominantly sodium, calcium and magnesium coupled with chloride, sulfate or bicarbonate. Concentrations of these salts are expressed as electric conductivity (EC) of the soil's saturation paste or saturation extract (Singer & Munns 2006). Electrical conductivity is the measure of a material's ability to conduct electricity by way of ion movement. Water being a poor conductor, EC measurement is an accepted measure and criterion for soil salinity.

Sodic soils contain Na as a significant proportion of their total exchangeable cations (Singer & Munns 2006). Generally saline soils are sodic soils because sodium is more abundant than others but not always. Useful indications of sodicity are exchangeable sodium percentage (ESP) and sodium absorption ratio (SAR). The ESP is the percentage of sodium expressed as a percentage of total exchangeable cations (Singer & Munns 2006).

$$\mathrm{ESP} = \frac{\mathrm{Na\ exch}}{(\mathrm{Ca} + \mathrm{Mg})\ \mathrm{exch}}$$

where Na, Ca, and Mg represent concentrations in milliequivalents per litre of the respective ions (Davis & Dewiest 1996).

The sodium absorption ratio estimates the ion replacement by the following formula:

$$\mathrm{SAR} = \frac{\mathrm{Na}}{\sqrt{\frac{\mathrm{Ca} + \mathrm{Mg}}{2}}}$$

where Na, Ca, and Mg refers to concentration in $\mathrm{mmol_c}$ $\mathrm{L_{-1}}$. (Davis & Dewiest 1996).

Sodic and saline soils are generally alkaline and exhibit a pH ranging from 8.3-8.5, at which the $CaCO_3$ precipitates at atmospheric CO_2 pressures (Singer and Munns 1996). The alkalinity and salt concentrations increase as water bodies transporting the salts evaporate. Moreover, irrigating of saline water increases salt accumulation in the soil profile due to evaporation and limited drainage.

It has been stated that salinity is the acute accumulation of salts within the soil profile. Singer and Munns (1996) define sodicity as a soil harbouring high levels of sodium, hence possessing a high exchangeable sodium percentage or high sodium absorption ratio. Sodium within soil profiles readily reduces structure inducing impermeability. Singer and Munns (1996) suggest critical values for ESP vary from 5 percent to 15 percent, depending on soil salinity. Table 1 illustrates the general classification of salt-affected soils.

Table 1 Classification of Salt-affected Soils (Pearson 2009)

Classification	Electrical Conductivity (dS/m)	Soil pH	Sodium Adsorption Ration (SAR)	Soil Physical Condition
Saline	>4	<8.5	<13	Normal
Sodic	<4	>8.5	≥13	Poor
Saline-Sodic	>4	<8.5	≥13	Normal
High pH	<4	>7.8	<13	Varies

The three principal physical effects of sodium are reductions in soil infiltration, hydraulic conductivity and surface crusting. These effects are replacement of calcium and magnesium ions by sodium ions on the soil clays and colloids.

2.2 The Use of CSG Water for Irrigation

Salinity inhibits plant development and growth however, the degree of severity is dependent on the climatic conditions, existing soil water, salt concentration, irrigation routines, plant variety and stage of development (Pearson K 2003). Plant available water is at its highest straight after irrigation and soil water salinity is at its lowest. However, the salts accumulate due to evaporation and plants withdrawing down water in the soil profile. The soil salinity increases as salts become more concentrated. Moreover, the osmotic potential decreases as the solute concentrations increase. Hence water moves towards regions of high solute concentrations, constricting the plant's ability to extract water. Moreover, this lowers the amount of available water regardless of the amount of water in the root zone (Pearson K, 2003). For water to enter the plant's roots the water potential must be less than the surrounding soil. To absorb moisture in to the roots from a saline soil, the plant cells must increase their solute concentration. Singer and Munns (1996) suggest that the solutes inducing osmotic regulation are either organic components made by the plant or salt ions taken from the soil.

Salt does not prevent plants from extracting water, plants are able to regulate their own osmotic potential. Regulation of osmotic potential requires substantial energy from the plant. Moreover, the plant succumbs to increased stress levels leading to the deterioration of the plant. Plant symptoms of salt damage include; slow growth, yellowing of leaves, death of leaves and tip, reduced germination and wilting of leaves even though the soils appears to be adequately moist, (Bodman & Lubach 1982).

Sodium is toxic to plants when the calcium concentrations are low and the soils have high clay percentages. The toxicity of sodium is dependent on the physical properties of the soil. Sodic soils will readily lose their structure because of particle deflocculation when salt concentrations in the soil solution are not high enough (Singer and Munns 1996). Crop productivity becomes near impossible when high salt concentrations cannot be maintained due to the top soil layer becoming impermeable creating a barrier for water infiltration. In addition decreased infiltration will cause erosion levels and runoff to increase. Sodic soils are generally inhospitable to vegetation and are not sustainably manageable for agriculture.

Soils containing high levels of sodium and low levels of other salts readily disperse clay in to individual hydrated particles of instead of remaining clustered. The hydrated particles are surrounded by exchangeable cations that repel particles from one another. Particles can lose their cohesion if these electrically repulsive forces become strong enough. Soils abundant in salt cohere particles by pushing exchangeable cations against clay particles, inducing minimal interference with cohesion of particles (Singer and Munns 1996). High soil water salinity causing fine particles to bind is known as flocculation (Pearson K 2003). Contrary to cations being held closely to clay particles, sodium cations are held loosely where it is hydrated and so the sodic colloids disperse. Despite soil aggregation and stabalisation improving with increased soil solution salinity, it has detrimental effects on plant growth. Moreover, soil salinity cannot be maintained to promote soil structure without hindering plant health (Pearson K 2003).

Figure 2 illustrates the transition from no reduction in saturated hydraulic conductivity to severe reduction in saturated hydraulic conductivity. The reductions are characterized by the positioning of the TEC curves. As the SAR increases and the salt concentration decreases the soils become progressively more unstable due to the soil solution becoming more dilute. This graphically illustrates the affects of rainfall events after the application of a saline water quality; the saturated hydraulic conductivity reduces as the SAR increases.

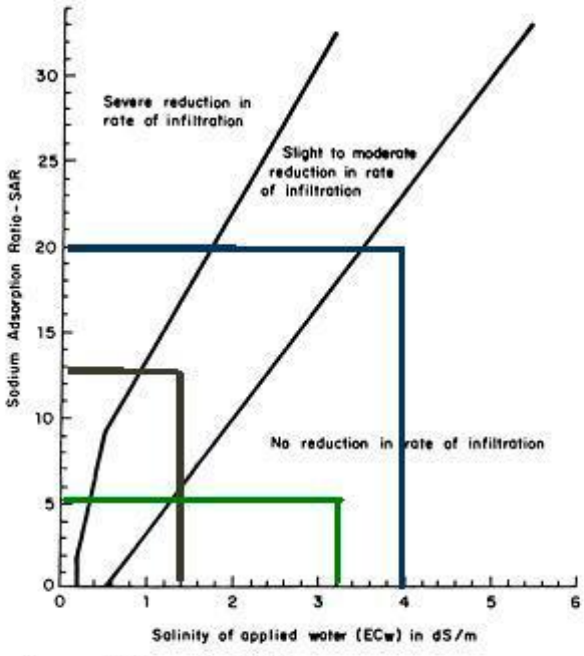


Figure 2 Change in infiltration with salinity (Ayers & Wescot 1985)

Bauder, J (2009) proposes that sprinkler irrigation and land spreading are two alternatives for beneficially disposing of saline and sodic water. Feasibility of land spreading is governed by the quality and degree of sodicity of irrigation water. Execution of this scheme would be impractical in areas where scientific irrigation water management and monitoring weren't previously practiced. Site selection for land spreading of sodic water is imperative to sustainability of adequate soil structure. Oster and Shainberg (2001) indicate a criterion for the application of sodic and saline water while sustaining soil quality and plant production which includes using saline and salt tolerant plants, maintaining yearly crop cover to minimize effects of rain forcing the heavily sodic soils to become unstable, periodic application of non-saline-sodic waters, monitoring applied water quality and soil chemistry, and periodic applications of chemicals to amend salt and sodium damaged soils.

Singer and Munns (1996) highlights, disturbance to the surface of soils susceptible to dispersion are most at risk for losses in structure and permeability. Seal formation is another process inducing reductions in hydraulic characteristics and is predominantly caused by either soil compaction from water impact or chemical dispersion where soil aggregates break down and clog pores. Oster and Shainberg (2001) reported on the sensitivity that sodium absorption ratio of applied water has on saturated hydraulic conductivities. Hydraulic conductivity is the speed at which water moves through a soil profile. This is a function of both soil properties and soil moisture content (Raine 2008). Rainfall or irrigating with non-saline water on soils that have previously been irrigated with saline or sodic water, will lower the EC to a greater extent than lower the SAR. This disproportionate reduction in salinity will disrupt the balance between flocculation promoted by the electrolyte concentration and dispersion promoted by sodicity (Bauder J 2009).

Soils heavily leached with sodium were found to have a substantial reduction in hydraulic characteristics than soils leached with calcium (Waldron et al. 1970). If the electrolyte concentration is maintained at the critical threshold, then the hydraulic conductivity will decrease as the exchangeable sodium percentage increases (Quirk & Schofield 1955). Moreover, the soil aggregates disperse by increasing electrolyte concentration because of the reduction in conductive porosity. This phenomenon is most extreme in soils with high clay contents. It should also be noted that calcium is immobolised when exposed to high pH levels and is precipitated out as calcium carbonate ($CaCO_3$).

It is preferable to irrigate less frequently with heavier quantities at each irrigation. Under this type of irrigation management, the surface soil is more thoroughly leached thus avoiding salt accumulation in the root zone. Leaching is the process of washing salts downward out of the root zone through natural rainfall, or irrigation in addition to that needed for plant growth. In a practical sense, most leaching is achieved during wet seasons when deep water penetration is achieved. Combinations of practices which encourage the rapid intake of rainfall will increase the leaching potential. Such practices include deep ripping, heavy organic matter residues on fallow ground, crop cover and gypsum applications. This is particularly important during the heavy summer rainfall period. Sandy soils will require irrigation on a more frequent basis than clay soils subjected to the same poor quality water and soil salt content. The salinity of blended water will depend on the original salinity levels of the different waters, and mixing proportions.

The results in this project have a direct impact on water use in Australia. If coal seam gas product water is recognized as a viable resource for irrigation, pressure will be relieved from Australia's dwindling water resources. Correct management of this mining by-product could potentially supplement farmers with an alternative resource base for water. Where available water from dams, creeks, rivers, and underground aquifers are scarce, extraction of water saturating coal seams may be utilized as an irrigable source of water. This would revolutionize irrigation management practices in Australia.

Correct management will adequately maintain soil permeability by selecting an appropriate salinity level in the irrigation water, even at excessively high sodicity levels. However, problems arise when non-saline waters are applied as they cause potential crusting, poor aeration, ponding and reduced hydraulic conductivity. Poor management will inevitably result in long-term damage to soil structure that may take decades to recover depending on the severity of soil dispersion. Conclusions from this project will deduce possible methodologies for determining the electrolyte threshold in soils, preventing the application of wrong saline and sodic water qualities.

2.3 Previous Research

Existing irrigation water quality criteria is determined using short term laboratory column replications and analyzing variations in soil performance over time. Previous studies utilized fully saturated disturbed soil columns and measured the hydraulic conductivity to analyse soil performance. Comparatively, these studies do not accurately model field conditions. They fail to consider such limitations as crusting, impact of rain events, and wetting and drying conditions. There is currently no standardised method for the routine determination of electrolyte thresholds to minimise structural degradation in soils. This project developed a strategy for the routine measurement of threshold electrolyte concentrations (TEC) and evaluated the differences in TEC across a range of soils.

There has been extensive scientific research conducted surrounding the adverse effects water quality has on the physical properties of soils. Majority of this research analysed saturated hydraulic conductivities of disturbed soil columns under constant flow. McNeal and Coleman (1966) conducted a number of studies characterizing the effects of EC and SAR on soil hydraulic and physical properties. Their studies concluded that soils high in kaolinite and sesquioxides were practically insensitive to variations in solution composition (McNeal & Coleman 1966). No single property was found to characterize a soils response to a given solution, although expressions of exchangeable sodium percentages and total salt concentrations produced comparable curves for soils with similar clay mineralogy (McNeal & Coleman 1966). McNeal and Coleman (1966) demonstrated a definite decrease in hydraulic conductivity over an exchangeable sodium percentage range of 20 to 35 and at concentrations of 3 to 50 meq/L. The process was irreversible with the reapplication of high salt solutions. McNeal and Coleman also observed soils containing high percentages of montmorillonite to be the least stable.

McNeal et al. (1966) analysed the effect of solution on the swelling of extracted soil clays. The results indicated that the solutions correlated with the relative hydraulic conductivity of the soils in the same solutions and with the domain model values (McNeal et al., 1966). This model proposes that sodium and calcium clays consist of distinct boundaries where only sodium regions swell at low salt concentrations (McNeal et al., 1966). The correlations indicate that the most plausible physical change inducing the reduction of hydraulic conductivity is the closing of conducting pores by internal swelling.

Frenkel et al. (1978) analysed the hydraulic conductivities of three southern California soils adjusted to different levels of exchangeable sodium at varying salt concentrations. The soils tested were primarily montmorillonitic, vermiculitic, and kaolinitic soils. The columns were initially leached with water qualities of SAR 10, 20 and 30, then leached with consecutively diluted water qualities of EC 10, 5 and 1 dS m^{-1} respectively, and finally distilled water. The montmorillonitic soil experienced a decline in hydraulic conductivity at EC = 1 dS m^{-1} and SAR 10, relative to the hydraulic conductivity at EC = 5. The kaolinitic soil experienced a reduction in hydraulic conductivity for only distilled water. The vermiculitic experienced a slight reduction in hydraulic conductivity at EC = 1 dS m^{-1} and a steep decline with distilled water. This study doesn't critically analyze the response that these soils have to varying exchangeable sodium percentages and salt concentrations under EC = 1 dS m^{-1} and SAR 10.

There have been limited studies completed investigating the effects of rain or pure water applied after the application of saline water. Shainberg et al. (1981a) conducted experiments on the effects of low electrolyte concentrations on clay dispersion and hydraulic conductivity of sodic soils. This study tested a Fallbrook soil (fine-loamy, mixed, thermic Typic Haploxeralfs) and reported an 80% reduction in hydraulic conductivity when deionised water was applied after infiltration of water quality of SAR 5. Moreover, it was reported that a 90% reduction in hydraulic conductivity occurred when deionised water was applied after infiltration of water quality of SAR 10. The soil's response to the sequential solutions was exacerbated by the sand-soil combination and high infiltration rates through the soil columns (Shainberg et al., 1981a). However, higher infiltrations rates resulted in greater detachment and dispersion of clay colloids. The sodic soils response to the deionised water was dependent of the soil's capacity to maintain high EC levels due to mineral dissolution, available calcium carbonate for reaction, exchangeable sodium and salinity of the soil. The Fallbrook soil was extremely sensitive to the level of exchangeable sodium and to the salt concentrations of the percolated solution (Shainberg et al., 1981a). The results indicated that soils exceeding ESP of 12% and soil solutions of 3 meq/L had reductions in both clay dispersion and hydraulic conductivity. Moreover, there was also a reduction in hydraulic conductivity and clay dispersion at ESP values of 1 and 2% when the soil solution was maintained at 0.5 meq/L effluent concentration after being leached with distilled water. Shainberg et al., (1981a) hypothesized that the response of soils to low ESP less than 20 after leaching with low electrolyte water is characterized by the maintained soil solution concentration at the solid phase.

Shainberg et al., (1981b) tested three soils to investigate the differences in rates of mineral dissolution and its influence on decreased hydraulic conductivity after the application of distilled water. Shainberg et al., (1981b) found that their results agreed with their hypothesis. It was concluded that differences in soils ability to undergo dispersion is important in affecting crust formation under rainfall conditions. Soils with higher dissolution rates were found to be less affected by exchangeable sodium (Shainberg et al., 1981b). Clay dispersion induces particle movement and possible lodgement in conducting pores is caused by low levels of electrolytes at even low levels of exchangeable sodium (Shainberg et al., 1981b). It was found that soils having moderate ESP could maintain their physical structure through majority of the soil profile, however still be susceptible to dispersion at the surface (Shainberg et al., 1981b).

3. Methodology and Preliminary Trials

There is currently no standardized method for determining the electrolyte threshold to minimize structural degradation in soils. This project developed a strategy for the routine measurement of threshold electrolyte concentrations (TEC) and evaluated the differences in TEC across a range of soils. The soils used throughout experimentation were obtained from two anonymous Coal Seam Gas extraction companies. The exact location of the soils is subject to confidentiality.

3.1 Materials and Methods for Short Column Hydraulic Conductivities

Preparation of the soil required the sampled soil to be air-dried and crushed by mortar and pestle then sieved to 2.36 mm. Buchner funnels were utilized to contain the soil samples for individual testing. Variations in bulk density were controlled by dropping the Buchner funnels from a height of 3 cm consecutively for three times on a hard surface. Filter paper was inserted in the bottom of the Buchner funnels to prevent soil loss through the perforated base. They were also layered on the soil surface to eliminate soil disturbance during solution application.

Each soil column had two separate pre-treatments applied on consecutive days. The purpose of consecutive pre-treatments was to allow for any initial consolidation errors from the first application. Pre-treatment solutions were a blend of deionised water and calcium chloride dihydrate (CaCl2.H2O). Pre-treatment solutions were selected at a sodium absorption ratio (SAR) and electrical conductivity (EC) that would not cause the soil samples to disperse. It was found that an EC of 2 dS and SAR of 0 were sufficient. To ensure complete saturation of the soil profile before the initial pre-treatment, the buchner funnels were immersed in the pre-treatment solution.

After the application of two pre-treatments, each soil was tested for various sodium absorption ratios over a range of electrical conductivities from 0.5 dS to 8 dS. Calcium chloride dihydrate (CaCl2.H2O) and sodium chloride (NaCl) were accurately measured on laboratory scales (Sartorius BP2105) to produce a bulk solution. Bulk solutions were made up for each individual curve. A curve represents a single group of five dots in the horizontal/diagonally positive direction as illustrated in figure 1. Five SAR solutions were tested at EC's 0.5, 1, 2, 4 and 8 using five columns for each soil. The respective solutions for EC's 0.5, 1, 2 and 4 were produced by diluting the bulk solution by half each time.

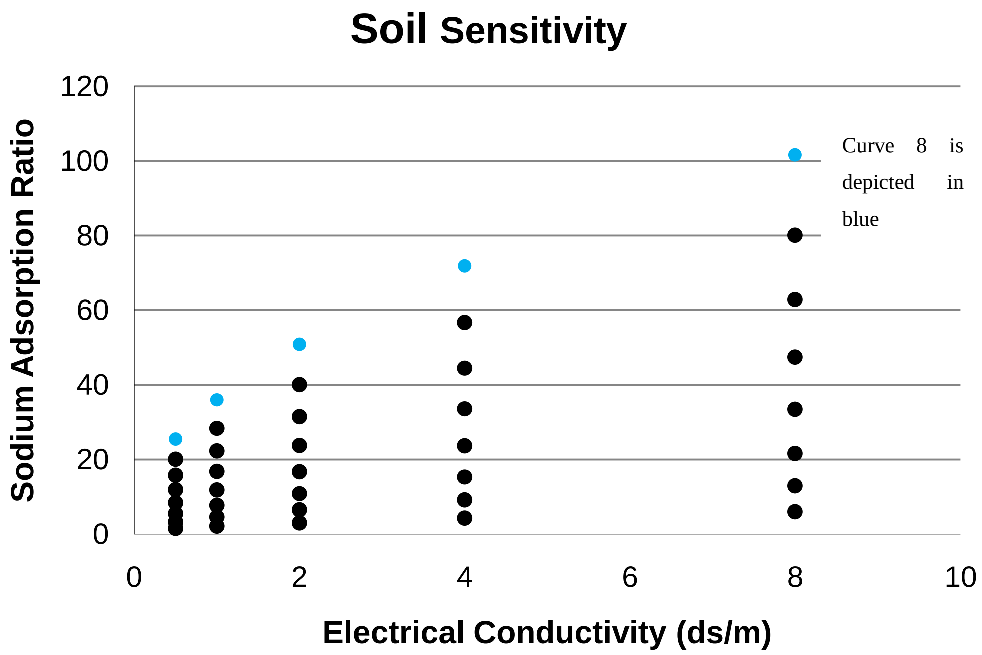


Figure 3 Range used for soil sensitivity tests

During treatments, each column was sequentially leached ensuring seven times the pore volume had been applied to guarantee equilibrium. Volumetric measurements of leachate were recorded in ten minute intervals until the water head was no long in contact with the inverted bottle of solution. Water head and soil depth were measured during experimentation to calculate the hydraulic conductivity. The last two readings of leachate volume were averaged and accepted as the final hydraulic conductivity for that soil.

Treatments were progressively applied to the same soil column until enough data had been collected to acquire data points for at least 60% reduction in saturated hydraulic conductivity. It was imperative that applied solutions had higher SAR's than the previous treatment otherwise the experiment was aborted.

Post-treatments were applied to each soil where only sodium chloride was added to the solutions. In many cases it is assumed that SAR infinity results in a saturated hydraulic conductivity of zero, hence a high SAR solution was applied to confirm or reject this condition.

All results were collaborated and imported into modeling software to perform three-dimensional analysis on the soils to acquire a representative graph of percentage reductions in saturated hydraulic conductivities.

3.2 Particle Size Analysis and Procedure

The particle size distribution is an important soil characteristic that has direct correlations with a many chemical and physical soil properties. The size, shape and coherence of these particles vary extensively from region to region and their respective climates. Quantity of particles will correlate with the strength of particle bonding and how much energy is required to break these bonds. However, sufficient energy needs to be applied to separate aggregates but not facture the primary particles. Often pre-treatments of soil are conducted to soften aggregates, however the introduction of ultrasonic equipment for particle size analysis has eliminated the need for pre-treatments.

Particle size analyses are conducted by firstly accurately weighing 25g of air-dried soil into a 250mL glass beaker, and then add 100mL of deionised water. Place the beaker under the ultrasonic probe so that the probe is inserted to a depth of 25mm into the suspension while leaving a finger width between the stand and the probe tip.
The sonifier utilised for particle size analysis was a Branson Sonifier. Ultrasonic energy was applied to the suspension at a setting of 50% capacity for a period of five

minutes. Appropriate safety equipment was used to prevent injury including gloves, earmuffs and safety glasses. The suspension was removed and contents emptied in to a sedimentation cylinder. The sedimentation cylinder was accurately fill with deionised water to a predetermined volume of 500mL and allowed to reach room temperature.

To determine the amount of material <20µm, the suspension was stirred with a plunger until the sedimentation cylinder was evenly mixed, allowed to settle for 4 minutes, 48 seconds then subsampled 10mL of suspension at 100mm with a volumetric pipette. The sample was transferred to a pre-weighed container where the contents were deposited and volumetric pipette rinsed twice inside with deionised water and also deposited into the container.

Figure 4 Apparatus for determination of particle size distribution

To determine the amount of material <2µm, the suspension was stirred again with a plunger until the sedimentation cylinder was evenly mixed, allowed to settle for 1 hour, 35 seconds then subsampled 10mL of suspension at 20mm with a volumetric pipette (See Figure 4). The sample was transferred to another pre-weighed container where the contents were deposited and volumetric pipette rinsed twice inside with deionised water as above.

Both containers were then placed into an oven (105°C) for a minimum period of 48 hours. After this period the contents of the containers were weighted total mass of sample determined. Percentages of sand silt and clay were calculated using the over dried masses, volume removed by pipette and total volume in sedimentation cylinder. This particle size analysis methodology was repeated for each soil.

Equations used in particle size analysis:

Oven dried mass = air dried mass × (percent water content / 100)

% Mass <20 µm = ((Mass <20µm dried container / Mass empty container) / 10mL) × ((500 / Oven dried mass) × 100)

% Mass <2 µm = ((Mass <2µm dried container / Mass empty container) / 10mL) × ((500 / Oven dried mass) × 100)

3.3 Results

Various factors affecting the measurement of the TEC in soil columns were evaluated. The key issues associated with routine analysis involved the selection of the soil column length, pre-wetting and consolidating the soil column and the sequential application of water with increasing sodium adsorption ratio on individual columns.

Determination of an effective routine analysis procedure was obtained via trial and error. In the initial stages there were discrepancies between the relative hydraulic conductivities of the curves. This methodology only used a single pretreatment with calcium chloride dihydrate (CaCl2.H2O) and each soil column was confined to a single water quality, e.g. each point on the graph was independent from any other point. This caused inconsistencies as the SAR increased. Naturally the relative saturated hydraulic conductivity reduces as the SAR increases, however initially the relative saturated hydraulic conductivity fluctuated as it increased in SAR. To promote consistency and to reduce soil consumption for laboratory testing, each column was confined to water qualities in a vertical direction. Providing that a single column of soil consistently has a higher SAR water quality than the previous applied to it, then the overall system will not be affected. However, this still did not produce enough consistency to produce a theoretical surface that decreased as SAR increased. The problem lied within the application of only a single pretreatment. The data indicated that the soil was slumping significantly after the pretreatment application. The data illustrated a reduction of 20 – 30% relative saturated hydraulic conductivity due to slumping and rearranging of soil particles (See Table C.1 Comparison of Initial Saturated Hydraulic Conductivities). Moreover, a second pretreatment of the same water quality was applied on consecutive days to combat this problem.

The data indicated that soils dried out quite significantly when left for days. The high clay content of some soils and their susceptibility to shrink and swell behavior meant that the application of water qualities must occur on consecutive days to prevent drying out. It was observed that when the soils dried out too much they cracked away from the wall. This could induce tunneling, and hence an increased saturated hydraulic conductivity as the SAR increases. Often 2 days was sufficient time to drastically affect results. In this case the test was aborted and then repeated.

An appropriate soil column height was investigated. The results for this project indicate that the height utilized for routine analysis of 2.5 – 3.0 cm was sufficient however, further study after completion of the experiments questioned whether these heights were acceptable for all soils. Finer textured soils in shallower soil columns may be subject to tunneling around the walls. This phenomenon was demonstrated in this project however, the results were inconclusive.

3.4 Conclusion

The methodology for determining the TEC in soils was found to be able to identify differences between the soils. Soils subjected to water with high sodium concentrations were generally found to have a substantial reduction in hydraulic conductivity compared to soils leached with calcium dominated water.

A substantial variation in the TEC was found between soils and there was no clear relationship between the TEC and the soil chemical or physical properties of the soils. This suggests that there is a need to individually measure the TEC for each soil and that it may not be possible to identify surrogate indicators of structural stability to saline-sodic water application. While the TEC measurement methodology appeared appropriate for the soils evaluated in this study, further work is needed to confirm that it is appropriate across a broader range of soils.

4. Characterizing Reduction in Ksat for Range of Soils

4.1 Introduction

This section contains a discussion on the graphical results from the routine analysis of soils and investigates relationships between the physical and chemical properties of soils and their responses to varying electrolyte concentrations. Visual inspection indicated that soils 1 to 3 were red sandy loam surface soils that transition through light clay to silty clay below 500 mm. Soil 3 appeared to be slightly heavier in texture. Soils 4 to 6 are slightly lighter, red sandy loam surface soils that transition through light clay to silty clay below 500 mm. Finally soils 7 to 9 are clay loams to light clay surface soils, that transition from light clay to silty clay below 500 mm. Glen Dale confirmed the above visual inspection by email on 17 November 2008.

Figure 5 Topographic representation of soil locations (Google Earth 2007)

Figure 5 illustrates the geographic locations of the soils. The exact location of these soils is restricted due to confidentiality. It should be noted that the area enclosed within points 3, 7, 8 and 9 is a hill comprised of Hutton Sandstone that rises above the general plateau level.

4.2 Particle Size Analysis Results

The results from the particle size analysis demonstrated a large range of soil texture compositions. The IUSS system was utilized to classify the sample soils.

Soils 1 and 5 were classified as loamy sand being coherent with medium sized sand granules and not easily sheared into a ribbon between the thumb and forefinger (See

Appendix B. Particle Size Analysis Results). Loamy sands have clay contents less than 5% which is consistent with the particle size analysis results. However Soil 5 demonstrated a clay content of 9% but was deemed acceptable.

Soils 2 and 7 were classified as silty loam (See

Appendix B. Particle Size Analysis Results). They have a coherent bolus and are very smooth and often silky when worked. Silty loams can form ribbons of approximately 25 mm and have clay content of approximately 25% and silt content in excess of 25%. However, both soils 2 and 7 were not consistent with the field texture classification grade. They both had a negative clay content of -1.8% after the particle size analysis. The inconsistency could be explained by not rinsing the pipette sufficiently between consecutive sampling. The Branson Sonifier may also not have been inserted close enough to the bottom of the beaker to ensure that the sonifier sufficiently separated aggregates but not facture the primary particles.

Soils 3 and W3 were classified as light medium clay which produces a plastic bolus and is smooth to touch (See

Appendix B. Particle Size Analysis Results). It has slight resistance to ribboning shear and can form a ribbon of approximately 75 mm. Light medium clays possess clay contents ranging from 40-45%, which is consistent with the results.

Soils 4, 6 and W1 were classified as a loam because it produces a coherent bolus that is rather spongy (See

Appendix B. Particle Size Analysis Results). Loams have a smooth feel when manipulated but with no obvious sandy or silky textures. They can often be greasy due to high organic matter present and produce a ribbon of approximately 25 mm. Loams have clay contents around 25%. However, Soil 6 demonstrated a clay content of only 12%. This discrepancy is too low to be ignored. The inconsistency could be explained by not rinsing the pipette sufficiently between consecutive sampling. The Branson Sonifier may also not have been inserted close enough to the bottom of the beaker to ensure that the sonifier sufficiently separated aggregates but not facture the primary particles. They sampling may not have been taken exactly from the correct depth. Temperature may also have contributed to the discrepancy as the temperature variation

Soil 8 was classified as light clay due to it producing a plastic bolus and being smooth to touch (See

Appendix B. Particle Size Analysis Results). There is slight resistance to shearing between the forefinger and thumb. Light clays will form a ribbon of 50 – 75 mm in length and possess clay contents of approximately 35 – 40%.

The greatest discretion of the particle size analysis results was soils 2 and 7. The particle size analysis was not repeated to investigate failed procedures, however the soils were sent off for commercial laboratory chemical assessment.

4.3 Laboratory Chemical Assessment

SGS Agritech conducted a chemical analysis and produced the following data illustrated in Table 1. Note that none of the soils can be classified as sodic as they all possess an exchangeable sodium percentage less than six. It should also be noted that none of the soils are particularly saline. The chemical compositions illustrated below do not drastically reflect the results obtained from the particle size analysis. No clear conclusion can be drawn from this information that there are direct links between the physical and chemical properties of soils.

Table 1 Selected chemical and physical properties of the soils

Soil	**pH**	**Org. Matter (%)**	**EC_w (dS m^{-1})**	**ESP (%)**	**CEC (meq 100 g^{-1})**	**<2 µm (g g^{-1})**	**2-20 µm (g g^{-1})**	**>20 µm (g g^{-1})**	**Texture***
1	7.00	2.6	0.70	0.5	12.12	4	20	77	Loamy sand
2	5.84	3.8	0.51	0.5	14.42	0	47	53	Silty loam
3	6.54	5.7	0.19	1.7	30.00	43	25	31	Clay
4	5.31	2.8	0.29	0.6	7.58	20	18	62	Loam
5	5.81	3.6	0.05	0.9	6.91	10	15	75	Loamy sand
6	4.76	3.9	0.05	2.3	4.50	12	15	73	Loam
7	6.37	4.6	1.65	1.7	39.69	1	67	32	Silty loam
8	7.43	4.6	0.22	3.6	27.54	38	18	43	Clay
9	6.71	4.9	0.08	2.1	25.22	37	31	33	Silty clay loam

** Indicative texture according to the PSA and IUSS texture triangle*

4.4 Short Column Saturated Hydraulic Conductivity Results

The methodology for determining the TEC in soils was found to be able to identify differences between the soils. Soils subjected to water with high sodium concentrations were generally found to have a substantial reduction in hydraulic conductivity compared to soils leached with calcium dominated water. However, the hydraulic conductivities for two soils (Soils 2 and 5) with low clay content were not affected by the application of saline-sodic water. See Appendix E for routine analysis data for complete tabulated results for the short column saturated hydraulic conductivity.

Figure illustrates a summary of the threshold electrolyte concentrations for the soils tested. Note that the industry standard for acceptable irrigation conditions is a maximum of 20% reduction in saturated hydraulic conductivity. Moreover, Figure illustrates the threshold electrolyte concentrations for a 80% relative hydraulic conductivity curves.

These are the maximum concentrations to which these soils can sustain an acceptable soil structure. However, on the occasion of a rainfall event the soil solution becomes diluted and forces the soil to become unstable however, an appropriate concentration for irrigation that will not induce a maximum reduction in hydraulic conductivity of 20% is subject to further research.

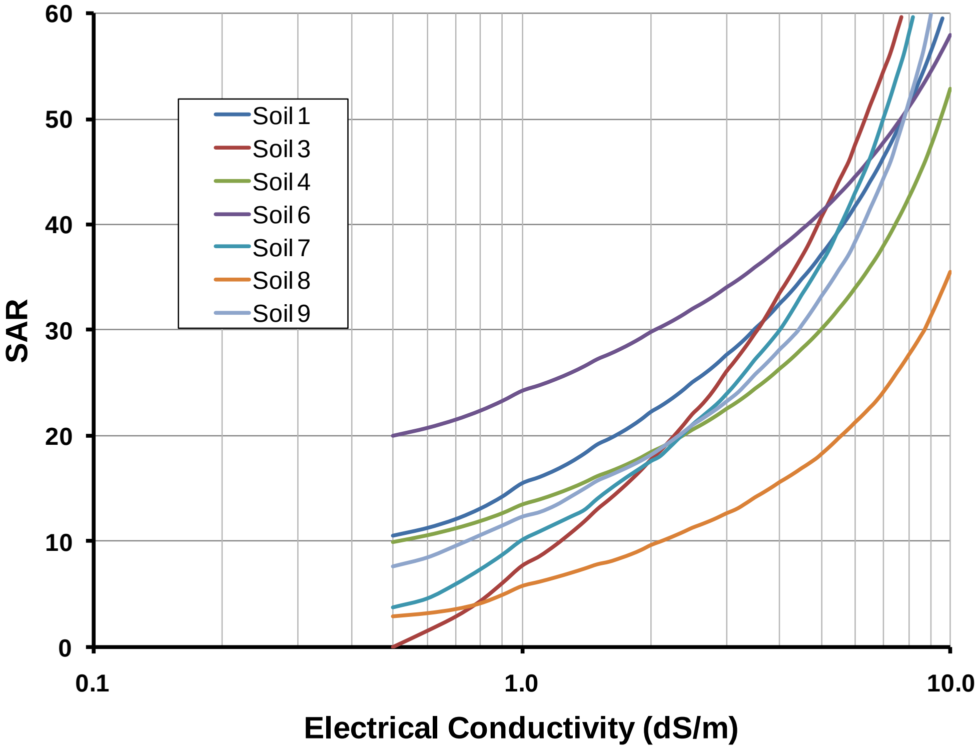


Figure 6 Summary of the TEC (i.e. 0.8Kca) curves for the soils

A substantial variation in the TEC was found between soils and there was no clear relationship between the TEC and the soil chemical or physical properties of the soils. This suggests that there is a need to individually measure the TEC for each soil and that it may not be possible to identify surrogate indicators of structural stability to saline-sodic water application. While the TEC measurement methodology appeared appropriate for the soils evaluated in this study, further work is needed to confirm that it is appropriate across a broader range of soils.

The data indicated that the soil was slumping significantly after the pretreatment application. The data illustrated a reduction of 20 – 30% relative saturated hydraulic conductivity due to slumping and rearranging of soil particles (See Table C.1 Comparison of Initial Saturated Hydraulic Conductivities). An appropriate number of pretreatment applications required to achieve a steady infiltration rate was inconclusive due to the soil particles continuously rearranging within the soil column.

Table 2 provides an indication of the saturated hydraulic conductivity of soils when a 2 dS/m $CaCl_2$ pretreatment water quality is applied. Note a broad range of saturated hydraulic conductivities. High infiltration rates indicate that the soil is predominantly sand and the lower infiltrations rates are indicative of a finer textured soil. These results correlate with the particle size analysis to some degree however, the determining exact saturated hydraulic conductivities that are expected for the various field texture grades is difficult due to slight transitions between grades.

Table 2 Saturated hydraulic conductivity of the soils when 2 dS m-1 CaCl2 solution applied

Soil	K_{ca} (cm h^{-1})
1	6.48 (±0.48)
2	4.42 (±0.46)
3	4.12 (±0.63)
4	7.86 (±0.51)
5	3.10 (±0.17)
6	1.60 (±0.11)

7	5.92 (±1.07)
8	5.83 (±0.13)
9	6.06 (±0.56)

The methodology for routine analysis was utilized to evaluate the TEC by measuring the reduction in hydraulic conductivity across a range of EC/SAR water quality combinations. The chemical properties of these soils were obtained and a particle size analysis conducted using a ultrasonic and pipette withdrawal method.

Various factors affecting the measurement of the TEC in soil columns were evaluated. The key issues associated with routine analysis involved the selection of the soil column length, pre-wetting and consolidating the soil column and the sequential application of water with increasing sodium adsorption ratio on individual columns.

4.5 Conclusion and Recommendations for Further Research

Coal seam methane by-product water has high sodicity and salinity concentrations which are potentially harmful to crops and soil structure. The soil tolerance to sodium is governed by the soil chemistry and physical structural properties and is typically characterised by a reduction in the soil hydraulic conductivity. The structural degradation is a function of both the salinity (i.e. electrolyte concentration) and sodicity of the applied water.

There is currently no standardised method for determining the electrolyte threshold to minimise structural degradation in soils. Hence, this project developed a strategy for the routine measurement of threshold electrolyte concentrations (TEC) and evaluated the differences in TEC across a range of soils.

Various factors affecting the measurement of the TEC in soil columns were evaluated. The key issues associated with routine analysis involved the selection of the soil column length, pre-wetting and consolidating the soil column and the sequential application of water with increasing sodium adsorption ratio on individual columns.

The methodology for routine analysis was utilised to evaluate the TEC for nine soils by measuring the reduction in hydraulic conductivity across a range of EC/SAR water quality combinations. The chemical properties of these soils were obtained and a particle size analysis conducted using a ultrasonic and pipette withdrawal method.

The methodology for determining the TEC in soils was found to be able to identify differences between the soils. Soils subjected to water with high sodium concentrations were generally found to have a substantial reduction in hydraulic conductivity compared to soils leached with calcium dominated water. However, the hydraulic conductivities for two soils with low clay content were not affected by the application of saline-sodic water. These soils had very low clay contents according to the particle size analysis, hence minimal dispersion occurred during the application of highly saline water.

A substantial variation in the TEC was found between soils and there was no clear relationship between the TEC and the soil chemical or physical properties of the soils. This suggests that there is a need to individually measure the TEC for each soil and that it may not be possible to identify surrogate indicators of structural stability to saline-sodic water application. While the TEC measurement methodology appeared appropriate for the soils evaluated in this study, further work is needed to confirm that it is appropriate across a broader range of soils.

Further work is required to identify appropriate sustainable water qualities for irrigation that minimises the effects of rain forcing soils irrigated with mining product water becoming unstable.

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Appendix A. Project Specification

University of Southern Queensland

FACULTY OF ENGINEERING AND SURVEYING

ENG4111/4112 Research Project

PROJECT SPECIFICATION

FOR: Leigh Hansen

TOPIC: Quantifying the reduction in hydraulic conductivity of disturbed soil columns as a function of the salinity and sodicity of applied water.

SUPERVISOR: Prof Steven Raine/Mr Erik Schmidt

SPONSORHSIP: National Centre of Engineering in Agriculture/Faculty of Engineering and Surveying

PROJECT AIM: To determine the electrolyte threshold in soils.

PROGRAMME: (**Issue A, date 23/03/09**)

5. Evaluate the reduction in Ksat for nine soils across a range of EC/SAR water combinations
   - Prepare soils by crushing and sieving the samples to the recommended standard size.
   - Conduct short column saturated hydraulic conductivity tests on soils by preparing water solutions at varying concentrations of sodium and calcium and treat each soil column (five columns per soil). Each soil column has a Pre-Treatment (stable concentration) and Treatment water applied to it.
   - Analyse data determining the relative hydraulic conductivity of each soil.
2. Evaluate the factors influencing the reduction in Ksat within the soil columns
   - Perform a particle size analysis on the selected soils to identify relationships with the saturated hydraulic conductivity
   - Conduct long column saturated hydraulic conductivity tests on selected soils using selected water quality treatments;
   - Analyse data and model the results for each soil. Compare results to short column tests identifying any discrepancies;
   - If appropriate, evaluate the soil chemistry at different locations in the columns.

AGREED_______________(student)________ __________________(supervisor)_____

Date: / / 2009 Date: / / 2009

Assistant Examiner: ______________________________

Appendix B. Particle Size Analysis Results

Table B.1 Particle Size Analysis Data

	Soil	Initial Weight (g)	Container #	Lid #	Final Weight (g)	% Clay	% Sand	% Silt
<20µm	1	41.5509	M19	M19	41.6614	23.205	76.795	
<2µm	1	41.3263	M39	M25	41.3433	3.57		19.635
<20µm	2	39.525	M76	M68	39.7487	46.977	53.023	
<2µm	2	41.1558	M6	M5	41.1471	-1.827		48.804
<20µm	3	40.0986	M68	M62	40.425	68.544	31.456	
<2µm	3	39.954	M73	M70	40.1608	43.428		25.116
<20µm	4	39.1945	M62	M68	39.3732	37.527	62.473	
<2µm	4	41.3983	M11	M2	41.4916	19.593		17.934
<20µm	5	41.1649	M7	M36	41.2816	24.507	75.493	
<2µm	5	39.9543	M73	M70	40.0006	9.723		14.784
<20µm	6	41.4938	M31	M26	41.6243	27.405	72.595	
<2µm	6	39.7552	M69	M76	39.8147	12.495		14.91
<20µm	7	41.4958	M6	M44	41.818	67.662	32.338	
<2µm	7	39.735	M68	M68	39.7265	-1.785		69.447
<20µm	8	41.4326	M2	M20	41.702	56.574	43.426	
<2µm	8	41.2755	M39	M36	41.4581	38.346		18.228
<20µm	9	39.7288	M63	M70	40.0495	67.347	32.653	
<2µm	9	40.0961	M64	M62	40.2711	36.75		30.597
<20µm	W1	41.409	M7	M14	41.5602	31.752	68.248	
<2µm	W1	37.5505	M61	M76	37.6533	21.588		10.164
<20µm	W3	41.4046	M42	M24	41.6651	54.705	45.295	
<2µm	W3	39.4344	M62	M69	39.6309	41.265		13.44

Appendix C. Comparison of Initial Saturated Hydraulic Conductivities

Table C.1 Comparison of Initial Saturated Hydraulic Conductivities

	Soil 1		Soil 2		Soil 3	
	Pre-treat 1	Pre-treat 2	Pre-treat 1	Pre-treat 2	Pre-treat 1	Pre-treat 2
Column 1 (cm/hr)	8.685	6.391	5.184	4.251	4.727	3.359
Column 2 (cm/hr)	10.546	6.999	5.432	4.506	4.114	3.699
Column 3 (cm/hr)	9.712	6.907	6.446	5.185	5.165	4.049
Column 4 (cm/hr)	7.583	5.823	4.716	3.977	6.049	4.892
Column 5 (cm/hr)	8.878	6.285	5.347	4.203	5.444	4.586
Average	9.0808	6.481	5.425	4.4244	5.0998	4.117

	Soil 4		Soil 5		Soil 6	
	Pre-treat 1	Pre-treat 2	Pre-treat 1	Pre-treat 2	Pre-treat 1	Pre-treat 2
Column 1 (cm/hr)	10.307	8.595	4.691	2.909	1.872	1.71
Column 2 (cm/hr)	9.181	7.62	5.144	3.15	1.782	1.673
Column 3 (cm/hr)	8.197	7.271	5.063	3.335	1.764	1.468
Column 4 (cm/hr)	9.205	7.683	4.751	2.947	1.653	1.512
Column 5 (cm/hr)	9.058	8.111	4.903	3.168	1.767	1.641
Average	9.1896	7.856	4.9104	3.1018	1.7676	1.6008

	Soil 7		Soil 8		Soil 9	
	Pre-treat 1	Pre-treat 2	Pre-treat 1	Pre-treat 2	Pre-treat 1	Pre-treat 2
Column 1 (cm/hr)	7.789	5.993	5.656	5.637	9.077	6.167
Column 2 (cm/hr)	7.517	6.303	5.961	5.922	7.84	6.394
Column 3 (cm/hr)	4.774	4.164	5.921	5.766	6.049	5.113
Column 4 (cm/hr)	7.305	6.073	5.916	5.954	6.913	6.087
Column 5 (cm/hr)	7.621	7.061	5.919	5.863	8.404	6.531
Average	7.0012	5.9188	5.8746	5.8284	7.6566	6.0584

	Soil W1		Soil W3	
	Pre-treat 1	Pre-treat 2	Pre-treat 1	Pre-treat 2
Column 1 (cm/hr)	12.002	9.439	2.938	2.745
Column 2 (cm/hr)	11.673	9.277	3.024	2.946
Column 3 (cm/hr)	12.416	9.948	3.118	2.592
Column 4 (cm/hr)	11.653	9.376	3.225	2.962
Column 5 (cm/hr)	11.455	10.203	4.239	3.824
Average	11.839844	9.6486592	3.3088	3.0138

Appendix D. Relative Saturated Hydraulic Conductivities of Sample Soils

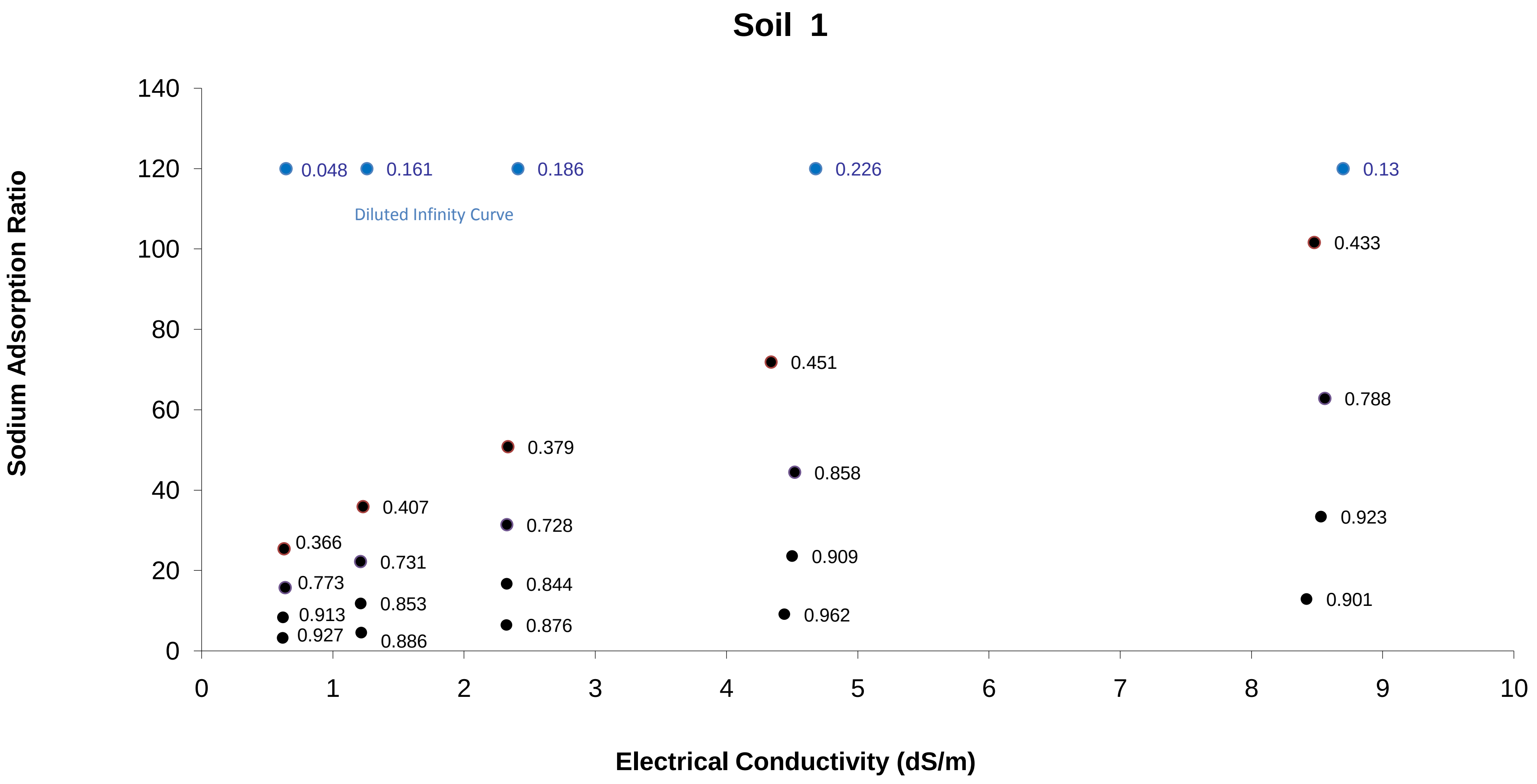

Figure D.1. Soil 1 relative saturated hydraulic conductivities over varying salt concentrations

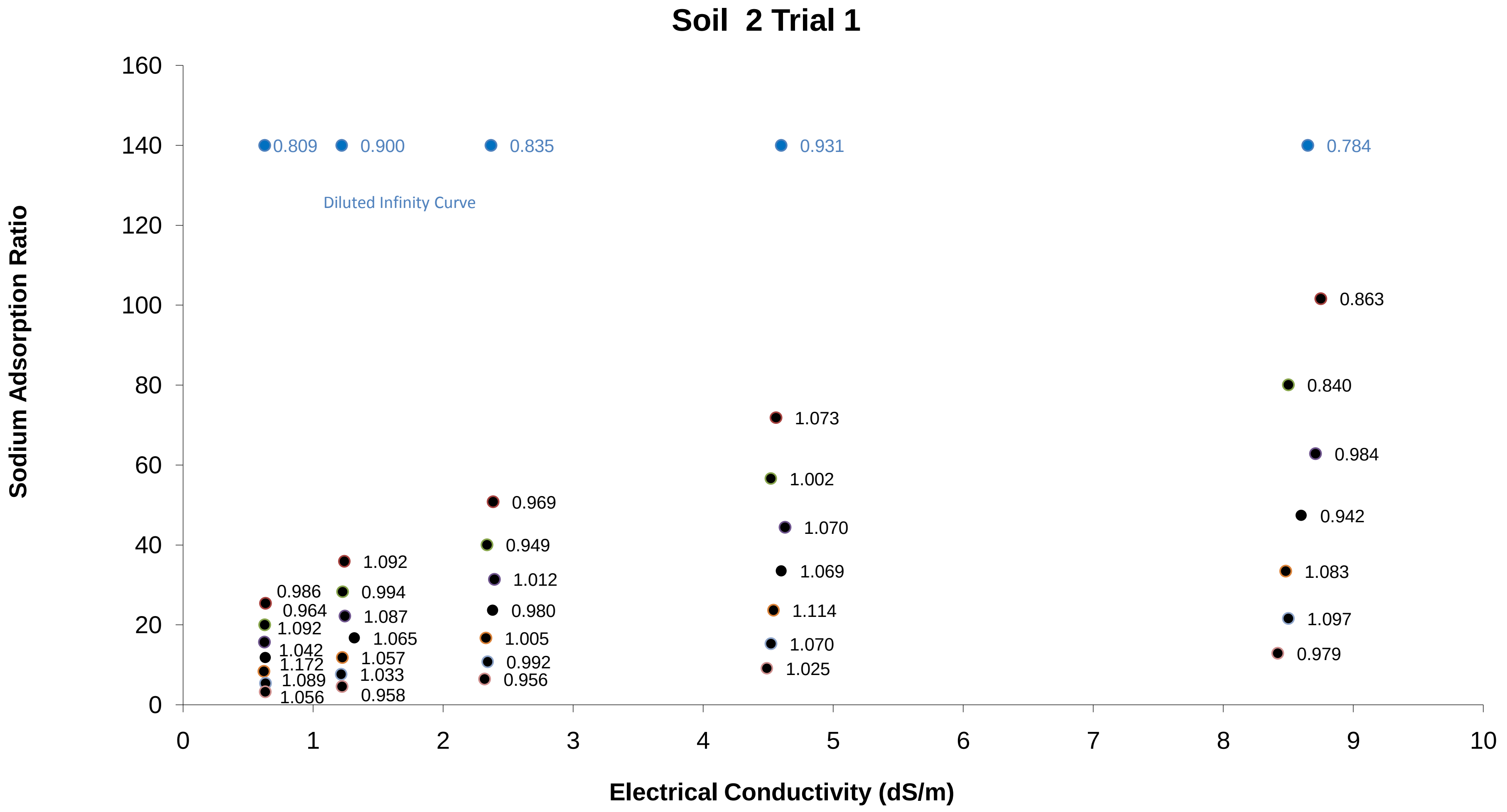

Figure D.2. Soil 2 relative saturated hydraulic conductivities over varying salt concentrations

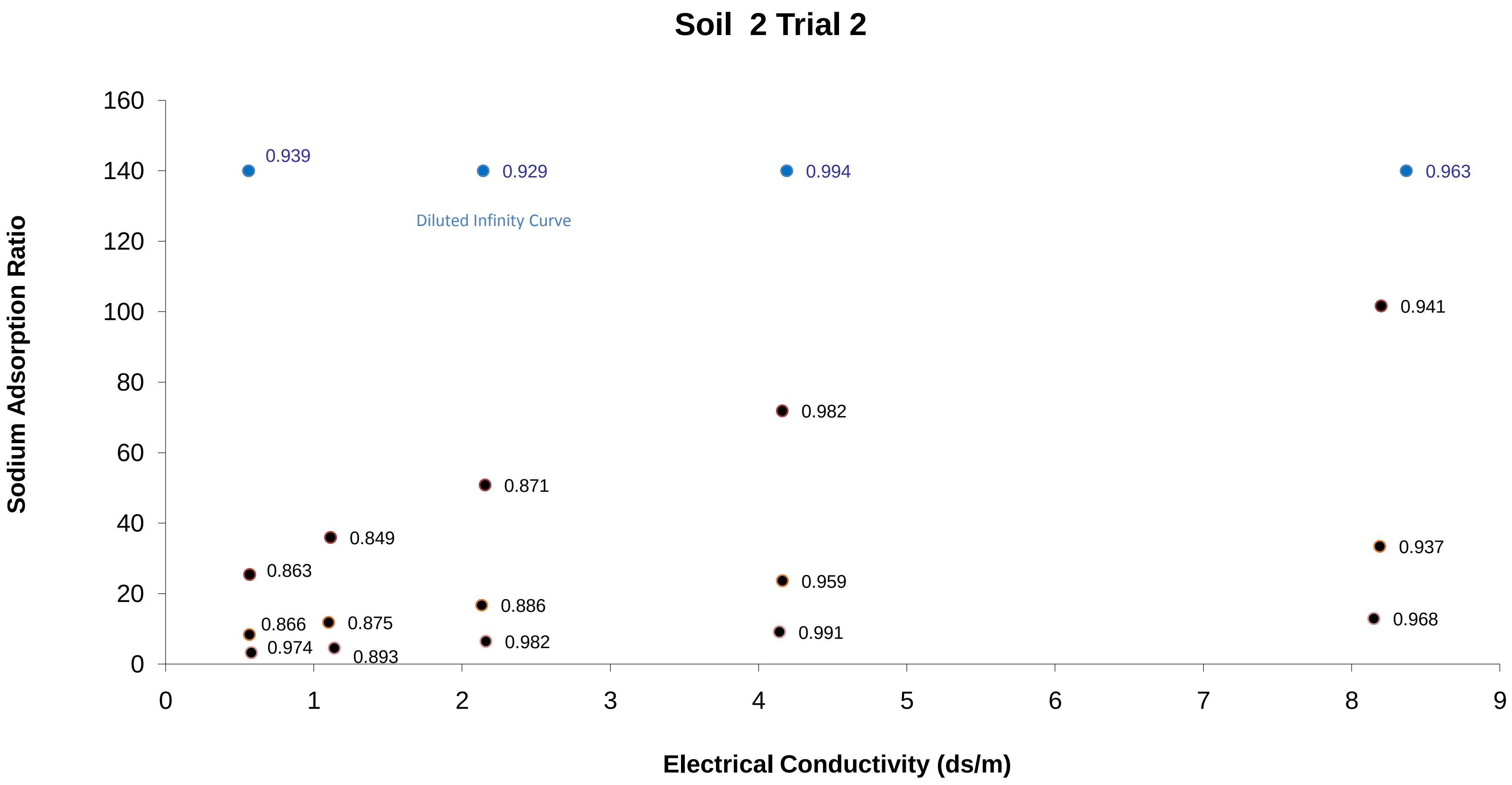

Figure D.3. Soil 2 Trial 2 relative saturated hydraulic conductivities over varying salt concentrations

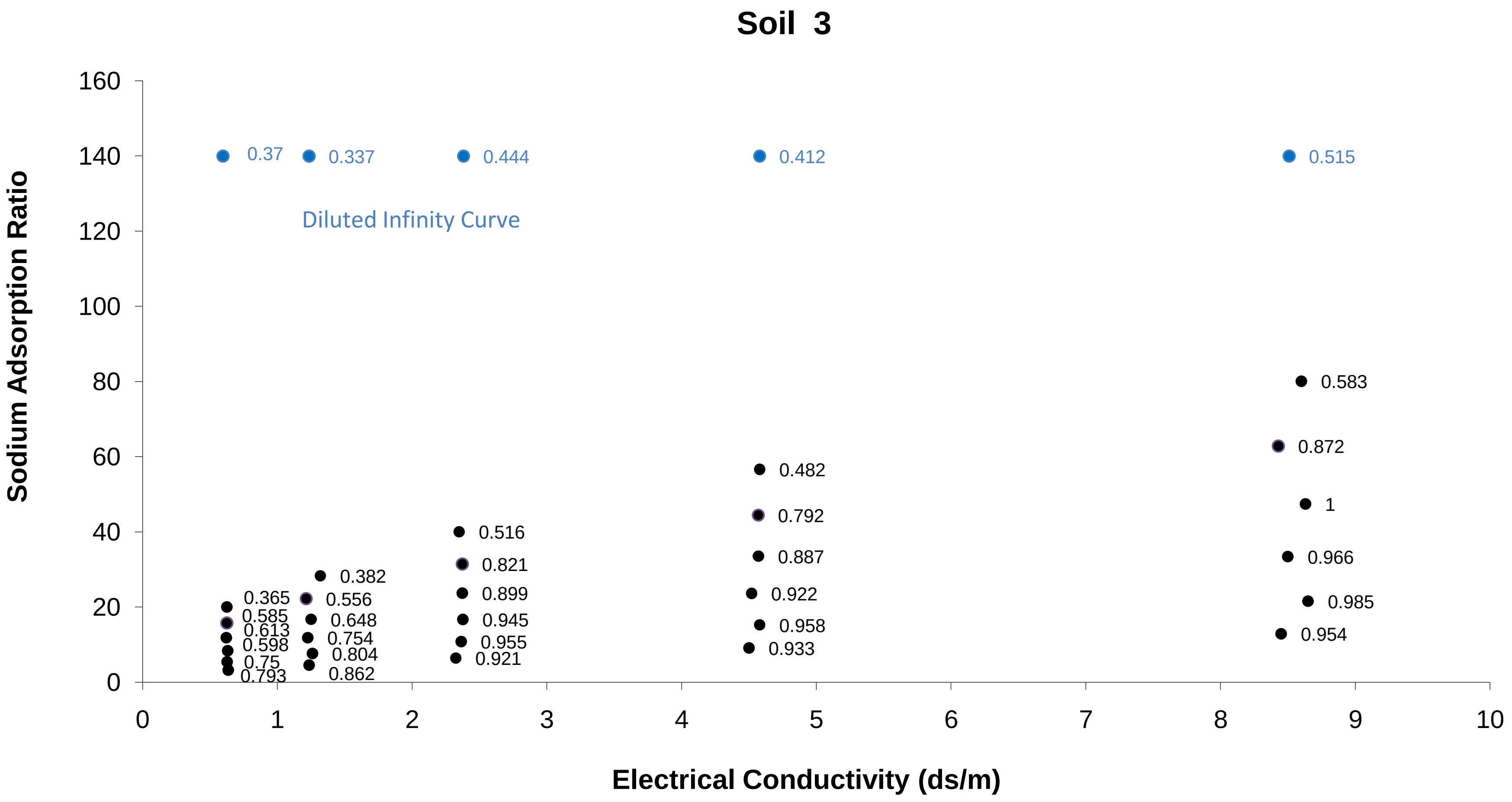

Figure D.4. Soil 3 relative saturated hydraulic conductivities over varying salt concentrations

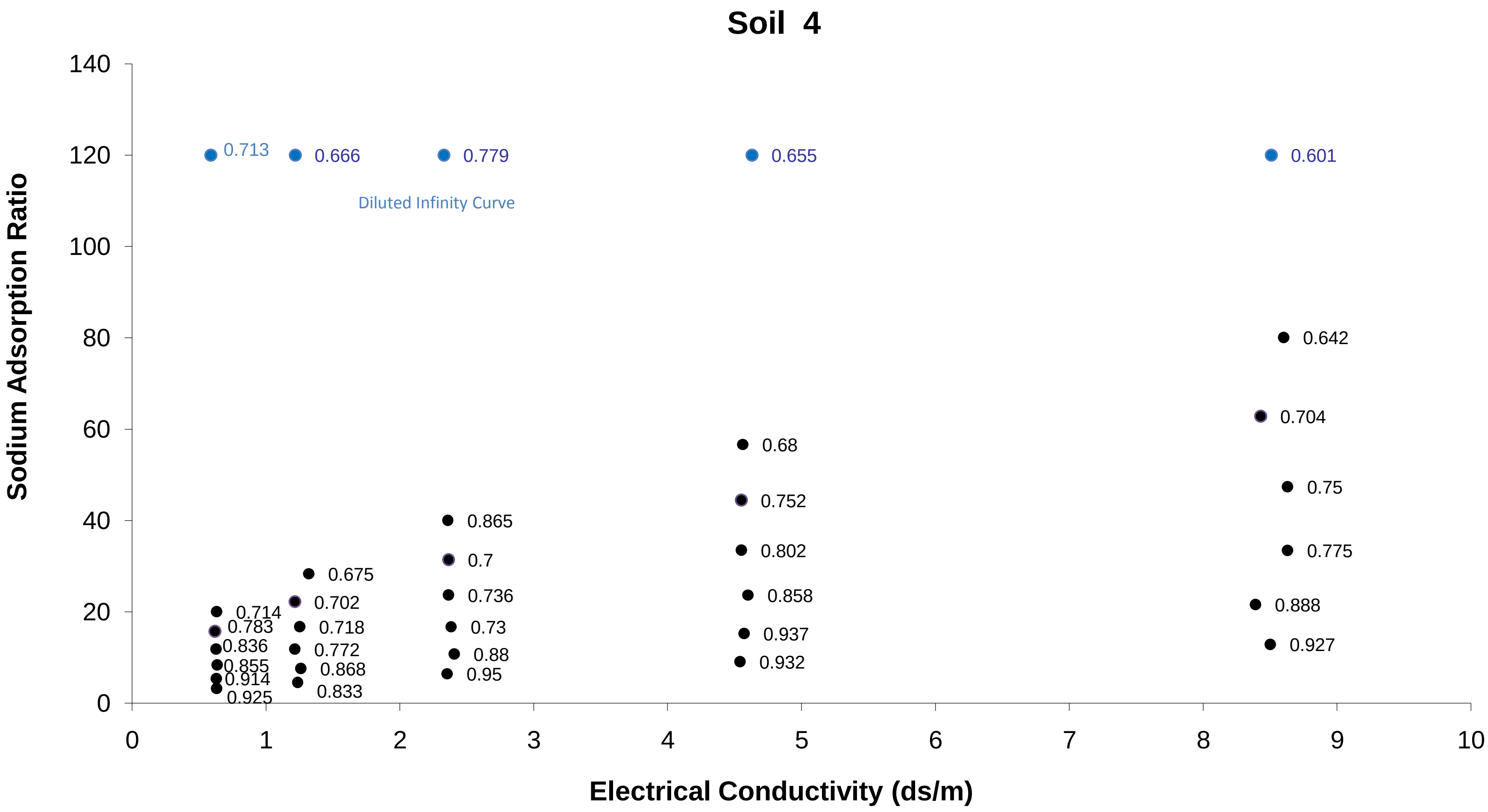

Figure D.5. Soil 4 relative saturated hydraulic conductivities over varying salt concentrations

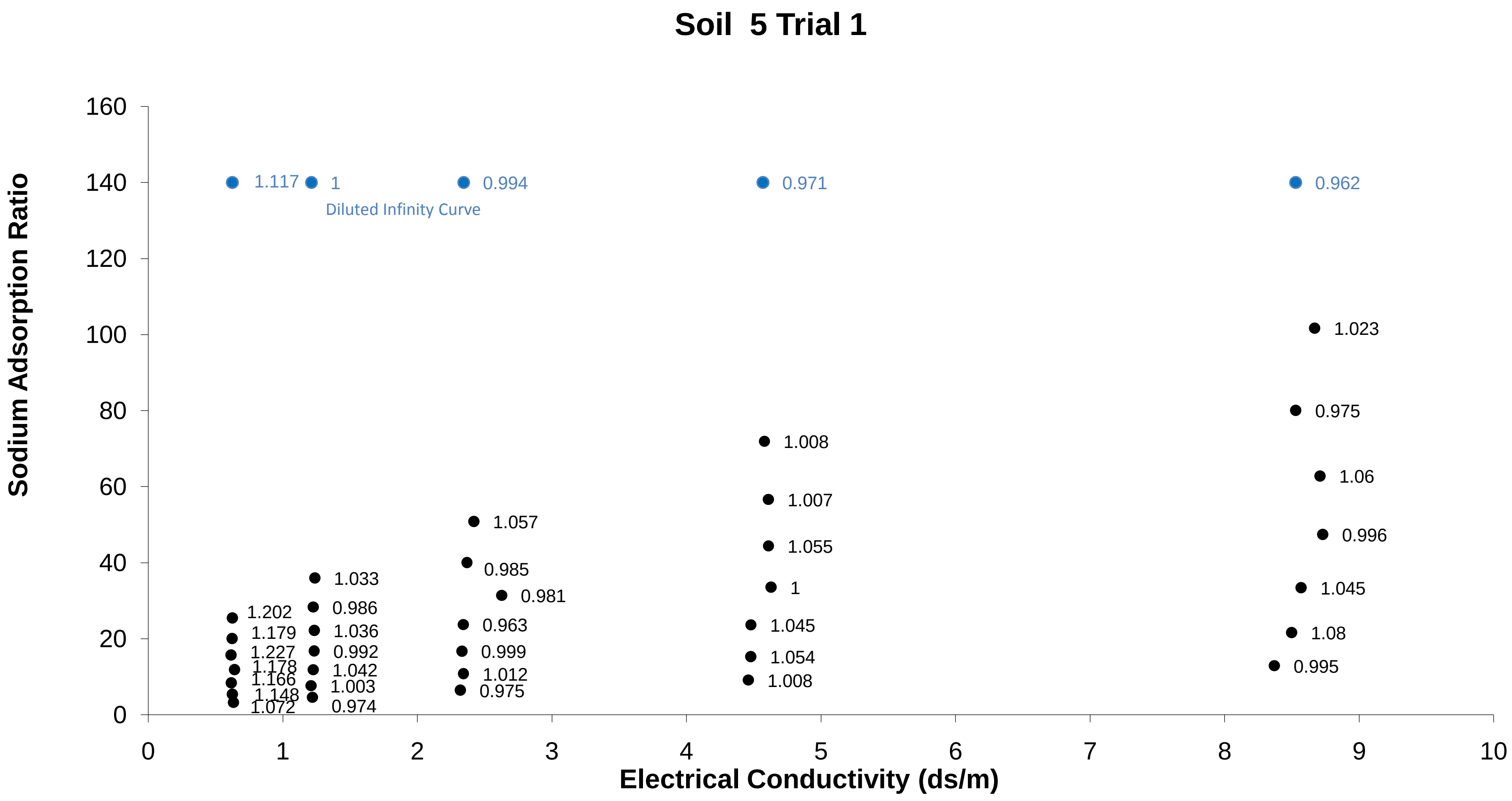

Figure D.6. Soil 5 relative saturated hydraulic conductivities over varying salt concentrations

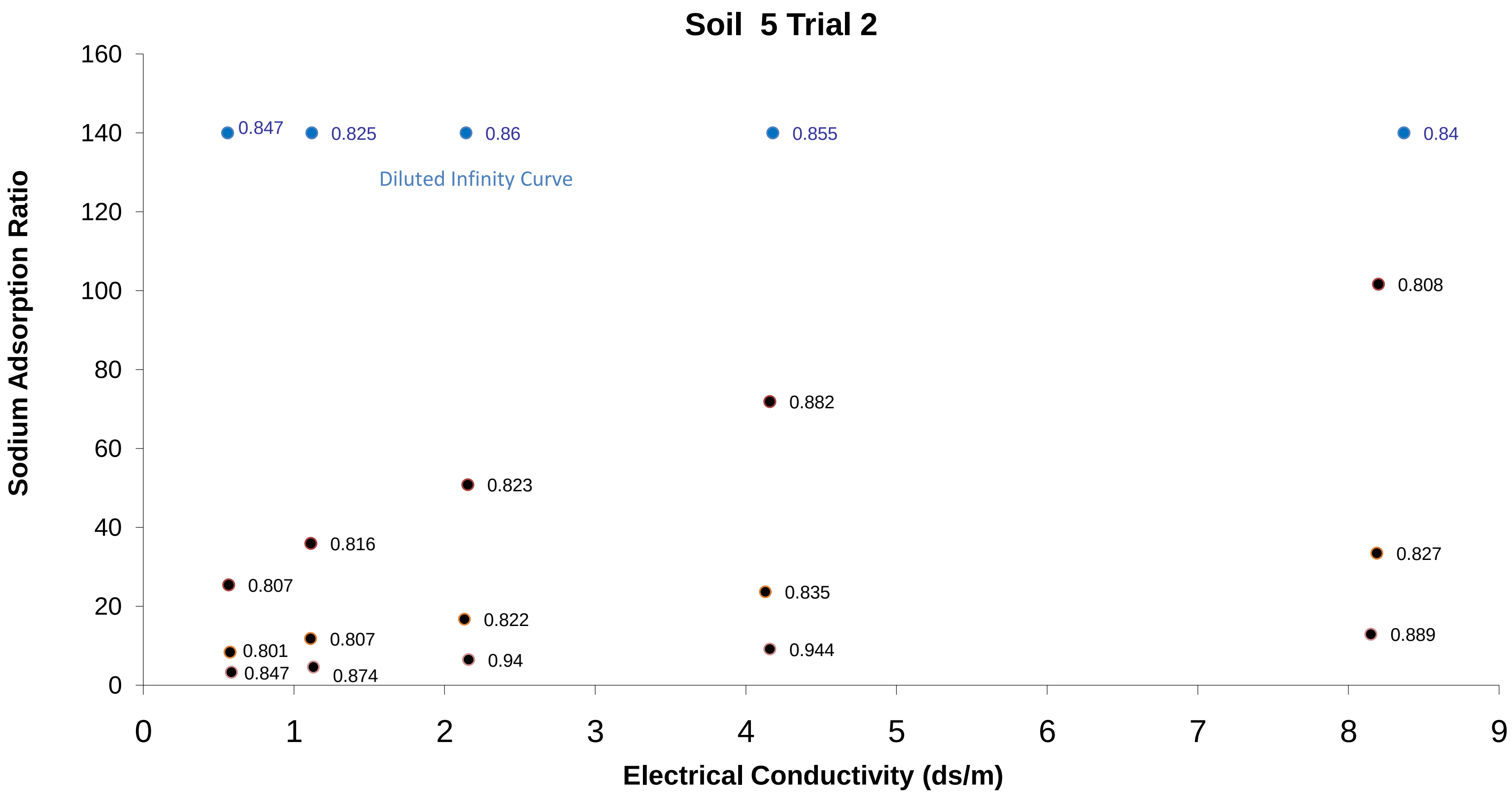

Figure D.7. Soil 5 Trial 2 relative saturated hydraulic conductivities over varying salt concentrations

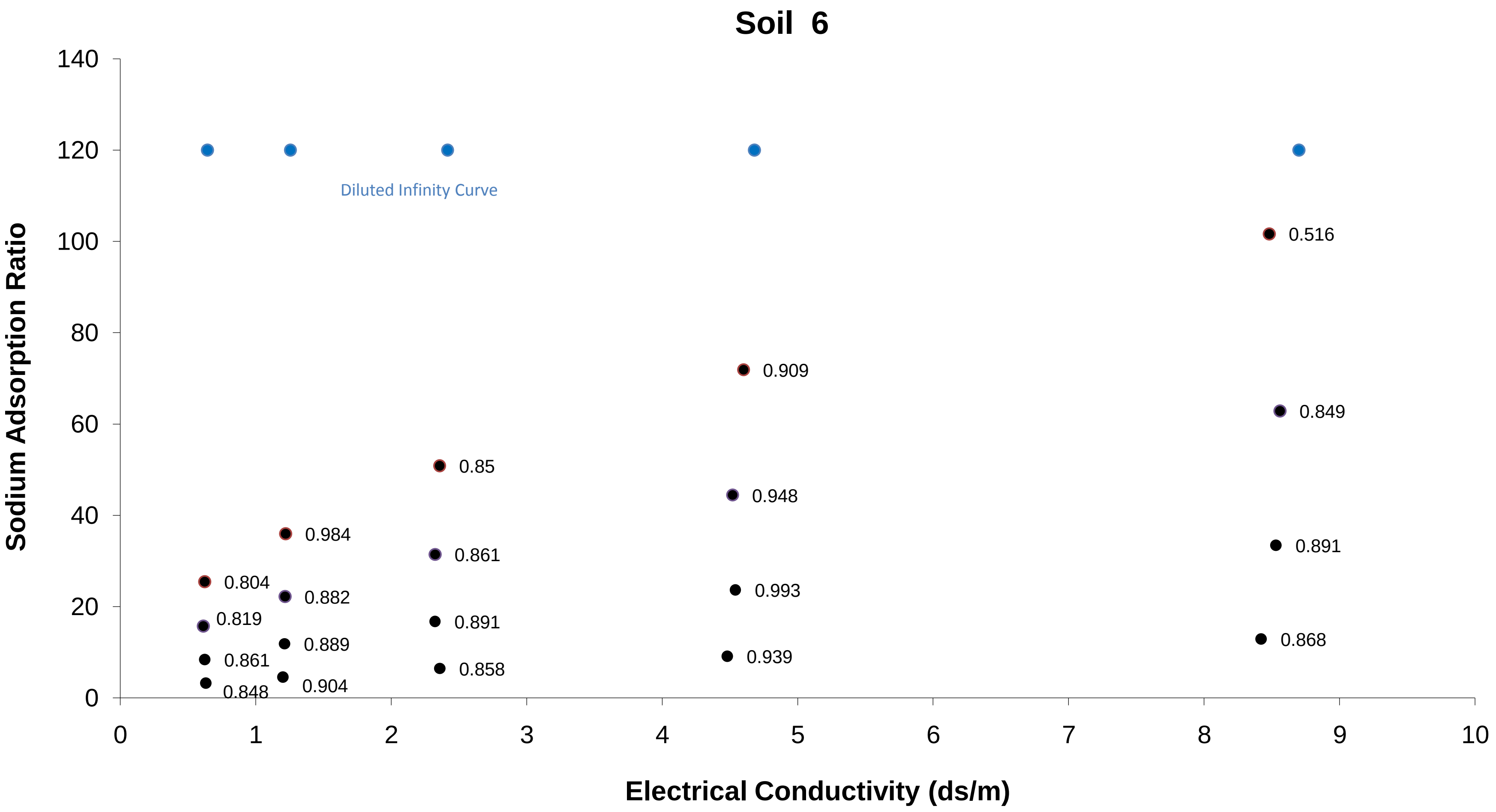

Figure D.85. Soil 6 relative saturated hydraulic conductivities over varying salt concentrations

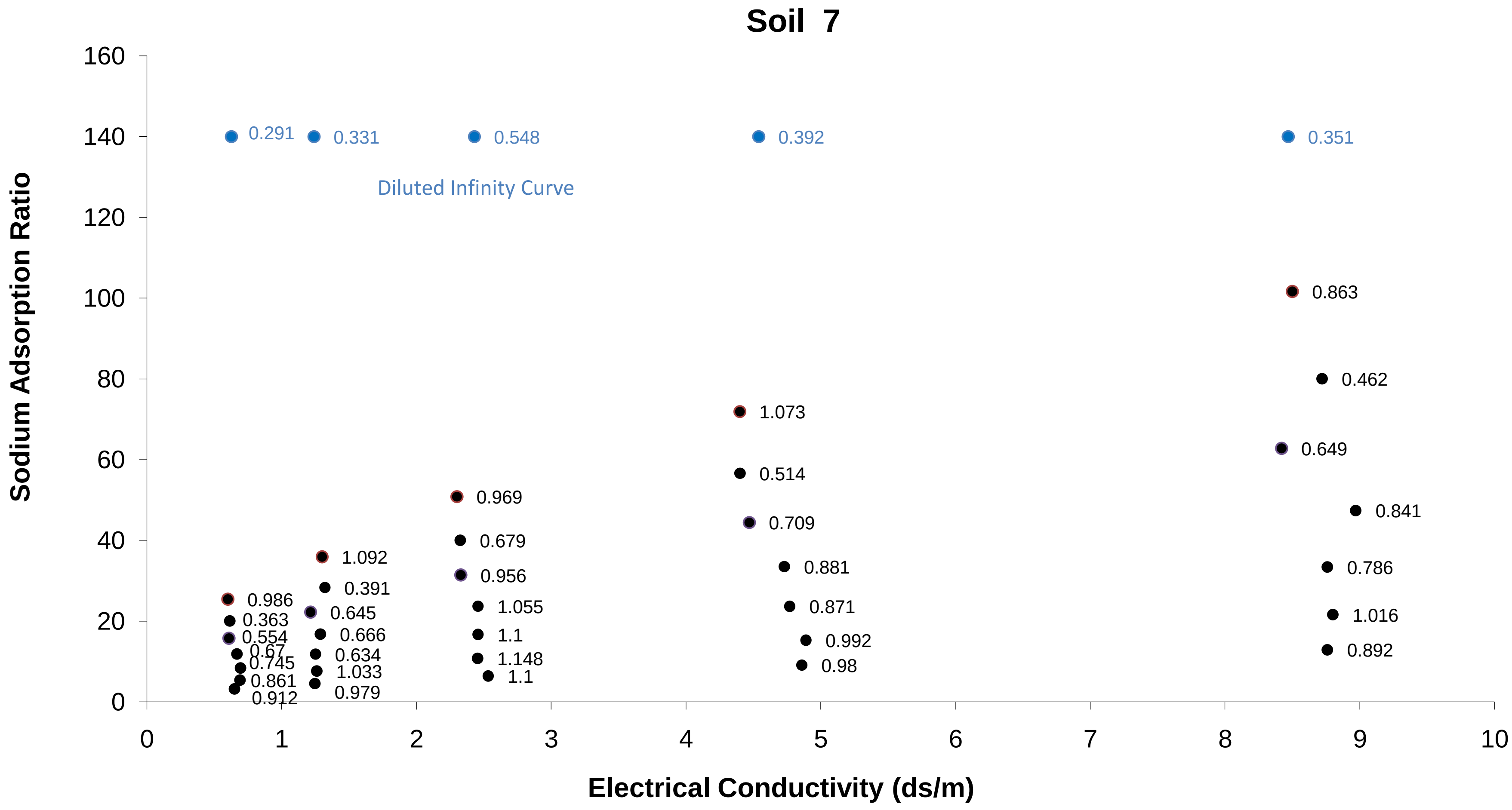

Figure D.9. Soil 7 relative saturated hydraulic conductivities over varying salt concentrations

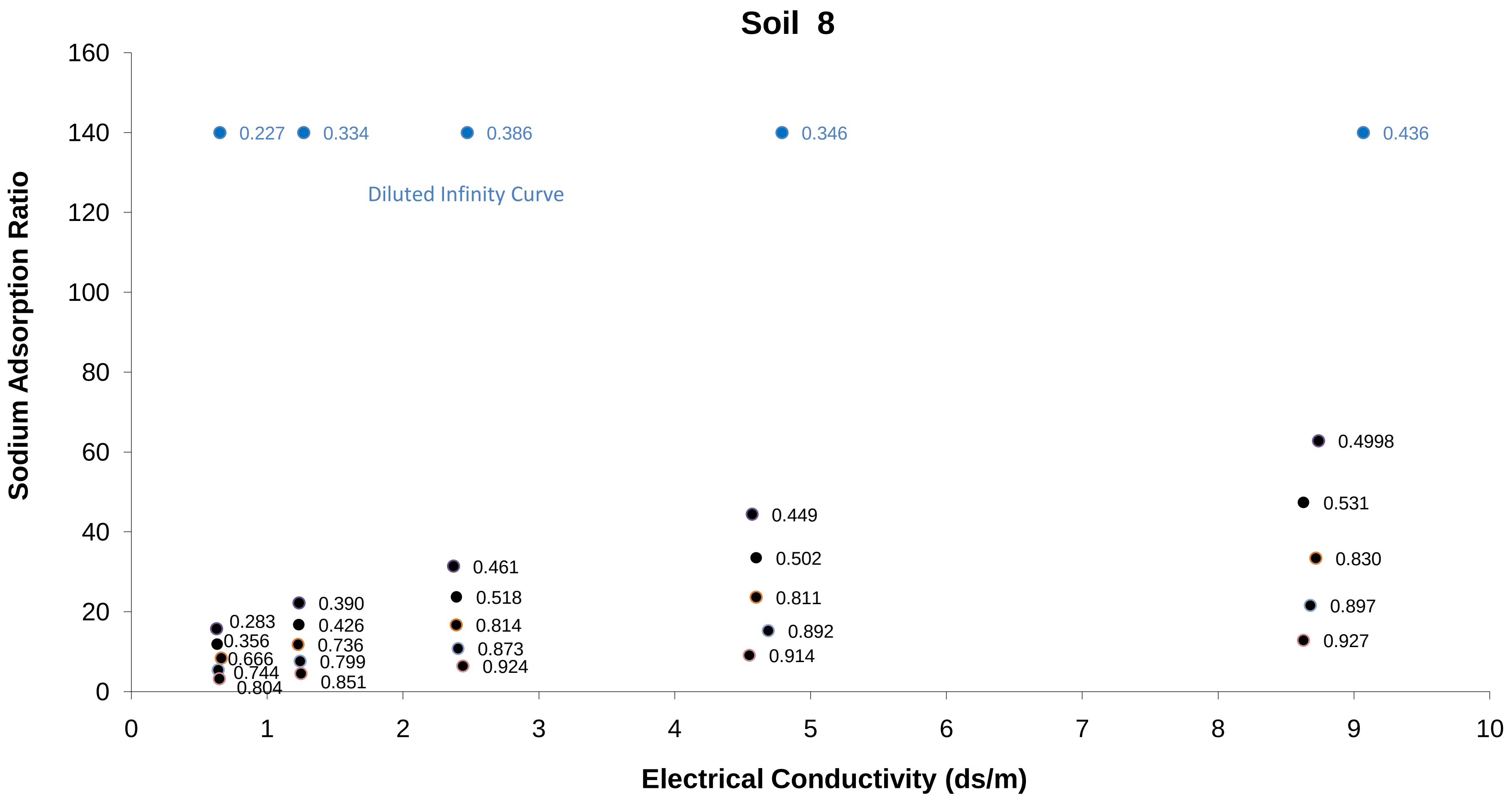

Figure D.10. Soil 8 relative saturated hydraulic conductivities over varying salt concentrations

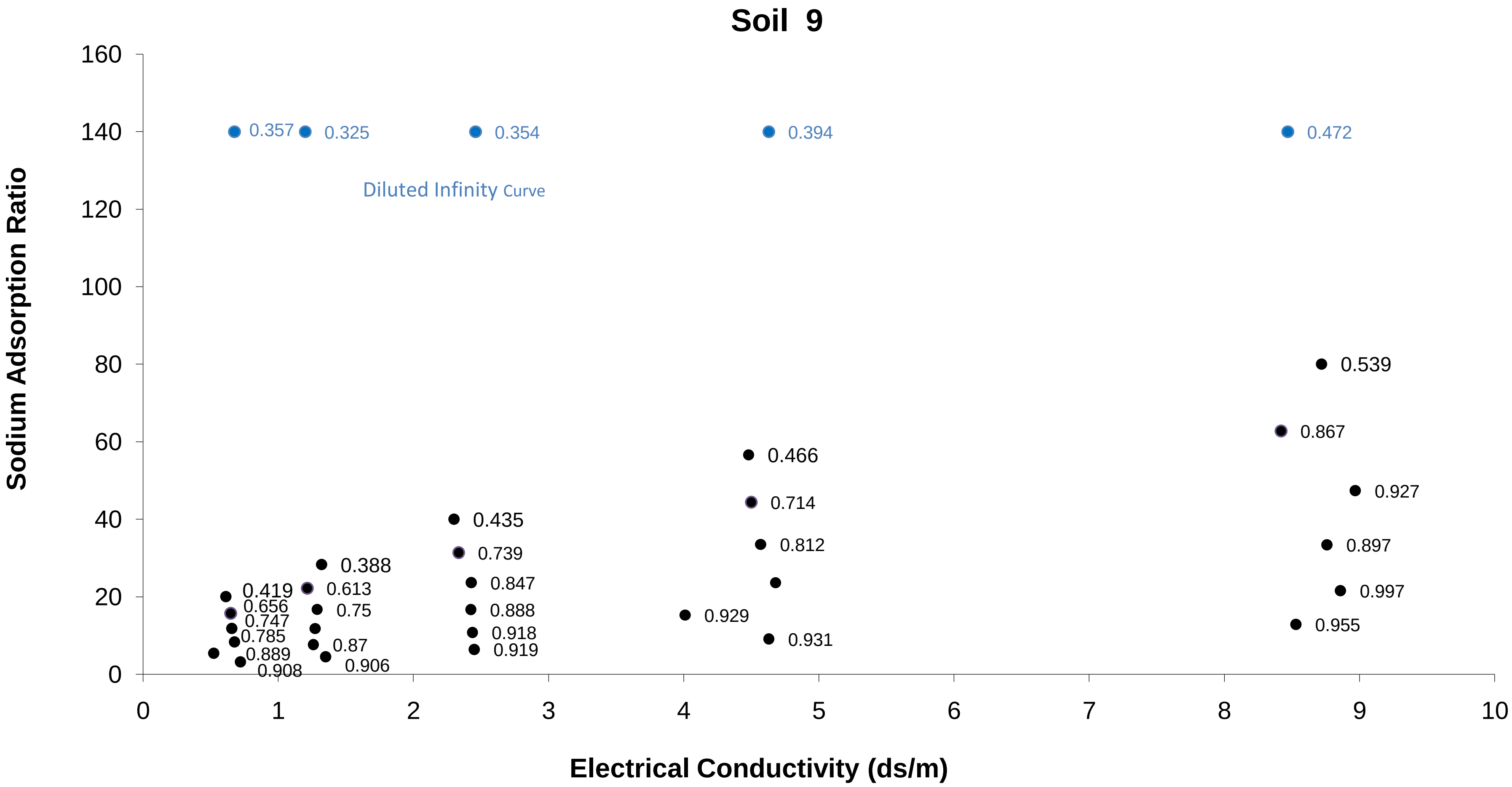

Figure D.11. Soil 9 relative saturated hydraulic conductivities over varying salt concentrations

Appendix E. Routine Analysis Data

Table E.1. Soil 1 routine analysis data

New Calculations of the standard solution used in the SAR trial										Corrected calculation as advised				Final Results			
Na (mequiv/L)	Ca (mequiv/L)	SAR	Est. EC	Na (mg/L)	Ca (mg/L)	NaCl (mg/L)	CaCl2.2 (H2O) (mg/L)	Total NaCl (g/4L)	Total CaCl2. H2O (g/4L)	Na (mg/L)	Ca (mg/L)	Na (mequiv/L)	Ca (mequiv/L)	Adjusted SAR	Est. EC	Meas. EC	Rksat %
80	0	#DIV/0!	8	1839.184	0	4675.16	0.00	18.70064	0	1839.168	0	80.00	0.00	140.0	8.0	8.650	0.784
40	0	#DIV/0!	4	919.592	0	2337.58	0.00	9.35032	0	919.5840001	0	40.00	0.00	140.0	4.0	4.600	0.931
20	0	#DIV/0!	2	459.796	0	1168.79	0.00	4.67516	0	459.792	0	20.00	0.00	140.0	2.0	2.368	0.835
10	0	#DIV/0!	1	229.898	0	584.39	0.00	2.33758	0	229.896	0	10.00	0.00	140.0	1.0	1.220	0.900
5	0	#DIV/0!	0.5	114.949	0	292.20	0.00	1.16879	0	114.948	0	5.00	0.00	140.0	0.5	0.628	0.809
78.8	1.2	101.7303626	8	1811.59624	24.048	4605.03	88.32	18.42013	0.35328	1811.58048	24.07744252	78.80	1.20	101.7	8.0	8.750	0.863
39.4	0.6	71.93422922	4	905.79812	12.024	2302.52	44.16	9.21006	0.17664	905.7902401	12.03872126	39.40	0.60	71.9	4.0	4.560	1.073
19.7	0.3	50.86518128	2	452.89906	6.012	1151.26	22.08	4.60503	0.08832	452.89512	6.019360631	19.70	0.30	50.8	2.0	2.384	0.969
9.85	0.15	35.96711461	1	226.44953	3.006	575.63	11.04	2.30252	0.04416	226.44756	3.009680316	9.85	0.15	35.9	1.0	1.240	1.092
4.925	0.075	25.43259064	0.5	113.224765	1.503	287.81	5.52	1.15126	0.02208	113.22378	1.504840158	4.92	0.08	25.4	0.5	0.633	0.986
78.1	1.9	80.1289093	8	1795.50338	38.076	4564.12	139.84	18.25650	0.55936	1795.48776	38.12261733	78.10	1.90	80.1	8.0	8.500	0.840
39.05	0.95	56.65969513	4	897.75169	19.038	2282.06	69.92	9.12825	0.27968	897.7438801	19.06130867	39.05	0.95	56.6	4.0	4.520	1.002
19.525	0.475	40.06445465	2	448.875845	9.519	1141.03	34.96	4.56412	0.13984	448.87194	9.530654333	19.52	0.48	40.0	2.0	2.337	0.949
9.7625	0.2375	28.32984757	1	224.4379225	4.7595	570.52	17.48	2.28206	0.06992	224.43597	4.765327166	9.76	0.24	28.3	1.0	1.227	0.994
4.88125	0.11875	20.03222732	0.5	112.2189613	2.37975	285.26	8.74	1.14103	0.03496	112.217985	2.382663583	4.88	0.12	20.0	0.5	0.628	0.964
77	3	62.87023673	8	1770.2146	60.12	4499.84	220.80	17.99936	0.8832	1770.1992	60.19360631	77.00	3.00	62.8	8.0	8.710	0.984

38.5	1.5	44.45597073	4	885.1073	30.06	2249.92	110.40	8.99968	0.4416	885.0996001	30.09680316	38.50	1.50	44.4	4.0	4.630	1.070
19.25	0.75	31.43511837	2	442.55365	15.03	1124.96	55.20	4.49984	0.2208	442.5498	15.04840158	19.25	0.75	31.4	2.0	2.394	1.012
9.625	0.375	22.22798536	1	221.276825	7.515	562.48	27.60	2.24992	0.1104	221.2749	7.524200789	9.62	0.38	22.2	1.0	1.244	1.087
4.8125	0.1875	15.71755918	0.5	110.6384125	3.7575	281.24	13.80	1.12496	0.0552	110.63745	3.762100395	4.81	0.19	15.7	0.5	0.625	1.092
75	5	47.4341649	8	1724.235	100.2	4382.96	368.00	17.53185	1.472	1724.22	100.3226772	75.00	5.01	47.4	8.0	8.600	0.942
37.5	2.5	33.54101966	4	862.1175	50.1	2191.48	184.00	8.76592	0.736	862.1100001	50.16133859	37.50	2.50	33.5	4.0	4.600	1.069
18.75	1.25	23.71708245	2	431.05875	25.05	1095.74	92.00	4.38296	0.368	431.055	25.0806693	18.75	1.25	23.7	2.0	2.380	0.980
9.375	0.625	16.77050983	1	215.529375	12.525	547.87	46.00	2.19148	0.184	215.5275	12.54033465	9.37	0.63	16.8	1.0	1.316	1.065
4.6875	0.3125	11.85854123	0.5	107.7646875	6.2625	273.94	23.00	1.09574	0.092	107.76375	6.270167324	4.69	0.31	11.9	0.5	0.631	1.042
71	9	33.46972098	8	1632.2758	180.36	4149.20	662.40	16.59682	2.6496	1632.2616	180.5808189	71.00	9.01	33.4	8.0	8.480	1.083
35.5	4.5	23.66666667	4	816.1379	90.18	2074.60	331.20	8.29841	1.3248	816.1308001	90.29040947	35.50	4.51	23.7	4.0	4.540	1.114
17.75	2.25	16.73486049	2	408.06895	45.09	1037.30	165.60	4.14920	0.6624	408.0654	45.14520473	17.75	2.25	16.7	2.0	2.329	1.005
8.875	1.125	11.83333333	1	204.034475	22.545	518.65	82.80	2.07460	0.3312	204.0327	22.57260237	8.87	1.13	11.8	1.0	1.224	1.057
4.4375	0.5625	8.367430244	0.5	102.0172375	11.2725	259.33	41.40	1.03730	0.1656	102.01635	11.28630118	4.44	0.56	8.4	0.5	0.621	1.172
63	17	21.60882173	8	1448.3574	340.68	3681.69	1251.20	14.72675	5.0048	1448.3448	341.0971024	63.00	17.02	21.6	8.0	8.500	1.097
31.5	8.5	15.27974438	4	724.1787	170.34	1840.84	625.60	7.36338	2.5024	724.1724001	170.5485512	31.50	8.51	15.3	4.0	4.520	1.070
15.75	4.25	10.80441086	2	362.08935	85.17	920.42	312.80	3.68169	1.2512	362.0862	85.27427561	15.75	4.26	10.8	2.0	2.342	0.992
7.875	2.125	7.639872189	1	181.044675	42.585	460.21	156.40	1.84084	0.6256	181.0431	42.6371378	7.87	2.13	7.6	1.0	1.215	1.033
3.9375	1.0625	5.402205432	0.5	90.5223375	21.2925	230.11	78.20	0.92042	0.3128	90.52155001	21.3185689	3.94	1.06	5.4	0.5	0.633	1.089
50	30	12.90994449	8	1149.49	601.2	2921.97	2208.00	11.68790	8.832	1149.48	601.9360631	50.00	30.04	12.9	8.0	8.420	0.979
25	15	9.128709292	4	574.745	300.6	1460.99	1104.00	5.84395	4.416	574.74	300.9680316	25.00	15.02	9.1	4.0	4.490	1.025
12.5	7.5	6.454972244	2	287.3725	150.3	730.49	552.00	2.92197	2.208	287.37	150.4840158	12.50	7.51	6.5	2.0	2.320	0.956

6.25	3.75	4.564354646	1	**143.68625**	**75.15**	**365.25**	**276.00**	**1.46099**	**1.104**	143.685	75.24200789	6.25	3.75	**4.6**	**1.0**	**1.224**	**0.958**
3.125	1.875	3.227486122	0.5	**71.843125**	**37.575**	**182.62**	**138.00**	**0.73049**	**0.552**	71.84250001	37.62100395	3.12	1.88	**3.2**	**0.5**	**0.632**	**1.056**
30	**50**	**6**	**8**	**689.694**	**1002**	**1753.18**	**3680.00**	**7.01274**	**14.72**	689.6880001	1003.226772	30.00	50.06	**6.0**	**8.0**		
15	25	4.242640687	4	**344.847**	**501**	**876.59**	**1840.00**	**3.50637**	**7.36**	344.844	501.6133859	15.00	25.03	**4.2**	**4.0**		
7.5	12.5	3	2	**172.4235**	**250.5**	**438.30**	**920.00**	**1.75318**	**3.68**	172.422	250.806693	7.50	12.52	**3.0**	**2.0**		
3.75	6.25	2.121320344	1	**86.21175**	**125.25**	**219.15**	**460.00**	**0.87659**	**1.84**	86.21100001	125.4033465	3.75	6.26	**2.1**	**1.0**		
1.875	3.125	1.5	0.5	**43.105875**	**62.625**	**109.57**	**230.00**	**0.43830**	**0.92**	43.1055	62.70167324	1.87	3.13	**1.5**	**0.5**		

Table E.2. Soil 2 routine analysis

New Calculations of the standard solution used in the SAR trial										Corrected calculation as advised				Final Results			
Na (mequiv /L)	Ca (mequiv/ L)	SAR	Est. EC	Na (mg/L)	Ca (mg/L)	NaCl (mg/L)	CaCl2.2 (H2O) (mg/L)	Total NaCl (g/4L)	Total CaCl2. H2O (g/4L)	Na (mg/L)	Ca (mg/L)	Na (mequiv/ L)	Ca (mequiv/ L)	Adjusted SAR	Est. EC	Meas. EC	Rksat %
80	0	#DIV/0!	8	1839.184	0	4675.16	0.00	18.70064	0	1839.168	0	80.00	0.00	140.0	8.0	8.650	0.784
40	0	#DIV/0!	4	919.592	0	2337.58	0.00	9.35032	0	919.5840001	0	40.00	0.00	140.0	4.0	4.600	0.931
20	0	#DIV/0!	2	459.796	0	1168.79	0.00	4.67516	0	459.792	0	20.00	0.00	140.0	2.0	2.368	0.835
10	0	#DIV/0!	1	229.898	0	584.39	0.00	2.33758	0	229.896	0	10.00	0.00	140.0	1.0	1.220	0.900
5	0	#DIV/0!	0.5	114.949	0	292.20	0.00	1.16879	0	114.948	0	5.00	0.00	140.0	0.5	0.628	0.809
78.8	1.2	101.7303626	8	1811.59624	24.048	4605.03	88.32	18.42013	0.35328	1811.58048	24.07744252	78.80	1.20	101.7	8.0	8.750	0.863
39.4	0.6	71.93422922	4	905.79812	12.024	2302.52	44.16	9.21006	0.17664	905.7902401	12.03872126	39.40	0.60	71.9	4.0	4.560	1.073
19.7	0.3	50.86518128	2	452.89906	6.012	1151.26	22.08	4.60503	0.08832	452.89512	6.019360631	19.70	0.30	50.8	2.0	2.384	0.969
9.85	0.15	35.96711461	1	226.44953	3.006	575.63	11.04	2.30252	0.04416	226.44756	3.009680316	9.85	0.15	35.9	1.0	1.240	1.092
4.925	0.075	25.43259064	0.5	113.224765	1.503	287.81	5.52	1.15126	0.02208	113.22378	1.504840158	4.92	0.08	25.4	0.5	0.633	0.986
78.1	1.9	80.1289093	8	1795.50338	38.076	4564.12	139.84	18.25650	0.55936	1795.48776	38.12261733	78.10	1.90	80.1	8.0	8.500	0.840
39.05	0.95	56.65969513	4	897.75169	19.038	2282.06	69.92	9.12825	0.27968	897.7438801	19.06130867	39.05	0.95	56.6	4.0	4.520	1.002
19.525	0.475	40.06445465	2	448.875845	9.519	1141.03	34.96	4.56412	0.13984	448.87194	9.530654333	19.52	0.48	40.0	2.0	2.337	0.949
9.7625	0.2375	28.32984757	1	224.4379225	4.7595	570.52	17.48	2.28206	0.06992	224.43597	4.765327166	9.76	0.24	28.3	1.0	1.227	0.994
4.88125	0.11875	20.03222732	0.5	112.2189613	2.37975	285.26	8.74	1.14103	0.03496	112.217985	2.382663583	4.88	0.12	20.0	0.5	0.628	0.964

77	3	62.87023673	8	1770.2146	60.12	4499.84	220.80	17.99936	0.8832	1770.1992	60.19360631	77.00	3.00	62.8	8.0	8.710	0.984
38.5	1.5	44.45597073	4	885.1073	30.06	2249.92	110.40	8.99968	0.4416	885.0996001	30.09680316	38.50	1.50	44.4	4.0	4.630	1.070
19.25	0.75	31.43511837	2	442.55365	15.03	1124.96	55.20	4.49984	0.2208	442.5498	15.04840158	19.25	0.75	31.4	2.0	2.394	1.012
9.625	0.375	22.22798536	1	221.276825	7.515	562.48	27.60	2.24992	0.1104	221.2749	7.524200789	9.62	0.38	22.2	1.0	1.244	1.087
4.8125	0.1875	15.71755918	0.5	110.6384125	3.7575	281.24	13.80	1.12496	0.0552	110.63745	3.762100395	4.81	0.19	15.7	0.5	0.625	1.092
75	5	47.4341649	8	1724.235	100.2	4382.96	368.00	17.53185	1.472	1724.22	100.3226772	75.00	5.01	47.4	8.0	8.600	0.942
37.5	2.5	33.54101966	4	862.1175	50.1	2191.48	184.00	8.76592	0.736	862.1100001	50.16133859	37.50	2.50	33.5	4.0	4.600	1.069
18.75	1.25	23.71708245	2	431.05875	25.05	1095.74	92.00	4.38296	0.368	431.055	25.0806693	18.75	1.25	23.7	2.0	2.380	0.980
9.375	0.625	16.77050983	1	215.529375	12.525	547.87	46.00	2.19148	0.184	215.5275	12.54033465	9.37	0.63	16.8	1.0	1.316	1.065
4.6875	0.3125	11.85854123	0.5	107.7646875	6.2625	273.94	23.00	1.09574	0.092	107.76375	6.270167324	4.69	0.31	11.9	0.5	0.631	1.042
71	9	33.46972098	8	1632.2758	180.36	4149.20	662.40	16.59682	2.6496	1632.2616	180.5808189	71.00	9.01	33.4	8.0	8.480	1.083
35.5	4.5	23.66666667	4	816.1379	90.18	2074.60	331.20	8.29841	1.3248	816.1308001	90.29040947	35.50	4.51	23.7	4.0	4.540	1.114
17.75	2.25	16.73486049	2	408.06895	45.09	1037.30	165.60	4.14920	0.6624	408.0654	45.14520473	17.75	2.25	16.7	2.0	2.329	1.005
8.875	1.125	11.83333333	1	204.034475	22.545	518.65	82.80	2.07460	0.3312	204.0327	22.57260237	8.87	1.13	11.8	1.0	1.224	1.057
4.4375	0.5625	8.367430244	0.5	102.0172375	11.2725	259.33	41.40	1.03730	0.1656	102.01635	11.28630118	4.44	0.56	8.4	0.5	0.621	1.172
63	17	21.60882173	8	1448.3574	340.68	3681.69	1251.20	14.72675	5.0048	1448.3448	341.0971024	63.00	17.02	21.6	8.0	8.500	1.097
31.5	8.5	15.27974438	4	724.1787	170.34	1840.84	625.60	7.36338	2.5024	724.1724001	170.5485512	31.50	8.51	15.3	4.0	4.520	1.070
15.75	4.25	10.80441086	2	362.08935	85.17	920.42	312.80	3.68169	1.2512	362.0862	85.27427561	15.75	4.26	10.8	2.0	2.342	0.992
7.875	2.125	7.639872189	1	181.044675	42.585	460.21	156.40	1.84084	0.6256	181.0431	42.6371378	7.87	2.13	7.6	1.0	1.215	1.033
3.9375	1.0625	5.402205432	0.5	90.5223375	21.2925	230.11	78.20	0.92042	0.3128	90.52155001	21.3185689	3.94	1.06	5.4	0.5	0.633	1.089
50	30	12.90994449	8	1149.49	601.2	2921.97	2208.00	11.68790	8.832	1149.48	601.9360631	50.00	30.04	12.9	8.0	8.420	0.979
25	15	9.128709292	4	574.745	300.6	1460.99	1104.00	5.84395	4.416	574.74	300.9680316	25.00	15.02	9.1	4.0	4.490	1.025

12.5	7.5	6.454972244	2	**287.3725**	**150.3**	**730.49**	**552.00**	**2.92197**	**2.208**	287.37	150.4840158	12.50	7.51	**6.5**	**2.0**	**2.320**	**0.956**
6.25	3.75	4.564354646	1	**143.68625**	**75.15**	**365.25**	**276.00**	**1.46099**	**1.104**	143.685	75.24200789	6.25	3.75	**4.6**	**1.0**	**1.224**	**0.958**
3.125	1.875	3.227486122	0.5	**71.843125**	**37.575**	**182.62**	**138.00**	**0.73049**	**0.552**	71.84250001	37.62100395	3.12	1.88	**3.2**	**0.5**	**0.632**	**1.056**
30	**50**	**6**	**8**	**689.694**	**1002**	**1753.18**	**3680.00**	**7.01274**	**14.72**	689.6880001	1003.226772	30.00	50.06	**6.0**	**8.0**		
15	25	4.242640687	4	**344.847**	**501**	**876.59**	**1840.00**	**3.50637**	**7.36**	344.844	501.6133859	15.00	25.03	**4.2**	**4.0**		
7.5	12.5	3	2	**172.4235**	**250.5**	**438.30**	**920.00**	**1.75318**	**3.68**	172.422	250.806693	7.50	12.52	**3.0**	**2.0**		
3.75	6.25	2.121320344	1	**86.21175**	**125.25**	**219.15**	**460.00**	**0.87659**	**1.84**	86.21100001	125.4033465	3.75	6.26	**2.1**	**1.0**		
1.875	3.125	1.5	0.5	**43.105875**	**62.625**	**109.57**	**230.00**	**0.43830**	**0.92**	43.1055	62.70167324	1.87	3.13	**1.5**	**0.5**		

Table E.3. Soil 2 Trial 2 routine analysis data

New Calculations of the standard solution used in the SAR trial										**Corrected calculation as advised**				**Final Results**			
Na (mequiv /L)	**Ca (mequiv /L)**	**SAR**	**Est. EC**	**Na (mg/L)**	**Ca (mg/L)**	**NaCl (mg/L)**	**CaCl2. 2(H2O) (mg/L)**	**Total NaCl (g/4L)**	**Total CaCl2. H2O (g/4L)**	**Na (mg/L)**	**Ca (mg/L)**	**Na (mequiv /L)**	**Ca (mequiv /L)**	**Adjusted SAR**	**Est. EC**	**Meas. EC**	**Rksat %**
80	**0**	**#DIV/0!**	**8**	**1839.184**	**0**	**4675.16**	**0.00**	**18.70064**	**0**	1839.168	0	80.00	0.00	**140.0**	**8.0**	**8.370**	**0.963**
40	0	#DIV/0!	4	**919.592**	**0**	**2337.58**	**0.00**	**9.35032**	**0**	919.5840001	0	40.00	0.00	**140.0**	**4.0**	**4.190**	**0.994**

20	0	#DIV/0!	2	459.796	0	1168.79	0.00	4.67516	0	459.792	0	20.00	0.00	140.0	2.0	2.143	0.929
10	0	#DIV/0!	1	229.898	0	584.39	0.00	2.33758	0	229.896	0	10.00	0.00	140.0	1.0		
5	0	#DIV/0!	0.5	114.949	0	292.20	0.00	1.16879	0	114.948	0	5.00	0.00	140.0	0.5	0.560	0.939
78.8	1.2	101.7303626	8	1811.59624	24.048	4605.03	88.32	18.42013	0.35328	1811.58048	24.07744252	78.80	1.20	101.7	8.0	8.200	0.941
39.4	0.6	71.93422922	4	905.79812	12.024	2302.52	44.16	9.21006	0.17664	905.7902401	12.03872126	39.40	0.60	71.9	4.0	4.160	0.982
19.7	0.3	50.86518128	2	452.89906	6.012	1151.26	22.08	4.60503	0.08832	452.89512	6.019360631	19.70	0.30	50.8	2.0	2.155	0.871
9.85	0.15	35.96711461	1	226.44953	3.006	575.63	11.04	2.30252	0.04416	226.44756	3.009680316	9.85	0.15	35.9	1.0	1.113	0.849
4.925	0.075	25.43259064	0.5	113.224765	1.503	287.81	5.52	1.15126	0.02208	113.22378	1.504840158	4.92	0.08	25.4	0.5	0.567	0.863
78.1	1.9	80.1289093	8	1795.50338	38.076	4564.12	139.84	18.25650	0.55936	1795.48776	38.12261733	78.10	1.90	80.1	8.0		
39.05	0.95	56.65969513	4	897.75169	19.038	2282.06	69.92	9.12825	0.27968	897.7438801	19.06130867	39.05	0.95	56.6	4.0		
19.525	0.475	40.06445465	2	448.875845	9.519	1141.03	34.96	4.56412	0.13984	448.87194	9.530654333	19.52	0.48	40.0	2.0		
9.7625	0.2375	28.32984757	1	224.4379225	4.7595	570.52	17.48	2.28206	0.06992	224.43597	4.765327166	9.76	0.24	28.3	1.0		
4.88125	0.11875	20.03222732	0.5	112.2189613	2.37975	285.26	8.74	1.14103	0.03496	112.217985	2.382663583	4.88	0.12	20.0	0.5		
77	3	62.87023673	8	1770.2146	60.12	4499.84	220.80	17.99936	0.8832	1770.1992	60.19360631	77.00	3.00	62.8	8.0		
38.5	1.5	44.45597073	4	885.1073	30.06	2249.92	110.40	8.99968	0.4416	885.0996001	30.09680316	38.50	1.50	44.4	4.0		
19.25	0.75	31.43511837	2	442.55365	15.03	1124.96	55.20	4.49984	0.2208	442.5498	15.04840158	19.25	0.75	31.4	2.0		
9.625	0.375	22.22798536	1	221.276825	7.515	562.48	27.60	2.24992	0.1104	221.2749	7.524200789	9.62	0.38	22.2	1.0		
4.8125	0.1875	15.71755918	0.5	110.6384125	3.7575	281.24	13.80	1.12496	0.0552	110.63745	3.762100395	4.81	0.19	15.7	0.5		
75	5	47.4341649	8	1724.235	100.2	4382.96	368.00	17.53185	1.472	1724.22	100.3226772	75.00	5.01	47.4	8.0		
37.5	2.5	33.54101966	4	862.1175	50.1	2191.48	184.00	8.76592	0.736	862.1100001	50.16133859	37.50	2.50	33.5	4.0		
18.75	1.25	23.71708245	2	431.05875	25.05	1095.74	92.00	4.38296	0.368	431.055	25.0806693	18.75	1.25	23.7	2.0		
9.375	0.625	16.77050983	1	215.529375	12.525	547.87	46.00	2.19148	0.184	215.5275	12.54033465	9.37	0.63	16.8	1.0		

4.6875	0.3125	11.85854123	0.5	107.7646875	6.2625	273.94	23.00	1.09574	0.092	107.76375	6.270167324	4.69	0.31	11.9	0.5		
71	9	33.46972098	8	1632.2758	180.36	4149.20	662.40	16.59682	2.6496	1632.2616	180.5808189	71.00	9.01	33.4	8.0	8.190	0.937
35.5	4.5	23.66666667	4	816.1379	90.18	2074.60	331.20	8.29841	1.3248	816.1308001	90.29040947	35.50	4.51	23.7	4.0	4.160	0.959
17.75	2.25	16.73486049	2	408.06895	45.09	1037.30	165.60	4.14920	0.6624	408.0654	45.14520473	17.75	2.25	16.7	2.0	2.132	0.886
8.875	1.125	11.83333333	1	204.034475	22.545	518.65	82.80	2.07460	0.3312	204.0327	22.57260237	8.87	1.13	11.8	1.0	1.100	0.875
4.4375	0.5625	8.367430244	0.5	102.0172375	11.2725	259.33	41.40	1.03730	0.1656	102.01635	11.28630118	4.44	0.56	8.4	0.5	0.565	0.866
63	17	21.60882173	8	1448.3574	340.68	3681.69	1251.20	14.72675	5.0048	1448.3448	341.0971024	63.00	17.02	21.6	8.0		
31.5	8.5	15.27974438	4	724.1787	170.34	1840.84	625.60	7.36338	2.5024	724.1724001	170.5485512	31.50	8.51	15.3	4.0		
15.75	4.25	10.80441086	2	362.08935	85.17	920.42	312.80	3.68169	1.2512	362.0862	85.27427561	15.75	4.26	10.8	2.0		
7.875	2.125	7.639872189	1	181.044675	42.585	460.21	156.40	1.84084	0.6256	181.0431	42.6371378	7.87	2.13	7.6	1.0		
3.9375	1.0625	5.402205432	0.5	90.5223375	21.2925	230.11	78.20	0.92042	0.3128	90.52155001	21.3185689	3.94	1.06	5.4	0.5		
50	30	12.90994449	8	1149.49	601.2	2921.97	2208.00	11.68790	8.832	1149.48	601.9360631	50.00	30.04	12.9	8.0	8.150	0.968
25	15	9.128709292	4	574.745	300.6	1460.99	1104.00	5.84395	4.416	574.74	300.9680316	25.00	15.02	9.1	4.0	4.140	0.991
12.5	7.5	6.454972244	2	287.3725	150.3	730.49	552.00	2.92197	2.208	287.37	150.4840158	12.50	7.51	6.5	2.0	2.160	0.982
6.25	3.75	4.564354646	1	143.68625	75.15	365.25	276.00	1.46099	1.104	143.685	75.24200789	6.25	3.75	4.6	1.0	1.137	0.893
3.125	1.875	3.227486122	0.5	71.843125	37.575	182.62	138.00	0.73049	0.552	71.84250001	37.62100395	3.12	1.88	3.2	0.5	0.577	0.974
30	50	6	8	689.694	1002	1753.18	3680.00	7.01274	14.72	689.6880001	1003.226772	30.00	50.06	6.0	8.0		
15	25	4.242640687	4	344.847	501	876.59	1840.00	3.50637	7.36	344.844	501.6133859	15.00	25.03	4.2	4.0		
7.5	12.5	3	2	172.4235	250.5	438.30	920.00	1.75318	3.68	172.422	250.806693	7.50	12.52	3.0	2.0		
3.75	6.25	2.121320344	1	86.21175	125.25	219.15	460.00	0.87659	1.84	86.21100001	125.4033465	3.75	6.26	2.1	1.0		
1.875	3.125	1.5	0.5	43.105875	62.625	109.57	230.00	0.43830	0.92	43.1055	62.70167324	1.87	3.13	1.5	0.5		

Table E.4. Soil 3 routine analysis data

New Calculations of the standard solution used in the SAR trial										Corrected calculation as advised				Final Results			
Na (mequiv/L)	Ca (mequiv/L)	SAR	Est. EC	Na (mg/L)	Ca (mg/L)	NaCl (mg/L)	CaCl2.2 (H2O) (mg/L)	Total NaCl (g/4L)	Total CaCl2. H2O (g/4L)	Na (mg/L)	Ca (mg/L)	Na (mequiv/L)	Ca (mequiv/L)	Adjusted SAR	Est. EC	Meas. EC	Rksat %
80	**0**	**#DIV/0!**	**8**	**1839.184**	**0**	**4675.16**	**0.00**	**18.70064**	**0**	1839.168	0	80.00	0.00	**140.0**	**8.0**	**8.510**	**0.515**
40	0	#DIV/0!	4	**919.592**	**0**	**2337.58**	**0.00**	**9.35032**	**0**	919.5840001	0	40.00	0.00	**140.0**	**4.0**	**4.580**	**0.412**
20	0	#DIV/0!	2	**459.796**	**0**	**1168.79**	**0.00**	**4.67516**	**0**	459.792	0	20.00	0.00	**140.0**	**2.0**	**2.383**	**0.444**
10	0	#DIV/0!	1	**229.898**	**0**	**584.39**	**0.00**	**2.33758**	**0**	229.896	0	10.00	0.00	**140.0**	**1.0**	**1.236**	**0.337**
5	0	#DIV/0!	0.5	**114.949**	**0**	**292.20**	**0.00**	**1.16879**	**0**	114.948	0	5.00	0.00	**140.0**	**0.5**	**0.597**	**0.370**
78.8	**1.2**	**101.7303626**	**8**	**1811.59624**	**24.048**	**4605.03**	**88.32**	**18.42013**	**0.35328**	1811.58048	24.07744252	78.80	1.20	**101.7**	**8.0**		
39.4	0.6	71.93422922	4	**905.79812**	**12.024**	**2302.52**	**44.16**	**9.21006**	**0.17664**	905.7902401	12.03872126	39.40	0.60	**71.9**	**4.0**		
19.7	0.3	50.86518128	2	**452.89906**	**6.012**	**1151.26**	**22.08**	**4.60503**	**0.08832**	452.89512	6.019360631	19.70	0.30	**50.8**	**2.0**		
9.85	0.15	35.96711461	1	**226.44953**	**3.006**	**575.63**	**11.04**	**2.30252**	**0.04416**	226.44756	3.009680316	9.85	0.15	**35.9**	**1.0**		
4.925	0.075	25.43259064	0.5	**113.224765**	**1.503**	**287.81**	**5.52**	**1.15126**	**0.02208**	113.22378	1.504840158	4.92	0.08	**25.4**	**0.5**		
78.1	**1.9**	**80.1289093**	**8**	**1795.50338**	**38.076**	**4564.12**	**139.84**	**18.25650**	**0.55936**	1795.48776	38.12261733	78.10	1.90	**80.1**	**8.0**	**8.600**	**0.583**
39.05	0.95	56.65969513	4	**897.75169**	**19.038**	**2282.06**	**69.92**	**9.12825**	**0.27968**	897.7438801	19.06130867	39.05	0.95	**56.6**	**4.0**	**4.580**	**0.482**
19.525	0.475	40.06445465	2	**448.875845**	**9.519**	**1141.03**	**34.96**	**4.56412**	**0.13984**	448.87194	9.530654333	19.52	0.48	**40.0**	**2.0**	**2.350**	**0.516**
9.7625	0.2375	28.32984757	1	**224.4379225**	**4.7595**	**570.52**	**17.48**	**2.28206**	**0.06992**	224.43597	4.765327166	9.76	0.24	**28.3**	**1.0**	**1.320**	**0.382**
4.88125	0.11875	20.03222732	0.5	**112.2189613**	**2.37975**	**285.26**	**8.74**	**1.14103**	**0.03496**	112.217985	2.382663583	4.88	0.12	**20.0**	**0.5**	**0.626**	**0.365**
77	**3**	**62.87023673**	**8**	**1770.2146**	**60.12**	**4499.84**	**220.80**	**17.99936**	**0.8832**	1770.1992	60.19360631	77.00	3.00	**62.8**	**8.0**	**8.430**	**0.872**

38.5	1.5	44.45597073	4	885.1073	30.06	2249.92	110.40	8.99968	0.4416	885.0996001	30.09680316	38.50	1.50	44.4	4.0	4.570	0.792
19.25	0.75	31.43511837	2	442.55365	15.03	1124.96	55.20	4.49984	0.2208	442.5498	15.04840158	19.25	0.75	31.4	2.0	2.373	0.821
9.625	0.375	22.22798536	1	221.276825	7.515	562.48	27.60	2.24992	0.1104	221.2749	7.524200789	9.62	0.38	22.2	1.0	1.215	0.556
4.8125	0.1875	15.71755918	0.5	110.6384125	3.7575	281.24	13.80	1.12496	0.0552	110.63745	3.762100395	4.81	0.19	15.7	0.5	0.626	0.585
75	5	47.4341649	8	1724.235	100.2	4382.96	368.00	17.53185	1.472	1724.22	100.3226772	75.00	5.01	47.4	8.0	8.630	1.000
37.5	2.5	33.54101966	4	862.1175	50.1	2191.48	184.00	8.76592	0.736	862.1100001	50.16133859	37.50	2.50	33.5	4.0	4.570	0.887
18.75	1.25	23.71708245	2	431.05875	25.05	1095.74	92.00	4.38296	0.368	431.055	25.0806693	18.75	1.25	23.7	2.0	2.373	0.899
9.375	0.625	16.77050983	1	215.529375	12.525	547.87	46.00	2.19148	0.184	215.5275	12.54033465	9.37	0.63	16.8	1.0	1.251	0.648
4.6875	0.3125	11.85854123	0.5	107.7646875	6.2625	273.94	23.00	1.09574	0.092	107.76375	6.270167324	4.69	0.31	11.9	0.5	0.622	0.613
71	9	33.46972098	8	1632.2758	180.36	4149.20	662.40	16.59682	2.6496	1632.2616	180.5808189	71.00	9.01	33.4	8.0	8.500	0.966
35.5	4.5	23.66666667	4	816.1379	90.18	2074.60	331.20	8.29841	1.3248	816.1308001	90.29040947	35.50	4.51	23.7	4.0	4.520	0.922
17.75	2.25	16.73486049	2	408.06895	45.09	1037.30	165.60	4.14920	0.6624	408.0654	45.14520473	17.75	2.25	16.7	2.0	2.377	0.945
8.875	1.125	11.83333333	1	204.034475	22.545	518.65	82.80	2.07460	0.3312	204.0327	22.57260237	8.87	1.13	11.8	1.0	1.226	0.754
4.4375	0.5625	8.367430244	0.5	102.0172375	11.2725	259.33	41.40	1.03730	0.1656	102.01635	11.28630118	4.44	0.56	8.4	0.5	0.631	0.598
63	17	21.60882173	8	1448.3574	340.68	3681.69	1251.20	14.72675	5.0048	1448.3448	341.0971024	63.00	17.02	21.6	8.0	8.650	0.985
31.5	8.5	15.27974438	4	724.1787	170.34	1840.84	625.60	7.36338	2.5024	724.1724001	170.5485512	31.50	8.51	15.3	4.0	4.580	0.958
15.75	4.25	10.80441086	2	362.08935	85.17	920.42	312.80	3.68169	1.2512	362.0862	85.27427561	15.75	4.26	10.8	2.0	2.364	0.955
7.875	2.125	7.639872189	1	181.044675	42.585	460.21	156.40	1.84084	0.6256	181.0431	42.6371378	7.87	2.13	7.6	1.0	1.260	0.804
3.9375	1.0625	5.402205432	0.5	90.5223375	21.2925	230.11	78.20	0.92042	0.3128	90.52155001	21.3185689	3.94	1.06	5.4	0.5	0.627	0.750

50	**30**	**12.90994449**	**8**	**1149.49**	**601.2**	**2921.97**	**2208.00**	**11.68790**	**8.832**	1149.48	601.9360631	50.00	30.04	**12.9**	**8.0**	**8.450**	**0.954**
25	15	9.128709292	4	**574.745**	**300.6**	**1460.99**	**1104.00**	**5.84395**	**4.416**	574.74	300.9680316	25.00	15.02	**9.1**	**4.0**	**4.500**	**0.933**
12.5	7.5	6.454972244	2	**287.3725**	**150.3**	**730.49**	**552.00**	**2.92197**	**2.208**	287.37	150.4840158	12.50	7.51	**6.5**	**2.0**	**2.324**	**0.921**
6.25	3.75	4.564354646	1	**143.68625**	**75.15**	**365.25**	**276.00**	**1.46099**	**1.104**	143.685	75.24200789	6.25	3.75	**4.6**	**1.0**	**1.236**	**0.862**
3.125	1.875	3.227486122	0.5	**71.843125**	**37.575**	**182.62**	**138.00**	**0.73049**	**0.552**	71.84250001	37.62100395	3.12	1.88	**3.2**	**0.5**	**0.635**	**0.793**
30	**50**	**6**	**8**	**689.694**	**1002**	**1753.18**	**3680.00**	**7.01274**	**14.72**	689.6880001	1003.226772	30.00	50.06	**6.0**	**8.0**		
15	25	4.242640687	4	**344.847**	**501**	**876.59**	**1840.00**	**3.50637**	**7.36**	344.844	501.6133859	15.00	25.03	**4.2**	**4.0**		
7.5	12.5	3	2	**172.4235**	**250.5**	**438.30**	**920.00**	**1.75318**	**3.68**	172.422	250.806693	7.50	12.52	**3.0**	**2.0**		
3.75	6.25	2.121320344	1	**86.21175**	**125.25**	**219.15**	**460.00**	**0.87659**	**1.84**	86.21100001	125.4033465	3.75	6.26	**2.1**	**1.0**		
1.875	3.125	1.5	0.5	**43.105875**	**62.625**	**109.57**	**230.00**	**0.43830**	**0.92**	43.1055	62.70167324	1.87	3.13	**1.5**	**0.5**		

Table E.3. Soil 4 routine analysis data

New Calculations of the standard solution used in the SAR trial										Corrected calculation as advised				Final Results			
Na (mequiv/L)	Ca (mequiv/L)	SAR	Est. EC	Na (mg/L)	Ca (mg/L)	NaCl (mg/L)	CaCl2.2 (H2O) (mg/L)	Total NaCl (g/4L)	Total CaCl2. H2O (g/4L)	Na (mg/L)	Ca (mg/L)	Na (mequiv/L)	Ca (mequiv/L)	Adjusted SAR	Est. EC	Meas. EC	Rksat %
80	0	#DIV/0!	8	1839.184	0	4675.16	0.00	18.70064	0	1839.168	0	80.00	0.00	140.0	8.0	8.510	0.601
40	0	#DIV/0!	4	919.592	0	2337.58	0.00	9.35032	0	919.5840001	0	40.00	0.00	140.0	4.0	4.630	0.655
20	0	#DIV/0!	2	459.796	0	1168.79	0.00	4.67516	0	459.792	0	20.00	0.00	140.0	2.0	2.329	0.779
10	0	#DIV/0!	1	229.898	0	584.39	0.00	2.33758	0	229.896	0	10.00	0.00	140.0	1.0	1.219	0.666
5	0	#DIV/0!	0.5	114.949	0	292.20	0.00	1.16879	0	114.948	0	5.00	0.00	140.0	0.5	0.587	0.713
78.8	1.2	101.7303626	8	1811.59624	24.048	4605.03	88.32	18.42013	0.35328	1811.58048	24.07744252	78.80	1.20	101.666	8.0		
39.4	0.6	71.93422922	4	905.79812	12.024	2302.52	44.16	9.21006	0.17664	905.7902401	12.03872126	39.40	0.60	71.889	4.0		
19.7	0.3	50.86518128	2	452.89906	6.012	1151.26	22.08	4.60503	0.08832	452.89512	6.019360631	19.70	0.30	50.833	2.0		
9.85	0.15	35.96711461	1	226.44953	3.006	575.63	11.04	2.30252	0.04416	226.44756	3.009680316	9.85	0.15	35.944	1.0		
4.925	0.075	25.43259064	0.5	113.224765	1.503	287.81	5.52	1.15126	0.02208	113.22378	1.504840158	4.92	0.08	25.417	0.5		
78.1	1.9	80.1289093	8	1795.50338	38.076	4564.12	139.84	18.25650	0.55936	1795.48776	38.12261733	78.10	1.90	80.079	8.0	8.600	0.642
39.05	0.95	56.65969513	4	897.75169	19.038	2282.06	69.92	9.12825	0.27968	897.7438801	19.06130867	39.05	0.95	56.624	4.0	4.560	0.680
19.525	0.475	40.06445465	2	448.875845	9.519	1141.03	34.96	4.56412	0.13984	448.87194	9.530654333	19.52	0.48	40.039	2.0	2.358	0.865
9.7625	0.2375	28.32984757	1	224.4379225	4.7595	570.52	17.48	2.28206	0.06992	224.43597	4.765327166	9.76	0.24	28.312	1.0	1.320	0.675
4.88125	0.11875	20.03222732	0.5	112.2189613	2.37975	285.26	8.74	1.14103	0.03496	112.217985	2.382663583	4.88	0.12	20.020	0.5	0.631	0.714
77	3	62.87023673	8	1770.2146	60.12	4499.84	220.80	17.99936	0.8832	1770.1992	60.19360631	77.00	3.00	62.831	8.0	8.430	0.704

38.5	1.5	44.45597073	4	**885.1073**	**30.06**	**2249.92**	**110.40**	**8.99968**	**0.4416**	885.0996001	30.09680316	38.50	1.50	**44.428**	**4.0**	**4.550**	**0.752**
19.25	0.75	31.43511837	2	**442.55365**	**15.03**	**1124.96**	**55.20**	**4.49984**	**0.2208**	442.5498	15.04840158	19.25	0.75	**31.415**	**2.0**	**2.363**	**0.700**
9.625	0.375	22.22798536	1	**221.276825**	**7.515**	**562.48**	**27.60**	**2.24992**	**0.1104**	221.2749	7.524200789	9.62	0.38	**22.214**	**1.0**	**1.215**	**0.702**
4.8125	0.1875	15.71755918	0.5	**110.6384125**	**3.7575**	**281.24**	**13.80**	**1.12496**	**0.0552**	110.63745	3.762100395	4.81	0.19	**15.708**	**0.5**	**0.617**	**0.783**
75	**5**	**47.4341649**	**8**	**1724.235**	**100.2**	**4382.96**	**368.00**	**17.53185**	**1.472**	1724.22	100.3226772	75.00	5.01	**47.4**	**8.0**	**8.630**	**0.750**
37.5	2.5	33.54101966	4	**862.1175**	**50.1**	**2191.48**	**184.00**	**8.76592**	**0.736**	862.1100001	50.16133859	37.50	2.50	**33.5**	**4.0**	**4.550**	**0.802**
18.75	1.25	23.71708245	2	**431.05875**	**25.05**	**1095.74**	**92.00**	**4.38296**	**0.368**	431.055	25.0806693	18.75	1.25	**23.7**	**2.0**	**2.363**	**0.736**
9.375	0.625	16.77050983	1	**215.529375**	**12.525**	**547.87**	**46.00**	**2.19148**	**0.184**	215.5275	12.54033465	9.37	0.63	**16.8**	**1.0**	**1.251**	**0.718**
4.6875	0.3125	11.85854123	0.5	**107.7646875**	**6.2625**	**273.94**	**23.00**	**1.09574**	**0.092**	107.76375	6.270167324	4.69	0.31	**11.9**	**0.5**	**0.626**	**0.836**
71	**9**	**33.46972098**	**8**	**1632.2758**	**180.36**	**4149.20**	**662.40**	**16.59682**	**2.6496**	1632.2616	180.5808189	71.00	9.01	**33.4**	**8.0**	**8.630**	**0.775**
35.5	4.5	23.66666667	4	**816.1379**	**90.18**	**2074.60**	**331.20**	**8.29841**	**1.3248**	816.1308001	90.29040947	35.50	4.51	**23.7**	**4.0**	**4.600**	**0.858**
17.75	2.25	16.73486049	2	**408.06895**	**45.09**	**1037.30**	**165.60**	**4.14920**	**0.6624**	408.0654	45.14520473	17.75	2.25	**16.7**	**2.0**	**2.383**	**0.730**
8.875	1.125	11.83333333	1	**204.034475**	**22.545**	**518.65**	**82.80**	**2.07460**	**0.3312**	204.0327	22.57260237	8.87	1.13	**11.8**	**1.0**	**1.215**	**0.772**
4.4375	0.5625	8.367430244	0.5	**102.0172375**	**11.2725**	**259.33**	**41.40**	**1.03730**	**0.1656**	102.01635	11.28630118	4.44	0.56	**8.4**	**0.5**	**0.635**	**0.855**
63	**17**	**21.60882173**	**8**	**1448.3574**	**340.68**	**3681.69**	**1251.20**	**14.72675**	**5.0048**	1448.3448	341.0971024	63.00	17.02	**21.6**	**8.0**	**8.390**	**0.888**
31.5	8.5	15.27974438	4	**724.1787**	**170.34**	**1840.84**	**625.60**	**7.36338**	**2.5024**	724.1724001	170.5485512	31.50	8.51	**15.3**	**4.0**	**4.570**	**0.937**
15.75	4.25	10.80441086	2	**362.08935**	**85.17**	**920.42**	**312.80**	**3.68169**	**1.2512**	362.0862	85.27427561	15.75	4.26	**10.8**	**2.0**	**2.405**	**0.880**
7.875	2.125	7.639872189	1	**181.044675**	**42.585**	**460.21**	**156.40**	**1.84084**	**0.6256**	181.0431	42.6371378	7.87	2.13	**7.6**	**1.0**	**1.260**	**0.868**
3.9375	1.0625	5.402205432	0.5	**90.5223375**	**21.2925**	**230.11**	**78.20**	**0.92042**	**0.3128**	90.52155001	21.3185689	3.94	1.06	**5.4**	**0.5**	**0.628**	**0.914**
50	**30**	**12.90994449**	**8**	**1149.49**	**601.2**	**2921.97**	**2208.00**	**11.68790**	**8.832**	1149.48	601.9360631	50.00	30.04	**12.9**	**8.0**	**8.500**	**0.927**

25	15	9.128709292	4	574.745	300.6	1460.99	1104.00	5.84395	4.416	574.74	300.9680316	25.00	15.02	9.1	4.0	4.540	0.932
12.5	7.5	6.454972244	2	287.3725	150.3	730.49	552.00	2.92197	2.208	287.37	150.4840158	12.50	7.51	6.5	2.0	2.352	0.950
6.25	3.75	4.564354646	1	143.68625	75.15	365.25	276.00	1.46099	1.104	143.685	75.24200789	6.25	3.75	4.6	1.0	1.236	0.833
3.125	1.875	3.227486122	0.5	71.843125	37.575	182.62	138.00	0.73049	0.552	71.84250001	37.62100395	3.12	1.88	3.2	0.5	0.630	0.925
30	50	6	8	689.694	1002	1753.18	3680.00	7.01274	14.72	689.6880001	1003.226772	30.00	50.06	6.0	8.0		
15	25	4.242640687	4	344.847	501	876.59	1840.00	3.50637	7.36	344.844	501.6133859	15.00	25.03	4.2	4.0		
7.5	12.5	3	2	172.4235	250.5	438.30	920.00	1.75318	3.68	172.422	250.806693	7.50	12.52	3.0	2.0		
3.75	6.25	2.121320344	1	86.21175	125.25	219.15	460.00	0.87659	1.84	86.21100001	125.4033465	3.75	6.26	2.1	1.0		
1.875	3.125	1.5	0.5	43.105875	62.625	109.57	230.00	0.43830	0.92	43.1055	62.70167324	1.87	3.13	1.5	0.5		

Table E.4. Soil 5 routine analysis

New Calculations of the standard solution used in the SAR trial										Corrected calculation as advised				Final Results			
Na (mequiv/L)	Ca (mequiv/L)	SAR	Est. EC	Na (mg/L)	Ca (mg/L)	NaCl (mg/L)	CaCl2.2 (H2O) (mg/L)	Total NaCl (g/4L)	Total CaCl2.H2O (g/4L)	Na (mg/L)	Ca (mg/L)	Na (mequiv/L)	Ca (mequiv/L)	Adjusted SAR	Est. EC	Meas. EC	Rksat %
80	0	#DIV/0!	8	1839.184	0	4675.16	0.00	18.70064	0	1839.168	0	80.00	0.00	140.0	8.0	8.530	0.962
40	0	#DIV/0!	4	919.592	0	2337.58	0.00	9.35032	0	919.5840001	0	40.00	0.00	140.0	4.0	4.570	0.971
20	0	#DIV/0!	2	459.796	0	1168.79	0.00	4.67516	0	459.792	0	20.00	0.00	140.0	2.0	2.345	0.994
10	0	#DIV/0!	1	229.898	0	584.39	0.00	2.33758	0	229.896	0	10.00	0.00	140.0	1.0	1.213	1.000
5	0	#DIV/0!	0.5	114.949	0	292.20	0.00	1.16879	0	114.948	0	5.00	0.00	140.0	0.5	0.625	1.117

78.8	**1.2**	**101.7303626**	**8**	**1811.59624**	**24.048**	**4605.03**	**88.32**	**18.42013**	**0.35328**	1811.58048	24.07744252	78.80	1.20	**101.7**	**8.0**	**8.670**	**1.023**
39.4	0.6	71.93422922	4	**905.79812**	**12.024**	**2302.52**	**44.16**	**9.21006**	**0.17664**	905.7902401	12.03872126	39.40	0.60	**71.9**	**4.0**	**4.580**	**1.008**
19.7	0.3	50.86518128	2	**452.89906**	**6.012**	**1151.26**	**22.08**	**4.60503**	**0.08832**	452.89512	6.019360631	19.70	0.30	**50.8**	**2.0**	**2.421**	**1.057**
9.85	0.15	35.96711461	1	**226.44953**	**3.006**	**575.63**	**11.04**	**2.30252**	**0.04416**	226.44756	3.009680316	9.85	0.15	**35.9**	**1.0**	**1.238**	**1.033**
4.925	0.075	25.43259064	0.5	**113.224765**	**1.503**	**287.81**	**5.52**	**1.15126**	**0.02208**	113.22378	1.504840158	4.92	0.08	**25.4**	**0.5**	**0.625**	**1.202**
78.1	**1.9**	**80.1289093**	**8**	**1795.50338**	**38.076**	**4564.12**	**139.84**	**18.25650**	**0.55936**	1795.48776	38.12261733	78.10	1.90	**80.1**	**8.0**	**8.530**	**0.975**
39.05	0.95	56.65969513	4	**897.75169**	**19.038**	**2282.06**	**69.92**	**9.12825**	**0.27968**	897.7438801	19.06130867	39.05	0.95	**56.6**	**4.0**	**4.610**	**1.007**
19.525	0.475	40.06445465	2	**448.875845**	**9.519**	**1141.03**	**34.96**	**4.56412**	**0.13984**	448.87194	9.530654333	19.52	0.48	**40.0**	**2.0**	**2.369**	**0.985**
9.7625	0.2375	28.32984757	1	**224.4379225**	**4.7595**	**570.52**	**17.48**	**2.28206**	**0.06992**	224.43597	4.765327166	9.76	0.24	**28.3**	**1.0**	**1.227**	**0.986**
4.88125	0.11875	20.03222732	0.5	**112.2189613**	**2.37975**	**285.26**	**8.74**	**1.14103**	**0.03496**	112.217985	2.382663583	4.88	0.12	**20.0**	**0.5**	**0.623**	**1.179**
77	**3**	**62.87023673**	**8**	**1770.2146**	**60.12**	**4499.84**	**220.80**	**17.99936**	**0.8832**	1770.1992	60.19360631	77.00	3.00	**62.8**	**8.0**	**8.710**	**1.060**
38.5	1.5	44.45597073	4	**885.1073**	**30.06**	**2249.92**	**110.40**	**8.99968**	**0.4416**	885.0996001	30.09680316	38.50	1.50	**44.4**	**4.0**	**4.610**	**1.055**
19.25	0.75	31.43511837	2	**442.55365**	**15.03**	**1124.96**	**55.20**	**4.49984**	**0.2208**	442.5498	15.04840158	19.25	0.75	**31.4**	**2.0**	**2.627**	**0.981**
9.625	0.375	22.22798536	1	**221.276825**	**7.515**	**562.48**	**27.60**	**2.24992**	**0.1104**	221.2749	7.524200789	9.62	0.38	**22.2**	**1.0**	**1.235**	**1.036**
4.8125	0.1875	15.71755918	0.5	**110.6384125**	**3.7575**	**281.24**	**13.80**	**1.12496**	**0.0552**	110.63745	3.762100395	4.81	0.19	**15.7**	**0.5**	**0.615**	**1.227**
75	**5**	**47.4341649**	**8**	**1724.235**	**100.2**	**4382.96**	**368.00**	**17.53185**	**1.472**	1724.22	100.3226772	75.00	5.01	**47.4**	**8.0**	**8.730**	**0.996**
37.5	2.5	33.54101966	4	**862.1175**	**50.1**	**2191.48**	**184.00**	**8.76592**	**0.736**	862.1100001	50.16133859	37.50	2.50	**33.5**	**4.0**	**4.630**	**1.000**
18.75	1.25	23.71708245	2	**431.05875**	**25.05**	**1095.74**	**92.00**	**4.38296**	**0.368**	431.055	25.0806693	18.75	1.25	**23.7**	**2.0**	**2.342**	**0.963**
9.375	0.625	16.77050983	1	**215.529375**	**12.525**	**547.87**	**46.00**	**2.19148**	**0.184**	215.5275	12.54033465	9.37	0.63	**16.8**	**1.0**	**1.234**	**0.992**
4.6875	0.3125	11.85854123	0.5	**107.7646875**	**6.2625**	**273.94**	**23.00**	**1.09574**	**0.092**	107.76375	6.270167324	4.69	0.31	**11.9**	**0.5**	**0.642**	**1.178**
71	**9**	**33.46972098**	**8**	**1632.2758**	**180.36**	**4149.20**	**662.40**	**16.59682**	**2.6496**	1632.2616	180.5808189	71.00	9.01	**33.4**	**8.0**	**8.570**	**1.045**

35.5	4.5	23.66666667	4	**816.1379**	**90.18**	**2074.60**	**331.20**	**8.29841**	**1.3248**	816.1308001	90.29040947	35.50	4.51	**23.7**	**4.0**	**4.480**	**1.045**
17.75	2.25	16.73486049	2	**408.06895**	**45.09**	**1037.30**	**165.60**	**4.14920**	**0.6624**	408.0654	45.14520473	17.75	2.25	**16.7**	**2.0**	**2.332**	**0.999**
8.875	1.125	11.83333333	1	**204.034475**	**22.545**	**518.65**	**82.80**	**2.07460**	**0.3312**	204.0327	22.57260237	8.87	1.13	**11.8**	**1.0**	**1.227**	**1.042**
4.4375	0.5625	8.367430244	0.5	**102.0172375**	**11.2725**	**259.33**	**41.40**	**1.03730**	**0.1656**	102.01635	11.28630118	4.44	0.56	**8.4**	**0.5**	**0.617**	**1.166**
63	**17**	**21.60882173**	**8**	**1448.3574**	**340.68**	**3681.69**	**1251.20**	**14.72675**	**5.0048**	1448.3448	341.0971024	63.00	17.02	**21.6**	**8.0**	**8.500**	**1.080**
31.5	8.5	15.27974438	4	**724.1787**	**170.34**	**1840.84**	**625.60**	**7.36338**	**2.5024**	724.1724001	170.5485512	31.50	8.51	**15.3**	**4.0**	**4.480**	**1.054**
15.75	4.25	10.80441086	2	**362.08935**	**85.17**	**920.42**	**312.80**	**3.68169**	**1.2512**	362.0862	85.27427561	15.75	4.26	**10.8**	**2.0**	**2.344**	**1.012**
7.875	2.125	7.639872189	1	**181.044675**	**42.585**	**460.21**	**156.40**	**1.84084**	**0.6256**	181.0431	42.6371378	7.87	2.13	**7.6**	**1.0**	**1.211**	**1.003**
3.9375	1.0625	5.402205432	0.5	**90.5223375**	**21.2925**	**230.11**	**78.20**	**0.92042**	**0.3128**	90.52155001	21.3185689	3.94	1.06	**5.4**	**0.5**	**0.626**	**1.148**
50	**30**	**12.90994449**	**8**	**1149.49**	**601.2**	**2921.97**	**2208.00**	**11.68790**	**8.832**	1149.48	601.9360631	50.00	30.04	**12.9**	**8.0**	**8.370**	**0.995**
25	15	9.128709292	4	**574.745**	**300.6**	**1460.99**	**1104.00**	**5.84395**	**4.416**	574.74	300.9680316	25.00	15.02	**9.1**	**4.0**	**4.460**	**1.008**
12.5	7.5	6.454972244	2	**287.3725**	**150.3**	**730.49**	**552.00**	**2.92197**	**2.208**	287.37	150.4840158	12.50	7.51	**6.5**	**2.0**	**2.320**	**0.975**
6.25	3.75	4.564354646	1	**143.68625**	**75.15**	**365.25**	**276.00**	**1.46099**	**1.104**	143.685	75.24200789	6.25	3.75	**4.6**	**1.0**	**1.220**	**0.974**
3.125	1.875	3.227486122	0.5	**71.843125**	**37.575**	**182.62**	**138.00**	**0.73049**	**0.552**	71.84250001	37.62100395	3.12	1.88	**3.2**	**0.5**	**0.633**	**1.072**
30	**50**	**6**	**8**	**689.694**	**1002**	**1753.18**	**3680.00**	**7.01274**	**14.72**	689.6880001	1003.226772	30.00	50.06	**6.0**	**8.0**		
15	25	4.242640687	4	**344.847**	**501**	**876.59**	**1840.00**	**3.50637**	**7.36**	344.844	501.6133859	15.00	25.03	**4.2**	**4.0**		
7.5	12.5	3	2	**172.4235**	**250.5**	**438.30**	**920.00**	**1.75318**	**3.68**	172.422	250.806693	7.50	12.52	**3.0**	**2.0**		
3.75	6.25	2.121320344	1	**86.21175**	**125.25**	**219.15**	**460.00**	**0.87659**	**1.84**	86.21100001	125.4033465	3.75	6.26	**2.1**	**1.0**		
1.875	3.125	1.5	0.5	**43.105875**	**62.625**	**109.57**	**230.00**	**0.43830**	**0.92**	43.1055	62.70167324	1.87	3.13	**1.5**	**0.5**		

Table E.5. Soil 5 Trial 2 routine analysis data

New Calculations of the standard solution used in the SAR trial										Corrected calculation as advised				Final Results			
Na (mequiv/L)	Ca (mequiv/L)	SAR	Est. EC	Na (mg/L)	Ca (mg/L)	NaCl (mg/L)	CaCl2.2 (H2O) (mg/L)	Total NaCl (g/4L)	Total CaCl2. H2O (g/4L)	Na (mg/L)	Ca (mg/L)	Na (mequiv/L)	Ca (mequiv/L)	Adjusted SAR	Est. EC	Meas. EC	Rksat %
80	0	#DIV/0!	8	1839.184	0	4675.16	0.00	18.70064	0	1839.168	0	80.00	0.00	140.0	8.0	8.370	0.840
40	0	#DIV/0!	4	919.592	0	2337.58	0.00	9.35032	0	919.5840001	0	40.00	0.00	140.0	4.0	4.180	0.855
20	0	#DIV/0!	2	459.796	0	1168.79	0.00	4.67516	0	459.792	0	20.00	0.00	140.0	2.0	2.143	0.860
10	0	#DIV/0!	1	229.898	0	584.39	0.00	2.33758	0	229.896	0	10.00	0.00	140.0	1.0	1.119	0.825
5	0	#DIV/0!	0.5	114.949	0	292.20	0.00	1.16879	0	114.948	0	5.00	0.00	140.0	0.5	0.560	0.847
78.8	1.2	101.7303626	8	1811.59624	24.048	4605.03	88.32	18.42013	0.35328	1811.58048	24.07744252	78.80	1.20	101.7	8.0	8.200	0.808
39.4	0.6	71.93422922	4	905.79812	12.024	2302.52	44.16	9.21006	0.17664	905.7902401	12.03872126	39.40	0.60	71.9	4.0	4.160	0.882
19.7	0.3	50.86518128	2	452.89906	6.012	1151.26	22.08	4.60503	0.08832	452.89512	6.019360631	19.70	0.30	50.8	2.0	2.155	0.823
9.85	0.15	35.96711461	1	226.44953	3.006	575.63	11.04	2.30252	0.04416	226.44756	3.009680316	9.85	0.15	35.9	1.0	1.113	0.816
4.925	0.075	25.43259064	0.5	113.224765	1.503	287.81	5.52	1.15126	0.02208	113.22378	1.504840158	4.92	0.08	25.4	0.5	0.567	0.807
78.1	1.9	80.1289093	8	1795.50338	38.076	4564.12	139.84	18.25650	0.55936	1795.48776	38.12261733	78.10	1.90	80.1	8.0		
39.05	0.95	56.65969513	4	897.75169	19.038	2282.06	69.92	9.12825	0.27968	897.7438801	19.06130867	39.05	0.95	56.6	4.0		
19.525	0.475	40.06445465	2	448.875845	9.519	1141.03	34.96	4.56412	0.13984	448.87194	9.530654333	19.52	0.48	40.0	2.0		
9.7625	0.2375	28.32984757	1	224.4379225	4.7595	570.52	17.48	2.28206	0.06992	224.43597	4.765327166	9.76	0.24	28.3	1.0		
4.88125	0.11875	20.03222732	0.5	112.2189613	2.37975	285.26	8.74	1.14103	0.03496	112.217985	2.382663583	4.88	0.12	20.0	0.5		
77	3	62.87023673	8	1770.2146	60.12	4499.84	220.80	17.99936	0.8832	1770.1992	60.19360631	77.00	3.00	62.8	8.0		

38.5	1.5	44.45597073	4	**885.1073**	**30.06**	**2249.92**	**110.40**	**8.99968**	**0.4416**	885.0996001	30.09680316	38.50	1.50	**44.4**	**4.0**		
19.25	0.75	31.43511837	2	**442.55365**	**15.03**	**1124.96**	**55.20**	**4.49984**	**0.2208**	442.5498	15.04840158	19.25	0.75	**31.4**	**2.0**		
9.625	0.375	22.22798536	1	**221.276825**	**7.515**	**562.48**	**27.60**	**2.24992**	**0.1104**	221.2749	7.524200789	9.62	0.38	**22.2**	**1.0**		
4.8125	0.1875	15.71755918	0.5	**110.6384125**	**3.7575**	**281.24**	**13.80**	**1.12496**	**0.0552**	110.63745	3.762100395	4.81	0.19	**15.7**	**0.5**		
75	**5**	**47.4341649**	**8**	**1724.235**	**100.2**	**4382.96**	**368.00**	**17.53185**	**1.472**	1724.22	100.3226772	75.00	5.01	**47.4**	**8.0**		
37.5	2.5	33.54101966	4	**862.1175**	**50.1**	**2191.48**	**184.00**	**8.76592**	**0.736**	862.1100001	50.16133859	37.50	2.50	**33.5**	**4.0**		
18.75	1.25	23.71708245	2	**431.05875**	**25.05**	**1095.74**	**92.00**	**4.38296**	**0.368**	431.055	25.0806693	18.75	1.25	**23.7**	**2.0**		
9.375	0.625	16.77050983	1	**215.529375**	**12.525**	**547.87**	**46.00**	**2.19148**	**0.184**	215.5275	12.54033465	9.37	0.63	**16.8**	**1.0**		
4.6875	0.3125	11.85854123	0.5	**107.7646875**	**6.2625**	**273.94**	**23.00**	**1.09574**	**0.092**	107.76375	6.270167324	4.69	0.31	**11.9**	**0.5**		
71	**9**	**33.46972098**	**8**	**1632.2758**	**180.36**	**4149.20**	**662.40**	**16.59682**	**2.6496**	1632.2616	180.5808189	71.00	9.01	**33.4**	**8.0**	**8.190**	**0.827**
35.5	4.5	23.66666667	4	**816.1379**	**90.18**	**2074.60**	**331.20**	**8.29841**	**1.3248**	816.1308001	90.29040947	35.50	4.51	**23.7**	**4.0**	**4.130**	**0.835**
17.75	2.25	16.73486049	2	**408.06895**	**45.09**	**1037.30**	**165.60**	**4.14920**	**0.6624**	408.0654	45.14520473	17.75	2.25	**16.7**	**2.0**	**2.132**	**0.822**
8.875	1.125	11.83333333	1	**204.034475**	**22.545**	**518.65**	**82.80**	**2.07460**	**0.3312**	204.0327	22.57260237	8.87	1.13	**11.8**	**1.0**	**1.111**	**0.807**
4.4375	0.5625	8.367430244	0.5	**102.0172375**	**11.2725**	**259.33**	**41.40**	**1.03730**	**0.1656**	102.01635	11.28630118	4.44	0.56	**8.4**	**0.5**	**0.576**	**0.801**
63	**17**	**21.60882173**	**8**	**1448.3574**	**340.68**	**3681.69**	**1251.20**	**14.72675**	**5.0048**	1448.3448	341.0971024	63.00	17.02	**21.6**	**8.0**		
31.5	8.5	15.27974438	4	**724.1787**	**170.34**	**1840.84**	**625.60**	**7.36338**	**2.5024**	724.1724001	170.5485512	31.50	8.51	**15.3**	**4.0**		
15.75	4.25	10.80441086	2	**362.08935**	**85.17**	**920.42**	**312.80**	**3.68169**	**1.2512**	362.0862	85.27427561	15.75	4.26	**10.8**	**2.0**		
7.875	2.125	7.639872189	1	**181.044675**	**42.585**	**460.21**	**156.40**	**1.84084**	**0.6256**	181.0431	42.6371378	7.87	2.13	**7.6**	**1.0**		
3.9375	1.0625	5.402205432	0.5	**90.5223375**	**21.2925**	**230.11**	**78.20**	**0.92042**	**0.3128**	90.52155001	21.3185689	3.94	1.06	**5.4**	**0.5**		
50	**30**	**12.90994449**	**8**	**1149.49**	**601.2**	**2921.97**	**2208.00**	**11.68790**	**8.832**	1149.48	601.9360631	50.00	30.04	**12.9**	**8.0**	**8.150**	**0.889**
25	15	9.128709292	4	**574.745**	**300.6**	**1460.99**	**1104.00**	**5.84395**	**4.416**	574.74	300.9680316	25.00	15.02	**9.1**	**4.0**	**4.160**	**0.944**
12.5	7.5	6.454972244	2	**287.3725**	**150.3**	**730.49**	**552.00**	**2.92197**	**2.208**	287.37	150.4840158	12.50	7.51	**6.5**	**2.0**	**2.160**	**0.940**

6.25	3.75	4.564354646	1	**143.68625**	**75.15**	**365.25**	**276.00**	**1.46099**	**1.104**	143.685	75.24200789	6.25	3.75	**4.6**	**1.0**	**1.130**	**0.874**
3.125	1.875	3.227486122	0.5	**71.843125**	**37.575**	**182.62**	**138.00**	**0.73049**	**0.552**	71.84250001	37.62100395	3.12	1.88	**3.2**	**0.5**	**0.585**	**0.847**
30	**50**	**6**	**8**	**689.694**	**1002**	**1753.18**	**3680.00**	**7.01274**	**14.72**	689.6880001	1003.226772	30.00	50.06	**6.0**	**8.0**		
15	25	4.242640687	4	**344.847**	**501**	**876.59**	**1840.00**	**3.50637**	**7.36**	344.844	501.6133859	15.00	25.03	**4.2**	**4.0**		
7.5	12.5	3	2	**172.4235**	**250.5**	**438.30**	**920.00**	**1.75318**	**3.68**	172.422	250.806693	7.50	12.52	**3.0**	**2.0**		
3.75	6.25	2.121320344	1	**86.21175**	**125.25**	**219.15**	**460.00**	**0.87659**	**1.84**	86.21100001	125.4033465	3.75	6.26	**2.1**	**1.0**		
1.875	3.125	1.5	0.5	**43.105875**	**62.625**	**109.57**	**230.00**	**0.43830**	**0.92**	43.1055	62.70167324	1.87	3.13	**1.5**	**0.5**		

Table E.6. Soil 6 routine analysis

New Calculations of the standard solution used in the SAR trial										Corrected calculation as advised				Final Results			
Na (mequiv/L)	Ca (mequiv/L)	SAR	Est. EC	Na (mg/L)	Ca (mg/L)	NaCl (mg/L)	CaCl2.2 (H2O) (mg/L)	Total NaCl (g/4L)	Total CaCl2. H2O (g/4L)	Na (mg/L)	Ca (mg/L)	Na (mequiv/L)	Ca (mequiv/L)	Adjusted SAR	Est. EC	Meas. EC	Rksat %
80	**0**	**#DIV/0!**	**8**	**1839.184**	**0**	**4675.16**	**0.00**	**18.70064**	**0**	1839.168	0	80.00	0.00	**120.0**	**8.0**	**8.700**	
40	0	#DIV/0!	4	**919.592**	**0**	**2337.58**	**0.00**	**9.35032**	**0**	919.5840001	0	40.00	0.00	**120.0**	**4.0**	**4.680**	
20	0	#DIV/0!	2	**459.796**	**0**	**1168.79**	**0.00**	**4.67516**	**0**	459.792	0	20.00	0.00	**120.0**	**2.0**	**2.415**	
10	0	#DIV/0!	1	**229.898**	**0**	**584.39**	**0.00**	**2.33758**	**0**	229.896	0	10.00	0.00	**120.0**	**1.0**	**1.255**	
5	0	#DIV/0!	0.5	**114.949**	**0**	**292.20**	**0.00**	**1.16879**	**0**	114.948	0	5.00	0.00	**120.0**	**0.5**	**0.642**	
78.8	**1.2**	**101.7303626**	**8**	**1811.59624**	**24.048**	**4605.03**	**88.32**	**18.42013**	**0.35328**	1811.58048	24.07744252	78.80	1.20	**101.7**	**8.0**	**8.480**	**0.516**
39.4	0.6	71.93422922	4	**905.79812**	**12.024**	**2302.52**	**44.16**	**9.21006**	**0.17664**	905.7902401	12.03872126	39.40	0.60	**71.9**	**4.0**	**4.600**	**0.909**
19.7	0.3	50.86518128	2	**452.89906**	**6.012**	**1151.26**	**22.08**	**4.60503**	**0.08832**	452.89512	6.019360631	19.70	0.30	**50.8**	**2.0**	**2.357**	**0.850**
9.85	0.15	35.96711461	1	**226.44953**	**3.006**	**575.63**	**11.04**	**2.30252**	**0.04416**	226.44756	3.009680316	9.85	0.15	**35.9**	**1.0**	**1.221**	**0.984**
4.925	0.075	25.43259064	0.5	**113.224765**	**1.503**	**287.81**	**5.52**	**1.15126**	**0.02208**	113.22378	1.504840158	4.92	0.08	**25.4**	**0.5**	**0.623**	**0.804**
78.1	**1.9**	**80.1289093**	**8**	**1795.50338**	**38.076**	**4564.12**	**139.84**	**18.25650**	**0.55936**	1795.48776	38.12261733	78.10	1.90	**80.1**	**8.0**		
39.05	0.95	56.65969513	4	**897.75169**	**19.038**	**2282.06**	**69.92**	**9.12825**	**0.27968**	897.7438801	19.06130867	39.05	0.95	**56.6**	**4.0**		
19.525	0.475	40.06445465	2	**448.875845**	**9.519**	**1141.03**	**34.96**	**4.56412**	**0.13984**	448.87194	9.530654333	19.52	0.48	**40.0**	**2.0**		
9.7625	0.2375	28.32984757	1	**224.4379225**	**4.7595**	**570.52**	**17.48**	**2.28206**	**0.06992**	224.43597	4.765327166	9.76	0.24	**28.3**	**1.0**		
4.88125	0.11875	20.03222732	0.5	**112.2189613**	**2.37975**	**285.26**	**8.74**	**1.14103**	**0.03496**	112.217985	2.382663583	4.88	0.12	**20.0**	**0.5**		
77	**3**	**62.87023673**	**8**	**1770.2146**	**60.12**	**4499.84**	**220.80**	**17.99936**	**0.8832**	1770.1992	60.19360631	77.00	3.00	**62.8**	**8.0**	**8.560**	**0.849**

38.5	1.5	44.45597073	4	**885.1073**	**30.06**	**2249.92**	**110.40**	**8.99968**	**0.4416**	885.0996001	30.09680316	38.50	1.50	**44.4**	**4.0**	**4.520**	**0.948**
19.25	0.75	31.43511837	2	**442.55365**	**15.03**	**1124.96**	**55.20**	**4.49984**	**0.2208**	442.5498	15.04840158	19.25	0.75	**31.4**	**2.0**	**2.324**	**0.861**
9.625	0.375	22.22798536	1	**221.276825**	**7.515**	**562.48**	**27.60**	**2.24992**	**0.1104**	221.2749	7.524200789	9.62	0.38	**22.2**	**1.0**	**1.216**	**0.882**
4.8125	0.1875	15.71755918	0.5	**110.6384125**	**3.7575**	**281.24**	**13.80**	**1.12496**	**0.0552**	110.63745	3.762100395	4.81	0.19	**15.7**	**0.5**	**0.613**	**0.819**
75	**5**	**47.4341649**	**8**	**1724.235**	**100.2**	**4382.96**	**368.00**	**17.53185**	**1.472**	1724.22	100.3226772	75.00	5.01	**47.4**	**8.0**		
37.5	2.5	33.54101966	4	**862.1175**	**50.1**	**2191.48**	**184.00**	**8.76592**	**0.736**	862.1100001	50.16133859	37.50	2.50	**33.5**	**4.0**		
18.75	1.25	23.71708245	2	**431.05875**	**25.05**	**1095.74**	**92.00**	**4.38296**	**0.368**	431.055	25.0806693	18.75	1.25	**23.7**	**2.0**		
9.375	0.625	16.77050983	1	**215.529375**	**12.525**	**547.87**	**46.00**	**2.19148**	**0.184**	215.5275	12.54033465	9.37	0.63	**16.8**	**1.0**		
4.6875	0.3125	11.85854123	0.5	**107.7646875**	**6.2625**	**273.94**	**23.00**	**1.09574**	**0.092**	107.76375	6.270167324	4.69	0.31	**11.9**	**0.5**		
71	**9**	**33.46972098**	**8**	**1632.2758**	**180.36**	**4149.20**	**662.40**	**16.59682**	**2.6496**	1632.2616	180.5808189	71.00	9.01	**33.4**	**8.0**	**8.530**	**0.891**
35.5	4.5	23.66666667	4	**816.1379**	**90.18**	**2074.60**	**331.20**	**8.29841**	**1.3248**	816.1308001	90.29040947	35.50	4.51	**23.7**	**4.0**	**4.540**	**0.993**
17.75	2.25	16.73486049	2	**408.06895**	**45.09**	**1037.30**	**165.60**	**4.14920**	**0.6624**	408.0654	45.14520473	17.75	2.25	**16.7**	**2.0**	**2.323**	**0.891**
8.875	1.125	11.83333333	1	**204.034475**	**22.545**	**518.65**	**82.80**	**2.07460**	**0.3312**	204.0327	22.57260237	8.87	1.13	**11.8**	**1.0**	**1.212**	**0.889**
4.4375	0.5625	8.367430244	0.5	**102.0172375**	**11.2725**	**259.33**	**41.40**	**1.03730**	**0.1656**	102.01635	11.28630118	4.44	0.56	**8.4**	**0.5**	**0.623**	**0.861**
63	**17**	**21.60882173**	**8**	**1448.3574**	**340.68**	**3681.69**	**1251.20**	**14.72675**	**5.0048**	1448.3448	341.0971024	63.00	17.02	**21.6**	**8.0**		
31.5	8.5	15.27974438	4	**724.1787**	**170.34**	**1840.84**	**625.60**	**7.36338**	**2.5024**	724.1724001	170.5485512	31.50	8.51	**15.3**	**4.0**		
15.75	4.25	10.80441086	2	**362.08935**	**85.17**	**920.42**	**312.80**	**3.68169**	**1.2512**	362.0862	85.27427561	15.75	4.26	**10.8**	**2.0**		
7.875	2.125	7.639872189	1	**181.044675**	**42.585**	**460.21**	**156.40**	**1.84084**	**0.6256**	181.0431	42.6371378	7.87	2.13	**7.6**	**1.0**		
3.9375	1.0625	5.402205432	0.5	**90.5223375**	**21.2925**	**230.11**	**78.20**	**0.92042**	**0.3128**	90.52155001	21.3185689	3.94	1.06	**5.4**	**0.5**		

50	**30**	**12.90994449**	**8**	**1149.49**	**601.2**	**2921.97**	**2208.00**	**11.68790**	**8.832**	1149.48	601.9360631	50.00	30.04	**12.9**	**8.0**	**8.420**	**0.868**
25	15	9.128709292	4	**574.745**	**300.6**	**1460.99**	**1104.00**	**5.84395**	**4.416**	574.74	300.9680316	25.00	15.02	**9.1**	**4.0**	**4.480**	**0.939**
12.5	7.5	6.454972244	2	**287.3725**	**150.3**	**730.49**	**552.00**	**2.92197**	**2.208**	287.37	150.4840158	12.50	7.51	**6.5**	**2.0**	**2.358**	**0.858**
6.25	3.75	4.564354646	1	**143.68625**	**75.15**	**365.25**	**276.00**	**1.46099**	**1.104**	143.685	75.24200789	6.25	3.75	**4.6**	**1.0**	**1.200**	**0.904**
3.125	1.875	3.227486122	0.5	**71.843125**	**37.575**	**182.62**	**138.00**	**0.73049**	**0.552**	71.84250001	37.62100395	3.12	1.88	**3.2**	**0.5**	**0.631**	**0.848**
30	**50**	**6**	**8**	**689.694**	**1002**	**1753.18**	**3680.00**	**7.01274**	**14.72**	689.6880001	1003.226772	30.00	50.06	**6.0**	**8.0**		
15	25	4.242640687	4	**344.847**	**501**	**876.59**	**1840.00**	**3.50637**	**7.36**	344.844	501.6133859	15.00	25.03	**4.2**	**4.0**		
7.5	12.5	3	2	**172.4235**	**250.5**	**438.30**	**920.00**	**1.75318**	**3.68**	172.422	250.806693	7.50	12.52	**3.0**	**2.0**		
3.75	6.25	2.121320344	1	**86.21175**	**125.25**	**219.15**	**460.00**	**0.87659**	**1.84**	86.21100001	125.4033465	3.75	6.26	**2.1**	**1.0**		
1.875	3.125	1.5	0.5	**43.105875**	**62.625**	**109.57**	**230.00**	**0.43830**	**0.92**	43.1055	62.70167324	1.87	3.13	**1.5**	**0.5**		

Table E.7. Soil 7 routine analysis data

New Calculations of the standard solution used in the SAR trial										Corrected calculation as advised				Final Results			
Na (mequiv/L)	Ca (mequiv/L)	SAR	Est. EC	Na (mg/L)	Ca (mg/L)	NaCl (mg/L)	CaCl2.2 (H2O) (mg/L)	Total NaCl (g/4L)	Total CaCl2. H2O (g/4L)	Na (mg/L)	Ca (mg/L)	Na (mequiv/L)	Ca (mequiv/L)	Adjusted SAR	Est. EC	Meas. EC	Rksat %
80	0	#DIV/0!	8	1839.184	0	4675.16	0.00	18.70064	0	1839.168	0	80.00	0.00	140.0	8.0	8.470	0.351
40	0	#DIV/0!	4	919.592	0	2337.58	0.00	9.35032	0	919.5840001	0	40.00	0.00	140.0	4.0	4.540	0.392
20	0	#DIV/0!	2	459.796	0	1168.79	0.00	4.67516	0	459.792	0	20.00	0.00	140.0	2.0	2.430	0.348
10	0	#DIV/0!	1	229.898	0	584.39	0.00	2.33758	0	229.896	0	10.00	0.00	140.0	1.0	1.240	0.331
5	0	#DIV/0!	0.5	114.949	0	292.20	0.00	1.16879	0	114.948	0	5.00	0.00	140.0	0.5	0.626	0.291
78.8	1.2	101.7303626	8	1811.59624	24.048	4605.03	88.32	18.42013	0.35328	1811.58048	24.07744252	78.80	1.20	101.7	8.0	8.5	0.863
39.4	0.6	71.93422922	4	905.79812	12.024	2302.52	44.16	9.21006	0.17664	905.7902401	12.03872126	39.40	0.60	71.9	4.0	4.4	1.073
19.7	0.3	50.86518128	2	452.89906	6.012	1151.26	22.08	4.60503	0.08832	452.89512	6.019360631	19.70	0.30	50.8	2.0	2.3	0.969
9.85	0.15	35.96711461	1	226.44953	3.006	575.63	11.04	2.30252	0.04416	226.44756	3.009680316	9.85	0.15	35.9	1.0	1.3	1.092
4.925	0.075	25.43259064	0.5	113.224765	1.503	287.81	5.52	1.15126	0.02208	113.22378	1.504840158	4.92	0.08	25.4	0.5	0.6	0.986
78.1	1.9	80.1289093	8	1795.50338	38.076	4564.12	139.84	18.25650	0.55936	1795.48776	38.12261733	78.10	1.90	80.1	8.0	8.720	0.462
39.05	0.95	56.65969513	4	897.75169	19.038	2282.06	69.92	9.12825	0.27968	897.7438801	19.06130867	39.05	0.95	56.6	4.0	4.400	0.514
19.525	0.475	40.06445465	2	448.875845	9.519	1141.03	34.96	4.56412	0.13984	448.87194	9.530654333	19.52	0.48	40.0	2.0	2.325	0.679
9.7625	0.2375	28.32984757	1	224.4379225	4.7595	570.52	17.48	2.28206	0.06992	224.43597	4.765327166	9.76	0.24	28.3	1.0	1.320	0.391
4.88125	0.11875	20.03222732	0.5	112.2189613	2.37975	285.26	8.74	1.14103	0.03496	112.217985	2.382663583	4.88	0.12	20.0	0.5	0.614	0.363
77	3	62.87023673	8	1770.2146	60.12	4499.84	220.80	17.99936	0.8832	1770.1992	60.19360631	77.00	3.00	62.8	8.0	8.420	0.649

38.5	1.5	44.45597073	4	**885.1073**	**30.06**	**2249.92**	**110.40**	**8.99968**	**0.4416**	885.0996001	30.09680316	38.50	1.50	**44.4**	**4.0**	**4.470**	**0.709**
19.25	0.75	31.43511837	2	**442.55365**	**15.03**	**1124.96**	**55.20**	**4.49984**	**0.2208**	442.5498	15.04840158	19.25	0.75	**31.4**	**2.0**	**2.330**	**0.956**
9.625	0.375	22.22798536	1	**221.276825**	**7.515**	**562.48**	**27.60**	**2.24992**	**0.1104**	221.2749	7.524200789	9.62	0.38	**22.2**	**1.0**	**1.215**	**0.645**
4.8125	0.1875	15.71755918	0.5	**110.6384125**	**3.7575**	**281.24**	**13.80**	**1.12496**	**0.0552**	110.63745	3.762100395	4.81	0.19	**15.7**	**0.5**	**0.609**	**0.554**
75	**5**	**47.4341649**	**8**	**1724.235**	**100.2**	**4382.96**	**368.00**	**17.53185**	**1.472**	1724.22	100.3226772	75.00	5.01	**47.4**	**8.0**	**8.970**	**0.841**
37.5	2.5	33.54101966	4	**862.1175**	**50.1**	**2191.48**	**184.00**	**8.76592**	**0.736**	862.1100001	50.16133859	37.50	2.50	**33.5**	**4.0**	**4.730**	**0.881**
18.75	1.25	23.71708245	2	**431.05875**	**25.05**	**1095.74**	**92.00**	**4.38296**	**0.368**	431.055	25.0806693	18.75	1.25	**23.7**	**2.0**	**2.456**	**1.055**
9.375	0.625	16.77050983	1	**215.529375**	**12.525**	**547.87**	**46.00**	**2.19148**	**0.184**	215.5275	12.54033465	9.37	0.63	**16.8**	**1.0**	**1.287**	**0.666**
4.6875	0.3125	11.85854123	0.5	**107.7646875**	**6.2625**	**273.94**	**23.00**	**1.09574**	**0.092**	107.76375	6.270167324	4.69	0.31	**11.9**	**0.5**	**0.667**	**0.670**
71	**9**	**33.46972098**	**8**	**1632.2758**	**180.36**	**4149.20**	**662.40**	**16.59682**	**2.6496**	1632.2616	180.5808189	71.00	9.01	**33.4**	**8.0**	**8.760**	**0.786**
35.5	4.5	23.66666667	4	**816.1379**	**90.18**	**2074.60**	**331.20**	**8.29841**	**1.3248**	816.1308001	90.29040947	35.50	4.51	**23.7**	**4.0**	**4.770**	**0.871**
17.75	2.25	16.73486049	2	**408.06895**	**45.09**	**1037.30**	**165.60**	**4.14920**	**0.6624**	408.0654	45.14520473	17.75	2.25	**16.7**	**2.0**	**2.457**	**1.100**
8.875	1.125	11.83333333	1	**204.034475**	**22.545**	**518.65**	**82.80**	**2.07460**	**0.3312**	204.0327	22.57260237	8.87	1.13	**11.8**	**1.0**	**1.251**	**0.634**
4.4375	0.5625	8.367430244	0.5	**102.0172375**	**11.2725**	**259.33**	**41.40**	**1.03730**	**0.1656**	102.01635	11.28630118	4.44	0.56	**8.4**	**0.5**	**0.694**	**0.745**
63	**17**	**21.60882173**	**8**	**1448.3574**	**340.68**	**3681.69**	**1251.20**	**14.72675**	**5.0048**	1448.3448	341.0971024	63.00	17.02	**21.6**	**8.0**	**8.800**	**1.016**
31.5	8.5	15.27974438	4	**724.1787**	**170.34**	**1840.84**	**625.60**	**7.36338**	**2.5024**	724.1724001	170.5485512	31.50	8.51	**15.3**	**4.0**	**4.890**	**0.992**
15.75	4.25	10.80441086	2	**362.08935**	**85.17**	**920.42**	**312.80**	**3.68169**	**1.2512**	362.0862	85.27427561	15.75	4.26	**10.8**	**2.0**	**2.454**	**1.148**
7.875	2.125	7.639872189	1	**181.044675**	**42.585**	**460.21**	**156.40**	**1.84084**	**0.6256**	181.0431	42.6371378	7.87	2.13	**7.6**	**1.0**	**1.260**	**1.033**
3.9375	1.0625	5.402205432	0.5	**90.5223375**	**21.2925**	**230.11**	**78.20**	**0.92042**	**0.3128**	90.52155001	21.3185689	3.94	1.06	**5.4**	**0.5**	**0.690**	**0.861**
50	**30**	**12.90994449**	**8**	**1149.49**	**601.2**	**2921.97**	**2208.00**	**11.68790**	**8.832**	1149.48	601.9360631	50.00	30.04	**12.9**	**8.0**	**8.760**	**0.892**
25	15	9.128709292	4	**574.745**	**300.6**	**1460.99**	**1104.00**	**5.84395**	**4.416**	574.74	300.9680316	25.00	15.02	**9.1**	**4.0**	**4.860**	**0.980**
12.5	7.5	6.454972244	2	**287.3725**	**150.3**	**730.49**	**552.00**	**2.92197**	**2.208**	287.37	150.4840158	12.50	7.51	**6.5**	**2.0**	**2.533**	**1.100**

6.25	3.75	4.564354646	1	**143.68625**	**75.15**	**365.25**	**276.00**	**1.46099**	**1.104**	143.685	75.24200789	6.25	3.75	**4.6**	**1.0**	**1.247**	**0.979**
3.125	1.875	3.227486122	0.5	**71.843125**	**37.575**	**182.62**	**138.00**	**0.73049**	**0.552**	71.84250001	37.62100395	3.12	1.88	**3.2**	**0.5**	**0.650**	**0.912**
30	**50**	**6**	**8**	**689.694**	**1002**	**1753.18**	**3680.00**	**7.01274**	**14.72**	689.6880001	1003.226772	30.00	50.06	**6.0**	**8.0**		
15	25	4.242640687	4	**344.847**	**501**	**876.59**	**1840.00**	**3.50637**	**7.36**	344.844	501.6133859	15.00	25.03	**4.2**	**4.0**		
7.5	12.5	3	2	**172.4235**	**250.5**	**438.30**	**920.00**	**1.75318**	**3.68**	172.422	250.806693	7.50	12.52	**3.0**	**2.0**		
3.75	6.25	2.121320344	1	**86.21175**	**125.25**	**219.15**	**460.00**	**0.87659**	**1.84**	86.21100001	125.4033465	3.75	6.26	**2.1**	**1.0**		
1.875	3.125	1.5	0.5	**43.105875**	**62.625**	**109.57**	**230.00**	**0.43830**	**0.92**	43.1055	62.70167324	1.87	3.13	**1.5**	**0.5**		

Table E.8. Soil 8 routine analysis data

New Calculations of the standard solution used in the SAR trial										Corrected calculation as advised				Final Results			
Na (mequiv/L)	Ca (mequiv/L)	SAR	Est. EC	Na (mg/L)	Ca (mg/L)	NaCl (mg/L)	CaCl2.2 (H2O) (mg/L)	Total NaCl (g/4L)	Total CaCl2. H2O (g/4L)	Na (mg/L)	Ca (mg/L)	Na (mequiv/L)	Ca (mequiv/L)	Adjusted SAR	Est. EC	Meas. EC	Rksat %
80	0	#DIV/0!	8	1839.184	0	4675.16	0.00	18.70064	0	1839.168	0	80.00	0.00	140.0	8.0	9.070	0.436
40	0	#DIV/0!	4	919.592	0	2337.58	0.00	9.35032	0	919.5840001	0	40.00	0.00	140.0	4.0	4.790	0.346
20	0	#DIV/0!	2	459.796	0	1168.79	0.00	4.67516	0	459.792	0	20.00	0.00	140.0	2.0	2.472	0.386
10	0	#DIV/0!	1	229.898	0	584.39	0.00	2.33758	0	229.896	0	10.00	0.00	140.0	1.0	1.269	0.334
5	0	#DIV/0!	0.5	114.949	0	292.20	0.00	1.16879	0	114.948	0	5.00	0.00	140.0	0.5	0.651	0.227
79.2	0.8	125.2261953	8	1820.79216	16.032	4628.41	58.88	18.51363	0.23552	1820.77632	16.05162835	79.20	0.80	125.1	8.0		
39.6	0.4	88.54829191	4	910.39608	8.016	2314.20	29.44	9.25682	0.11776	910.3881601	8.025814175	39.60	0.40	88.5	4.0		
19.8	0.2	62.61309767	2	455.19804	4.008	1157.10	14.72	4.62841	0.05888	455.19408	4.012907087	19.80	0.20	62.6	2.0		
9.9	0.1	44.27414595	1	227.59902	2.004	578.55	7.36	2.31420	0.02944	227.59704	2.006453544	9.90	0.10	44.2	1.0		
4.95	0.05	31.30654884	0.5	113.79951	1.002	289.28	3.68	1.15710	0.01472	113.79852	1.003226772	4.95	0.05	31.3	0.5		
78.8	1.2	101.7303626	8	1811.59624	24.048	4605.03	88.32	18.42013	0.35328	1811.58048	24.07744252	78.80	1.20	101.7	8.0		
39.4	0.6	71.93422922	4	905.79812	12.024	2302.52	44.16	9.21006	0.17664	905.7902401	12.03872126	39.40	0.60	71.9	4.0		
19.7	0.3	50.86518128	2	452.89906	6.012	1151.26	22.08	4.60503	0.08832	452.89512	6.019360631	19.70	0.30	50.8	2.0		
9.85	0.15	35.96711461	1	226.44953	3.006	575.63	11.04	2.30252	0.04416	226.44756	3.009680316	9.85	0.15	35.9	1.0		
4.925	0.075	25.43259064	0.5	113.224765	1.503	287.81	5.52	1.15126	0.02208	113.22378	1.504840158	4.92	0.08	25.4	0.5		
77	3	62.87023673	8	1770.2146	60.12	4499.84	220.80	17.99936	0.8832	1770.1992	60.19360631	77.00	3.00	62.8	8.0	8.740	0.500

38.5	1.5	44.45597073	4	**885.1073**	**30.06**	**2249.92**	**110.40**	**8.99968**	**0.4416**	885.0996001	30.09680316	38.50	1.50	**44.4**	**4.0**	**4.570**	**0.449**
19.25	0.75	31.43511837	2	**442.55365**	**15.03**	**1124.96**	**55.20**	**4.49984**	**0.2208**	442.5498	15.04840158	19.25	0.75	**31.4**	**2.0**	**2.371**	**0.461**
9.625	0.375	22.22798536	1	**221.276825**	**7.515**	**562.48**	**27.60**	**2.24992**	**0.1104**	221.2749	7.524200789	9.62	0.38	**22.2**	**1.0**	**1.234**	**0.390**
4.8125	0.1875	15.71755918	0.5	**110.6384125**	**3.7575**	**281.24**	**13.80**	**1.12496**	**0.0552**	110.63745	3.762100395	4.81	0.19	**15.7**	**0.5**	**0.627**	**0.283**
75	**5**	**47.4341649**	**8**	**1724.235**	**100.2**	**4382.96**	**368.00**	**17.53185**	**1.472**	1724.22	100.3226772	75.00	5.01	**47.4**	**8.0**	**8.630**	**0.531**
37.5	2.5	33.54101966	4	**862.1175**	**50.1**	**2191.48**	**184.00**	**8.76592**	**0.736**	862.1100001	50.16133859	37.50	2.50	**33.5**	**4.0**	**4.600**	**0.502**
18.75	1.25	23.71708245	2	**431.05875**	**25.05**	**1095.74**	**92.00**	**4.38296**	**0.368**	431.055	25.0806693	18.75	1.25	**23.7**	**2.0**	**2.394**	**0.518**
9.375	0.625	16.77050983	1	**215.529375**	**12.525**	**547.87**	**46.00**	**2.19148**	**0.184**	215.5275	12.54033465	9.37	0.63	**16.8**	**1.0**	**1.234**	**0.426**
4.6875	0.3125	11.85854123	0.5	**107.7646875**	**6.2625**	**273.94**	**23.00**	**1.09574**	**0.092**	107.76375	6.270167324	4.69	0.31	**11.9**	**0.5**	**0.632**	**0.356**
71	**9**	**33.46972098**	**8**	**1632.2758**	**180.36**	**4149.20**	**662.40**	**16.59682**	**2.6496**	1632.2616	180.5808189	71.00	9.01	**33.4**	**8.0**	**8.720**	**0.830**
35.5	4.5	23.66666667	4	**816.1379**	**90.18**	**2074.60**	**331.20**	**8.29841**	**1.3248**	816.1308001	90.29040947	35.50	4.51	**23.7**	**4.0**	**4.600**	**0.811**
17.75	2.25	16.73486049	2	**408.06895**	**45.09**	**1037.30**	**165.60**	**4.14920**	**0.6624**	408.0654	45.14520473	17.75	2.25	**16.7**	**2.0**	**2.392**	**0.814**
8.875	1.125	11.83333333	1	**204.034475**	**22.545**	**518.65**	**82.80**	**2.07460**	**0.3312**	204.0327	22.57260237	8.87	1.13	**11.8**	**1.0**	**1.228**	**0.736**
4.4375	0.5625	8.367430244	0.5	**102.0172375**	**11.2725**	**259.33**	**41.40**	**1.03730**	**0.1656**	102.01635	11.28630118	4.44	0.56	**8.4**	**0.5**	**0.662**	**0.666**
63	**17**	**21.60882173**	**8**	**1448.3574**	**340.68**	**3681.69**	**1251.20**	**14.72675**	**5.0048**	1448.3448	341.0971024	63.00	17.02	**21.6**	**8.0**	**8.680**	**0.897**
31.5	8.5	15.27974438	4	**724.1787**	**170.34**	**1840.84**	**625.60**	**7.36338**	**2.5024**	724.1724001	170.5485512	31.50	8.51	**15.3**	**4.0**	**4.690**	**0.892**
15.75	4.25	10.80441086	2	**362.08935**	**85.17**	**920.42**	**312.80**	**3.68169**	**1.2512**	362.0862	85.27427561	15.75	4.26	**10.8**	**2.0**	**2.406**	**0.873**
7.875	2.125	7.639872189	1	**181.044675**	**42.585**	**460.21**	**156.40**	**1.84084**	**0.6256**	181.0431	42.6371378	7.87	2.13	**7.6**	**1.0**	**1.244**	**0.799**
3.9375	1.0625	5.402205432	0.5	**90.5223375**	**21.2925**	**230.11**	**78.20**	**0.92042**	**0.3128**	90.52155001	21.3185689	3.94	1.06	**5.4**	**0.5**	**0.640**	**0.744**

50	**30**	**12.90994449**	**8**	**1149.49**	**601.2**	**2921.97**	**2208.00**	**11.68790**	**8.832**	1149.48	601.9360631	50.00	30.04	**12.9**	**8.0**	**8.630**	**0.927**
25	15	9.128709292	4	**574.745**	**300.6**	**1460.99**	**1104.00**	**5.84395**	**4.416**	574.74	300.9680316	25.00	15.02	**9.1**	**4.0**	**4.550**	**0.914**
12.5	7.5	6.454972244	2	**287.3725**	**150.3**	**730.49**	**552.00**	**2.92197**	**2.208**	287.37	150.4840158	12.50	7.51	**6.5**	**2.0**	**2.441**	**0.924**
6.25	3.75	4.564354646	1	**143.68625**	**75.15**	**365.25**	**276.00**	**1.46099**	**1.104**	143.685	75.24200789	6.25	3.75	**4.6**	**1.0**	**1.250**	**0.851**
3.125	1.875	3.227486122	0.5	**71.843125**	**37.575**	**182.62**	**138.00**	**0.73049**	**0.552**	71.84250001	37.62100395	3.12	1.88	**3.2**	**0.5**	**0.648**	**0.804**
30	**50**	**6**	**8**	**689.694**	**1002**	**1753.18**	**3680.00**	**7.01274**	**14.72**	689.6880001	1003.226772	30.00	50.06	**6.0**	**8.0**		
15	25	4.242640687	4	**344.847**	**501**	**876.59**	**1840.00**	**3.50637**	**7.36**	344.844	501.6133859	15.00	25.03	**4.2**	**4.0**		
7.5	12.5	3	2	**172.4235**	**250.5**	**438.30**	**920.00**	**1.75318**	**3.68**	172.422	250.806693	7.50	12.52	**3.0**	**2.0**		
3.75	6.25	2.121320344	1	**86.21175**	**125.25**	**219.15**	**460.00**	**0.87659**	**1.84**	86.21100001	125.4033465	3.75	6.26	**2.1**	**1.0**		
1.875	3.125	1.5	0.5	**43.105875**	**62.625**	**109.57**	**230.00**	**0.43830**	**0.92**	43.1055	62.70167324	1.87	3.13	**1.5**	**0.5**		

Table E.9. Soil 9 routine analysis data

New Calculations of the standard solution used in the SAR trial										Corrected calculation as advised				Final Results			
Na (mequiv/L)	Ca (mequiv/L)	SAR	Est. EC	Na (mg/L)	Ca (mg/L)	NaCl (mg/L)	CaCl2.2 (H2O) (mg/L)	Total NaCl (g/4L)	Total CaCl2. H2O (g/4L)	Na (mg/L)	Ca (mg/L)	Na (mequiv/L)	Ca (mequiv/L)	Adjusted SAR	Est. EC	Meas. EC	Rksat %
80	0	#DIV/0!	8	1839.184	0	4675.16	0.00	18.70064	0	1839.168	0	80.00	0.00	140.0	8.0	8.470	0.472
40	0	#DIV/0!	4	919.592	0	2337.58	0.00	9.35032	0	919.5840001	0	40.00	0.00	140.0	4.0	4.630	0.394
20	0	#DIV/0!	2	459.796	0	1168.79	0.00	4.67516	0	459.792	0	20.00	0.00	140.0	2.0	2.460	0.354
10	0	#DIV/0!	1	229.898	0	584.39	0.00	2.33758	0	229.896	0	10.00	0.00	140.0	1.0	1.200	0.325
5	0	#DIV/0!	0.5	114.949	0	292.20	0.00	1.16879	0	114.948	0	5.00	0.00	140.0	0.5	0.676	0.357
78.8	1.2	101.7303626	8	1811.59624	24.048	4605.03	88.32	18.42013	0.35328	1811.58048	24.07744252	78.80	1.20	101.7	8.0		
39.4	0.6	71.93422922	4	905.79812	12.024	2302.52	44.16	9.21006	0.17664	905.7902401	12.03872126	39.40	0.60	71.9	4.0		
19.7	0.3	50.86518128	2	452.89906	6.012	1151.26	22.08	4.60503	0.08832	452.89512	6.019360631	19.70	0.30	50.8	2.0		
9.85	0.15	35.96711461	1	226.44953	3.006	575.63	11.04	2.30252	0.04416	226.44756	3.009680316	9.85	0.15	35.9	1.0		
4.925	0.075	25.43259064	0.5	113.224765	1.503	287.81	5.52	1.15126	0.02208	113.22378	1.504840158	4.92	0.08	25.4	0.5		
78.1	1.9	80.1289093	8	1795.50338	38.076	4564.12	139.84	18.25650	0.55936	1795.48776	38.12261733	78.10	1.90	80.1	8.0	8.720	0.539
39.05	0.95	56.65969513	4	897.75169	19.038	2282.06	69.92	9.12825	0.27968	897.7438801	19.06130867	39.05	0.95	56.6	4.0	4.480	0.466
19.525	0.475	40.06445465	2	448.875845	9.519	1141.03	34.96	4.56412	0.13984	448.87194	9.530654333	19.52	0.48	40.0	2.0	2.300	0.435
9.7625	0.2375	28.32984757	1	224.4379225	4.7595	570.52	17.48	2.28206	0.06992	224.43597	4.765327166	9.76	0.24	28.3	1.0	1.320	0.358
4.88125	0.11875	20.03222732	0.5	112.2189613	2.37975	285.26	8.74	1.14103	0.03496	112.217985	2.382663583	4.88	0.12	20.0	0.5	0.611	0.419
77	3	62.87023673	8	1770.2146	60.12	4499.84	220.80	17.99936	0.8832	1770.1992	60.19360631	77.00	3.00	62.8	8.0	8.420	0.867

38.5	1.5	44.45597073	4	**885.1073**	**30.06**	**2249.92**	**110.40**	**8.99968**	**0.4416**	885.0996001	30.09680316	38.50	1.50	**44.4**	**4.0**	**4.500**	**0.714**
19.25	0.75	31.43511837	2	**442.55365**	**15.03**	**1124.96**	**55.20**	**4.49984**	**0.2208**	442.5498	15.04840158	19.25	0.75	**31.4**	**2.0**	**2.335**	**0.739**
9.625	0.375	22.22798536	1	**221.276825**	**7.515**	**562.48**	**27.60**	**2.24992**	**0.1104**	221.2749	7.524200789	9.62	0.38	**22.2**	**1.0**	**1.215**	**0.613**
4.8125	0.1875	15.71755918	0.5	**110.6384125**	**3.7575**	**281.24**	**13.80**	**1.12496**	**0.0552**	110.63745	3.762100395	4.81	0.19	**15.7**	**0.5**	**0.648**	**0.656**
75	**5**	**47.4341649**	**8**	**1724.235**	**100.2**	**4382.96**	**368.00**	**17.53185**	**1.472**	1724.22	100.3226772	75.00	5.01	**47.4**	**8.0**	**8.970**	**0.927**
37.5	2.5	33.54101966	4	**862.1175**	**50.1**	**2191.48**	**184.00**	**8.76592**	**0.736**	862.1100001	50.16133859	37.50	2.50	**33.5**	**4.0**	**4.570**	**0.812**
18.75	1.25	23.71708245	2	**431.05875**	**25.05**	**1095.74**	**92.00**	**4.38296**	**0.368**	431.055	25.0806693	18.75	1.25	**23.7**	**2.0**	**2.428**	**0.847**
9.375	0.625	16.77050983	1	**215.529375**	**12.525**	**547.87**	**46.00**	**2.19148**	**0.184**	215.5275	12.54033465	9.37	0.63	**16.8**	**1.0**	**1.288**	**0.750**
4.6875	0.3125	11.85854123	0.5	**107.7646875**	**6.2625**	**273.94**	**23.00**	**1.09574**	**0.092**	107.76375	6.270167324	4.69	0.31	**11.9**	**0.5**	**0.656**	**0.747**
71	**9**	**33.46972098**	**8**	**1632.2758**	**180.36**	**4149.20**	**662.40**	**16.59682**	**2.6496**	1632.2616	180.5808189	71.00	9.01	**33.4**	**8.0**	**8.760**	**0.897**
35.5	4.5	23.66666667	4	**816.1379**	**90.18**	**2074.60**	**331.20**	**8.29841**	**1.3248**	816.1308001	90.29040947	35.50	4.51	**23.7**	**4.0**	**4.680**	
17.75	2.25	16.73486049	2	**408.06895**	**45.09**	**1037.30**	**165.60**	**4.14920**	**0.6624**	408.0654	45.14520473	17.75	2.25	**16.7**	**2.0**	**2.425**	**0.888**
8.875	1.125	11.83333333	1	**204.034475**	**22.545**	**518.65**	**82.80**	**2.07460**	**0.3312**	204.0327	22.57260237	8.87	1.13	**11.8**	**1.0**	**1.273**	
4.4375	0.5625	8.367430244	0.5	**102.0172375**	**11.2725**	**259.33**	**41.40**	**1.03730**	**0.1656**	102.01635	11.28630118	4.44	0.56	**8.4**	**0.5**	**0.676**	**0.785**
63	**17**	**21.60882173**	**8**	**1448.3574**	**340.68**	**3681.69**	**1251.20**	**14.72675**	**5.0048**	1448.3448	341.0971024	63.00	17.02	**21.6**	**8.0**	**8.860**	**0.997**
31.5	8.5	15.27974438	4	**724.1787**	**170.34**	**1840.84**	**625.60**	**7.36338**	**2.5024**	724.1724001	170.5485512	31.50	8.51	**15.3**	**4.0**	**4.010**	**0.929**
15.75	4.25	10.80441086	2	**362.08935**	**85.17**	**920.42**	**312.80**	**3.68169**	**1.2512**	362.0862	85.27427561	15.75	4.26	**10.8**	**2.0**	**2.437**	**0.918**
7.875	2.125	7.639872189	1	**181.044675**	**42.585**	**460.21**	**156.40**	**1.84084**	**0.6256**	181.0431	42.6371378	7.87	2.13	**7.6**	**1.0**	**1.260**	**0.870**
3.9375	1.0625	5.402205432	0.5	**90.5223375**	**21.2925**	**230.11**	**78.20**	**0.92042**	**0.3128**	90.52155001	21.3185689	3.94	1.06	**5.4**	**0.5**	**0.522**	**0.889**

50	**30**	**12.90994449**	**8**	**1149.49**	**601.2**	**2921.97**	**2208.00**	**11.68790**	**8.832**	1149.48	601.9360631	50.00	30.04	**12.9**	**8.0**	**8.530**	**0.955**
25	15	9.128709292	4	**574.745**	**300.6**	**1460.99**	**1104.00**	**5.84395**	**4.416**	574.74	300.9680316	25.00	15.02	**9.1**	**4.0**	**4.630**	**0.931**
12.5	7.5	6.454972244	2	**287.3725**	**150.3**	**730.49**	**552.00**	**2.92197**	**2.208**	287.37	150.4840158	12.50	7.51	**6.5**	**2.0**	**2.450**	**0.919**
6.25	3.75	4.564354646	1	**143.68625**	**75.15**	**365.25**	**276.00**	**1.46099**	**1.104**	143.685	75.24200789	6.25	3.75	**4.6**	**1.0**	**1.351**	**0.906**
3.125	1.875	3.227486122	0.5	**71.843125**	**37.575**	**182.62**	**138.00**	**0.73049**	**0.552**	71.84250001	37.62100395	3.12	1.88	**3.2**	**0.5**	**0.720**	**0.908**
30	**50**	**6**	**8**	**689.694**	**1002**	**1753.18**	**3680.00**	**7.01274**	**14.72**	689.6880001	1003.226772	30.00	50.06	**6.0**	**8.0**		
15	25	4.242640687	4	**344.847**	**501**	**876.59**	**1840.00**	**3.50637**	**7.36**	344.844	501.6133859	15.00	25.03	**4.2**	**4.0**		
7.5	12.5	3	2	**172.4235**	**250.5**	**438.30**	**920.00**	**1.75318**	**3.68**	172.422	250.806693	7.50	12.52	**3.0**	**2.0**		
3.75	6.25	2.121320344	1	**86.21175**	**125.25**	**219.15**	**460.00**	**0.87659**	**1.84**	86.21100001	125.4033465	3.75	6.26	**2.1**	**1.0**		
1.875	3.125	1.5	0.5	**43.105875**	**62.625**	**109.57**	**230.00**	**0.43830**	**0.92**	43.1055	62.70167324	1.87	3.13	**1.5**	**0.5**		