EstProc DEFRA Project FD1905

REPLIES TO QUESTIONNAIRE TO PREPARE FOR
Cohesive Sediments Workshop
Southampton Oceanography Centre (SOC)
12-13 May 2003

This questionnaire was circulated to all the EstProc partners in advance of the above meeting. Replies were solicited only for those tasks that relate to cohesive sediments. Questions were addressed to "experimenters" (including process researchers making use of existing data), and "modellers" (including 1DV, 1DH, 2DV, 2DH and 3D models). The intention of the questionnaire was:

1. *To help the experimenters appreciate the problems that modellers perceive in introducing new processes into their models, and identify which models the experimenters might aim their results at*
2. *To encourage modellers to add new processes into their models, and identify the most appropriate providers of such processes*
3. *To make a first draft of the structure of each of the algorithmic outputs of the project, as required by the Terms of Reference*
4. *To decide the best route to formulate the algorithms.*

REPLY FROM HR WALLINGFORD (JEZ SPEARMAN, RICHARD SOULSBY)

To modellers:
M1: What input parameters describing mud properties do your models presently require (name the model(s) and list output and input parameters [with units])?
For most consultancy work a 2D mud transport model is used with the following parameters:

- **Critical bed shear stress for deposition (calibrated within reasonable limits)**
- **Critical bed shear stress for erosion (calibrated within reasonable limits)**
- **Settling velocity (constant or a power function of concentration, calibrated within reasonable limits)**
- **Erosion rate constant (in the Partheniades equation – this can vary quite widely and is really a calibration parameter)**
- **Dry density (usually based on a reasonable estimate given the material type)**

For more complex problems or research a 3D mud transport might be used with Other processes added, including,

- **Consolidation (using Gibsons equation which relates effective stress and permeability and requires empirical parameters describing the inter-particle attraction or a simplified version which involves defined layers with specified dry densities, erosion thresholds and thicknesses)**
- **Turbulence damping functions (empirical coefficients for these coming from the literature).**
- **More complex representations of settling velocity involving measurements of turbulence (where in situ data is available the functions are generally tuned to the data though there are generic equations in the literature) and hindered settling.**
- **Fluid mud processes (such as entrainment rates, dewatering rates, critical stress at which dewatering occurs, gelling concentration, etc).**

M2: What benefits (in improving simulation accuracy) might you gain from additional processes (list desired processes)?
Unless the calibration data set is large and very detailed it is not expected that there will *necessarily* be an improvement in *accuracy*. Essentially the model is calibrated to the observations and so generally fits the limited data "well". The addition of more parameters to "tune" to the data can increase uncertainty by providing more than one

combination which matches the observations. What is of benefit is when the addition of a process allows the reproduction of an observed "feature" in the model results. This enhances confidence in the model results.

e.g. 1. Delft (Han Winterwerp) has found that the correct sort of sediment fluxes into Rotterdam Harbour are not reproduced by mud transport models unless the effect of turbulent damping is included. Here the "feature" is very high sedimentation given relatively low concentrations although the accuracy of the prediction of deposition is obviously increased when turbulent damping is included in the model.

2. Andreas Malcherek (Hamburg) modelled the mud transport in the Weser Estuary and found that he could not reproduce the measured concentrations except by allowing settling velocity to vary with turbulence. Here the accuracy of the model predictions of concentration might have improved but it is not known whether a statistical correlation showed this to be formally true and moreover it is not known whether other features of the model were improved.

3. Jez Spearman and Bill Roberts (HR) found that for a high quality settling velocity data set in the Tamar, the prediction of settling velocity was not improved by applying complex generic formulae and the best results were a power law dependent on concentration alone or the mean value of settling velocity. Here more complexity produced less accuracy. However, a site specific multi-variate analsysis by Andy Manning (Plymouth Uni) involving concentration and turbulence has produced the most accurate result.

M3: What problems might you encounter if you introduce new input parameters?
As stated above, more input parameters can improve things by allowing observed features to be reproduced or can make things worse by increasing uncertainty in the model (and even reducing accuracy). It is true that the processes represented in the model are not the same as reality and thus the use of "real" data (such as erosion threshold) will not necessarily improve the model predictions. Bed friction, for instance, in practical modelling is not just the physical friction of the sediment grains but takes into account other processes about which there is no data.

As for the supply of spatial data for a specific parameter, such as the distribution of the erosion threshold, the following considerations apply:

- **Given the uncertainty in the measured data, does the distribution of the measured data reflect the sediment quality or the measurement uncertainty? – Have there been tests undertaken to compare the variation in the parameter over a large area with repeated measurements in the vicinity of each other?**
- **Does the spatial data represent seasonal variation? Or is it misleading in this sense?**
- **Does the data cover all of the estuary or just a part? If not all, how do we estimate the sediment parameter for the parts of the estuary where there is no data?**
- **How does this initial distribution change when impacts (for instance erosion or deposition) occurs? Will the assumptions made in this respect be more important than the spatial variation of the parameter?**

To experimenters:
Re: WCI bed shear stresses
E1: What physical processes are you aiming to parameterise (list the "output parameters" of an algorithm encapsulating your results [with units])?
The mean and max bed shear-stresses over a wave-cycle for combined (monochromatic) waves plus currents over a smooth (mud) bed.
Outputs: Mean and max bed shear-stress [N/m2]
E2: What input parameters to a model would be needed if these processes were to be introduced to a model (list them [with units])?
Inputs: Depth-averaged current speed [m/s]; wave bottom orbital velocity amplitude [m/s]; wave period [s]; angle between current and wave propagation directions [degrees]; water depth [m]; kinematic viscosity [m2/s]

E3: What coefficients are involved in the parameterisations, and how confident are you of their (universal?) values?
Won't know until method is completed.
E4: What outputs of existing models do you think would be improved by including these additional processes, and what percentage improvement in accuracy would you hope the model will achieve?
Erosion and deposition rates for mud, improvements of ~50%.
E5: Can you help the modellers with the problem of the spatial distribution of new parameters in their models (e.g. are the input parameters easily known, or can they be related to some other quantity that is)?
Input parameters can be calculated easily from distributions of currents and waves from hydrodynamic models.

Re: Suspended mud profiles
E1: What physical processes are you aiming to parameterise (list the "output parameters" of an algorithm encapsulating your results [with units])?
Concentration of suspended mud by tidal currents as a function of height above bed.
Output: Mass concentration [kg/m3]
E2: What input parameters to a model would be needed if these processes were to be introduced to a model (list them [with units])?
Inputs: Depth-averaged current speed [m/s]; bed shear-stress [N/m2]; water depth [m]; height above bed [m]; bulk density of mud bed [kg/m3]; threshold shear-stresses of erosion and deposition [N/m2]
E3: What coefficients are involved in the parameterisations, and how confident are you of their (universal?) values?
Coefficients describing settling velocity as function of concentration; mud erosion rate constant. Site-specific or default values. Site-specific involves extensive testing of mud properties, default values accurate to about factor of 5.
E4: What outputs of existing models do you think would be improved by including these additional processes, and what percentage improvement in accuracy would you hope the model will achieve?
Suspended concentrations, transport rates, erosion and deposition rates, and hence morphodynamics. Factor of 3 improvement over existing methods.
E5: Can you help the modellers with the problem of the spatial distribution of new parameters in their models (e.g. are the input parameters easily known, or can they be related to some other quantity that is)?
Site-specific coefficients can probably be treated as constant for a study area. Currents, shear-stresses and depths all easily available spatially from models.

To modellers and experimenters:
EM1: Should the algorithms be written: (a) by the experimenter who derived the new results, (b) by a modeller based on scientific results written in a report or paper by the experimenter, (c) as an iterative process (if so, who makes the first draft)?
(c), with experimenters making the first draft, then pass to a modelling colleague (perhaps via an intermediary "analyst" to generalise it).

REPLY FROM POL (DAVID PRANDLE, ANDY LANE)

To modellers:
M1: What input parameters describing mud properties do your models presently require (name the model(s) and list output and input parameters [with units])?
Initial surficial distributions,boundary inputs
Erosion rate as f (velocity or shear stress) usually just akUpower**
a = coefficient adjusted for best overall (linear) fit to conc,
k = bed stress coefficient
Settling velocities (and indirectly calculated turbulence profiles)
Bed 'capture' rate
In random walk simulations,individual particles can have biol,chem.,etc properties and a spectra of settling velocities)

M2: What benefits (in improving simulation accuracy) might you gain from additional processes (list desired processes)?
Very simple to incorporate a wide range of activities (consolidation, sorting, chemical transfers with direct leeching to dissolved etc) at bed - but see below

M3: What problems might you encounter if you introduce new input parameters?
Difficulty generally is that more processes do not increase 'errors' they just expand the response characteristics via the much wider and uncertain specifications of the additional 'empirical' coefficients

To modellers and experimenters:
EM1: Should the algorithms be written: (a) by the experimenter who derived the new results, (b) by a modeller based on scientific results written in a report or paper by the experimenter, (c) as an iterative process (if so, who makes the first draft)?
You expect an experimenter to synthesise results within some forcing-response algorithm
Modellers are entirely fickle in selecting algorithms, you can choose (i) what produces 'sensible' results,(ii) what 'fits' your data ,(iii) what is perceived wisdom (even if knowingly 'wrong' -easier to defend)

It is essential that both communities/individuals maintain workshop and individual contacts- it is often the 'peculiar' result that spoilt the paper and hence omitted that is of common interest and produces progress. New paradigms come from exploring conditions in which 'good' models don't work!

REPLY FROM UNIVERSITY OF PLYMOUTH (ANDY MANNING)

To experimenters:
E1: What physical processes are you aiming to parameterise (list the “output parameters” of an algorithm encapsulating your results [with units])?

- **Macrofloc (flocs>160 □m) Settling Velocity (units = mm s^{-1})**
- **Microfloc (flocs<160 □m) Settling Velocity(units = mm s^{-1})**
- **Division of cohesive matter throughout floc populations (dimensionless parameter)**
- **Effects of Suspended Particulate Matter (SPM) concentration on Drag Reduction**

E2: What input parameters to a model would be needed if these processes were to be introduced to a model (list them [with units])?

- **SPM Concentration (mg l^{-1})**
- **A Turbulence parameter such as: Turbulent Shear Stress, or (N m^{-2})Turbulent Shear, G, (s^{-1})**

E3: What coefficients are involved in the parameterisations, and how confident are you of their (universal?) values?

- **All empirically derived.**

E4: What outputs of existing models do you think would be improved by including these additional processes, and what percentage improvement in accuracy would you hope the model will achieve?

- **Sediment rates and distributions, in particular mass settling flux rates**

E5: Can you help the modellers with the problem of the spatial distribution of new parameters in their models (e.g. are the input parameters easily known, or can they be related to some other quantity that is)?

- **Our empirical algorithms are derived from data sets which cover a wide range of estuarine conditions and would therefore be applicable at many locations throughout an estuary.**

To modellers and experimenters:
EM1: Should the algorithms be written: (a) by the experimenter who derived the new results, (b) by a modeller based on scientific results written in a report or paper by the experimenter, (c) as an iterative process (if so, who makes the first draft)?
C. The first draft of the algorithms should be by the experimenter who derived the new results.

Reply from GML: David M Paterson, Emma Defew, Roo Perkins

To experimenters:
E1: What physical processes are you aiming to parameterise (list the "output parameters" of an algorithm encapsulating your results [with units])?
Critical thresholds and erosion rates for cohesive, non-cohesive and mixed sediment, both model systems and natural sediments (N m^{-2} : kg m^{-2} s^{-1})

E2: What input parameters to a model would be needed if these processes were to be introduced to a model (list them [with units])?
Critical thresholds (N m^{-2})
Erosion rate (kg m^{-2} s^{-1})

E3: What coefficients are involved in the parameterisations, and how confident are you of their (universal?) values?
This depends on the nature of the measurement e,g law of the Wall (Von Karman's) but often calibrations are based on Shield's type data which is open to variation. I am not very confident of their generic robustness between methods.

E4: What outputs of existing models do you think would be improved by including these additional processes, and what percentage improvement in accuracy would you hope the model will achieve?
Any model used to determine the ETDC cycle of natural sediments, particularly those concerned with intertidal and salt-marsh systems where temporal changes and biogenic mediation are more influential.

E5: Can you help the modellers with the problem of the spatial distribution of new parameters in their models (e.g. are the input parameters easily known, or can they be related to some other quantity that is)?
Yes, we have produce spatially explicit maps of sediment stability of a number of habitats.

To modellers and experimenters:
EM1: Should the algorithms be written: (a) by the experimenter who derived the new results, (b) by a modeller based on scientific results written in a report or paper by the experimenter, (c) as an iterative process (if so, who makes the first draft)?
Iterative

REPLY FROM ABPmer (PAUL NORTON)
To modellers:

M1: What input parameters describing mud properties do your models presently require (name the model(s) and list output and input parameters [with units])?

Delft3D (morphological model)	MIKE21
Inputs:	**Inputs:**
Sedimentation velocity (m/day)	**Conc. dependent settling velocity (m/s)**
Critical shear stress sedimentation (N/m^2)	**Crit. Shear stress for deposition (N/m^2)**
Critical stress for erosion (N/m^2)	**Crit. Shear stress for erosion (N/m^2)**
Erosion coefficient (g/m^2/day)	**Erosion rate coefficient (g/m^2/s)**
Particle size (m)	**Erosion power coeff (-)**
Dry bed density (kg/m^3)	**Sliding coeff (not previously used)**
Sediment density (kg/m^3)	**Transition rate between layers (g/m^2/s)**
	Initial thickness of 3 sed. layers (mm)
	Density of 3 layers (kg/m^3)
Outputs:	**Outputs:**
Bed level (m)	**Net sedimentation (g/m2)**
Sediment concentration (g/m^3)	**Thickness of layers (mm)**
	Sediment concentration (g/m^3)

M2: What benefits (in improving simulation accuracy) might you gain from additional processes (list desired processes)?
Spatial representation of erosion threshold stresses would be an improvement to the existing model set up (particularly along the intertidal). However, in large area models it is often difficult to accurately model the intertidal, particularly in terms of the wetting and drying processes.

Consolidation process not included in any existing commercial software. With increased computing power we are making longer morphological simulations of several months. An assumed sediment density can significantly alter apparent erosion/accretion. Density variations through the consolidation process should therefore be considered as potentially important with these longer-term simulations.

M3: What problems might you encounter if you introduce new input parameters?
Where existing models do not allow spatial variability of key parameters, this would be a relatively simple task to include. One of the biggest problems in modelling studies is having sufficient data to properly calibrate a model. Whilst introducing additional parameters may improve the representation of the physics, if it is not possible to provide suitable calibration any improvement may be lost due to the additional uncertainties introduced.

To experimenters:
E1: What physical processes are you aiming to parameterise (list the “output parameters” of an algorithm encapsulating your results [with units])?
Preliminary investigations into the consolidation process with laboratory experiments including density and erosion threshold measurements over time.

E2: What input parameters to a model would be needed if these processes were to be introduced to a model (list them [with units])?
The model would require the following:
- Consolidation rate
- Rate of density change
- Relationship between density and erosion threshold

E3: What coefficients are involved in the parameterisations, and how confident are you of their (universal?) values?

Investigations to date have been specific site and have not been developed into a parametric model.

E4: What outputs of existing models do you think would be improved by including these additional processes, and what percentage improvement in accuracy would you hope the model will achieve?
See comments above on long-term morphological simulations. Improvements to predictions would depend on the local conditions and may be of the order of 20%.

E5: Can you help the modellers with the problem of the spatial distribution of new parameters in their models (e.g. are the input parameters easily known, or can they be related to some other quantity that is)?
More research on consolidation process required before we can achieve this.

To modellers and experimenters:
EM1: Should the algorithms be written: (a) by the experimenter who derived the new results, (b) by a modeller based on scientific results written in a report or paper by the experimenter, (c) as an iterative process (if so, who makes the first draft)?
Algorithms should initially be drafted by the original experimenters. Any modifications to the algorithm by modellers should be approved by experimenters.

REPLY FROM WL DELFT HYDRAULICS (HAN WINTERWERP)

My major concern is that I think we don't yet understand the overall behaviour of the sediment transport properly, and I am not keen to introduce new algorithms at this moment.
This is why I focus on the overall mud balance of the Humber.

To modellers:
M1: What input parameters describing mud properties do your models presently require (name the model(s) and list output and input parameters [with units])?
bed shear stress [Pa], velocities [m/s], settling velocity [m/s], gelling concentration [kg/m^3], critical shear stress for erosion [Pa], erosion rate parameter [kg/m^2/s].

Note that first two parameters are not really mud properties, but it is crucial that they properly assessed/computed, incl. effect of waves.

M2: What benefits (in improving simulation accuracy) might you gain from additional processes (list desired processes)?
Three processes have to be included properly to improve modelling of mud transport in estuaries:

1. **channel-shoal interaction: this is merely an extrapolation/improvement of current modelling ability/accuracy, and should include the effect of flow, waves and biology,**
2. **sediment-fluid interaction: sediment-induced buoyancy effects and effective hydrodynamic roughness,**
3. **sand-mud mixtures: effect of mixtures in sediment properties.**

M3: What problems might you encounter if you introduce new input parameters?
Problems to be expected/encountered:

1. **variability in space and time,**
2. **seasonal variability,**
3. **measurability: can we establish proper data set to validate our models, c.q. model descriptions.**

To modellers and experimenters:
EM1: Should the algorithms be written: (a) by the experimenter who derived the new results, (b) by a modeller based on scientific results written in a report or paper by the experimenter, (c) as an iterative process (if so, who makes the first draft)?
(c) real progress can only be obtained iteratively in my opinion. It does not matter who makes the first draft.

REPLY FROM PML (ROSE WOOD, JOHN WIDDOWS AND REG UNCLES)

To modellers:
M1: What input parameters describing mud properties do your models presently require (name the model(s) and list output and input parameters [with units])?
All RW models need:- critical erosion threshold, and variation of erosion rate as erosion continues down the bed column.
All the saltmarsh models, use:
For erosion:-
Critical erosion threshold stress (N m^{-2}), or critical erosion velocity at a particular height above the bed, and a relation converting velocity at this height to bed stress.
Maximum sediment which can be eroded at a particular bed stress (g m^{-2}).
Rate constant for erosion (s^{-1}), with erosion rate taken as proportional to the remaining sediment available for erosion at a particular bed stress.
These 3 parameters can all be dependent on measures of biological components of the sediment.
Bed sediment density (mass of sediment grains in given volume of wet sediment) – at the moment I keep this constant through the bed sediment column, but it could vary with depth into the bed.
(RW uses an erosion rate which depends on applied bed stress, and mass eroded so far; it could be re-expressed in terms of change in critical erosion stress down a vertical column of bed sediment). It is straightforward to change the algorithm for erosion rate.

For deposition:
Fall velocity (m s^{-1}, kept constant).
Critical deposition threshold stress (N m^{-2}). This parameter is dependent on biological parameters, in my models.

For the bed feedback models, at present, RW uses an erosion rate (g m^{-2} s^{-1}) which varies linearly with excess bed stress; and so I use an erosion rate constant (g m^{-2} s^{-1}).

For biological-sediment interactions, the cohesive sediment parameters vary in space and time due to biological components, as well as varying vertically down the bed sediment column and spatially due to the physical nature of the sediment.

M2: What benefits (in improving simulation accuracy) might you gain from additional processes (list desired processes)?
Improved spatial and temporal variation
Additional processes which would improve accuracy of model:
Bed stress due to waves in very shallow water, and nature of wave spectra in very shallow water.
How fast (and how) bed sediment re-establishes profiles of erodability and density after erosion or deposition or exposure-to-air events have occurred.
Effects of mixed sediment grain sizes on erosion and deposition rates.

M3: What problems might you encounter if you introduce new input parameters?
You always run the risk that introducing a more complex version of a process, requiring
new parameters which may vary in space and time and may only be known for a few cases, will produce worse results than using a coarser parameterization.
Lack of field validation data makes it difficult to choose between different formulations and parameter values for a process, when many formulations can produce reasonable results; and even basic forcing data (wave spectra, tidal inundation times and depths over the timescale of months to years- over which measurable changes in bed height occur) are not known over the shallowest intertidal areas.

To experimenters:
E1: What physical processes are you aiming to parameterise (list the “output parameters” of an algorithm encapsulating your results [with units])?

We are aiming to parameterise critical erosion thresholds, erosion rates and deposition rates in terms of flow parameters, sediment parameters and biological parameters (like stem height, stem density, animal density).

Comparison of Bed shear stresses (Pa) in the annular flume and field in relation to depth-averaged and near-bed current velocities.

Mean and maximum bed shear stresses (Pa) and near-bed currents over tidal cycles, with and without waves, in a shallow and relatively sheltered estuary (e.g. Tavy).

E2: What input parameters to a model would be needed if these processes were to be introduced to a model (list them [with units])?
SPM conc (mg l^{-1})
Biota density (units depending on biota e.g. chlorophyll a (ug g^{-1} dry sediment or mg m^{-2}); macrofauna abundance ind. m^{-2}; biomass mg m^{-2})
Bed shear stress (N m^{-2})

E3: What coefficients are involved in the parameterisations, and how confident are you of their (universal?) values?
Empirically derived

E4: What outputs of existing models do you think would be improved by including these additional processes, and what percentage improvement in accuracy would you hope the model will achieve?
Spatial and temporal changes in erosion and deposition, and therefore morphology.

E5: Can you help the modellers with the problem of the spatial distribution of new parameters in their models (e.g. are the input parameters easily known, or can they be related to some other quantity that is)?
Many of the biological parameters are variable in space and time, but you can provide ranges, and distinguish times and places where densities are very high(say for bivalves), and where they are very low.

To modellers and experimenters:
EM1: Should the algorithms be written: (a) by the experimenter who derived the new results, (b) by a modeller based on scientific results written in a report or paper by the experimenter, (c) as an iterative process (if so, who makes the first draft)?

It should be an iterative process, with discussions about the behaviour and physical justification of any formulations produced.

REPLY FROM CCRU (TOM SPENCER, IRIS MOLLER, ROZ TURNER)
To experimenters **(field observations / data)**:
E1: What physical processes are you aiming to parameterise (list the "output parameters" of an algorithm encapsulating your results [with units])?
Physical processes:
Wave attenuation processes over saltmarshes. and the effect of vegetation roughness on wave attentuation

Outputs:
Significant wave heights or rms wave heights over saltmarsh surfaces
Units: metres.
Peak period or zero-upcrossing period of waves over saltmarsh surfaces
Units: seconds.
Full wave spectra over saltmarsh surfaces
Units: energy per frequency band (e.g. Joules/m^2).

E2: What input parameters to a model would be needed if these processes were to be introduced to a model (list them [with units])?
Fixed inputs for all model runs
Surface elevations (cross-shore transect or, ideally, 3-D to capture creek/edge/saltpan morphology)
Units: metres
Surface roughness (vegetation induced)
Units: non-dimensional?
Bed viscosity / permeability
(Particle size distributions of sediment?)
Units: phi
(Organic content of sediment?)
Units: % by dry weight ?

Variable inputs
Significant wave heights or rms wave heights at the seaward saltmarsh margin
Units: metres.
Peak period or zero-upcrossing period of waves at the seaward margin
Units: seconds.
Full wave spectra at the seaward margin
Units: energy per frequency band (e.g. Joules/m^2).

E3: What coefficients are involved in the parameterisations, and how confident are you of their (universal?) values?
Shoaling coefficient
Percolation coefficient
Friction coefficient
Viscous friction coefficient

E4: What outputs of existing models do you think would be improved by including these additional processes, and what percentage improvement in accuracy would you hope the model will achieve?
Improved modelling of changing pattern of wave attenuation with changes in water depth, incident wave conditions, and seasonal / locational variations in vegetation cover and/or sediment type.

E5: Can you help the modellers with the problem of the spatial distribution of new parameters in their models (e.g. are the input parameters easily known, or can they be related to some other quantity that is)?
Improved morphology can be obtained by intensive surveys (although this is costly), and LiDAR surveys are not (yet) accurate enough (of the order of decimetres) and are affected by errors due to presence of vegetation canopy.
Surface roughness is very difficult to quantify and much work needs to be done to develop improved techniques. Vegetation-induced roughness not only depends on

vegetation height and density but also on the geometry, structural properties and buoyancy of individual types of vegetation. CCRU is hoping to develop techniques to improve the practicalities of quantifying properties that may be used as indicators of roughness.
Particle size can be obtained by point sampling and making assumptions about uniformity over certain areas. A better understanding of spatial variations in substrate characteristics may be forthcoming from developments in remote sensing techniques

To modellers and experimenters:
EM1: Should the algorithms be written: (a) by the experimenter who derived the new results, (b) by a modeller based on scientific results written in a report or paper by the experimenter, (c) as an iterative process (if so, who makes the first draft)?
Certainly not b) and unlikely to be a). We favour c) with the first draft being resolved through initial discussions.