CANADIAN ROYALTIES INC.

Montréal, le 15 mai 2013

Madame Anne-Marie Gaudet
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N/Réf. : 101-53046-03

Objet : Projet Nunavik Nickel, Canadian Royalties Inc.
Étude d'impact sur l'environnement et le milieu social pour l'aménagement d'infrastructures portuaires et la gestion des sédiments à la baie Déception
Complément d'information

Madame,

Une copie du rapport mentionné en objet vous a été transmise en novembre 2012. À la suite de l'analyse de cette dernière, des questions de la part du COFEX-N ont été transmises par courriel à l'attention de madame Gail Amyot de Canadian Royalties Inc. (CRI), le 1er mai 2013.

La présente vise à fournir les précisions et compléments d'information demandés.

Veuillez noter que le concept préliminaire du quai permanent présenté dans l'étude déposée en novembre 2012 a fait l'objet d'une révision par les ingénieurs-concepteurs de CRI. Les plans révisés sont joints à l'annexe 1.

Les principales modifications apportées au concept du quai permanent sont les suivantes :

- la cellule nord a été déplacée dans le même axe et à proximité de la cellule sud;
- le concept du pont reliant la rive à la cellule sud a été révisé; un pont pourvu d'un appui central est proposé;
- les manœuvres de chargement et de déchargement se feront sur les cellules de palplanches;

- une passerelle permettant le passage d'un tout-terrain de type côte à côte relie les deux cellules;
- des feux de signalisation ont été ajoutés sur les cellules nord et sud;
- les systèmes de déglaçage des parois de palplanches ont été retirés, car jugés non requis.

Les nouvelles coordonnées géographiques centrales ainsi que les coordonnées de projection UTM (datum NAD 83, zone 18 N) des cellules de palplanches sont indiquées sur les plans joints à la présente. Ces coordonnées sont les suivantes :

- Cellule sud
  - 62° 08' 20,7" de latitude nord
  - 74° 40' 50,6" de longitude ouest
  - X = 516 631,484 m est
  - Y = 6 889 715,450 m nord
- Cellule nord
  - 62° 08' 22" de latitude nord
  - 74° 40' 54,2 de longitude ouest
  - X = 516 594,735 m est
  - Y = 6 889 756,371 m nord

Il a été décidé de procéder aux manœuvres de chargement et de déchargement des navires directement à partir des cellules de palplanches. Puisque CRI sera propriétaire du navire, l'obligation de réduire le temps requis pour ces manœuvres n'est donc plus une contrainte. Ces opérations seront toutes aussi sécuritaires; le navire accostera directement sur les cellules de palplanches lesquelles seront protégées à l'aide de systèmes de défense.

L'aménagement du pont nécessitera la construction d'un support intermédiaire. Ce dernier sera constitué de pieux foncés jusqu'au roc, lesquels seront protégés par un enrochement. Ce dernier est requis pour empêcher la glace d'adhérer aux pieux et, conséquemment, de préserver leur intégrité. La construction du support intermédiaire du pont sera exécutée depuis le tablier du pont, lequel sera temporairement supporté par une barge sur vérins (« jack-up barge »).

La construction des cellules de palplanches sera effectuée depuis l'autre travée du pont pour la cellule sud et depuis une barge pour la cellule nord.

Il est à noter que pour contrer l'impact des glaces sur les cellules, la paroi de palplanches sera renforcée par l'ajout de panneaux de béton armé verticaux fixés sur la face interne de celles-ci (plan 506117_8000_41D1_0009, plan 506117_8000_42D1_004).

Une couronne, également faite de béton armé, viendra coiffer le mur de palplanches permettant l'ancrage des échelles et des systèmes de défense (plan 506117_8000_41D1_0010). Des dalles de béton y seront également fixées. Ces dalles, de longueurs et de largeurs variables selon leur utilité, permettront l'installation des ouvrages suivants :

- assises pour la passerelle reliant les deux cellules de palplanches : une assise sur chaque cellule;
- assise pour le pont : une assise sur la cellule sud uniquement;
- ancrage des bollards;
- ancrage des feux de signalisation et de leur système électrique.

Les plans 506117_8000_41D1_0009 et 506117_8000_42D1_0001 présentent l'aménagement général de ces ouvrages.

Selon ce nouveau concept, les volumes de sédiments dragués se trouvent considérablement diminués. L'installation de la cellule 1 (nord) nécessitera un dragage de l'ordre de 15 000 m^3 (23 000 m^3 initialement), tandis que pour la cellule 2 (sud), le dragage est estimé à environ 7 000 m^3 (20 000 m^3 initialement). Ainsi, un volume de sédiments totalisant environ 22 000 m^3 sera dragué. Le volume a été obtenu par comparaison des surfaces à l'aide d'un logiciel de dessin assisté par ordinateur (CAO).

Pour ce qui est du volume de pierres requis pour l'empierrement autour des cellules, il se trouve également diminué. Il sera constitué de roches de différents calibres disposées comme illustré sur le plan 506117_8000_41-D1_0007. Autour de la cellule 1 (nord), le volume est estimé à 13 100 m^3, couvrant 2 920 m^2, tandis que pour la cellule 2 (sud), le volume révisé de l'ordre de 5 700 m^3 disposés sur 1 535 m^2.

Le concept d'aménagement du quai permanent révisé entrainera une modification de l'habitat du poisson de l'ordre de 5 400 m^2 : la superficie occupée par les deux cellules de palplanches est maintenue et couvrira environ 940 m^2, tandis que l'enrochement autour de ces dernières occupera environ 4 455 m^2. Le support intermédiaire installé dans la zone de marnage sera également protégé de l'impact des glaces à l'aide d'enrochement couvrant une superficie de l'ordre de 470 m^2. Contrairement au concept initial, l'enrochement autour des cellules de palplanches sera submergé en tout temps, seul l'enrochement autour du support intermédiaire se trouvera hors de l'eau à marée basse.

Ainsi, malgré le fait que les empierrements devraient être colonisés par la végétation aquatique et l'épibenthos, créant ainsi des habitats d'alimentation pour le poisson, en plus de constituer des abris contre la prédation ou des aires de repos grâce à la présence d'interstices entre les roches, une superficie évaluée à 5 400 m^2 sera considérée et fera l'objet de mesures de compensation du poisson en vertu des dispositions sur la protection de l'habitat du poisson de la Loi sur les pêches (LCR, 1985, c.F-14).

Pour toute question relative à ce document, n'hésitez pas à contacter la soussignée.

Veuillez agréer, Madame, nos salutations distinguées.

Gail Amyot, ing, M. Sc.
Vice-présidente Environnement, santé et sécurité
Canadian Royalties Inc.

p. j. Réponses aux questions et commentaires
Annexe 1 – Plans révisés du quai permanent signés et scellés
Annexe 2 – Stantec Consulting Ltd : Rapports géotechniques
Annexe 3 – GENIVAR : Note technique : méthodes de dragage

c. c. Monsieur Claude D'Astous, MDDEFP central
Madame Alexandra Roio, MDDEFP central
Madame Isabelle Dorion, MDDEFP régional
Monsieur Michael Barrett, ARK-CCEK
Madame Mishall Naseer, ARTIN
Madame Natalie Gagné, GENIVAR INC.

QUESTIONS ET COMMENTAIRES COFEX-N

Enjeux

1- Détaillez les vérifications qui ont été faites quant à la stabilité des talus (justification pente) du dragage et sur la protection en enrochement qui sera réalisée.

2- Informations sur le choix et l'ancrage des structures et leur stabilité à long terme (on voit sur les plans que le matériel qui ceinture les 2 cellules de palplanche est excavé pour être remplacé par de la pierre). Si la protection en enrochement faisait défaut en raison d'un mauvais calibre de pierre ou du non-respect des critères de filtre, est-ce que la stabilité des 2 cellules serait alors compromise?

3- Informations sur les conditions extrêmes (études agitation, vents, glaces, séismes, etc.) et leur prise en compte dans le design/conception des infrastructures (critères de conception à utiliser).

Réponses – Enjeux :

1- CRI a mandaté la firme Stantec Consulting Ltd. (Stantec) pour préparer un rapport géotechnique complet incluant les paramètres requis pour la conception des ouvrages constituant le quai permanent proposé à la baie Déception. Une copie de ce rapport est jointe à l'annexe 2 du présent document.
2- Les analyses de stabilités sont présentées dans le rapport géotechnique (Stantec, 2013). Le choix du type d'enrochement autour des cellules a fait l'objet de calculs afin d'assurer la stabilité globale des cellules de palplanches considérant les charges appliquées ainsi que l'impact des glaces en plus d'offrir une protection contre l'affouillement potentiel du fond marin dû aux fonctionnements des moteurs des navires. Il importe de noter que les travaux seront exécutés sous la supervision des surveillants de chantiers mandatés par CRI afin d'assurer le respect des exigences indiquées aux plans et devis.
3- Les conditions extrêmes ont été prises en compte lors de la conception du quai permanent et des ouvrages connexes.

<u>Questions détaillées</u>

a. *Il faudrait vérifier si la pente a été stabilisée après le glissement de terrain. Est-ce qu'il y a eu des travaux correctifs?*

Réponse :

À la suite des évènements de juillet 2011, les grosses roches ont été retirées de manière à préserver la navigabilité à proximité de la berge. Pour ce qui est de la pente, elle s'est stabilisée naturellement. Le design finalement retenu par les ingénieurs, de concert avec les spécialistes de CRI, pour l'aménagement

d’infrastructures portuaires à la baie Déception est basé sur une caractérisation approfondie du site proposé, les sondages ont été réalisés à l’été 2012, soit après le glissement. Le site choisi pour la construction des cellules de palplanches est optimal considérant la nature des sols présents et du socle rocheux ainsi que les contraintes liées à la navigation.

b. *Il y a probablement une faille/faiblesse dans la pente, est-ce qu'il y a présence d'érosion continue?*

Réponse :

La couche d’argile à argile silteuse présente une faible capacité portante. Cette couche sera draguée préalablement à l’installation des cellules de palplanches selon les recommandations des rapports géotechniques Stantec, 2012 et 2013. Le fond marin est stable et il n’y a pas de signe d’érosion continue.

Dragage

a. *L'argile pourrait être sensible. On n'a pas en main les propriétés physiques de l'argile.*

Réponse :

Les propriétés de l’argile sont clairement définies dans les rapports géotechniques de Stantec (Stantec, 2012; Stantec, 2013)

b. *Est-ce que des études géotechniques ont été réalisées en détail?*

Réponse :

Les rapports géotechniques (Stantec, 2012; Stantec, 2013) sont disponibles à l’annexe 2 du présent document.

c. *Est-ce qu'une analyse avec recommandations par un ingénieur géologue a été faite des données du relevé géotechnique?*

Réponse :

Les rapports géotechniques incluant les recommandations d’un ingénieur géologue (Stantec, 2012; Stantec, 2013) sont disponibles à l’annexe 2 du présent document.

d. *Est-ce qu'on a évalué la stabilité des talus d'excavation lors des travaux de dragage?*

Réponse :

Les rapports géotechniques incluant les analyses de stabilité des talus (Stantec, 2012; Stantec, 2013) sont disponibles à l'annexe 2 du présent document.

e. *Les pentes 3:1 ne seraient peut-être pas stables (étant donné la présence d'argile), pendant la période des travaux. Les volumes de dragage pourraient être plus importants + production accrue de M.E.S.*

Réponse :

Les experts estiment que la pente d'excavation de 3:1 est réaliste, mais qu'elle pourrait aller jusqu'à 5:1, dans lequel cas, les installations pour la gestion des sédiments en milieu terrestre possèdent une capacité de stockage suffisante.

f. *Comment peut-on être sûr de la stabilité des pentes?*

Réponse :

Voir le rapport géotechnique Stantec, 2013 ci-joint à l'annexe 2.

g. *Le scénario de dragage sur 1 mois à 16 h/jour, 100 m^3/heure est vraiment ultra optimiste (la cadence de dragage créera beaucoup de turbidité.). Est-ce qu'ils ont une option B plus réaliste si les travaux de dragage sont ralentis par les conditions météos et que le calendrier ne peut pas être modifié (cheminement critique)?*

Réponse :

Il est prévu que le dragage des sédiments soit réalisé sur une période pouvant aller jusqu'à 24 heures par jour. Il est estimé qu'environ 15 jours de dragage seront requis pour chacune des cellules de palplanches.

Une note technique comparant diverses méthodes de dragage est présentée à l'annexe 3. CRI préconise l'utilisation de la benne preneuse environnementale permettant de réduire la remise en suspension des particules fines lors des travaux de dragage et pour cette raison, cette méthode a été présentée dans l'EIES. Cependant, une méthode hydraulique pourrait être acceptée s'il est démontré que les eaux retournées à la baie Déception rencontrent les critères de qualité de l'eau applicables à la baie Déception. Comme indiqué dans la note technique, la méthode hydraulique pour le dragage semble plus rapide lorsque les conditions sont optimales (absence de roche).

L'entrepreneur mandaté par CRI pour la réalisation des travaux de dragage est averti des conditions et contraintes présentes à la baie Déception. Les documents contractuels prévoient qu'il doit choisir la méthode de travail utilisée et faire la démonstration que celle-ci rencontre les exigences de performance spécifiées aux documents d'appel d'offres.

Section 7 : Description du projet

a. *Est-ce qu'une étude d'agitation a été réalisée? Les données de vent ne couvrent que 10 ans et datent de plus de 40 ans. La plage de données semble insuffisante et non représentative.*

Réponse :

Les mesures de vent à la baie Déception sont rares (données privées non disponibles). Afin d'obtenir un portrait général, les vents mesurés à la station météorologique Salluit A (aéroport), située à plus de 50 km à l'est, sont utilisés pour la période de 1992 à 2012. Les spécialistes ont dû travailler avec les données disponibles.

Lors de l'élaboration du premier concept de quai en 2010, les conditions environnementales ont été considérées pour déterminer la hauteur minimale requise du quai. Cette évaluation était basée sur la variation des marées, la hauteur des vagues, ainsi que le potentiel de rehaussement du niveau de l'eau en raison des changements climatiques. La hauteur de cellules de palplanches a été fixée sur la base de ces considérations, elle est la même que celle proposée dans le premier concept.

b. *Est-ce que les ouvrages ont été conçus pour les conditions extrêmes (seulement des données moyennes, non en conditions extrêmes, ont été retenues)? A-t-on basé la grosseur des enrochements sur les conditions extrêmes de vagues, vents et marées?*

Réponse :

Les enrochements sont requis pour contrer l'effet des glaces et non des vents. Comme présenté dans le rapport géotechnique, les cellules sont stables par elles-mêmes contre les vents et les vagues.

c. *Est-ce qu'une étude sur le batillage des bateaux a été réalisée? En lien avec la dynamique sédimentaire : la vitesse et la présence des bateaux à quai peuvent créer de l'érosion (celle-ci dépend également de la présence de végétation sur place).*

Réponse :

Une étude sur le batillage des navires n'a pas été réalisée. En raison de la nature des berges à la baie Déception (roc affleurant ou à faible profondeur) les berges présentent peu de risque d'érosion. De plus, certaines conditions et contraintes

imposées à la navigation et à l'aménagement des quais à la baie Déception peuvent indirectement limiter les impacts du batillage, à savoir :

- la vitesse des navires est limitée à 7 nœuds;
- l'enrochement prévu au pied des cellules de palplanches, côté navire, sert à contrer l'affouillement.

Les hydrauliciens et géomorphologues consultés sont d'avis qu'une étude sur le batillage à baie Déception n'est pas pertinente.

d. *Pourquoi le quai n'a pas été conçu avec des ducs-d'Albe? (le volume de dragage serait alors moins important)*

Réponse :

Les ducs-d'Albe sont indiqués quand le sol de fondation a des caractéristiques permettant le battage des tubes (sable ou argile). Quand les fonds sont rocheux, les ducs-d'Albe sont alors réalisés sous forme d'ouvrage massif (caissons) permettant de reprendre les charges et contraintes imposées (vents, glace, navire, et autres).

De plus, l'enrochement autour de la pile intermédiaire sert à briser les glaces à la faveur des marées descendantes, ce qui n'est pas possible entre les ducs d'Albe et les navires.

e. *Qu'est-ce qui garantit que la cellule de palplanche (qui n'est pas ancrée au roc) ne bougera pas à long terme?*

Réponse :

Le design des cellules de palplanches a été élaboré considérant l'ensemble des contraintes et charges appliquées auxquelles des facteurs de sécurité ont été appliqués. Voir le rapport géotechnique Stantec, 2013 ci-joint à l'annexe 2.

f. *Pourquoi n'y a-t-il pas un enrochement des deux côtés d'une des cellules?*

Réponse :

Le plan 506117_8000_41-D1_0006 joint à l'annexe 1 illustre la distribution de l'enrochement autour des deux cellules de palplanches.

g. *Pour les enrochements sur l'argile, comment sont-ils assurés que la roche ne s'enfoncera pas dans l'argile (comme ça a été le cas avec le glissement en 2011)- Il n'y a aucune indication sur les calibres de pierre qui seront utilisés, les critères de filtre ne sont présentement pas respectés, car il n'y a aucune transition de granulométrie entre l'argile et la pierre de protection?*

Réponse :

Lors des évènements de 2011, les roches déposées sur le fond marin ne se sont pas enfoncées dans la couche d'argile telle qu'anticipée : l'enrochement est demeuré sur le dessus de la couche argileuse sans pénétrer, provoquant une surcharge sur celle-ci jusqu'à ce que cette couche d'argile cède et provoque le glissement.

Dans le concept révisé, l'enrochement proposé remplacera le volume d'argile excavé. Quoique le poids de l'enrochement est d'environ 10 % supérieur à celui de l'argile qu'il remplace, s'il y avait un glissement, la roche formerait une partie importante du plan de cisaillement. L'enrochement permet de renforcer la pente par rapport à son état original et conséquemment, les spécialistes considèrent que le facteur de sécurité contre la rupture de pente obtenu à la suite de l'enrochement est équivalent ou supérieur à celui obtenu initialement.

h. *Questionnement sur l'ancrage des infrastructures permanentes : l'action des glaces et des vagues pourrait déstabiliser la protection en enrochement et créer de l'affouillement ou de l'érosion.*

Réponse :

Comme présenté dans le rapport géotechnique (Stantec, 2013), les cellules sont stables par elles-mêmes contre les vents et les vagues. L'enrochement ceinturant les cellules de palplanches permet d'augmenter la stabilité des cellules contre l'impact des glaces (côté rive) et contrer l'affouillement (côté navire).

i. *Est-ce qu'on a évalué la possibilité que la base des palplanches se déchausse sous l'effet des propulseurs des navires? Est-ce qu'une solution est envisagée?*

Réponse :

L'enrochement prévu au pied des cellules côté navire sert à contrer cet affouillement.

j. *Questionnement sur la stabilité des talus même une fois enroché : Peut-être qu'il n'y aurait pas de problème une fois enroché, mais entre-temps, est-ce que les études nécessaires ont été réalisées pour s'assurer de la stabilité des talus (vagues de dimensionnement, effort des glaces, critère de filtre et transition granulaire)?*

Réponse :

Comme mentionné précédemment, les experts estiment que la pente d'excavation de 3:1 permet d'assurer la stabilité des talus, mais qu'elle pourrait aller jusqu'à 5:1 du côté navire. Les études de stabilité ont été réalisées considérant l'ensemble des

contraintes applicables. Il est à noter que les travaux d'excavation de l'argile, d'aménagement des cellules et d'enrochement se dérouleront sur une période d'environ 4 mois (juin à septembre 2013), donc, avant la formation de glace.

k. Est-ce que les séismes ont été considérés? Est-ce qu'une gestion du risque est réalisée ou les ouvrages sont conçus pour résister aux séismes? (si on décide de construire en faisant fi des risques de séisme, éboulement, etc., il faut bien le documenter, surtout lorsque des travaux ont lieu en présence d'argile dans le milieu).

Réponse :

Pour les analyses en conditions pseudostatiques, une accélération horizontale du roc (peak ground acceleration – PGA) de 0,102 g a été considérée (valeur de l'aléa sismique obtenue de Ressources naturelles Canada pour la baie Déception correspondant à 2 % de la valeur d'accélération sur une période de récurrence de 1 dans 50 ans).

Pour l'analyse de stabilité des pentes en condition pseudostatique, les valeurs des coefficients sismiques suivants ont été utilisées : k_h = 0.051 g et k_v = 0 g. La valeur de k_h retenue est basée sur les recommandations de Hynes-Griffin et Franklin (1984) qui suggèrent que pour l'analyse en condition pseudostatique, 50 % de la valeur de l'accélération horizontale du roc est appropriée.

Pour le calcul du facteur de sécurité en condition pseudostatique, il a été supposé que les charges sismiques et celles dues à l'expansion des glaces (thermal ice loading) n'agissent pas simultanément, en ce sens qu'elles sont toutes deux considérées comme des charges extraordinaires. Les analyses réalisées en conditions pseudostatiques pour la cellule nord donnent un coefficient de sécurité de 1,63, comparativement à 2,63 considérant les charges permanentes seules. (Voir courriel de réponses complémentaires de Stantec, 7 mai 2013).

Considérant que le facteur de sécurité de la cellule sud sous les charges permanentes (3,05) est supérieur à celui de la cellule nord (2,63), il n'a pas été jugé utile de déterminer le facteur de sécurité en conditions pseudostatiques pour cette dernière, mais il sera supérieur à 1,63.

Annexe 1

Plans révisés du quai permanent signés et scellés

CANADIAN ROYALTIES INC.

PROJET NUNAVIK NICKEL

8000 SERIES

STEEL SHEET PILE CELLS
BRIDGED OPTION/
CELLULES DE PALPLANCHES D'OPTIONS
COMBLE

ISSUED FOR PERMIT
EMIS POUR PERMIS

SNC·LAVALIN

REGISTERED PROFESSIONAL ENGINEER
PEGNL
CHRISTOPHER M. FUDGE
SIGNATURE
2013-04-05
DATE
NEWFOUNDLAND & LABRADOR

ORDRE DES INGÉNIEURS DU QUÉBEC
Permis Temporaire / Temporary Licence
Nom / Name Christopher Fudge
No. OIQ PT01760
Nul après / Void after 2013-10-29
Site: NUNAVIK NICKEL PROJECT / NOTHERN QUEBEC

FOR PERMIT
NOT FOR CONSTRUCTION

POUR PERMIS
PAS POUR CONSTRUCTION

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506117-8000-4101-0012	DISPOSITIF D'AMARRAGE
506117-8000-41D1-0013	LES DÉTAILS D'AMARRAGE
506117-8000-41D1-0014	LES DÉTAILS D'AMARRAGE
506117-8000-4101-0015	PLAN DE PILE ET SECTIONS
506117-8000-42D1-0001	BOUCHON A BÉTON PLANS
506117-8000-42D1-0002	BOUCHON A BÉTON DE DÉTAILS - CELLULE OU NORD
506117-8000-42D1-0003	BOUCHON A BÉTON DE DÉTAILS - CELLULE DU SUD
506117-8000-4201-0004	AMARRAGE DE DÉTAILS CONRETS DE RENFORT
506117-8000-42D1-0005	POUTRELLES DE GLACE
506117-8000-4201-0006	RENFORCES COORDONNÉES CULÉE EN BÉTON
506117-8000-42D1-0007	SSP CELLULES COORDONNÉES CULÉE EN BÉTON
506117-8000-42D1-0008	SSP CELLULES COURONNÉMENT EN BÉTON

05 APRIL 2013
05 AVRIL 2013

PROJECT No./ PROJET No.
506117

DESIGN CRITERIA

CODES AND STANDARDS

1. DESIGN OF THE WHARF CONFORMS TO THE FOLLOWING CODES AND STANDARDS: CAN/CSA–A23.3 – DESIGN OF CONCRETE STRUCTURES.

SERVICE LIFE AND DURABILITY

1. THE STRUCTURE IS DESIGNED FOR A SERVICE LIFE OF 15 YEARS.

ICE DATA AND LOADS

DATA:

EXTREME MAXIMUM LEVEL ICE THICKNESS:	2.1m
BREAK–UP ICE THICKNESS:	1.4m
ICE BUSTLE THICKNESS (AVG.):	4.3m

LOADS:

THERMAL:	275kN/m
FLOE IMPACT:	8.6 MN
ICE LOAD DUE TO ICE BREAKING SHIP:	8.9 MN
GLOBAL PRESSURE:	700kPa

SEISMIC

1. GROUND ACCELERATION:

PEAK GROUND ACCELERATION:	0.16
PROBABILITY OF EXCEEDANCE IN 50 YEARS:	2%
AVERAGE RETURN PERIOD IN YEARS:	475

MARINE CRITERIA

1. TIDES REFERENCED TO CHART DATUM (CD), BASED ON CANADIAN HYDROGRAPHIC SERVICE (CHS) CHART No. 5457 ARE AS FOLLOWS:

EXTREME HIGH WATER LEVEL (EHWL):	5.9 m (ESTIMATED)
HIGHER HIGH WATER LEVEL, LARGE TIDE (HHWL):	5.6 m
HIGHER HIGH WATER LEVEL, MEAN TIDE:	4.7 m
MEAN WATER LEVEL (MWL):	2.9 m
LOWER LOW WATER LEVEL, MEAN TIDE:	1.0 m
LOWER LOW WATER LEVEL, LARGE TIDE (LLWL):	0.2 m
EXTREME LOW WATER LEVEL (ELWL):	0.0 m

2. CURRENT
   CURRENT SET PARALLEL TO THE BERTH FACE: 1.0 KNOT (ESTIMATED)
   CURRENT SET PERPENDICULAR TO THE BERTH FACE: 0.5 KNOT (ESTIMATED)
3. WIND
   WIND LOADS FOR ASSESSING MOORING LOADS ARE BASED ON WIND SPEEDS AS PROVIDED BY ATMOSPHERIC ENVIRONMENT SERVICE.
   RETURN PERIOD WIND: 50 YEAR
   WIND SPEED (30 SEC DURATION): 140 KILOMETERS PER HOUR
4. WAVE CLIMATE
   FOR ESTABLISHING DECK ELEVATION (ZERO OVERTOPPING):
   RETURN PERIOD: 1 YEAR
   MAXIMUM WAVE HEIGHT: 1.0 METERS
5. WAVE LOADS:
   RETURN PERIOD: 50 YEAR
   SIGNIFICANT WAVE HEIGHT 2.0 METERS

DESIGN VESSELS

VESSEL TYPE	DEADWEIGHT TONNES	LOA (m)	BEAM (m)	MINIMUM FREEBOARD (m)	MAXIMUM DRAFT (m)
HANDYSIZE	25,000	189	26.6	3.95	11.75

BERTHING IMPACT AND MOORING LOADS

VESSEL APPROACH VELOCITY PERPENDICULAR TO THE BERTH FACE:

VESSEL:	0.2 m/sec

MOORING LOADS:

FORE AND AFT SHORE MOORINGS:	200 TONNES
BREAST LINE SHORE BOLLARDS:	200 TONNES
SPRING LINE CELL BOLLARDS:	100 TONNES

DOCK LOADS

VEHICLE AND OTHER DECK LOADS ARE LISTED IN THE FOLLOWING SUBSECTIONS:

1. UNIFORM AND STORAGE LOADS 50 kPa
2. SHIPLOADER: HOLD

GENERAL NOTES

1.0 CONCRETE AND REINFORCEMENT

1.1 CONCRETE SHALL BE C–XL CLASS, 35MPa.

1.2 CAST IN PLACE CLEAR CONCRETE COVER TO THE REINFORCING STEEL SHALL BE AS FOLLOWS, UNLESS OTHERWISE NOTED:

BOTTOM SURFACES 100mm
SIOE SURFACES 75mm
TOP SURFACES 75mm

1.3 NO MORE THAN 25% OF THE LONGITUDINAL REINFORCING IN MEMBERS EXCEEDING 500mm DEEP SHALL BE SPLICED AT THE SAME LOCATION. ADJACENT BARS SHALL NOT BE SPLICED AT THE SAME LOCATION.

1.4 SPLICES IN MEMBERS LESS THAN OR EQUAL TO 500mm DEEP SHALL BE STAGGERED SO THAT NO MORE THAN EVERY THIRD BAR IS SPLICED AT ANY ONE SECTION.

1.5 MINIMUM LAP LENGTHS FOR ANY REINFORCING SPLICES SHALL BE AS FOLLOWS UNLESS OTHERWISE NOTED.

BAR SIZE	BARS OTHER THAN TOP BARS	TOP BARS
10M	400	500
15M	500	600
20M	600	800
25M	1000	1300
30M	1200	1600
35M	1500	2000

TOP BARS ARE HORIZONTAL REINFORCING BARS SO PLACED THAT MORE THAN 300mm OF CONCRETE IS CAST IN THE MEMBER BELOW THE REINFORCEMENT.

1.6 UNLESS NOTED OTHERWISE, ALL CORNERS TO BE CHAMFERED/FILLETED 25mm.

2.0 GROUT

2.1 GROUT BETWEEN SHEET PILE CELLS AND PRECAST CONCRETE ICE IMPACT BEAMS SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 20MPa.

2.2 MIX PROPORTIONS FOR GROUT FOR PRECAST CONCRETE ICE IMPACT BEAMS SHALL BE AS FOLLOWS, TO YIELD APPROXIMATE ONE CUBIC METER:

CEMENT (TYPE 10):	160kg
FLY ASH OR SLAG:	200kg
SILICA FUME:	40kg
CONCRETE SAND, SSD:	1500kg
WATER:	200±kg

WATER CONTENT SHALL BE ADJUSTED AS REQUIRED TO PROVIDE GROUT HAVING SUFFICENT FLOW OF 25± 3 SECONDS, AS PER CSA–A23.2–1B.

AIR ENTRANING ADMIXTURE AS NECESSARY FOR AIR CONTENT OF 9% ±1%

2.3 SAND FOR GROUT SHALL CONFORM TO CSA–A23.1 WITH A MAXIMUM FINENESS MODULUS OF 2.6 MASONRY SAND CONFORMING TO CSA–A179 MAY BE USED AS AN ALTERNATE.

2.4 UPON APPROVAL FROM THE COMPANY'S REPRESENTATIVE, A PORTION OF THE SAND MAY BE SUBSTITUTED WITH AGGREGATE CONFORMING TO CSA–A23.1 HAVING A MAXIMUM SIZE OF 10mm.

2.5 GROUT SHALL BE TESTED IN ACCORDANCE WITH CSA–A23.1. THE TESTING FREQUENCY SHALL BE DETERMINED BY THE COMPANY'S REPRESENTATIVE.

3.0 STEEL

3.1 FOR SHEET PILE STEEL GRADES, SEE SPECIFICATIONS.

3.2 UNLESS NOTED OTHERWISE, ALL MISCELLANEOUS METAL FABRICATIONS SHALL BE HOT–DIP GALVANIZED TO CSA G164.

3.3 FABRICATION, ERECTION, CONNECTION DESIGN AND DETAILING OF ALL STRUCTURAL STEEL AND CONNECTIONS SHALL BE IN ACCORDANCE WITH CAN/CSA S16.1–01.

3.4 WELDING SHALL CONFORM TO CAN/CSA W59–03 AND SHALL BE PERFORMED BY CERTIFIED WELDERS. FABRICATION SHOPS SHALL BE APPROVED BY THE CANADIAN WELDING BUREAU TO CAN/CSA W47.1–03.

3.5 STRUCTURAL STEEL SHALL MEET CAN/CSA G40.20–04 FOR GENERAL REQUIREMENTS, AND CAN/CSA G40.21–04 FOR QUALITY.

3.6 GRADES OF MATERIAL, UNLESS NOTED OTHERWISE:

STRUCTURAL STEEL AND MISC. METAL	350W
BOLTS, NUTS, AND WASHERS	ASTM A325M
ANCHOR BOLTS	ASTM A307
STEEL PIPE PILES	ASTM A252 GR.

3.7 ALL STEEL SHALL BE CHARPY IMPACT TESTED IN ACCORDANCE WITH CLAUSE 10.23.31 OF CAN/CSA S6 FOR A SERVICE TEMPERATURE OF –50°C. STEEL PIPE.

3.8 REFER TO SPECIFICATIONS FOR ADDITIONAL INFORMATION

FOR PERMIT
NOT FOR CONSTRUCTION

CRITÈRES DE CONCEPTION

CODES ET NORMES

1. CONCEPTION DU QUAI EST CONFORME AUX CODES SUIVANTS CAN/CSA–A23.3 – LA CONCEPTION DES STRUCTURES EN BÉTON.

DURÉE DE VIE ET DURABILITE

1. LA STRUCTURE EST CONCUE POUR UNE OURÉE DE VIE DE 15 ANS

DONNEES SUR LES GLACES ET LES CHARGES

DONNEES:

EXTREME EPAISSEUR MAXIMALE DE LA GLACE UNIFORME:	2.1m
ÉCLATEMENT EPAISSEUR DE LA GLACE:	1.4m
EPAISSEUR DE LA GLACE AGITATION (AVG.):	4.3m

CHARGES:

THERMIQUE:	275kN/m
L'IMPACT FLOE:	8.6 MN
CHARGE DE GLACE EN RAISON DE NAIVRE BRISE–GLACE:	8.9 MN
PRESSION GLOBALE:	700kPa

SISMIQUE

1. ACCÉLÉRATION DU SOL:

ACCÉLÉRATION MAXIMALE DU SOL:	0.16
PROBABILITE DE DÉPASSEMENT EN 5 ANS:	2%
PÉRIODE DE RETOUR MOYENNE AU COURS DES ANNEES:	475

CRITÈRES MARINES

1. TIDES RÉFERENCES AU ZÉRO DES CARTES (CD) BASÉE SUR LE SERVICE HYDROGRAPHIC DU CANADA (SHC) NO. 5457 SONT LES SUIVANTS:

EXTREME NIVEAU D'EAU ÉLEVÉ (ENDE):	5.9 m (ESTIMEE)
NIVEAU D'EAU SUPERIEUR ÉLEVÉ, GRANOE MARÉE(NDSE):	5.6 m
HIGHER HIGH WATER LEVEL, MOYEN DE LA MARÉE:	4.7 m
LE NIVEAU MOYEN DE L'EAU (NML):	2.9 m
BAS NIVEAU D'EAU BAS, MOYEN DE LA MARÉE:	1.0 m
BAS NIVEAU D'EAU BAS, GRANDE MAREÉ (BNDB):	0.2 m
EXTREME FAIBLE NIVEAU D'EAU (EFND):	0.0 m

2. COURANT
   PARALLÉLEMENT ENSEMBLE ACTUEL SUR LE VISAGE COUCHETTE: 1.0 KNOT (ESTIMEE)
   PERPENDICULAIRE ENSEMBLE ACTUAL SUR LE VISAGE COUCHETTE: 0.5 KNOT (ESTIMEE)
3. VENT
   LES CHARGES DE VENT POUR ÉVALEUR LES CHARGES D'AMARRAGE SONT BASES SUR LA VITESSE DU VENT COMME PREVU PAR LE SERVICE DE L'ENVIRONNEMENT ATMOSPHÉRIQUE.
   RETOUR VENT PÉRIODE 50 YEAR
   LA VITESSE DE VENT (30 SEC DURÉE): 140 KILOMETERS PAR HEURE
4. CLIMAT DES VAGUES
   POUR ÉTABLIR ÉLEVATION DE PONT (ZÉRO FRANCHISSEMENT):
   PÉRIODE DE RÉTOUR: 1 AN
   HAUTEUR MAXINALE DES VAGUES: 1.0m
5. CHARGES DES VAGUES:
   PÉRIODE DE RETOUR: 50 ANS
   HAUTEUR SIGNIFICATIVE DES VAGUES 2.0m

DESIGN VESSELS

TYPE DE NAVIRE	TONNES DE PORT EN LOURD	LHT (m)	FAISCEAU (m)	FRANC–BOARD MINIMAL (m)	TIRANT D'EAU MAXIMAL (m)
HANDYSIZE	25,000	189	26.6	3.95	11.75

L'IMPACT ACCOSTAGE ET D'AMARRAGE DES CHARGES

VITESSE PERPENDICULAIRE NAVIRE APPROCHÉ DE LA SURFACE COUCHETTE:

NAVIRE	0.2 m/sec

CHARGES DES AMARRAGE:

AVANT ET ARRIERE AMARRES A TERRE:	200 TONNES
SEIN LUNE BORNES RIVE:	200 TONNES
BORNES A RESSORT DE LIGNEES CELLULAIRES:	100 TONNES

CHARGES DOCK

VEHICULE ET D'AUTRES CHARGES DE PONT SONT ÉNUMERES DANS LES PARAGRAPHES SUIVANTS:

1. CHARGES UNIFORMES ET DE STOCKAGE 50 kPa
3. CHARGEUR DE NAVIRES: TENIR

POUR PERMIS
PAS POUR CONSTRUCTION

REMARGUES GÉNÉRALES

1.0 BÉTON ET DES ARMATURES

1.1 LE BÉTON OUIT ÊTRÉ C–XL CLASSE, 35MPa

1.2 COULÉ EN PLACE ENROBAGE DE BÉTON CLAIR POUR L'ACIER D'ARATURE SONT FIXÉES COMME SUIT, SAUF INOICATION CONTRAIRE:

SURFACES INFERIEURES 100mm
LES SURFACES LATERALES 75mm
SURFACES SUPERIEURES 75mm

1.3 PAS PLUS DE 25% DE LAXÉ LONGITUDINAL DE RENFORT DANS LES MAMBRES DÉPASSANT 500mm DE PROFONDEUR DOIVENT ÊTRÉ RACCORDÉES AU MEME ENDROIT. LES BARRES ADJANCENTES NE DOIVENT PAS ÊTRÉ RACCORDÉES AU MEME ENDROIT.

1.4 EPISSEURS DANS LES MEMBRES DE MOINS DE 500mm DE PROFONDEUR ÉGALE À OT DOIVENT SORTE QUE PAS PLUS DE CHAQUE TROISIEME BARRE EST ÉPISSE À TOUT PRÉMIERE SECTION.

1.5 LONGUEUERS TOUR MINIMALE RÉQUISE POUR LES EPISSURES DE RENFORT EST FIXÉ COMME SUIT, SAUF INDINCATION CONTRAIRE

.

TAILLE DE LA BARRE	BAR AUTRE QUE DES BARRES SUPERIEURES	BARRES SUPERIEURES
10M	400	500
15M	500	600
20M	600	800
25M	1000	1300
30M	1200	1600
35M	1500	2000

BARRES SPUERIEURES BARRES HORIZONTALES DE RENFORT SONT PLACES DE SORTE QUE PLUS DE 300mm DE BÉTON EST COULÉ DANS L'ÉLEMENT DE RENFORT AU–DESSOUS DE L'.

1.6 SAUF INDICATION CONTRAIRE, TOUS LES COINS SONT CHANFERED/ FILETS 25mm.

2.0 LE COULIS

2.1 LE COULIS ENTRÉ LESS CELLULES DE PALPLANCHES ET DU BÉTON PRÉFABRIQUE POUTRES D'IMPACT GLACE DOIT AVIOR UNE RESISTANCE MINIMALE À LA COMPREEION OE 20MPa.

2.2 PROPORTIONS DU MÉLANGE DE VCOULIS DE BÉTON PRÉFABRIQUE POUTRELLES DE GLACE EST LA SUIVANTE, POUR DONNER ENVIRON IN MÉTRE CUBE:

CIMENT (TYPE 10):	160kg
LES CENDRES VOLANTES OU DE LATTIER:	200kg
LE FUMÉE DE SILICE:	40kg
SABLE A BÉTON, SSD:	1500kg
L'EAU:	200±kg

LE TENEUR EN EAU DOIT ÊTRÉ ADJUSTÉE AU BESOIN POUR FOURNIR COULIS AYANT UN DEBIT SUFFISANT DE LA 25± 3 SÉCONDES COMME PAR CSA–A23.2–1B.

MÉLANGE DE FORMATION D'AIR EN TANT QUE DE DESOIN POUR LA TENEUR EN AIR DU 9% ±1%

2.3 SABLE POUR COULIS DOIVANT ÊTRÉ CONFORMES À LA NORME CSA–A23.1 AVEC UN MODULE DE FINESSE MAXIMALE DE 2.6 OE SABLE A GRANULOMETRIE CONFORMÉ A CSA–A179 PEUT ÊTRÉ UTILISE COMME UN SUBSTITUT.

2.4 LORS DE L'APPROBATION DU RÉPRESENTANT DE L'ÉNTERPRISE, UNE PARTIE DU SABLE PEUT ETRÉ SUBSTITUE AVEC DES GRANULATS CONFORMES À LA NORME CSA–A23.1 AYANT UNE TAILLE MAXIMALE 10mm.

2.5 LE COULIS DOIT ÊTRÉ TESTÉE CONFORMÉMENT À LA NORME CSA–A–23.1. LA FRÉQUENCE DES TESTS SERA DETERMINÉE PAR LE RÉPRESENTANT OE L'ÉNTERPRISE.

3.0 ACIER

3.1 POUR LES GRADES DE PALPLANCHES EN ACIER, VOIR LES SPÉCIFICATIONS

3.2 SAUF INDICATION CONTRAIRE, TOUTES LES FABRICATIONS MÉTALLIQUES DIVERS SONT GALVANISES A CHAUD–SÉLON LEA NORME CSA–G164.

3.3 FABRICATION, DE MONTAGE CONNEXION DES, ET LES DÉTAILS DE TOUT L'ACIER STRUCTEREL ET LES RACCORDS DOIVENT ÊTRÉ CONFORMES À CAN/CSA S16.1–01.

3.4 SOUDAGE DOIVENT ÊTRÉ CONFORMES AUX CAN/CSA W59–03 ET DOIVENT ÊTRÉ ÉXÉCUTES PAR DES SOUDEURS CERTIFIES, LES ATELIERS DE FABRICATION DOIT ÊTRÉ APPROUVE PAR LE BUREAU DE SOUDAGE TO CAN/CSA W47.1–03.

3.5 ACIER DE CONSTRUCTION DOIVENT STAISFAIRE CAN/CSA G40.20–04 POUR EXIGENCES GÉNÉRALES ET CAN/CSA G40.21–04 POUR LA QUALITÉ.

3.6 GRADES DE MATERIAUX, SAUF INDICATION CONTRAIRE:

ACIER DE CONSTRUCITON ET DIVERS METAUX	350W
BOULONS, ÉCROUS ET RONDELLES	ASTM A325M
LES BOULONS D'ANCRAGE	ASTM A307
PIEUX TUBULAIRES EN ACIER	ASTM A252 GR.

3.7 TOUT EN ACIER DOIT ÊTRÉ TESTE AU CHOC CHARPY CONFORMÉMENT À L'ARTICLE 23.10.31 DE LA NORME CAN/CSA S6 POUR UNE TEMPERATURE DE SERVICE DE –50°C, DE TUYAUX EN ACIER.

3.8 RÉPORTEZ–VOUS AUX SPÉCIFICATIONS POUR PLUS D'INFORMATIONS

ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

REVISION REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**
P1	ISSUED FOR PERMIT EMIS POUR PERMIS	2013/04/05		

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**

INITIALS: * DESIGNED ** APPROVED

No	REFERENCE DRAWINGS NUMBER

PROFESSIONAL SEAL

REGISTERED PROFESSIONAL ENGINEER
PEGL
PROVINCE OF NEWFOUNDLAND AND LABRADOR
CHRISTOPHER H. FUDGE
SIGNATURE
2013-04-05
DATE
PROFESSIONAL ENGINEER – NEWFOUNDLAND AND LABRADOR

SNC·LAVALIN
455, René–Lévesque Blvd. West
Montréal (Québec)
Canada H2Z 1Z3

PREPARATION	APPROVAL
DESIGNED: C. FUDGE	PROJECT DISCIPLINE ENGINEER: N. GILLIS
DRAWN: T. YOUNG	CLIENT:
CHECKED: C. FUDGE	DATE: 2013/03/22
SCALE: AS NOTED	

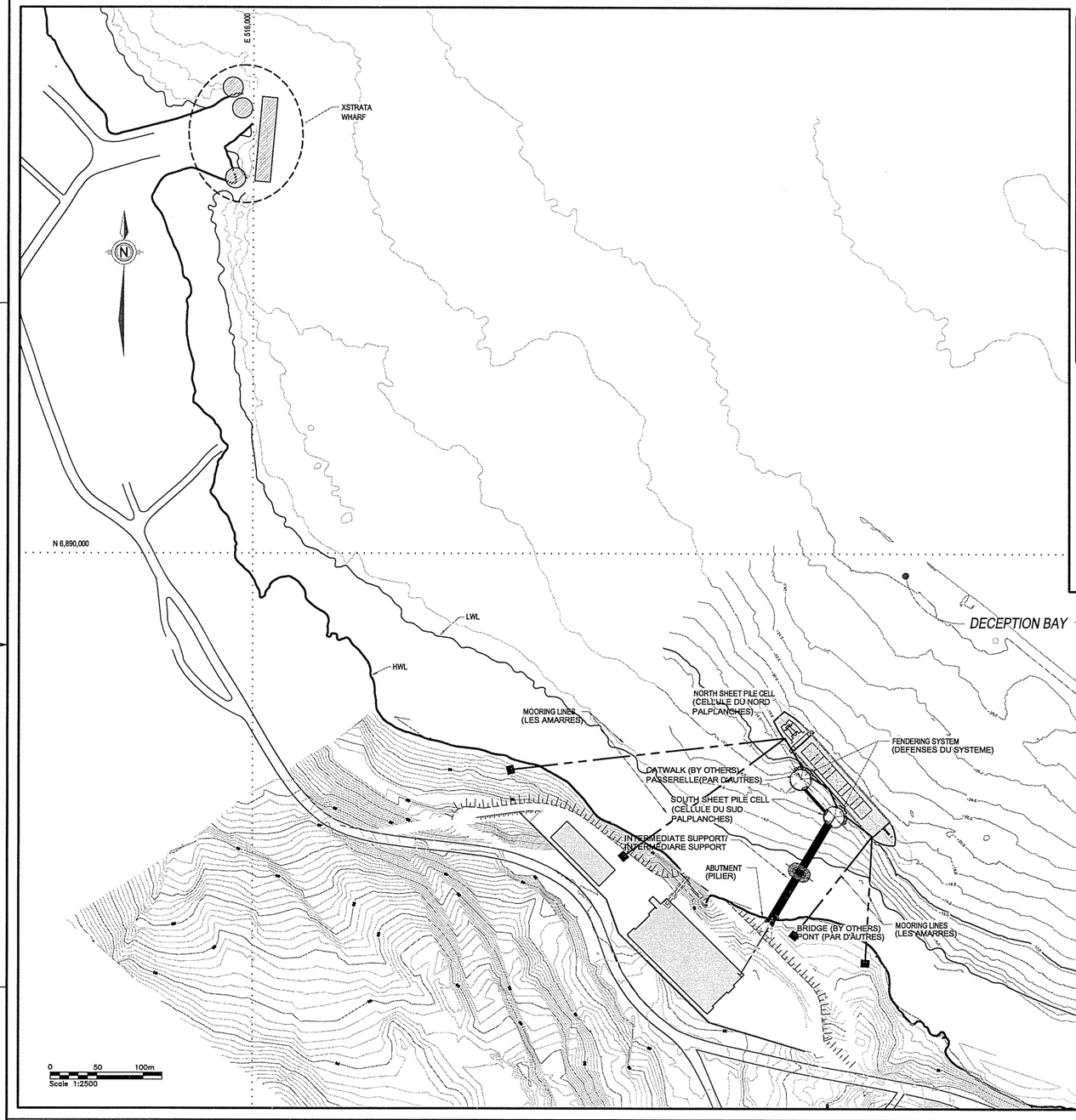
CLIENT: NUNAVIKNICKEL

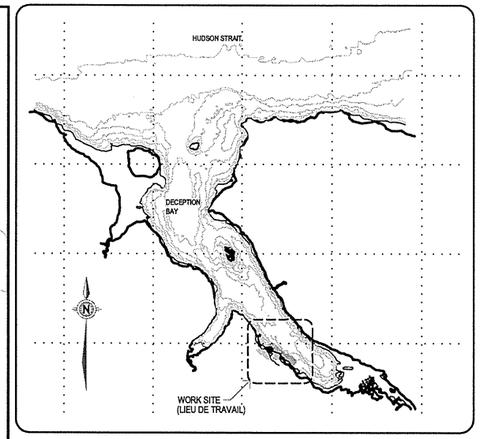
PROJECT: DECEPTION BAY PORT

TITLE: SITE 2
GENERAL NOTES & DESIGN CRITERIA
SITE 2 – REMARGUES GÉNÉRALES ET CRITÈRES DE CONCEPTION

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
506117	8000	41 D1	0001	P1

020878A1HEN – FRAME A1 HORIZONTAL ENGLISH

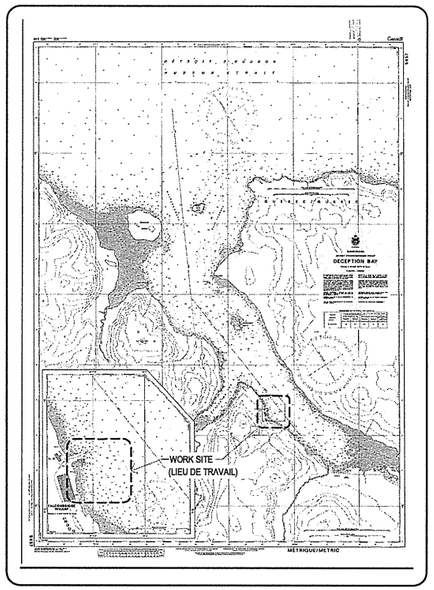




LOCATION PLAN

FOR PERMIT
NOT FOR CONSTRUCTION

POUR PERMIS
PAS POUR CONSTRUCTION



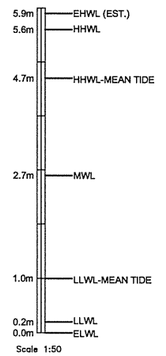
LOCATION PLAN - CHART 5457

GENERAL NOTES:

1. GRID REFERENCE : UTM NAD83.
2. DEPTHS ARE IN METRES AND ARE REDUCED TO CHART DATUM (LOWEST NORMAL TIDE) WHICH AT DECEPTION BAY IS 2.5m BELOW MEAN WATER LEVEL.
3. HYDROGRAPHIC CONTOURS BASED ON CHS CHART 5457 AND SOUNDING SURVEY BY FUGRO JACQUES GEOSURVEYS JULY 2008

INDICATIONS GÉNÉRALES:

1. GRILLE DE REFERENCE : UTM NAD83.
2. LES PROFONDEURS SONT EN MÈTRES ET REDUIT AU ZÉRO DES CATES (BASSE MAREÉ MORNALE) QUI EST A DOECEPTION BAY 2.5m SOUS LE NIVEAU MOYEN DE L'EAU.
3. CONTOURS HYDROGRAPHIQUES EN FONCTION OT TABLEAU CHS 5457 ET LEVEBATHYMÉTRIQUES PAR FUGRO JACQUES GEOSURVEYS JUILLET 2008.



ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

ISSUE REGISTER

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P1	ISSUED FOR PERMIT EMS POUR PERMIS	2013/04/05		

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INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REFERENCE DRAWINGS NUMBER

PROFESSIONAL SEAL

REGISTERED PROFESSIONAL ENGINEER PROVINCE OF NEWFOUNDLAND & LABRADOR PEGNL CHRISTOPHER M. FUDGE SIGNATURE 2013-04-05 DATE

SNC·LAVALIN
455, René-Lévesque Blvd. West
Montréal (Québec)
Canada H2Z 1Z3

PREPARATION	APPROVAL
DESIGNED: C. FUDGE	PROJECT DISCIPLINE ENGINEER: N. GILLIS
DRAWN: T. YOUNG	CLIENT:
CHECKED: C. FUDGE	DATE: 2013/04/22

SCALE: AS NOTED

CLIENT: CANADIAN ROYALTIES INC.

PROJECT: NUNAVIK NICKEL — DECEPTION BAY PORT

TITLE: SITE PLAN
PLAN DU SITE

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
505117	8000	41 D1	0002	P1

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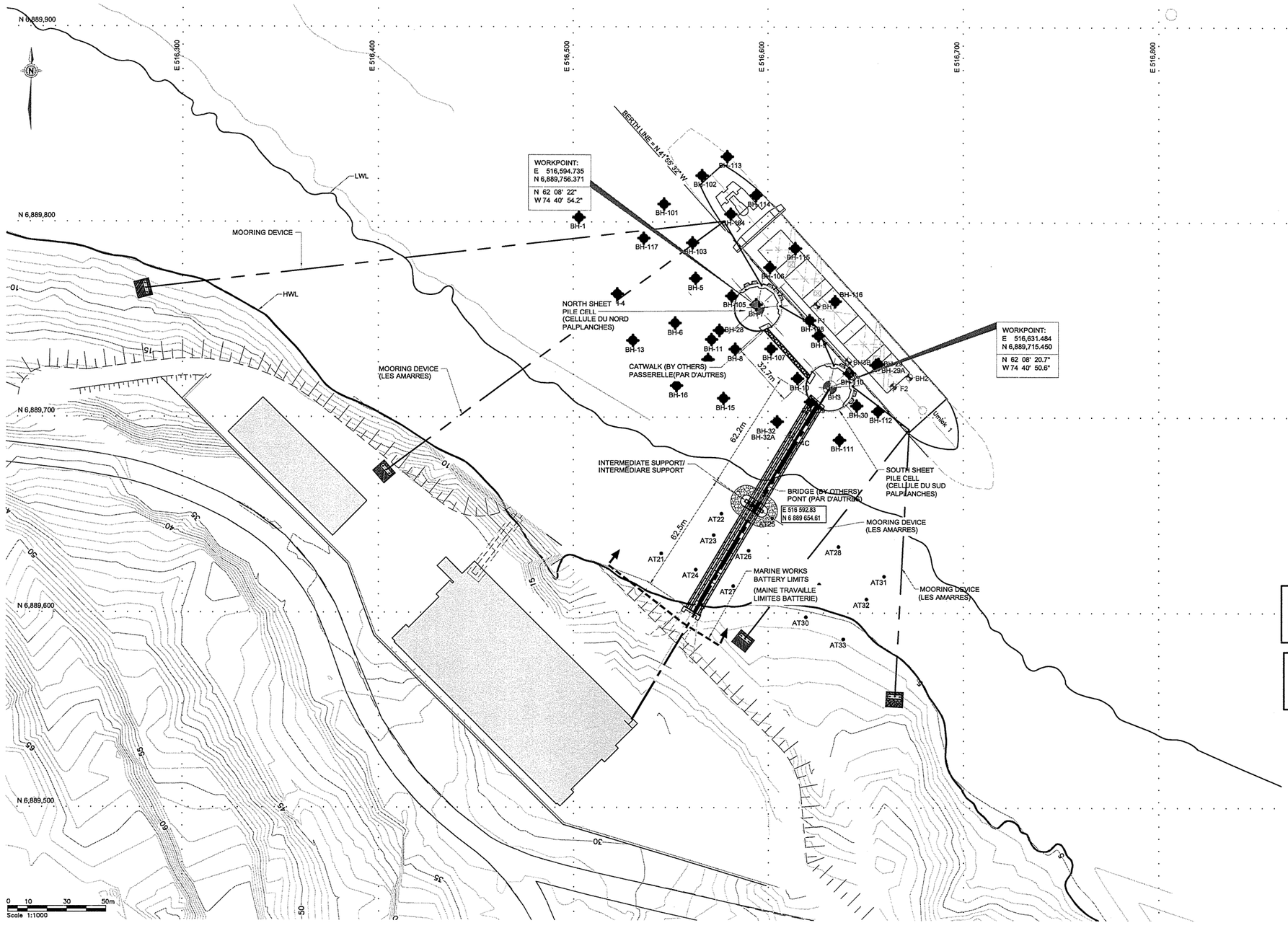

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

ISSUE REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**
P1	ISSUED FOR PERMIT EMIS POUR PERMIS	2013/04/05		

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REFERENCE DRAWINGS NUMBER

PROFESSIONAL SEAL

ASSOCIATION OF PROFESSIONAL ENGINEERS AND GEOSCIENTISTS NEWFOUNDLAND & LABRADOR
PEGNL
PERMIT TO PRACTICE
CHRISTOPHER M. FUDGE
SIGNATURE
DATE
2013-04-05

SNC·LAVALIN
455, René-Lévesque Blvd. West
Montréal (Québec)
Canada H2Z 1Z3

PREPARATION	APPROVAL
DESIGNED C. FUDGE	PROJECT DISCIPLINE ENGINEER N. GILLIS
DRAWN T.YOUNG	CLIENT
CHECKED C. FUDGE	DATE 2013/03/22
SCALE AS NOTED	

CLIENT
CANADIAN ROYALTIES INC.

PROJECT
NUNAVIK NICKEL
DECEPTION BAY PORT

TITLE
GENERAL ARRANGEMENT
ARRAGEMENT DU GÉNÉRALE

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
506117	8000	41 D1	0003	P1

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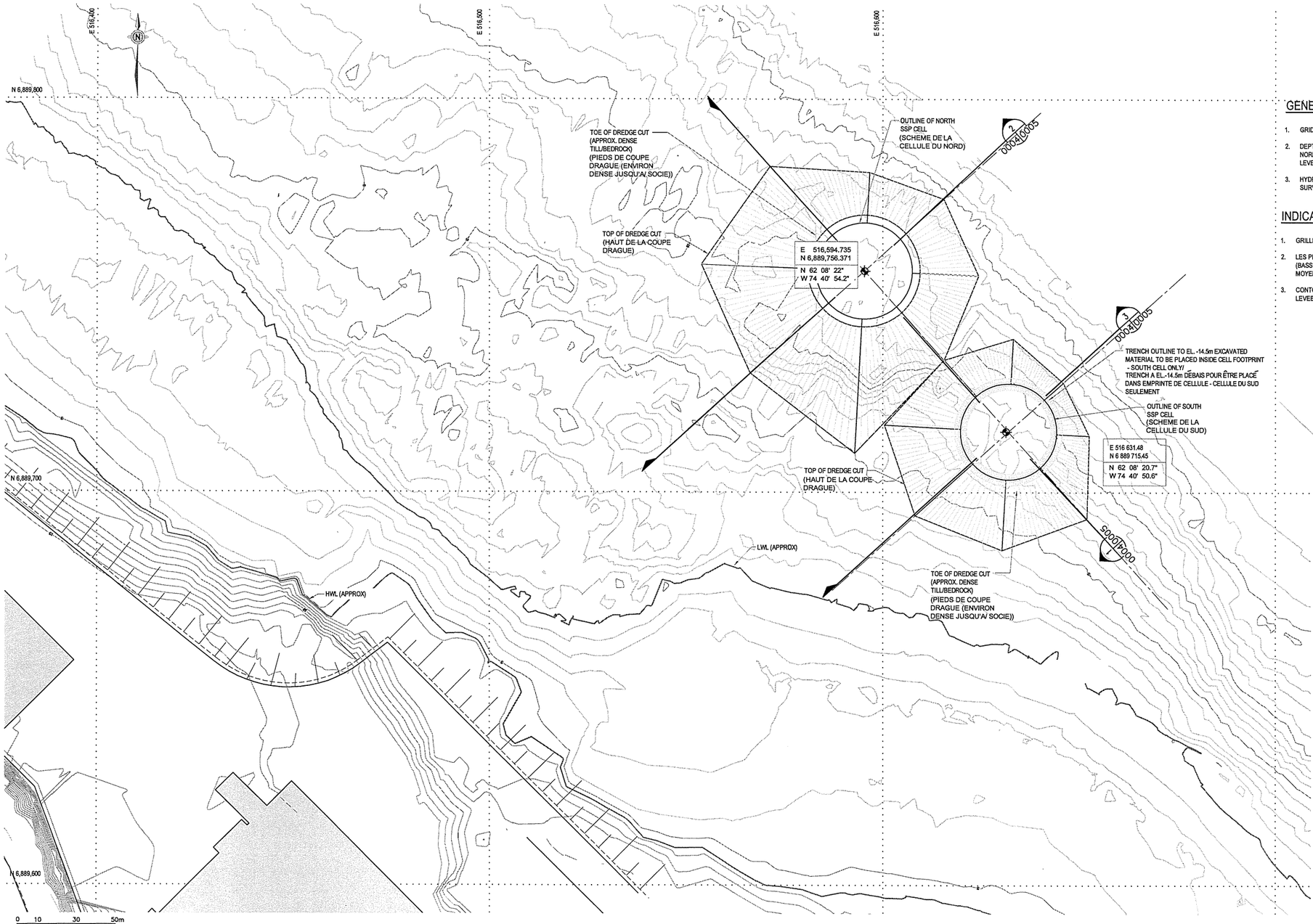

DREDGING VOLUMES (m^3)	
NORTH CELL	15,000
SOUTH CELL	7,000

VOLUMES DE DRAGAGE (m^3)	
CELLULE NORD	15,000
CELLULE SUD	7,000

GENERAL NOTES:

1. GRID REFERENCE : UTM NAD83.
2. DEPTHS ARE IN METRES AND ARE REDUCED TO CHART DATUM (LOWEST NORMAL TIDE) WHICH AT DECEPTION BAY IS 2.9m BELOW MEAN WATER LEVEL.
3. HYDROGRAPHIC CONTOURS BASED ON CHS CHART 5457 AND SOUNDING SURVEY BY FUGRO JACQUES GEOSURVEYS JULY 2008

INDICATIONS GÉNÉRALES:

1. GRILLE DE RÉFERENCE : UTM NAD83.
2. LES PROFONDEURS SONT EN MÈTRES ET REDUIT AU ZÉRO DES CATES (BASSE MARÉE MORNALE) QUI EST A DDECEPTION BAY 2.9m SOUS LE NIVEAU MOYEN DE L'EAU.
3. CONTOURS HYDROGRAPHIQUES EN FONCTION OT TABLEAU CHS 5457 ET LEVEBATHYMETRIQUES PAR FUGRO JACQUES GEOSURVEYS JUILLET 2008.

FOR PERMIT
NOT FOR CONSTRUCTION

POUR PERMIS
PAS POUR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

ISSUE REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**
P1	ISSUED FOR PERMIT EMIS POUR PERMIS	2013/04/05		

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REFERENCE DRAWINGS NUMBER

PROFESSIONAL SEAL

REGISTERED PROFESSIONAL ENGINEER
PEGL
PERMISSION TO PRACTICE NEWFOUNDLAND & LABRADOR
CHRISTOPHER M. FUDGE
SIGNATURE
2013-04-05
DATE
NEWFOUNDLAND & LABRADOR

SNC·LAVALIN
455, René-Lévesque Blvd. West
Montréal (Québec)
Canada H2Z 1Z3

PREPARATION	APPROVAL
DESIGNED: C. FUDGE	PROJECT DISCIPLINE ENGINEER: N. GILLIS
DRAWN: T. YOUNG	CLIENT:
CHECKED: C. FUDGE	DATE: 2013/03/22
SCALE: AS NOTED	

CLIENT: CANADIAN ROYALTIES INC.

PROJECT: NUNAVIK NICKEL — DECEPTION BAY PORT

TITLE: DREDGING PLAN
PLAN DU DRAGAGE

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
506117	8000	41	D1 0004	P1

020878A11HEN – FRAME A1 HORIZONTAL ENGLISH

LAST SAVE: 2013/04/05 – 2:21pm
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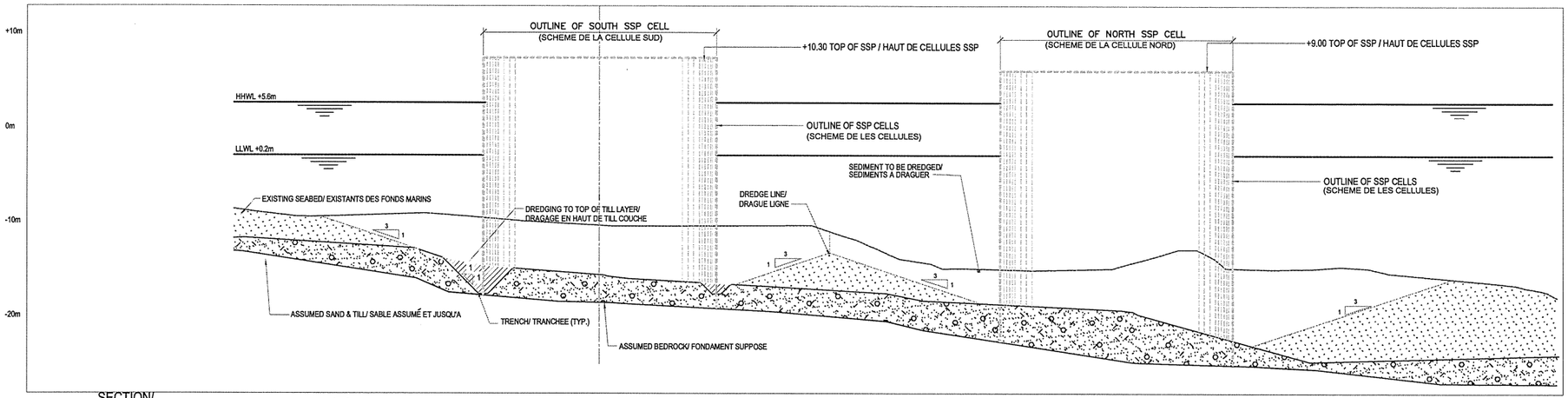

SECTION/
SECTION 1
0004|0005

0 5 10m
Scale 1:250

GENERAL NOTES:

1. EXISTING BEDROCK INFERRED FROM FUGRO JACQUES GEOSURVEYS, JULY 2008.
2. ASSUMED SEABED, BEDROCK, AND SAND/TILL ELEVATIONS INTERPOLATED FROM FUGRO JACQUES SURVEY AND TOPOGRAPHIC SURVEY.

INDICATIONS GENERALES:

1. SICIÉ EXISTANT DEDUIT DE FUGRO JACQUES GEOSURVEYS, JULIET 2008.
2. SUPPOSE DES FONDS MARINS, LE SUBSTRATUM ROCHEUX ET DE SABLE/ ÉLEVATIONS JUSQU'A INTERPOLÉE A PARTIR DE FUGRO JACQUES GEOSURVEYS ET RÉLEVE TOPOGRAPHIQUE

CLAY/ ARGILE

TILL/ JUSQU'A QUE

ROCK/ROCK

DREDGING VOLUMES (m^3)	
NORTH CELL	15,000
SOUTH CELL	7,000

VOLUMES DE DRAGAGE (m^3)	
CELLULE NORD	15,000
CELLULE SUD	7,000

SECTION/
SECTION 3
0004|0005

0 5 10m
Scale 1:250

SECTION/
SECTION 2
0004|0005

0 5 10m
Scale 1:250

FOR PERMIT
NOT FOR CONSTRUCTION

POUR PERMIS
PAS POUR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

ISSUE REGISTER

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P1	ISSUED FOR PERMIT EMIS POUR PERMIS	2013/04/05		

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

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INITIALS: * DESIGNED ** APPROVED

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No	REFERENCE DRAWINGS NUMBER

PROFESSIONAL SEAL

REGISTERED PROFESSIONAL ENGINEER
PEGL
CHRISTOPHER M. FUDGE
SIGNATURE
2013-04-25
DATE
NEWFOUNDLAND & LABRADOR

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PREPARATION	APPROVAL
DESIGNED C. FUDGE	PROJECT DISCIPLINE ENGINEER N. GILLIS
DRAWN T. YOUNG	CLIENT
CHECKED C. FUDGE	DATE 2013/03/22
SCALE AS NOTED	

CLIENT
CANADIAN ROYALTIES INC.

PROJECT
NUNAVIK NICKEL
DECEPTION BAY PORT

TITLE
DREDGING SECTIONS
SECTIONS DU DRAGAGE

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
506117	8000	41	D1 0005	P1

020878A1HEN – FRAME A1 HORIZONTAL ENGLISH

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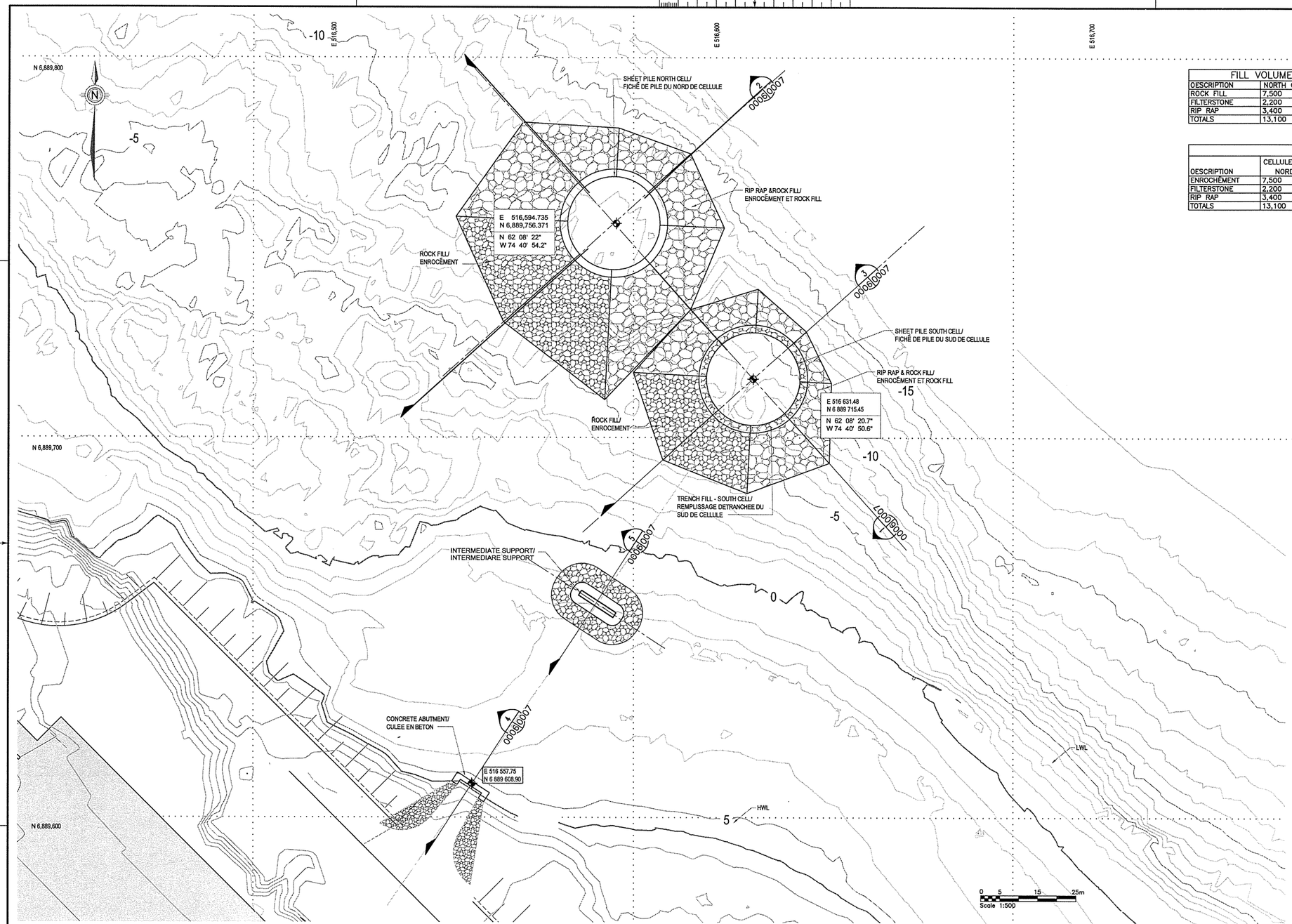

FILL VOLUMES (m^3)		
DESCRIPTION	NORTH CELL	SOUTH CELL
ROCK FILL	7,500	2,500
FILTERSTONE	2,200	1,100
RIP RAP	3,400	2,100
TOTALS	13,100	5,700

DESCRIPTION	CELLULE DU NORD	CELLULE DU SUD
ENROCHEMENT	7,500	2,500
FILTERSTONE	2,200	1,100
RIP RAP	3,400	2,100
TOTALS	13,100	5,700

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PAS POUR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No
P1		2013/04/05	ISSUED FOR PERMIT EMIS POUR PERMIS	

ISSUE REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**

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REVISION REGISTER

No	REFERENCE DRAWINGS NUMBER

PROFESSIONAL SEAL

REGISTRATION PROFESSIONAL ENGINEER
PEGL
CHRISTOPHER M. FUDGE
NEWFOUNDLAND & LABRADOR
DATE

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PREPARATION	APPROVAL
DESIGNED C. FUDGE	PROJECT DISCIPLINE ENGINEER N. GILLIS
DRAWN T. YOUNG	CLIENT
CHECKED C. FUDGE	DATE 2013/03/22
SCALE AS NOTED	

CLIENT
CANADIAN ROYALTIES INC.

PROJECT
NUNAVIK NICKEL
DECEPTION BAY PORT

TITLE
RIP RAP/ ROCK FILL BERMS
RIP RAP/ ENROCHEMENT BERMES
DE REMPLISSAGE

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
506117	8000	41_D1	0006	P1

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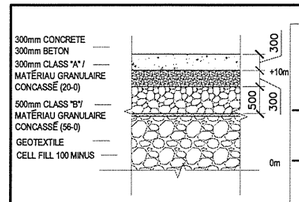

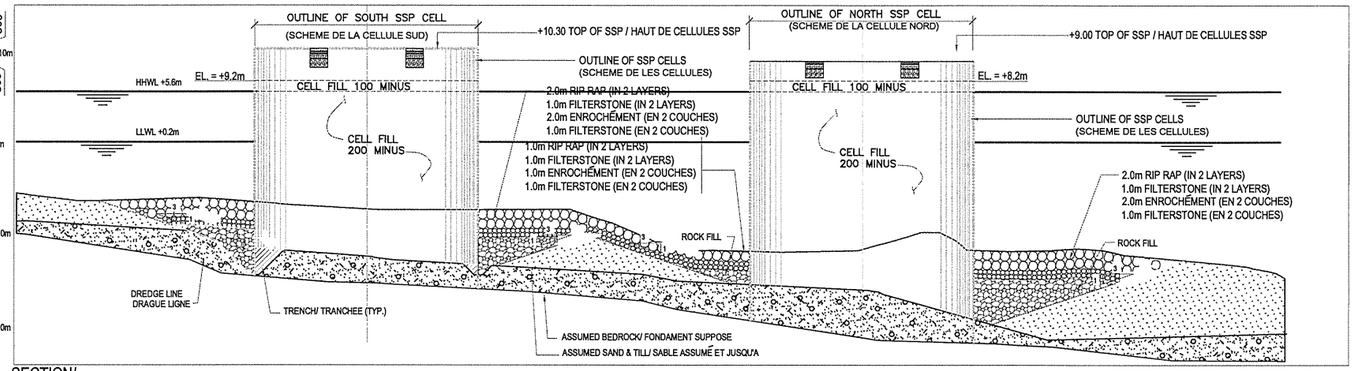

SECTION/
SECTION
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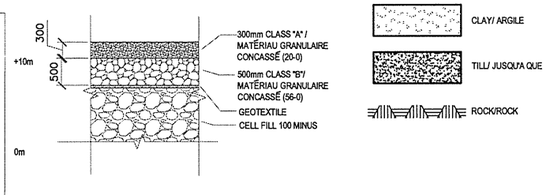
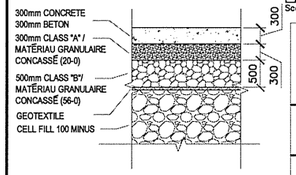
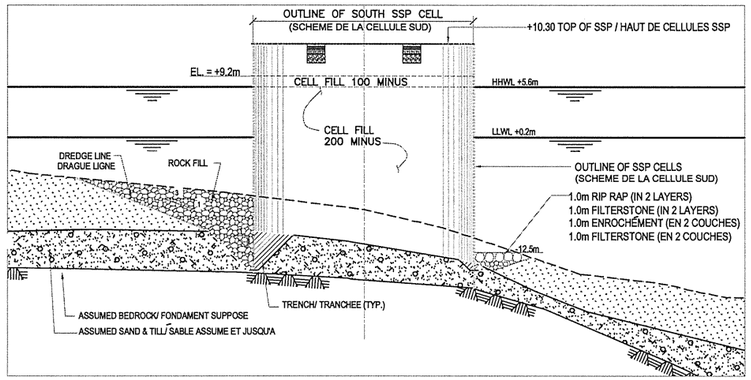
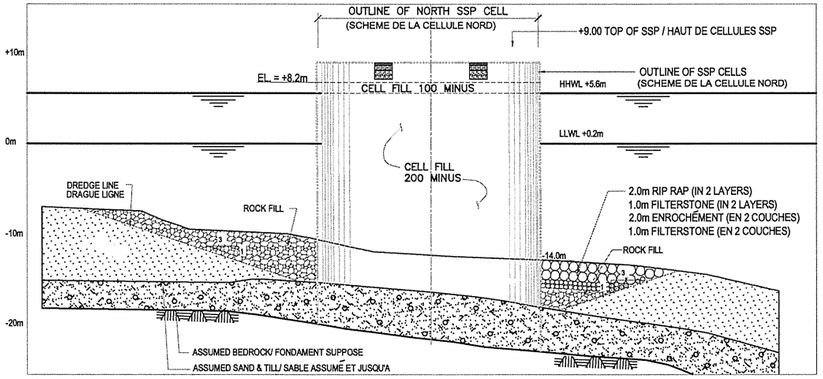
Scale 1:300
1
0006 0007



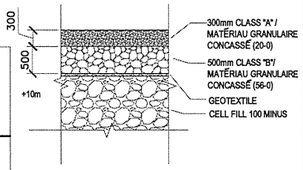




SECTION/
SECTION
0 5 10 15m
Scale 1:300
3
0006 0007

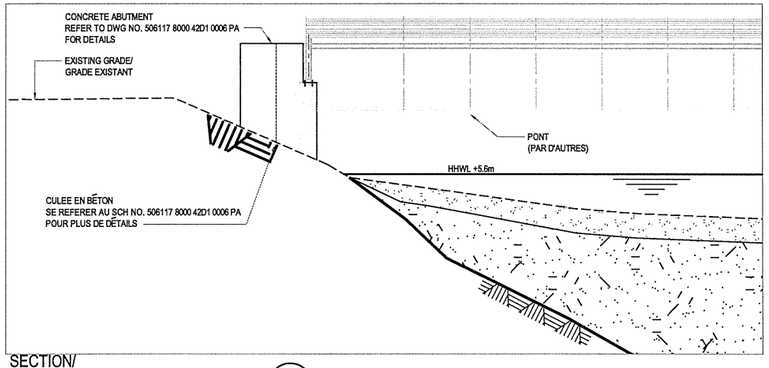


SECTION/
SECTION
0 5 10 15m
Scale 1:300
2
0006 0007

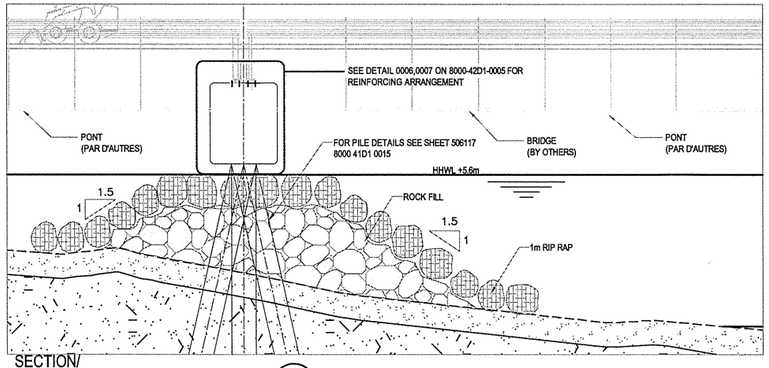


FILL VOLUMES (m^3)		
DESCRIPTION	NORTH CELL	SOUTH CELL
ROCK FILL	7,500	2,500
FILTERSTONE	2,200	1,100
RIP RAP	3,400	2,100
TOTALS	13,100	5,700

	CELLULE DU NORD	CELLULE DU SUD
DESCRIPTION		
ENROCHEMENT	7,500	2,500
FILTERSTONE	2,200	1,100
RIP RAP	3,400	2,100
TOTALS	13,100	5,700



SECTION/
SECTION
0 1 3 5m
Scale 1:100
4
0006 0007



SECTION/
SECTION
0 1 3 5m
Scale 1:100
5
0006 0007

GENERAL NOTES:

1. EXISTING BEDROCK INFERRED FROM FUGRO JACQUES GEOSURVEYS, JULY 2008.
2. ASSUMED SEABED, BEDROCK, AND SAND/TILL ELEVATIONS INTERPOLATED FROM FUGRO JACQUES SURVEY AND TOPOGRAPHIC SURVEY.

INDICATIONS GENERALES:

1. SICIE EXISTANT DEDUIT DE FUGRO JACQUES GEOSURVEYS, JULIET 2008.
2. SUPPOSE DES FONDS MARINS, LE SUBSTRATUM ROCHEUX ET DE SABLE/ ÉLEVATIONS JUSQU'A INTERPOLÉE A PARTIR DE FUGRO JACQUES GEOSURVEYS ET RÉLEVE TOPOGRAPHIQUE

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PAS POUR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

ISSUE REGISTER

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ISSUE REGISTER

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P1	ISSUED FOR PERMIT EMIS POUR PERMIS	2013/04/05		

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No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REFERENCE DRAWINGS NUMBER

PROFESSIONAL SEAL
PROFESSIONAL ENGINEERS GOVERNMENT OF NEWFOUNDLAND & LABRADOR
PEGNL
CHRISTOPHER M. FUDGE
2013-04-05

SNC·LAVALIN
455, René-Lévesque Blvd. West
Montréal (Québec)
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PREPARATION	APPROVAL
DESIGNED C. FUDGE	PROJECT DISCIPLINE ENGINEER N. GILLIS
DRAWN T.YOUNG	CLIENT
CHECKED C. FUDGE	DATE 2013/03/22
SCALE AS NOTED	

CLIENT
CANADIAN ROYALTIES INC.

PROJECT
NUNAVIK NICKEL
DECEPTION BAY PORT

TITLE
ROCK FILL SECTIONS/
BASCULEZ SECTIONS DE REMPLISSAGE

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
506117	8000	41 D1	0007	P1

0208781A1HEN – FRAME A1 HORIZONTAL ENGLISH

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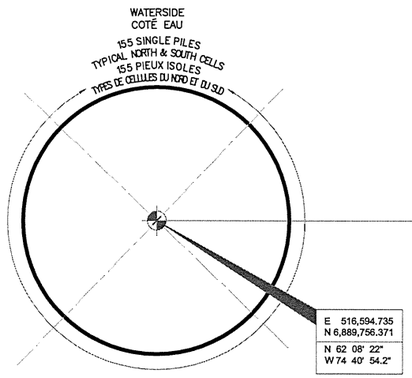
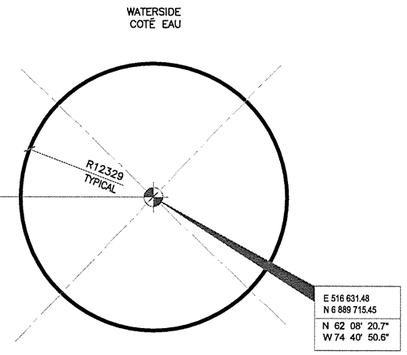


NORTH CELL
CELLULE DU NORD



SOUTH CELL
CELLULE DU SUD

55000

PLAN – SHEET PILE LAYOUT
PLAN–PLAN PALPLANCHE 1 0001 0008

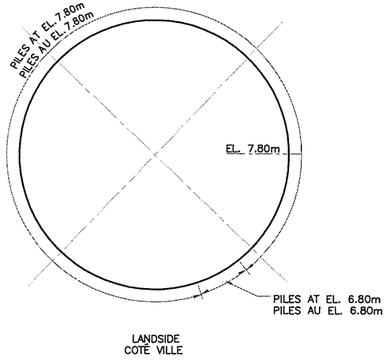
0 5 10m
Scale 1:250

NOTES:

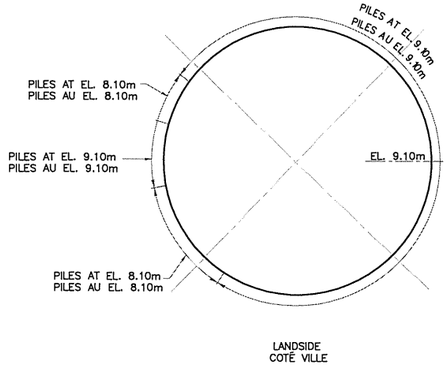
1. STEEL SHEET PILES SHALL BE MANUFACTURED IN ACCORDANCE WITH EUROPEAN STANDARD EN 10248, PARTS 1 AND 2. MINIMUM STEEL GRADE SHALL BE S355 GP.
2. MINIMUM PILE THICKNESS SHALL BE 12.7mm.
3. MINIMUM INTERLOCK STRENGTH SHALL BE 5500 kN PER METRE WHEN TESTED TO EN 10248.
4. ARRANGEMENT OF SHEET PILES IS BASED ON FLAT PILES WITH A NORMAL WIDTH OF 500mm. DIMENSIONS OF CELLS ARE NOMINAL. PRIOR TO EXPANSION FROM FILLING. DIMENSIONS WILL VARY DEPENDING ON EXACT CONSTRUCTION SEQUENCE.
5. FOR TOP ELEVATION OF PILES, SEE SECTIONS AND NOTES ON OWGS 8000–41D1–0005,0007,0010,0011.

INDICATIONS:

1. PALPLANCHES D'ACIER DOIVENT ÊTRÉ FABRIQUES SELON LA NORME EURPEERINE EN 10248, PARTIE 1 ET 2. NUANCE D'ACIER S355 MINIMALE EST GP.
2. EPAISSEUR MINIMALE EST DE PILE 12.7mm.
3. RESISTANCE MINIMALE INTERLOCK SERA DE 55 KN PAR METRE LORS D'UN ESSAI EN 10248.
4. ARRANGEMENT DE PALPLANCHES RÉPOSE SUR PILES AVEC UN FLT LARGEUR MORNALE DE 500mm. DIMENSIONS DE CELLULES SONT NOMINALES, AVANT L'EXPASION DU REMPLISSAGE. DIMENSIONS VARIE EN FONCTION SEQUENCE DE CONSTRUCTION EXACT.
5. D'ÉLEVATION CONSEIL DES PILES, VOIR LES SECTIONS ET NOTES SUR DESSINS 8000–41D1–0005,0007,0010,0011.



NORTH CELL
CELLULE DU NORD



SOUTH CELL
CELLULE DU SUD

PLAN – SHEET PILE CUT–OFF
PLAN – COUPER FEULLE DE PILE 2 0008 0008

0 5 10m
Scale 1:250

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ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

ISSUE REGISTER

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P1	ISSUED FOR PERMIT EMIS POUR PERMIS	2013/04/05		

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

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INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REFERENCE DRAWINGS NUMBER

PROFESSIONAL SEAL

ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS AND GEOPHYSICISTS OF NEWFOUNDLAND & LABRADOR
PEGL
CHRISTOPHER M. FUDGE
2013-04-05

SNC·LAVALIN
455, René-Lévesque Blvd. West
Montréal (Québec)
Canada H2Z 1Z3

PREPARATION	APPROVAL
DESIGNED: C. FUDGE	PROJECT DISCIPLINE ENGINEER: N. GILLIS
DRAWN: T. YOUNG	CLIENT:
CHECKED: C. FUDGE	DATE: 2013/03/22
SCALE: AS NOTED	

CLIENT: CANADIAN ROYALTIES INC.

PROJECT: NUNAVIK NICKEL
DECEPTION BAY PORT

TITLE: SSP CELLS–PLAN VIEW
LES CELLULES SSP PLAN VUE

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
506117	8000	41	D1	0008	P1

0208784THEH – FRAME A1 HORIZONTAL ENGLISH

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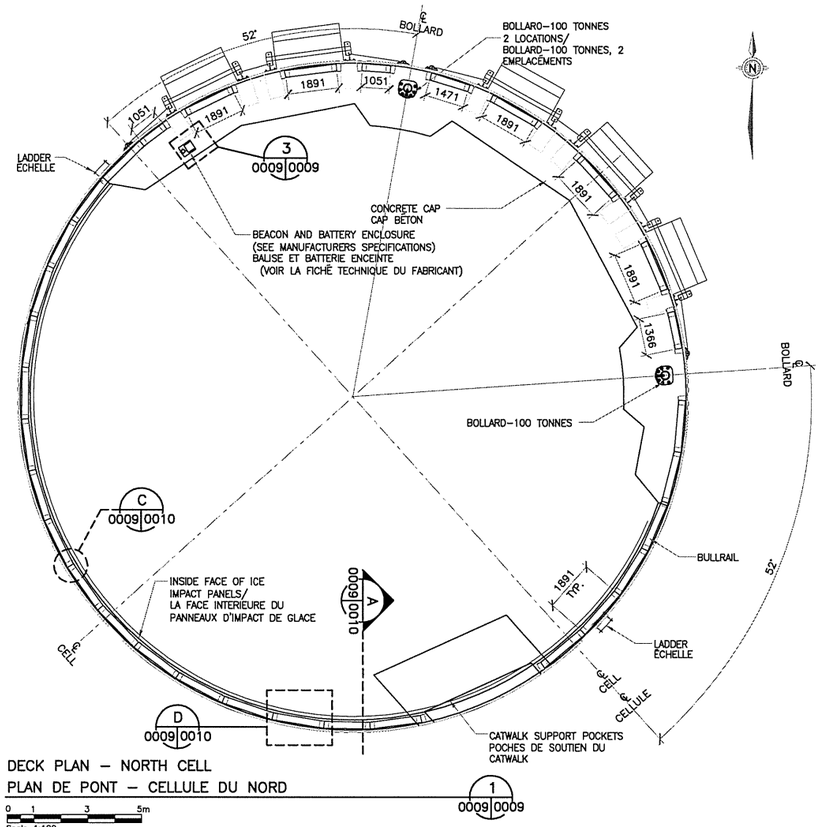
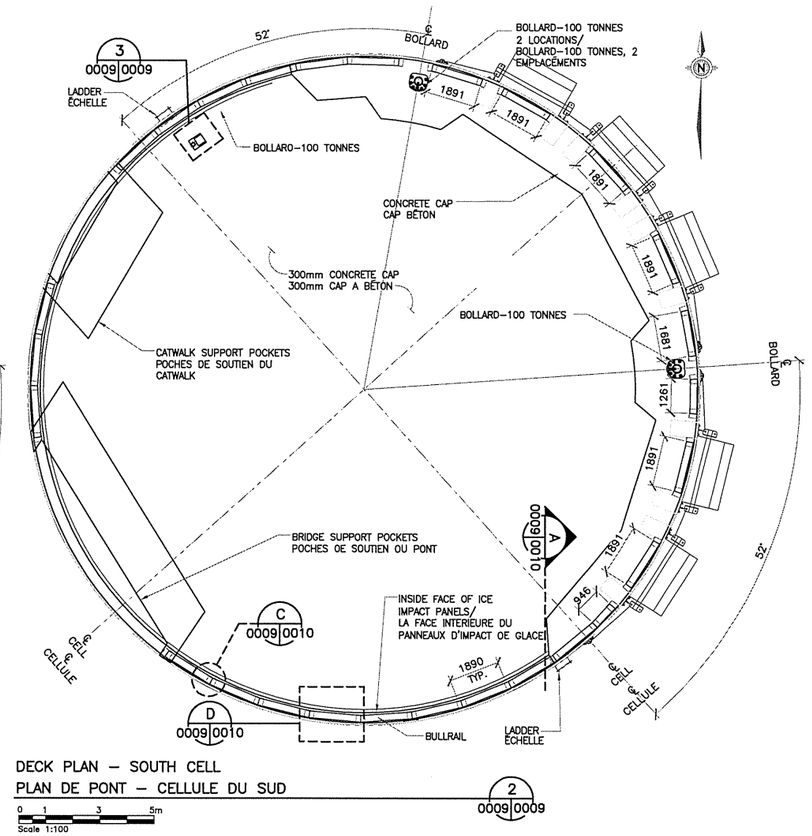


DECK PLAN – NORTH CELL
PLAN DE PONT – CELLULE DU NORD

1
0009 0009

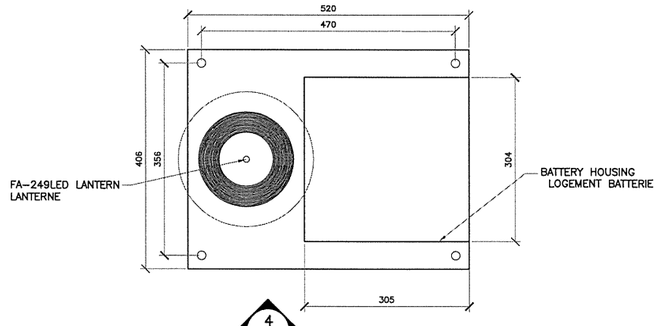
0 1 3 5m
Scale 1:100



DECK PLAN – SOUTH CELL
PLAN DE PONT – CELLULE DU SUD

2
0009 0009

0 1 3 5m
Scale 1:100

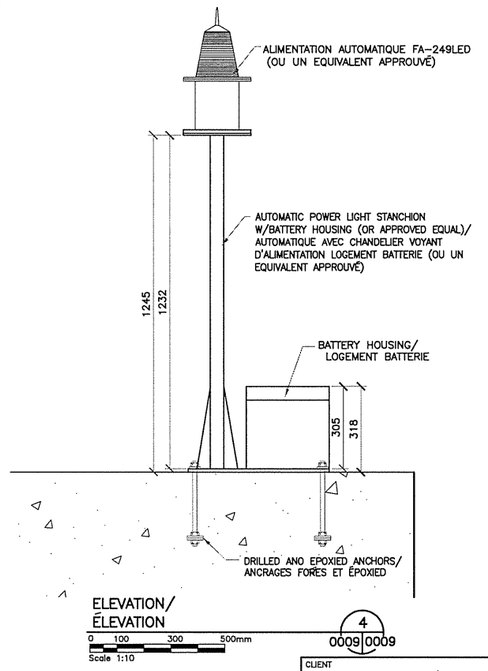


4
0009 0009

PLAN/
PLAN

0 100 300 500mm
Scale 1:10

3
0009 0009



ELEVATION/
ÉLÉVATION

0 100 300 500mm
Scale 1:10

4
0009 0009

NOTES:
1) LIGHT STANCHION TO BE FABRICATED FROM STEEL AND HOT DIPPED GALVANIZED

INDICATIONS:
1) CHANDELIER FEU A ETRE FABRIQUE EN ACIER ET GALVANISE A CHAUD

FOR PERMIT
NOT FOR CONSTRUCTION

POUR PERMIS
PAS POUR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

ISSUE REGISTER

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REVISION REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REFERENCE DRAWINGS NUMBER

PROFESSIONAL SEAL

REGISTERED PROFESSIONAL ENGINEER
PEGL
CHRISTOPHER M. FUDGE
2013-04-05
NEWFOUNDLAND & LABRADOR

SNC·LAVALIN
455, René–Lévesque Blvd. West
Montréal (Québec)
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PREPARATION	APPROVAL
DESIGNED C. FUDGE	PROJECT DISCIPLINE ENGINEER N. GILLIS
DRAWN T.YOUNG	CLIENT
CHECKED C. FUDGE	DATE 2013/03/22
SCALE AS NOTED	

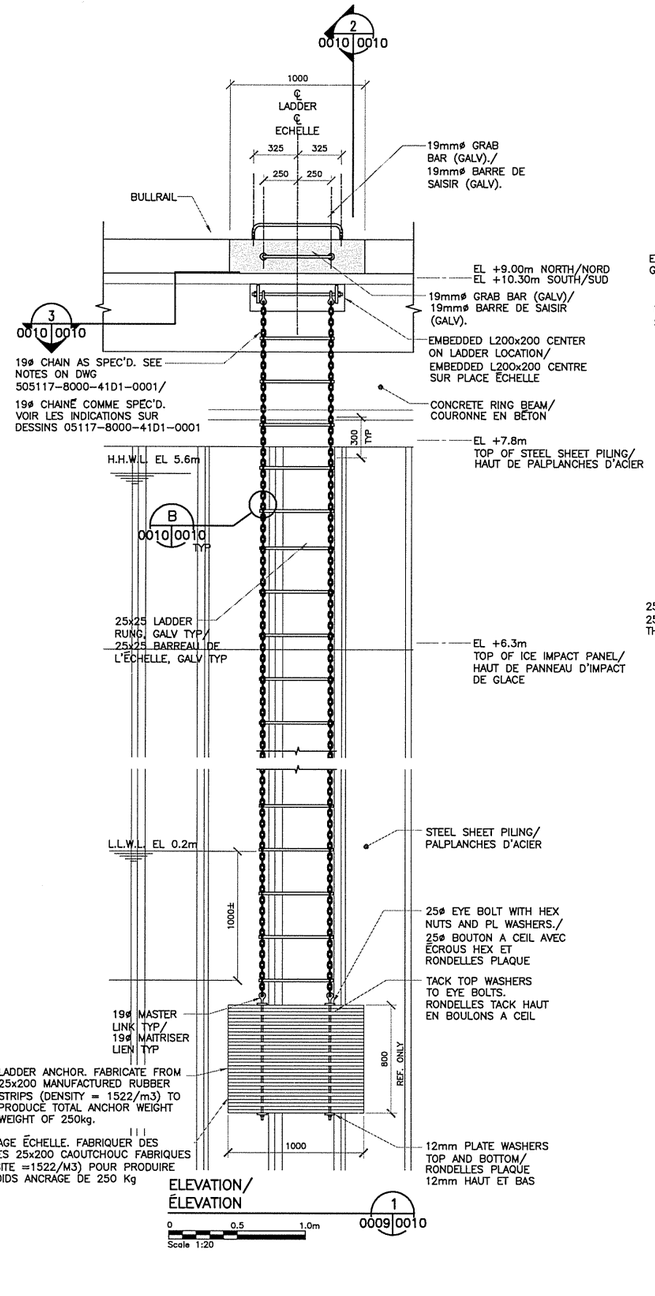
CLIENT
CANADIAN ROYALTIES INC.

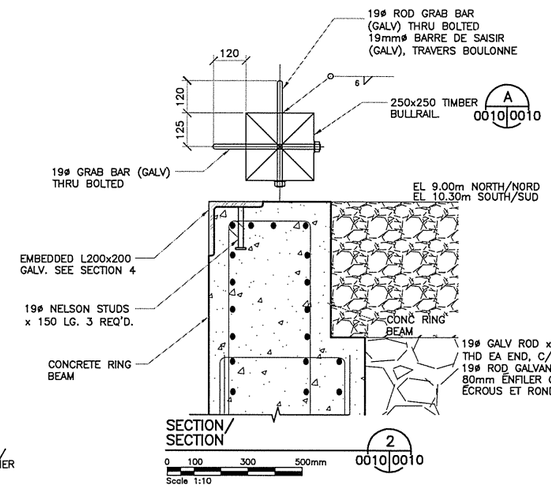
PROJECT
NUNAVIK NICKEL
DECEPTION BAY PORT

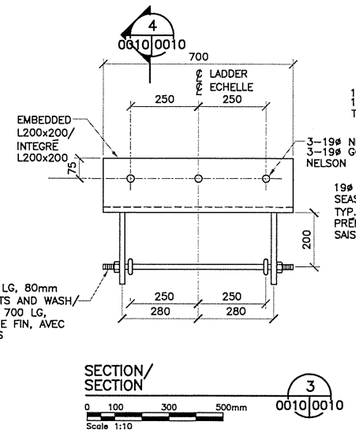
TITLE
SSP CELLS–DECK PLAN
PLAN DE PONT SSP CELLULES

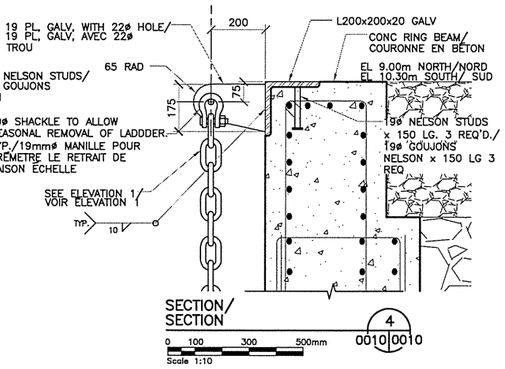
PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
506117	8000	41	0009	P1

D2087BA11HEN – FRAME A1 HORIZONTAL ENGLISH









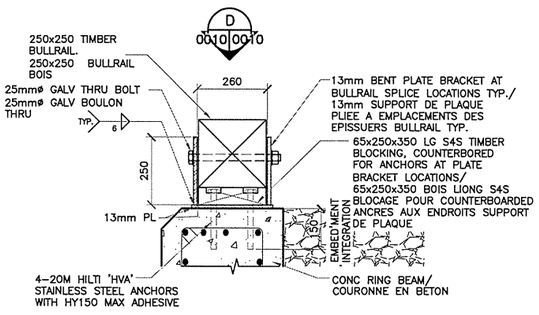
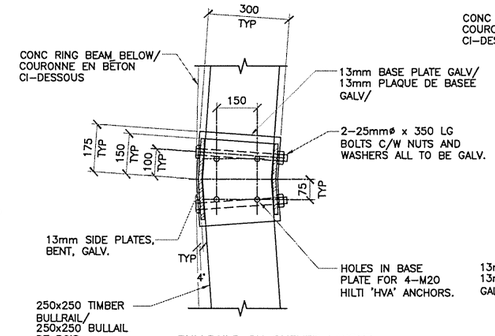
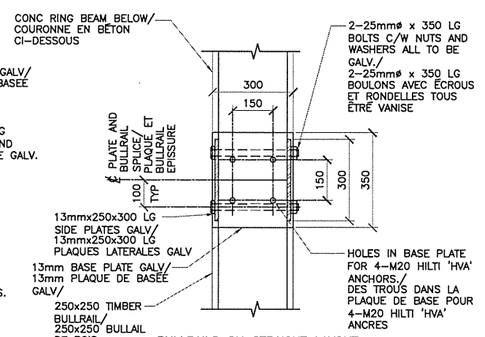


PLATE BRACKET AND BULLRAIL SPLICE DETAIL
SUPPORT DE PLAQUE ET DETAIL EPISSURE BULLRAIL

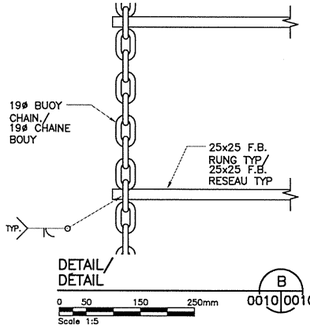


BULLRAILS ON CURVED LAYOUT
BULLRAILS SUR PLAN COURBE



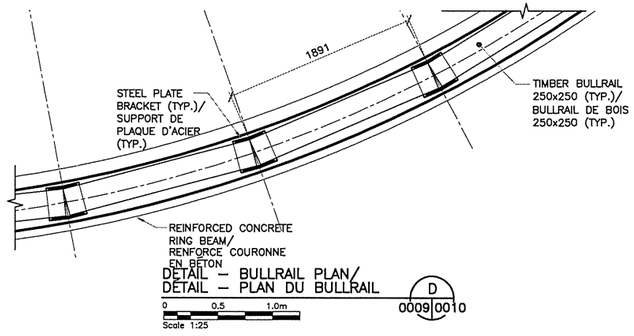
BULLRAILS ON STRAIGHT LAYOUT
BULLRAILS SUR PLAN DROITE

DETAILS/ DETAILS
A
0009 0010
0 100 300 500mm
Scale 1:10



DETAIL/ DÉTAIL
B
0010 0010
0 50 150 250mm
Scale 1:5

DETAILS/ DETAILS
C
0009 0010
0 100 300 500mm
Scale 1:10



DETAIL - BULLRAIL PLAN/
DÉTAIL - PLAN DU BULLRAIL
D
0009 0010
0 0.5 1.0m
Scale 1:25

FOR PERMIT
NOT FOR CONSTRUCTION

POUR PERMIS
PAS POUR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

ISSUE REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**
P1	ISSUED FOR PERMIT / EMIS POUR PERMIS	2013/04/05		

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REFERENCE DRAWINGS NUMBER

PROFESSIONAL SEAL

REGISTERED PROFESSIONAL ENGINEER
PEGL
PROVINCE OF NEWFOUNDLAND & LABRADOR
CHRISTOPHER M. FUDGE
24-04-05
DATE

SNC·LAVALIN
455, René-Lévesque Blvd. West
Montréal (Québec)
Canada H2Z 1Z3

PREPARATION	APPROVAL
DESIGNED: C. FUDGE	PROJECT DISCIPLINE ENGINEER: N. GILLIS
DRAWN: T.YOUNG	CLIENT:
CHECKED: C. FUDGE	DATE: 2013/03/22
SCALE: AS NOTED	

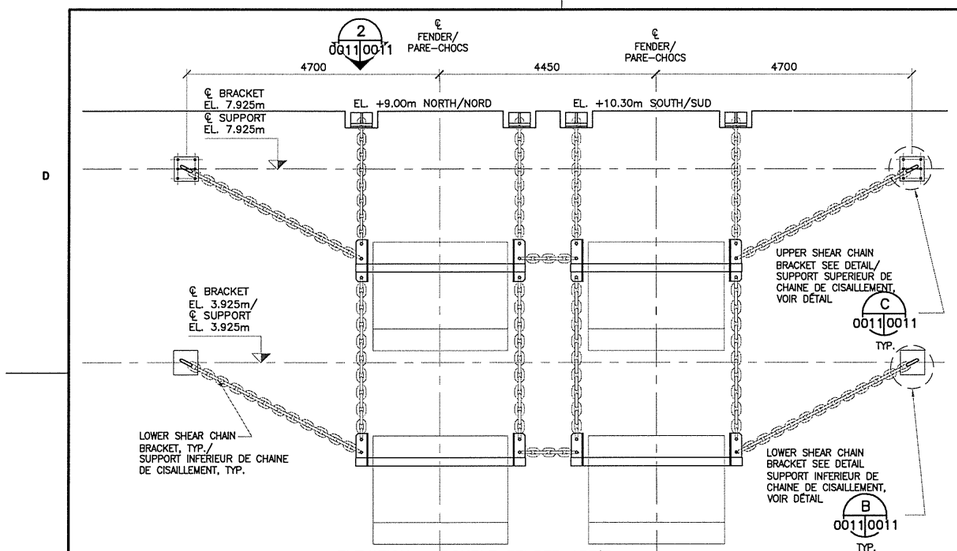
CLIENT
CANADIAN ROYALTIES INC.

PROJECT
NUNAVIK NICKEL
DECEPTION BAY PORT

TITLE
LADDER & BULLRAIL DETAILS
DÉTAILS DES ÉCHELLE ET BULLRAIL

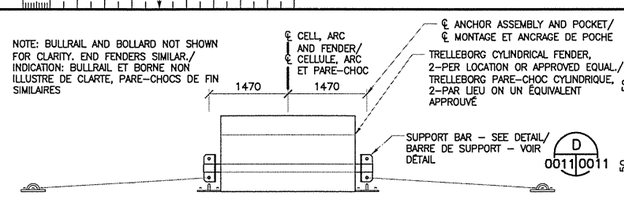
PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
506117	8000	41 D1	0010	P1

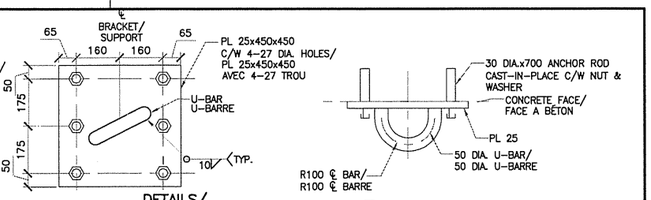
0208784THEN - FRAME A1 HORIZONTAL ENGLISH



ELEVATION – DOUBLE FENDER ARR'T
ELEVATION – ARR'T PARE–CHOCS DOUBLE 1 0011|0011

Scale 1:50



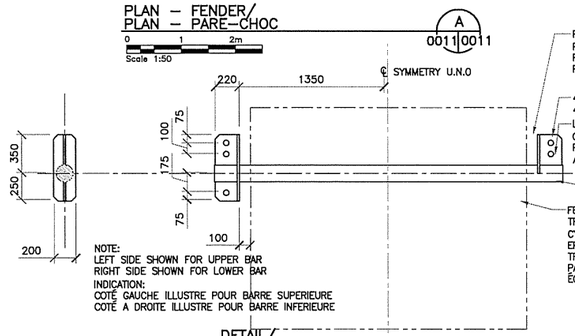


DETAILS/ DETAILS C 0011|0011

Scale 1:10

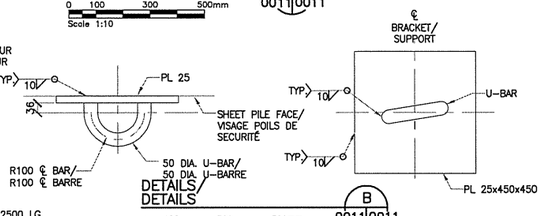
PLAN – FENDER/ PLAN – PARE–CHOC A 0011|0011

Scale 1:50



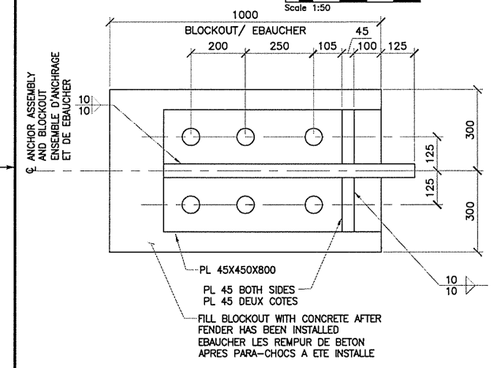
DETAIL/ DÉTAIL D 0011|0011

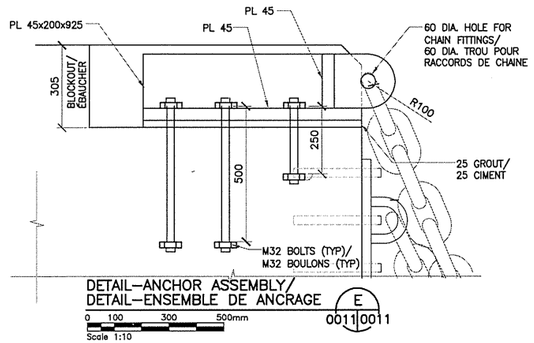
Scale 1:25



DETAILS/ DETAILS B 0011|0011

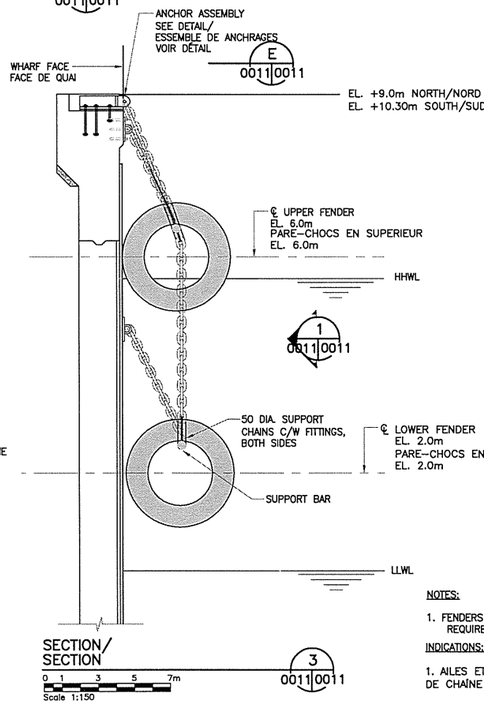
Scale 1:10





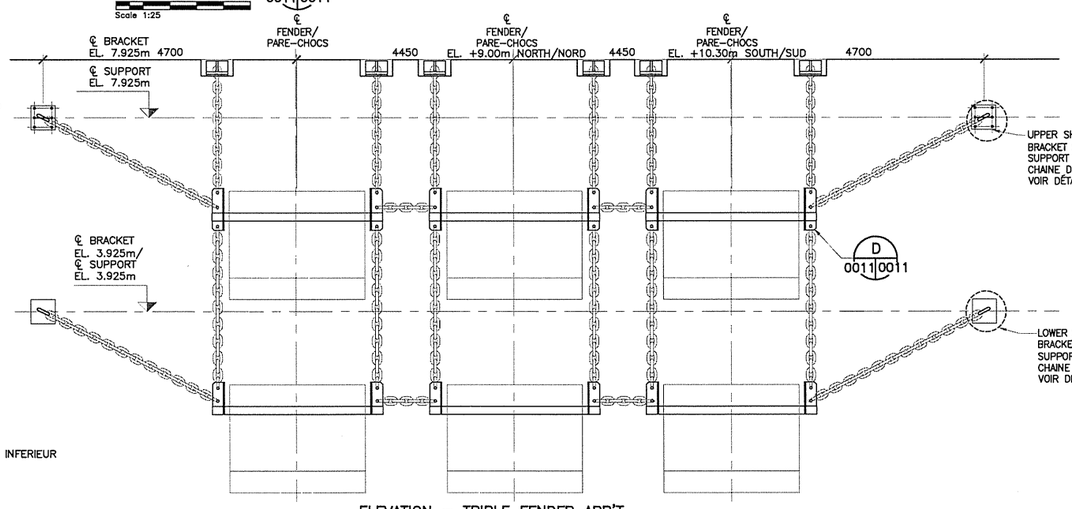
DETAIL–ANCHOR ASSEMBLY/ DETAIL–ENSEMBLE DE ANCRAGE E 0011|0011

Scale 1:10



SECTION/ SECTION 3 0011|0011

Scale 1:150



ELEVATION – TRIPLE FENDER ARR'T
ELEVATION – ARR'T PARE CHOC TRIPLE 4 0011|0011

Scale 1:50

NOTES:

1. FENDERS AND HARDWARE SUPPLIED BY OWNER. MODIFICATION TO CHAIN LENGTHS MAY BE REQUIRED

INDICATIONS:

1. AILES ET MATÉRIEL FOURNI PAR LE PROPRIETAIRE. MODIFICATION DE LA LONGUEUR DE CHAÎNE PEUT ETRE NECESSAIRE

POUR PERMIS
PAS POUR CONSTRUCTION

FOR PERMIT
NOT FOR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

ISSUE REGISTER

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INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REFERENCE DRAWINGS NUMBER

PROFESSIONAL SEAL

REGISTERED PROFESSIONAL ENGINEERS PEGNL PROFESSIONAL ENGINEERS GOVERNMENT OF NEWFOUNDLAND & LABRADOR
CHRISTOPHER M. FUDGE
PROVINCE
2013-04-25
DATE

SNC·LAVALIN
455, René–Lévesque Blvd. West
Montréal (Québec)
Canada H2Z 1Z3

PREPARATION	APPROVAL
DESIGNED C. FUDGE	PROJECT DISCIPLINE ENGINEER N. GILLIS
DRAWN T.YOUNG	CLIENT
CHECKED C. FUDGE	DATE 2013/03/22
SCALE AS NOTED	

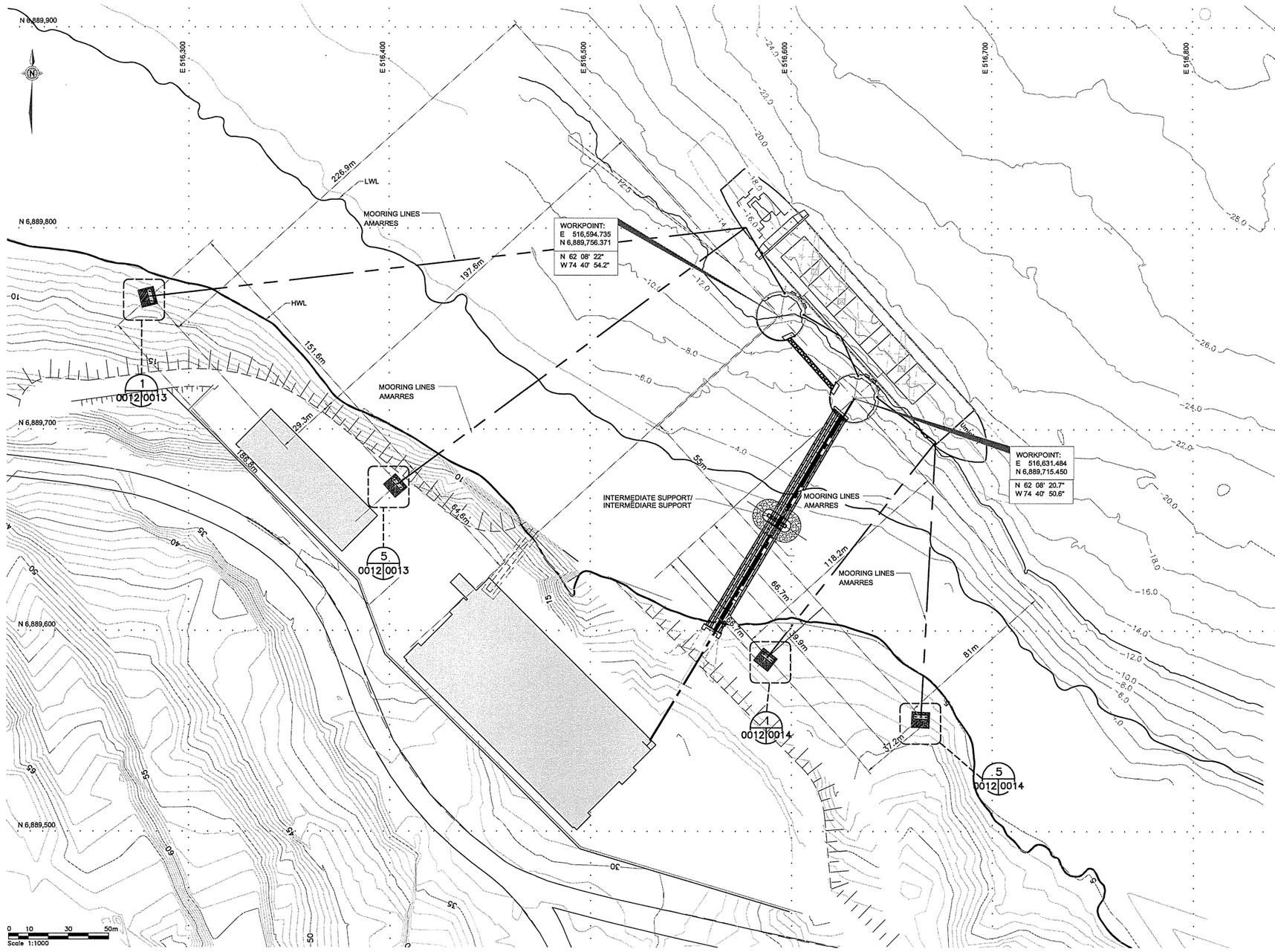
CLIENT
CANADIAN ROYALTIES INC.

PROJECT
NUNAVIK NICKEL
DECEPTION BAY PORT

TITLE
FENDER DETAILS
DÉTAILS DE PARE–CHOCS

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
506117	8000	41	D1 0011	P1

020878A1.MEN – FRAME A1 HORIZONTAL ENGLISH



NOTES:
1) PRETENSION MOORING LINES TO MINIMIZE OR ELIMINATE LINE SAG.
2) LOCATION OF LAND BASED BOLLARDS MAY VARY DEPENDING ON SITE CONDITIONS./

INDICATIONS:
1) AMARRES PRETENDTION DE REDUIRE OU D'ELIMINER SAG LIGNE.
2) EMPLACEMENT DES BORNES TERRESTRES PEUVENT VARIER SELON LES CONDIONS DU SITE.

FOR PERMIT
NOT FOR CONSTRUCTION

POUR PERMIS
PAS POUR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

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REVISION REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REFERENCE DRAWINGS NUMBER

PROFESSIONAL SEAL

PROFESSIONAL ENGINEERS GOVERNMENT OF NEWFOUNDLAND & LABRADOR
PEGNL
CHRISTOPHER M. FUDGE
2013-04-05
DATE

SNC·LAVALIN
SNC·LAVALIN
455, René-Lévesque Blvd. West
Montréal (Québec)
Canada H2Z 1Z3

PREPARATION		APPROVAL	
DESIGNED	C. FUDGE	PROJECT DISCIPLINE ENGINEER	N. GILLIS
DRAWN	T.YOUNG	CLIENT	
CHECKED	C. FUDGE	DATE	2013/03/22
SCALE	AS NOTED		

CLIENT
CANADIAN ROYALTIES INC.

PROJECT
NUNAVIK NICKEL
DECEPTION BAY PORT

TITLE
MOORING ARRANGEMENT
ARRANGEMENT DE AMARRES

PROJECT No	SUBDIVISION		SUBJECT	SERIAL	REV.
506117	8000	41	D1	0012	P1

020872A1HEN – FRAME A1 HORIZONTAL ENGLISH

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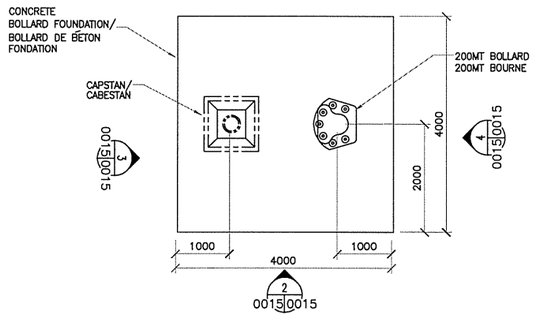
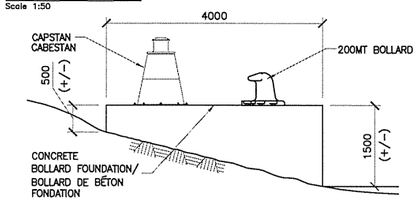


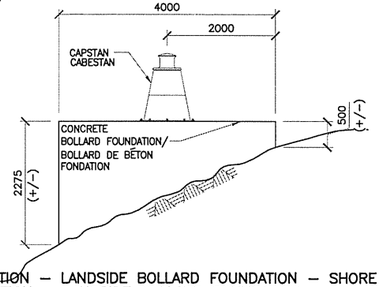
PLAN – LANDSIDE BOLLARD FOUNDATION – SHORE MOORING #1
PLAN – LANDSIDE BOLLARD FOUNDATION – AMMARAGE SHORE No. 1 — 1 — 0012 0013

Scale 1:50



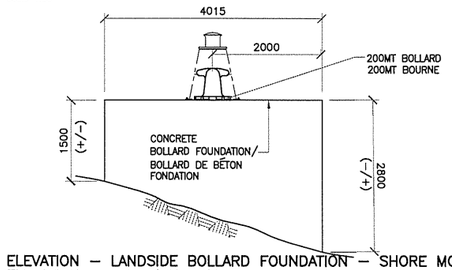
ELEVATION – LANDSIDE BOLLARD FOUNDATION – SHORE MOORING #1
ELEVATION – LANDSIDE BOLLARD FOUNDATION – AMMARAGE SHORE No. 1 — 2 — 0013 0013

Scale 1:50



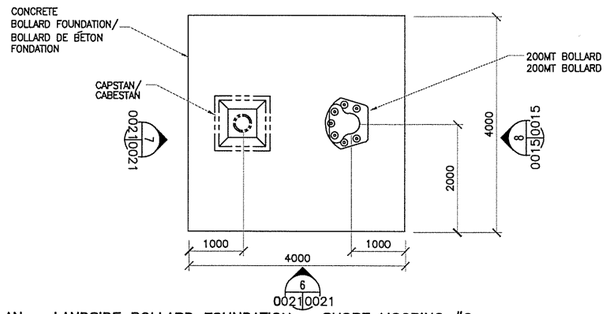
ELEVATION – LANDSIDE BOLLARD FOUNDATION – SHORE MOORING #1
ELEVATION – LANDSIDE BOLLARD FOUNDATION – AMMARAGE SHORE No. 1 — 3 — 0013 0013

Scale 1:50



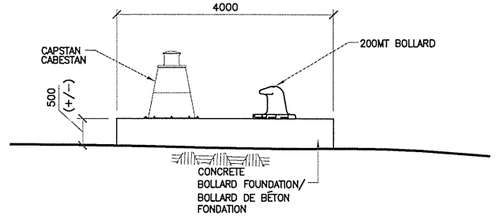
ELEVATION – LANDSIDE BOLLARD FOUNDATION – SHORE MOORING #1
ELEVATION – LANDSIDE BOLLARD FOUNDATION – AMMARAGE SHORE No. 1 — 4 — 0013 0013

Scale 1:50



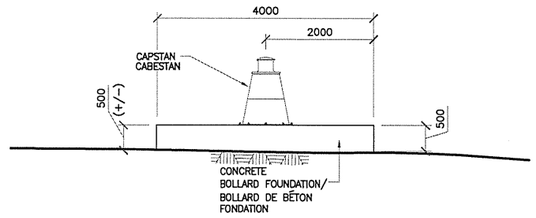
PLAN – LANDSIDE BOLLARD FOUNDATION – SHORE MOORING #2
PLAN – LANDSIDE BOLLARD FOUNDATION – AMMARAGE SHORE No. 2 — 5 — 0012 0013

Scale 1:50



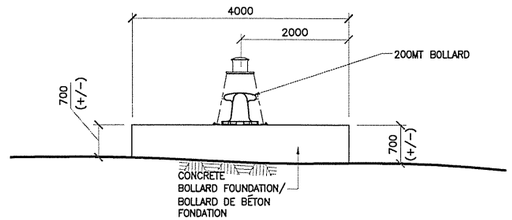
ELEVATION – LANDSIDE BOLLARD FOUNDATION – SHORE MOORING #2
ELEVATION – LANDSIDE BOLLARD FOUNDATION – AMMARAGE SHORE No. 2 — 6 — 0013 0013

Scale 1:50



ELEVATION – LANDSIDE BOLLARD FOUNDATION – SHORE MOORING #2
ELEVATION – LANDSIDE BOLLARD FOUNDATION – AMMARAGE SHORE No. 2 — 7 — 0013 0013

Scale 1:50



ELEVATION – LANDSIDE BOLLARD FOUNDATION – SHORE MOORING #2
ELEVATION – LANDSIDE BOLLARD FOUNDATION – AMMARAGE SHORE No. 2 — 8 — 0013 0013

Scale 1:50

NOTES:
1) ALL BOLLARDS AND CAPSTANS ARE OWNER SUPPLIED.
2) SEE DRAWING 506117 8000 42D1 0004 FOR REINFORCING DETAILS TYPICAL ALL BOLLARD FOUNDATIONS.
3) ROCK SLOPE MAY VARY DEPENDING ON FINAL BOLLARD LOCATION

INDICATIONS:
1) TOUTES LES BOLLARDS ET CABESTANS ÊTES PROPRIETAIRE FOURNI.
2) VOIR 506117 8000 42D1 0004 DESSINS POUR RENFORCER DÉTAILS TYPIQUES TOUTES LES FONDATIONS BOLLARD
3) PENTE ROCK PEUVENT VARIER EN FONCTION DE BOLLARD EMPLACEMENT FINAL

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NOT FOR CONSTRUCTION

POUR PERMIS
PAS POUR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

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REVISION REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REFERENCE DRAWINGS NUMBER

PROFESSIONAL SEAL

REGISTERED PROFESSIONAL ENGINEER
PEGL
Engineers, Geologists and Land Surveyors
CHRISTOPHER M. FUDGE
SIGNATURE 2013-04-05
DATE
NEWFOUNDLAND & LABRADOR

SNC·LAVALIN
SNC·LAVALIN
455, René-Lévesque Blvd. West
Montréal (Québec)
Canada H2Z 1Z3

PREPARATION	APPROVAL
DESIGNED B. TUCKER / C. FUDGE	PROJECT DISCIPLINE ENGINEER N. GILLIS
DRAWN T.YOUNG	CLIENT
CHECKED C. FUDGE	DATE 2013/03/22
SCALE AS NOTED	

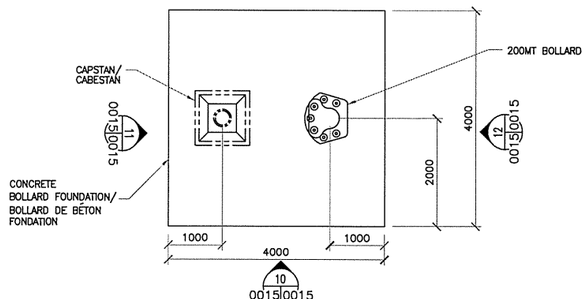
CLIENT
CANADIAN ROYALTIES INC.

PROJECT
NUNAVIK NICKEL
DECEPTION BAY PORT

TITLE
SITE 2
MOORINGS DETAILS
DÉTAILS DE AMMARES

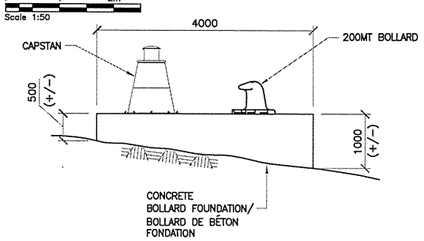
PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
506117	8000	41 D1	0013	P1

020878A1HEN – FRAME A1 HORIZONTAL ENGLISH



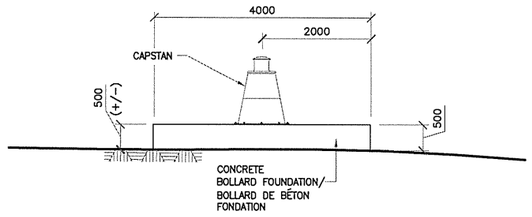
PLAN – LANDSIDE BOLLARD FOUNDATION – SHORE MOORING #3
PLAN – LANDSIDE BOLLARD FOUNDATION – AMMARAGE SHORE No. 3 — 1 / 0014|0014

0 1 2m
Scale 1:50



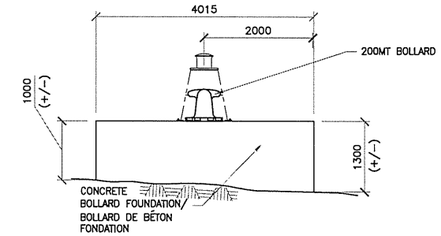
ELEVATION – LANDSIDE BOLLARD FOUNDATION – SHORE MOORING #3
ELEVATION – LANDSIDE BOLLARD FOUNDATION – AMMARAGE SHORE No. 3 — 2 / 0014|0014

0 1 2m
Scale 1:50



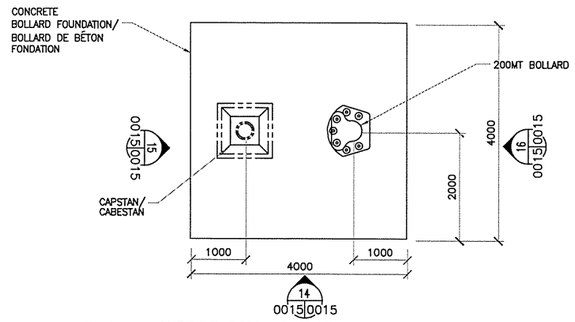
ELEVATION – LANDSIDE BOLLARD FOUNDATION – SHORE MOORING #3
ELEVATION – LANDSIDE BOLLARD FOUNDATION – AMMARAGE SHORE No. 3 — 3 / 0014|0014

0 1 2m
Scale 1:50



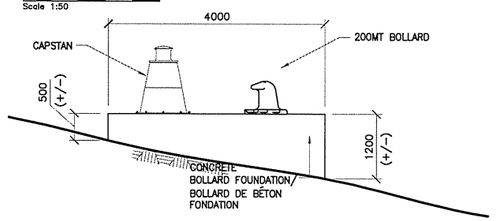
ELEVATION – LANDSIDE BOLLARD FOUNDATION – SHORE MOORING #3
ELEVATION – LANDSIDE BOLLARD FOUNDATION – AMMARAGE SHORE No. 3 — 4 / 0014|0014

0 1 2m
Scale 1:50



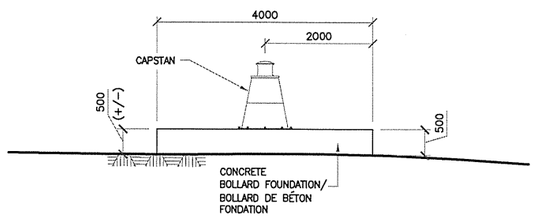
PLAN – LANDSIDE BOLLARD FOUNDATION – SHORE MOORING #4
PLAN – LANDSIDE BOLLARD FOUNDATION – AMMARAGE SHORE No. 4 — 5 / 0014|0014

0 1 2m
Scale 1:50



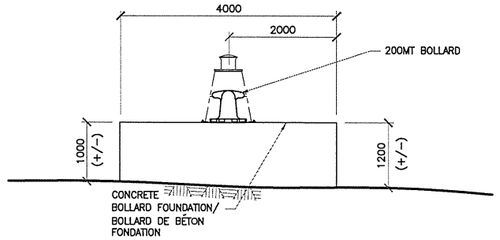
ELEVATION – LANDSIDE BOLLARD FOUNDATION – SHORE MOORING #4
ELEVATION – LANDSIDE BOLLARD FOUNDATION – AMMARAGE SHORE No. 4 — 6 / 0014|0014

0 1 2m
Scale 1:50



ELEVATION – LANDSIDE BOLLARD FOUNDATION – SHORE MOORING #4
ELEVATION – LANDSIDE BOLLARD FOUNDATION – AMMARAGE SHORE No. 4 — 7 / 0014|0014

0 1 2m
Scale 1:50



ELEVATION – LANDSIDE BOLLARD FOUNDATION – SHORE MOORING #4
ELEVATION – LANDSIDE BOLLARD FOUNDATION – AMMARAGE SHORE No. 4 — 8 / 0014|0014

0 1 2m
Scale 1:50

NOTES:
1) ALL BOLLARDS AND CAPSTANS ARE OWNER SUPPLIED.
2) SEE DRAWING 506117 8000 42D1 0004 FOR REINFORCING DETAILS TYPICAL ALL BOLLARD FOUNDATIONS.
3) ROCK SLOPE MAY VARY DEPENDING ON FINAL BOLLARD LOCATION

INDICATIONS:
1) TOUTES LES BOLLARDS ET CABESTANS ÉTES PROPRIETAIRE FOURNI.
2) VOIR 506117 8000 42D1 0004 DESSINS POUR RENFORCER DÉTAILS TYPIQUES TOUTES LES FONDATIONS BOLLARD
3) PENTE ROCK PEUVENT VARIER EN FONCTION DE BOLLARD EMPLACEMENT FINAL

FOR PERMIT
NOT FOR CONSTRUCTION

POUR PERMIS
PAS POUR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

ISSUE REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**
P1	ISSUED FOR PERMIT EMIS POUR PERMIS	2013/04/05		

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REFERENCE DRAWINGS NUMBER

PROFESSIONAL SEAL
PEGNL PROFESSIONAL ENGINEERS GOVERNED BY THE ENGINEERING AND GEOSCIENCE ACT
CHRISTOPHER M. FUDGE
2013-04-05
NEWFOUNDLAND & LABRADOR

SNC·LAVALIN
455, René-Lévesque Blvd. West
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Canada H2Z 1Z3

PREPARATION	APPROVAL
DESIGNED: B. TUCKER / C. FUDGE	PROJECT DISCIPLINE ENGINEER: N. GILLIS
DRAWN: T.YOUNG	CLIENT:
CHECKED: C. FUDGE	DATE: 2013/03/22
SCALE: AS NOTED	

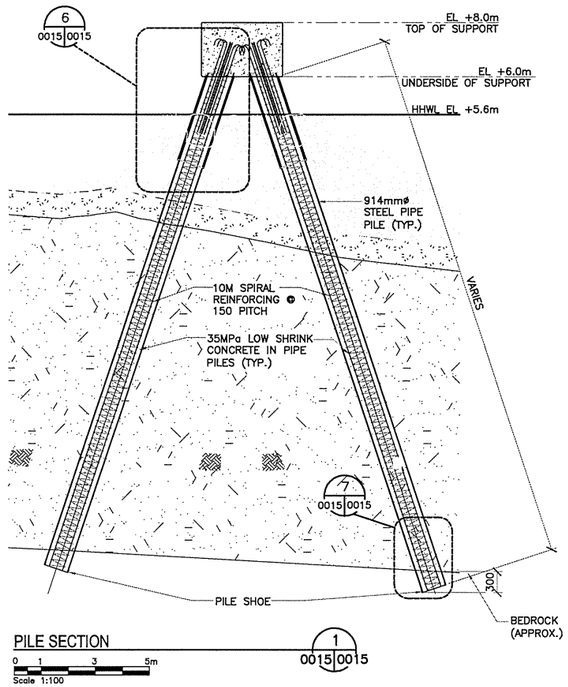
CLIENT
CANADIAN ROYALTIES INC.

PROJECT
NUNAVIK NICKEL
DECEPTION BAY PORT

TITLE
SITE 2
MOORINGS DETAILS
DÉTAILS DE AMMARES

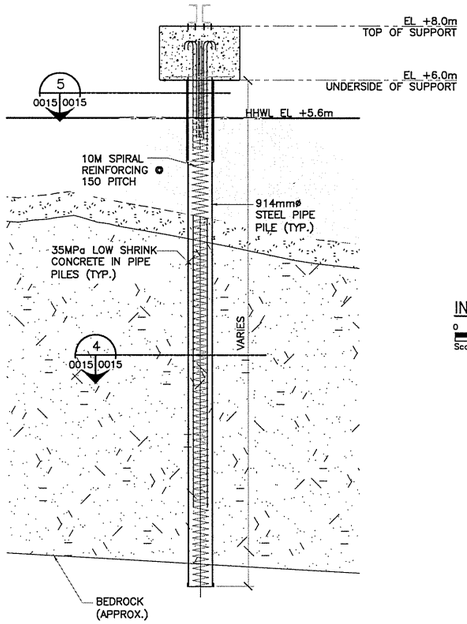
PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
506117	8000	41	D1 0014	P1

020878A1HEN – FRAME A1 HORIZONTAL ENGLISH



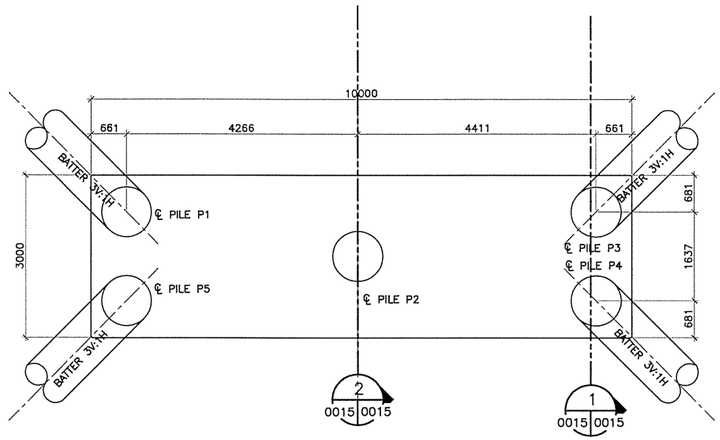
PILE SECTION 1 — 0015 0015

Scale 1:100



PILE SECTION 2 — 0015 0015

Scale 1:100

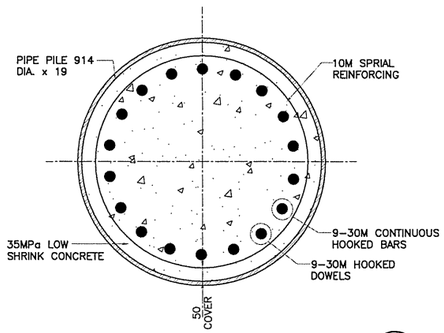


INTERMEDIATE SUPPORT/ PILE PLAN — 3 — 0015 0015

Scale 1:50

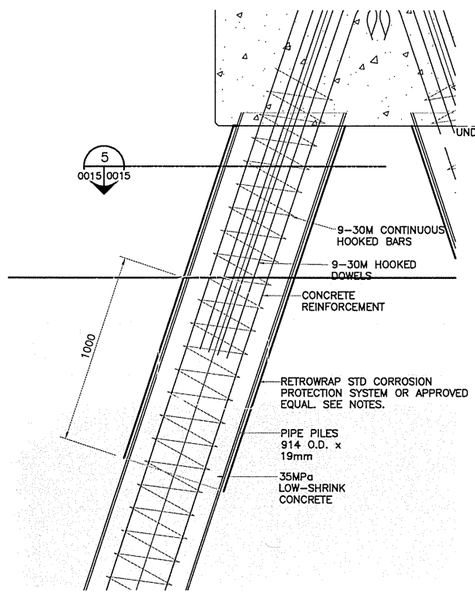
SECTION — 4 — 0015 0015

Scale 1:10



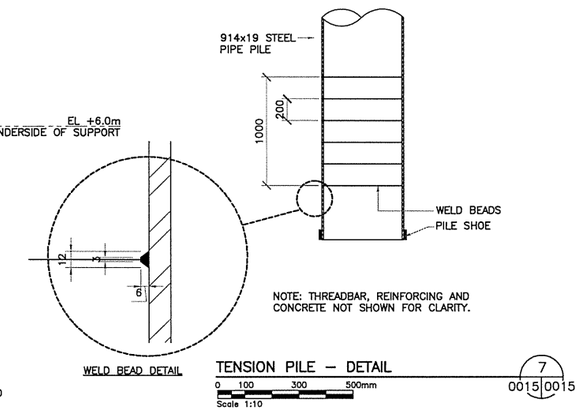
SECTION — 5 — 0015 0015

Scale 1:10



SECTION DETAIL — 6 — 0015 0015

Scale 1:25



TENSION PILE – DETAIL — 7 — 0015 0015

Scale 1:10

FOR PERMIT
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POUR PERMIS
PAS POUR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

ISSUE REGISTER

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REVISION REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REFERENCE DRAWINGS NUMBER

PROFESSIONAL SEAL

REGISTERED PROFESSIONAL ENGINEER
PEGL
PROVINCE OF NEWFOUNDLAND & LABRADOR
CHRISTOPHER M. FUDGE
SIGNATURE
2013-04-05
DATE

SNC·LAVALIN
455, René-Lévesque Blvd. West
Montréal (Québec)
Canada H2Z 1Z3

PREPARATION	APPROVAL
DESIGNED: C. FUDGE	PROJECT DISCIPLINE ENGINEER: N. GILLIS
DRAWN: T.YOUNG	CLIENT:
CHECKED: C. FUDGE	DATE: 2013/03/22
SCALE: AS NOTED	

CLIENT: CANADIAN ROYALTIES INC.

PROJECT: NUNAVIK NICKEL — DECEPTION BAY PORT

TITLE: PILE PLAN AND SECTIONS/ PLAN DE PILE ET SECTIONS

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
506117	8000	41 D1	0015	P1

020878A1HEN – FRAME A1 HORIZONTAL ENGLISH

LAST SAVE: 2013/04/05 – 3:29pm
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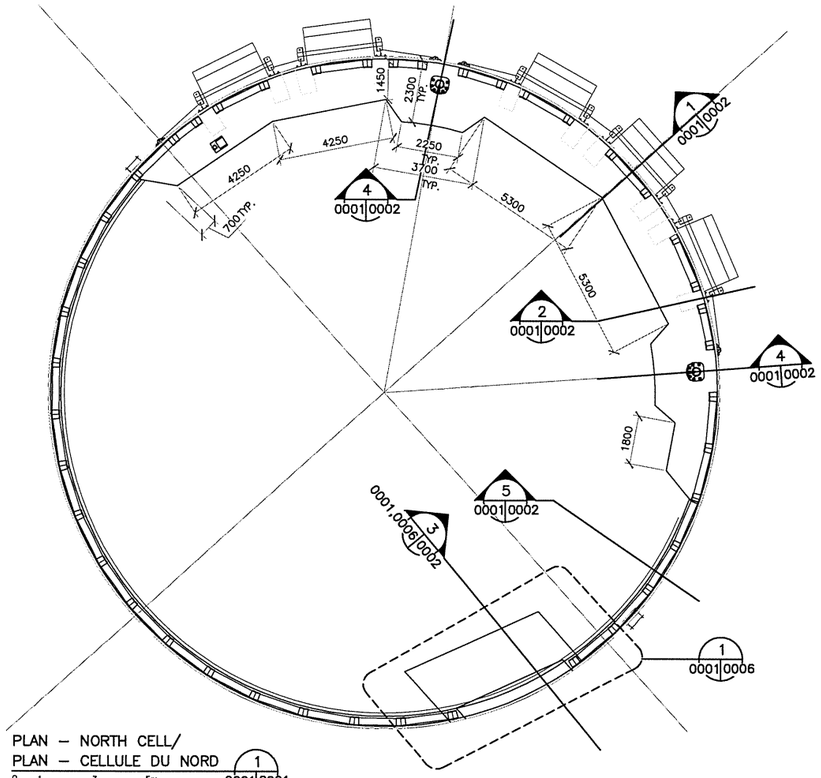
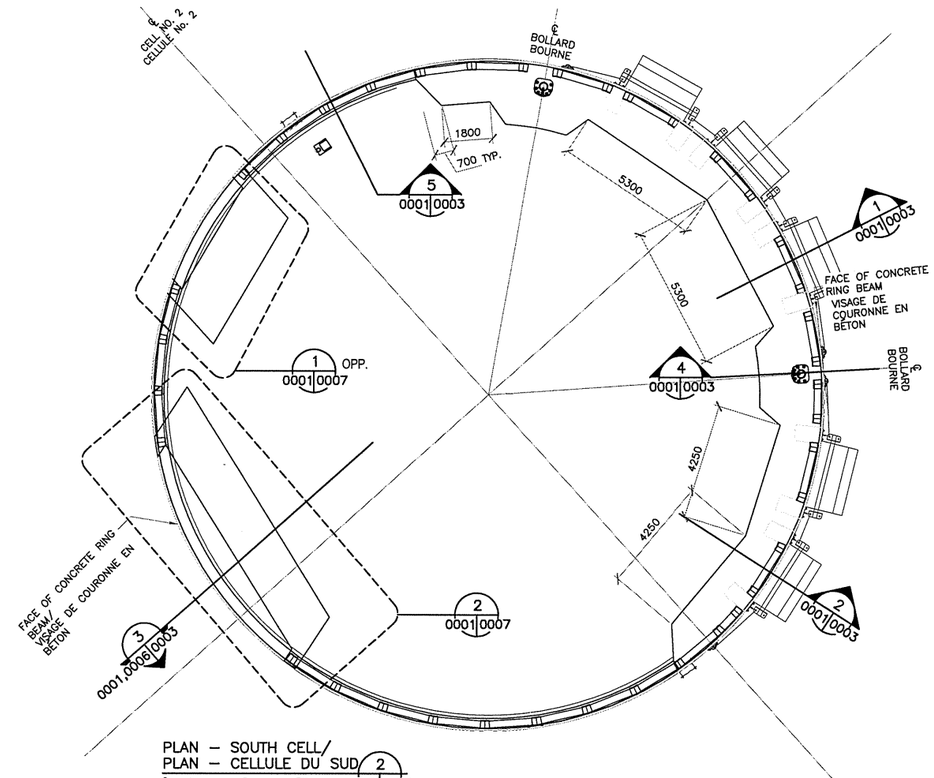


PLAN – NORTH CELL/
PLAN – CELLULE DU NORD 1 0001|0001

0 1 3 5m
Scale 1:100



PLAN – SOUTH CELL/
PLAN – CELLULE DU SUD 2 0001|0001

0 1 3 5m
Scale 1:100

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PAS POUR CONSTRUCTION

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REVISION REGISTER

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REVISION REGISTER

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PROFESSIONAL SEAL

REGISTERED PROFESSIONAL ENGINEER
PEGL
CHRISTOPHER M. FUDGE
2013-04-05
DATE
NEWFOUNDLAND & LABRADOR

SNC·LAVALIN
455, René-Lévesque Blvd. West
Montréal (Québec)
Canada H2Z 1Z3

PREPARATION	APPROVAL
DESIGNED C. FUDGE	PROJECT DISCIPLINE ENGINEER N. GILLIS
DRAWN T.YOUNG	CLIENT
CHECKED C.FUDGE	DATE 2013/03/22
SCALE AS NOTED	

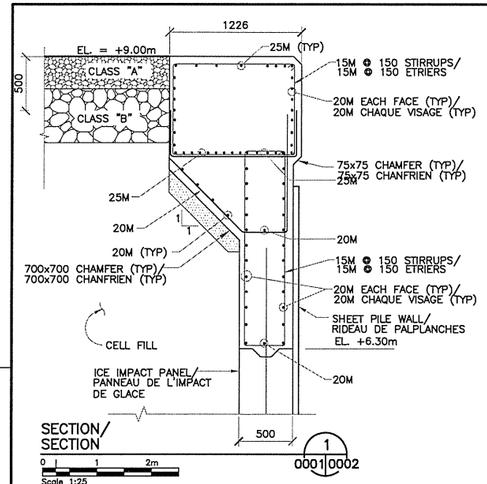
CLIENT
CANADIAN ROYALTIES INC.

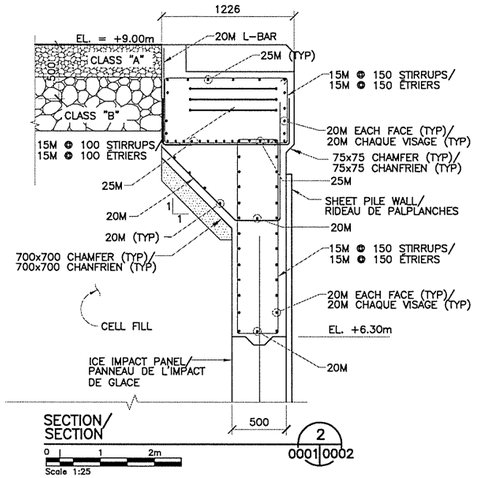
PROJECT
NUNAVIK NICKEL
DECEPTION BAY PORT

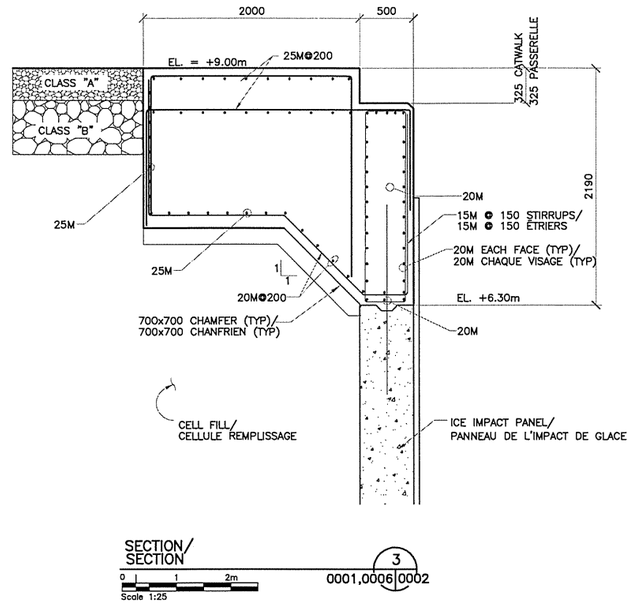
TITLE
SSP CELLS
CONCRETE CAP REINFORCEMENT
SSP CELLULES
CAP À BÉTON RENFORT

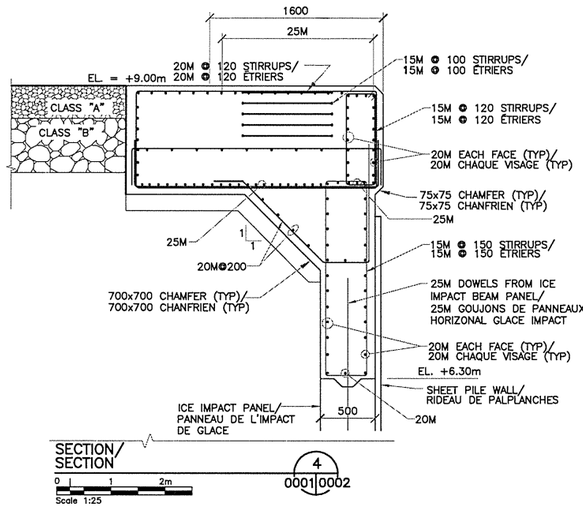
PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
506117	8000	42 \ D1	0001	P1

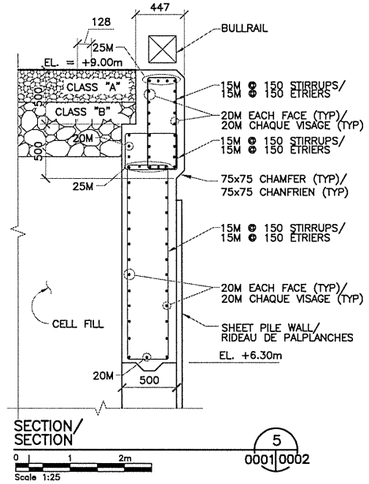
0208784THEN – FRAME A1 HORIZONTAL ENGLISH











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POUR PERMIS
PAS POUR CONSTRUCTION

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REVISION REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REFERENCE DRAWINGS NUMBER

PROFESSIONAL SEAL

REGISTERED PROFESSIONAL ENGINEER
PROVINCE OF NEWFOUNDLAND & LABRADOR
PEGNL
CHRISTOPHER M. FUDGE
Fudge
2013-04-05
DATE

SNC·LAVALIN
455, René-Lévesque Blvd. West
Montréal (Québec)
Canada H2Z 1Z3

PREPARATION	APPROVAL
DESIGNED C. FUDGE	PROJECT DISCIPLINE ENGINEER N. GILLIS
DRAWN T.YOUNG	CLIENT
CHECKED C. FUDGE	DATE 2013/03/22
SCALE AS NOTED	

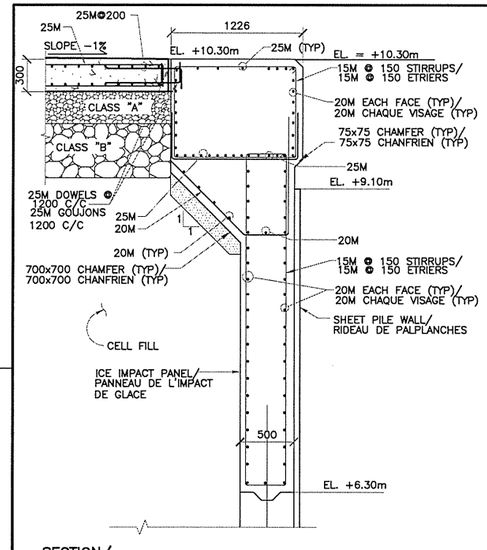
CLIENT
CANADIAN ROYALTIES INC.

PROJECT
NUNAVIK NICKEL
DECEPTION BAY PORT

TITLE
CONCRETE CAP REINFORCING DETAILS – NORTH CELL
CAP À BÉTON COORDONNÉES – CELLULE DU NORD

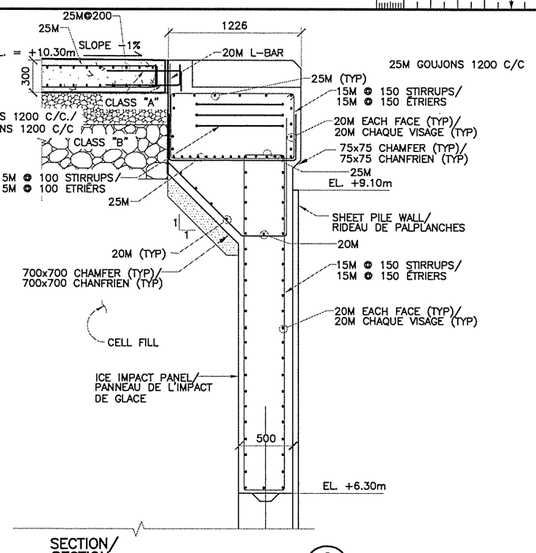
PROJECT No	SUBDMISION	SUBJECT	SERIAL	REV.
506117	8000	42 | D1	0002	P1

0206784 1HEN – FRAME A1 HORIZONTAL ENGLISH



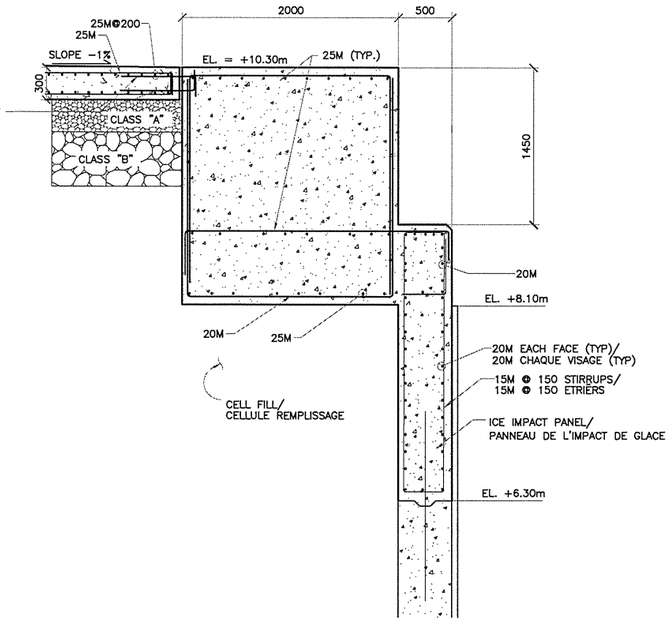
SECTION/
SECTION 1 0001|0002

Scale 1:25



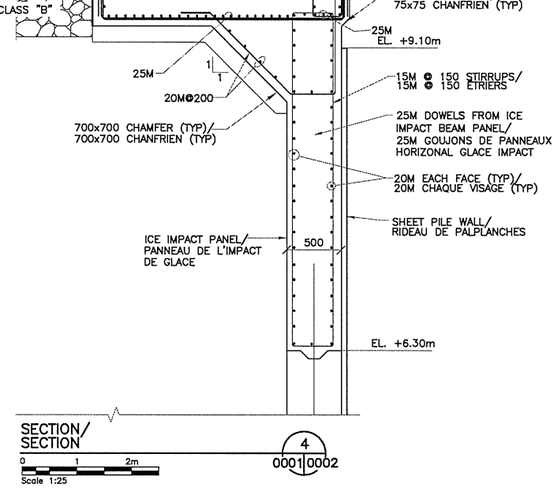
SECTION/
SECTION 2 0001|0002

Scale 1:25



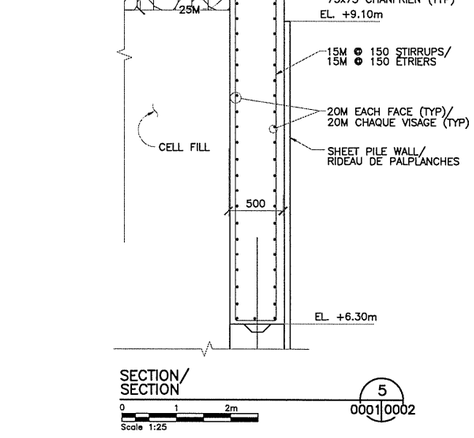
SECTION/
SECTION 3 0001,0006|0002

Scale 1:25



SECTION/
SECTION 4 0001|0002

Scale 1:25



SECTION/
SECTION 5 0001|0002

Scale 1:25

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ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

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REVISION REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**

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REVISION REGISTER

No	REFERENCE DRAWINGS NUMBER

PROFESSIONAL SEAL

REGISTERED PROFESSIONAL ENGINEER
PEGL
PROFESSIONAL ENGINEERS GOVERNMENT REGULATED
CHRISTOPHER M. FUDGE
LICENCE
2013-04-05
DATE
NEWFOUNDLAND & LABRADOR

SNC·LAVALIN
455, René-Lévesque Blvd. West
Montréal (Québec)
Canada H2Z 1Z3

PREPARATION	APPROVAL
DESIGNED: C. FUDGE	PROJECT DISCIPLINE ENGINEER: N. GILLIS
DRAWN: T.YOUNG	CLIENT:
CHECKED: C. FUDGE	DATE: 2013/03/22
SCALE: AS NOTED	

CLIENT
CANADIAN ROYALTIES INC.

PROJECT
NUNAVIK NICKEL
DECEPTION BAY PORT

TITLE
CONCRETE CAP REINFORCING
DETAILS – SOUTH CELL
CAP À BÉTON COORDONNÉES
– CELLULE DU SUD

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
506117	8000	42 | D1	0003	P1

020878A1HEN – FRAME A1 HORIZONTAL ENGLISH

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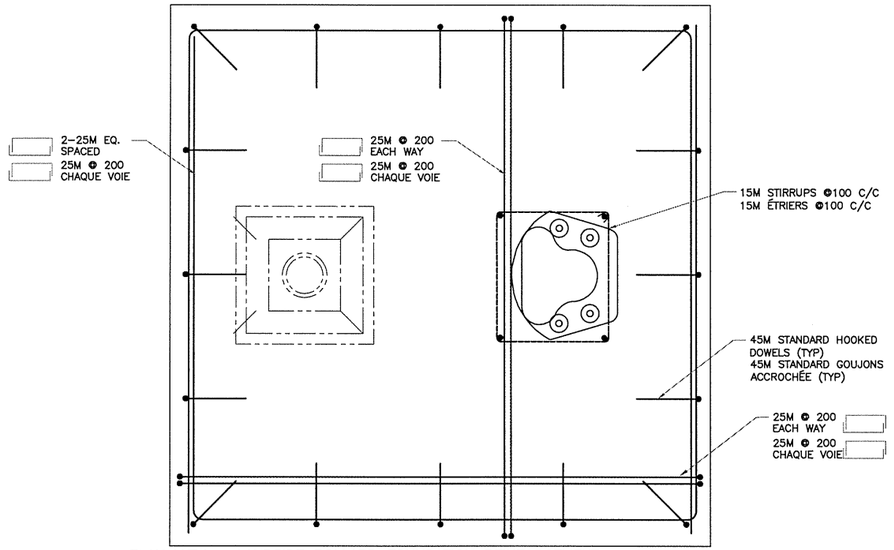
PAS POUR CONSTRUCTION

NOTE: REINFORCEMENT DETAILS SHOWN FOR MOORING STRUCTURE 1. REINFORCEMENT DETAILS FOR MOORING STRUCTURE 2, 3, & 4 SIMILAR

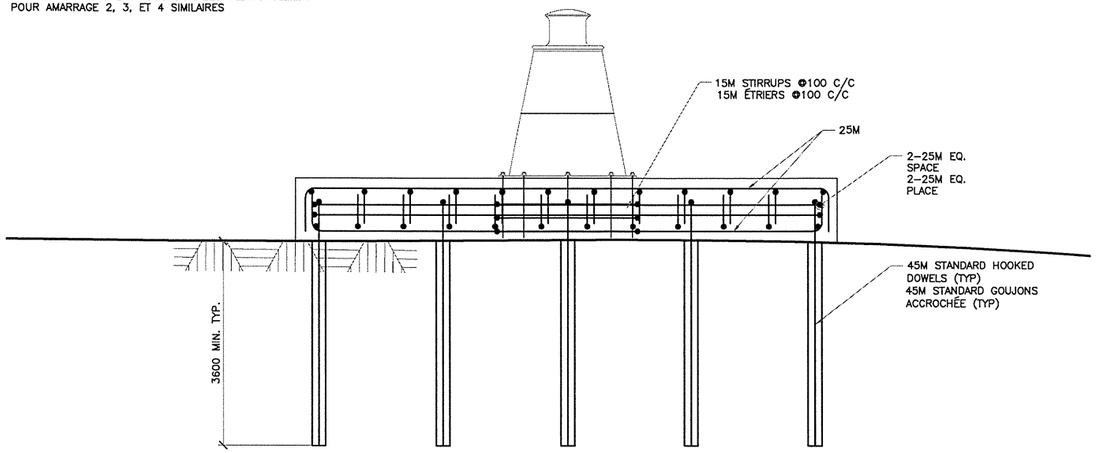
INDICATION: DÉTAILS DE RENFORCÉMENT DE MOUILLAGE ILLUSTRE STRUCTURE 1. COORDONNEES REINFORCÉMENT POUR AMARRAGE 2, 3, ET 4 SIMILAIRES



PLAN VIEW – LANDSIDE BOLLARD FOUNDATION REINFORCEMENT/
PLAN VUE – COTÉ VILLE BOLLARD FOUNDATION DE REINFORCEMENT

1
0003|0003

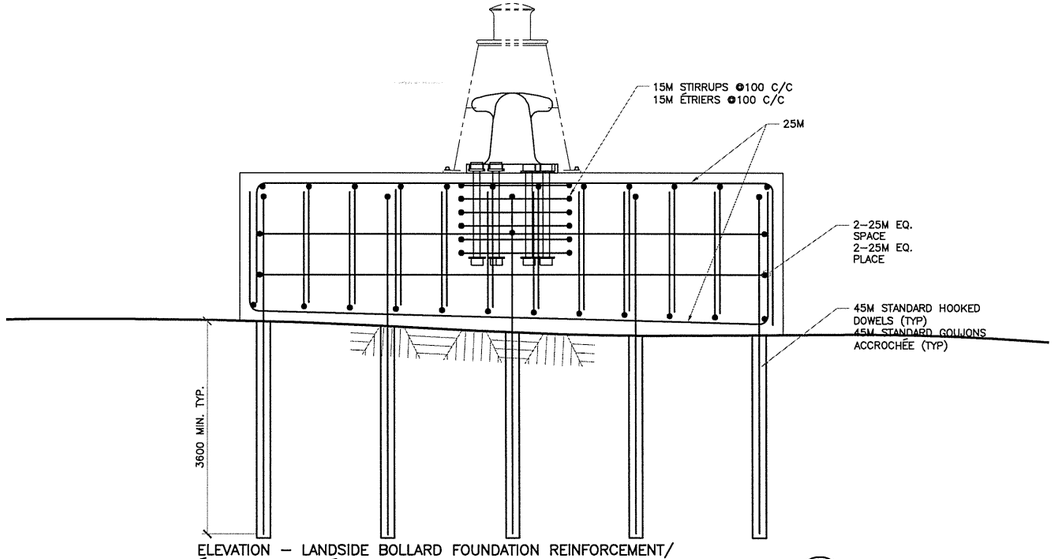
0 1 2m
Scale 1:50



ELEVATION – LANDSIDE BOLLARD FOUNDATION REINFORCEMENT/
ÉLEVATION – COTÉ VILLE BOLLARD FOUNDATION DE REINFORCEMENT

2
0003|0003

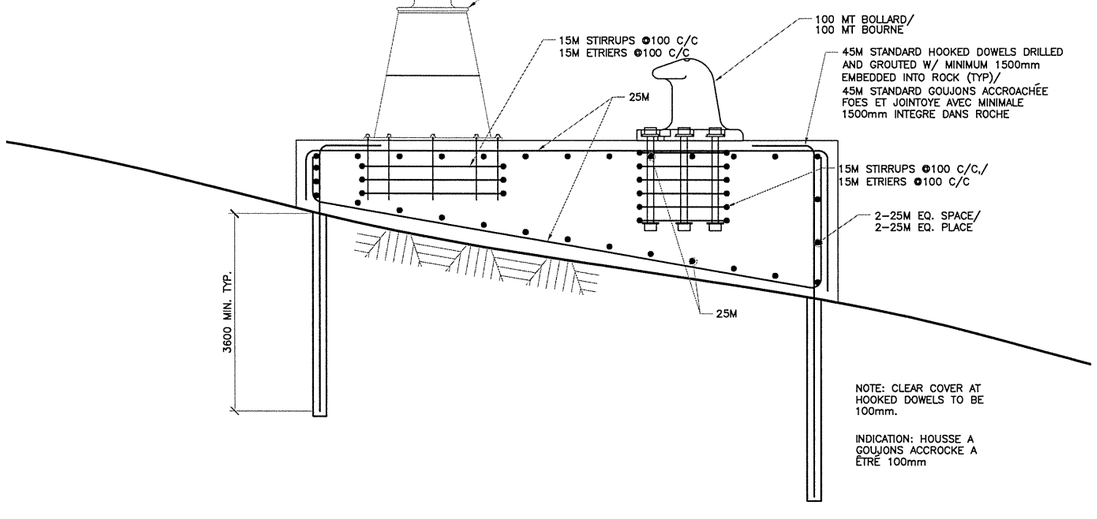
0 1 2m
Scale 1:50



ELEVATION – LANDSIDE BOLLARD FOUNDATION REINFORCEMENT/
ÉLEVATION – COTÉ VILLE BOURNE FOUNDATION DE REINFORCEMENT

3
0003|0003

0 1 2m
Scale 1:50



NOTE: CLEAR COVER AT HOOKED DOWELS TO BE 100mm.

INDICATION: HOUSSE A GOUJONS ACCROCKE A ÉTRÉ 100mm

ELEVATION – LANDSIDE BOLLARD FOUNDATION REINFORCEMENT/
ÉLEVATION – COTÉ VILLE BOLLARD FOUNDATION DE REINFORCEMENT

4
0003|0003

0 1 2m
Scale 1:50

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ISSUE REGISTER

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ISSUE REGISTER

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REVISION REGISTER

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INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REFERENCE DRAWINGS NUMBER

PROFESSIONAL SEAL

REGISTERED PROFESSIONAL ENGINEER
PEGL
CHRISTOPHER M. FUDGE
2013-04-05
DATE
NEWFOUNDLAND & LABRADOR

SNC·LAVALIN
455, René-Lévesque Blvd. West
Montréal (Québec)
Canada H2Z 1Z3

PREPARATION	APPROVAL
DESIGNED C. FUDGE	PROJECT DISCIPLINE ENGINEER N. GILLIS
DRAWN T. YOUNG	CLIENT
CHECKED C. FUDGE	DATE 2013/03/22
SCALE AS NOTED	

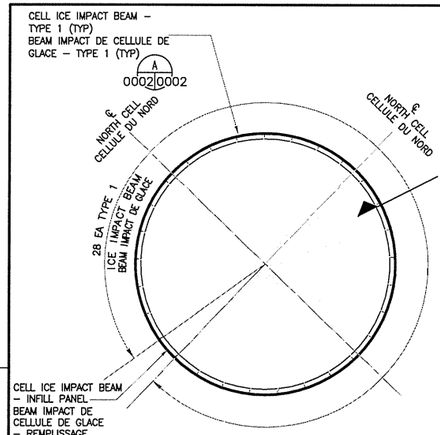
CLIENT
CANADIAN ROYALTIES INC.

PROJECT
NUNAVIK NICKEL
DECEPTION BAY PORT

TITLE
SITE 2– MOORINGS CONCRETE REINFORCING DETAILS (TYP)
SITE 2 – AMARRES BÉTON COORDONNÉES DE RENFORT

PROJECT No	SUBDMISION	SUBJECT	SERIAL	REV.
506117	8000	42 | D1	0004	P1

0205784THEN – FRAME A1 HORIZONTAL ENGLISH



PLAN – ICE IMPACT BEAMS/
PLAN – POUTRES D'IMPACT DE GLACE 1 0004 0004

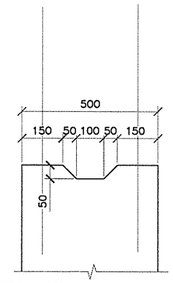
0 5 10m
Scale 1:250

NOTES:

1. CHAMFER ALL EDGES 50mm.
2. AFTER PLACEMENT OF ICE IMPACT BEAMS AND FILLING OF CELLS, CONTRACTOR TO GROUT VOID BETWEEN SHEET PILES AND ICE IMPACT BEAMS. PREVENT BONDING OF GROUT TO SHEET PILES.

INDICATIONS:

1. TOUS BORDS CHANFRIEN 50mm.
2. APRES LE PLACEMENT DE POUTRES D'IMPACT DE GLACE ET DE REMPLISSAGE DES CELLULES, ENTREPRENEUR AU COULIS CIDE ENTRE LES PALPLANCHES ET POUTRELLES DE LA CIE. ÉVITIER DE COLLAGE DE COULIS DE PALPLANCHES.



SHEAR KEY DETAIL/
DÉTAIL – CLE DE CISALLEMENT B 0004 0004

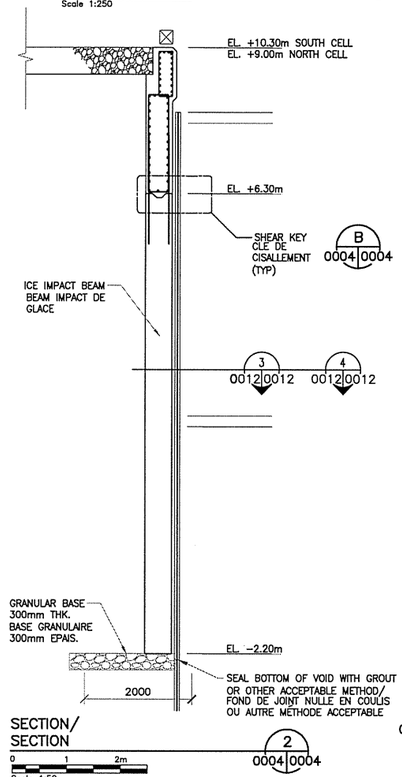
0 100 300 500mm
Scale 1:10

NOTE:

1) TYPE 1 PANELS ARE SUPPLIED BY THE OWNER. CONTRACTOR IS RESPONSIBLE FOR FABRICATION OF INFILL PANELS. CONTRACTOR IS RESPONSIBLE FOR INSTALLATION OF ALL PANELS.

INDICATION:

1) TYPE 1 PANNEAUX SONT FOURNIS PAR LE PROPIETAIRE ENTREPRENEUR EST RESPONABLE DE FABRICATION DE PANNEAUX DE REMPLISSAGE ENTRÉPRENEUR EST RESPONSABLE DE L'INSTALLATION DE TOUS LES PANNEAUX



SECTION/
SECTION 2 0004 0004

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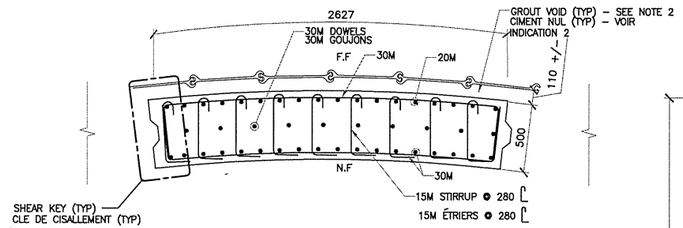
Scale 1:50



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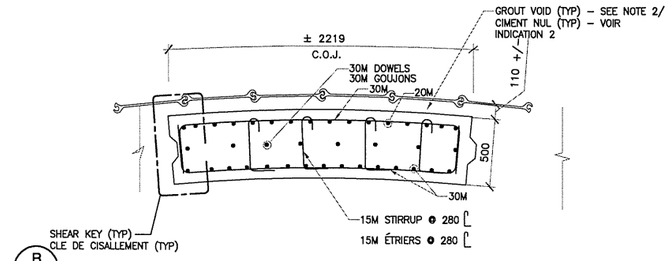

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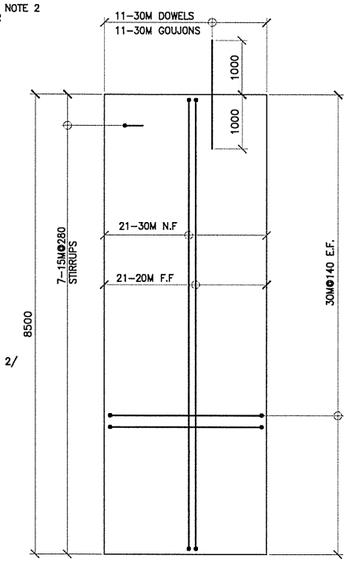

TYPE 1 PANEL/
TYPE 1 PANNEAU A 0004 0004

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Scale 1:50

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NEWFOUNDLAND & LABRADOR ASSOCIATION OF PROFESSIONAL ENGINEERS
PEGL
CHRISTOPHER M. FUDGE
2013-04-05

SNC·LAVALIN
455, René-Lévesque Blvd. West
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DESIGNED C. FUDGE	PROJECT DISCIPLINE ENGINEER N. GILLIS
DRAWN T.YOUNG	CLIENT
CHECKED C.FUDGE	DATE 2013/03/22
SCALE AS NOTED	

CLIENT
CANADIAN ROYALTIES INC.

PROJECT
NUNAVIK NICKEL
DECEPTION BAY PORT

TITLE
SSP CELLS– ICE IMAPCT BEAMS
SSP CELLULES –
POUTRES D'IMPACT DES GLACE

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
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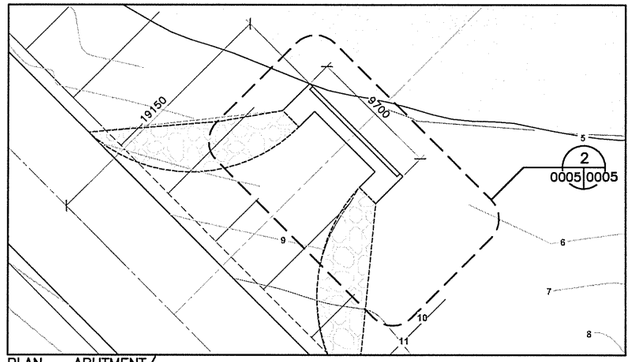

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PLAN – CULÉE

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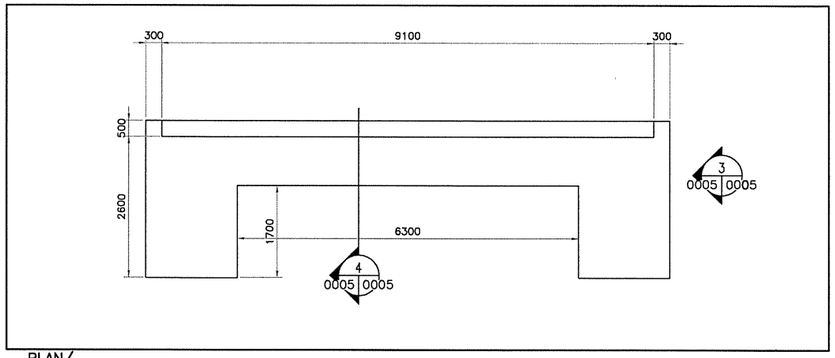

PLAN/
PLAN

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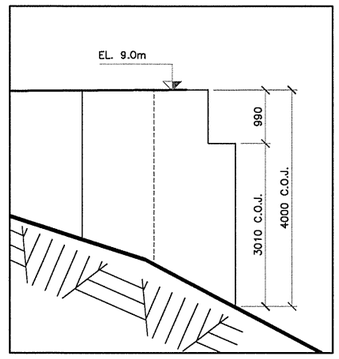
Scale 1:50



ELEVATION/
ÉLÉVATION

3
0005 0005

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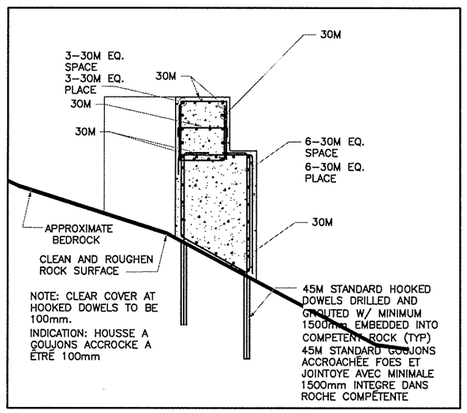

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DÉTAIL–SECTION DU REBAR

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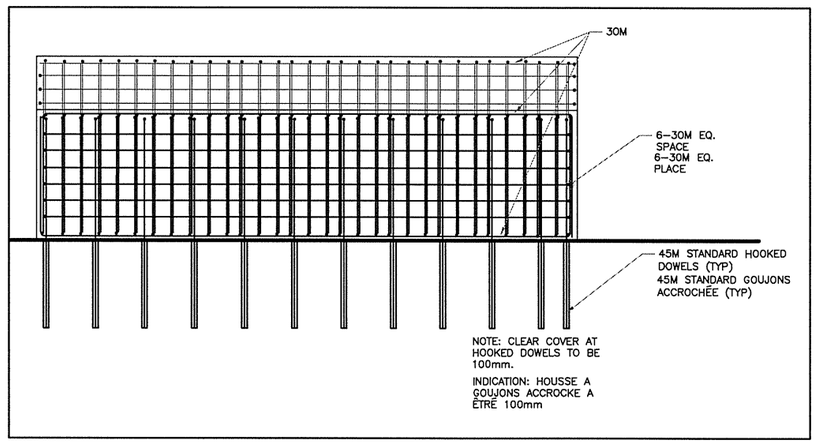

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DÉTAIL–REBAR CULÉE

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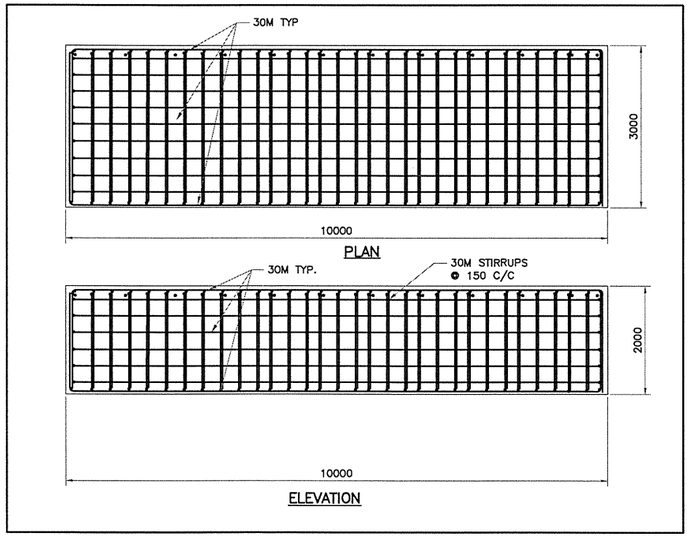

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CAP INTERMÉDAIRE PONT EN BÉTON

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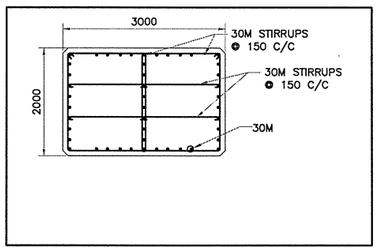

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INTERMEDIATE BRIDGE CONCRETE CAP/
DÉTAIL–SECTION DU REBAR–
CAP INTERMÉDAIRE PONT EN BÉTON

7
0005 0005

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Scale 1:50

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REGISTERED PROFESSIONAL ENGINEER
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and Labrador
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DRAWN: T.YOUNG	CLIENT:
CHECKED: C.FUDGE	DATE: 2013/03/22
SCALE: AS NOTED	

CLIENT
CANADIAN ROYALTIES INC.

PROJECT
NUNAVIK NICKEL
DECEPTION BAY PORT

TITLE
REINFORCED CONCRETE DETAILS
RENFORCES CULEÉ
EN BÉTON

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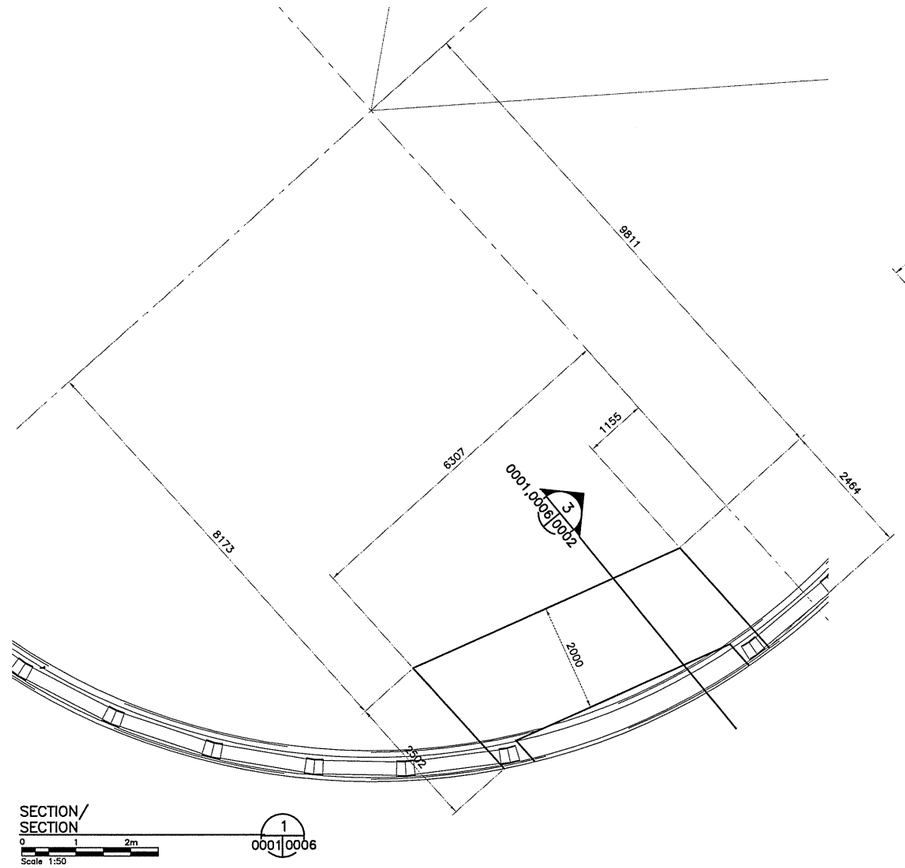

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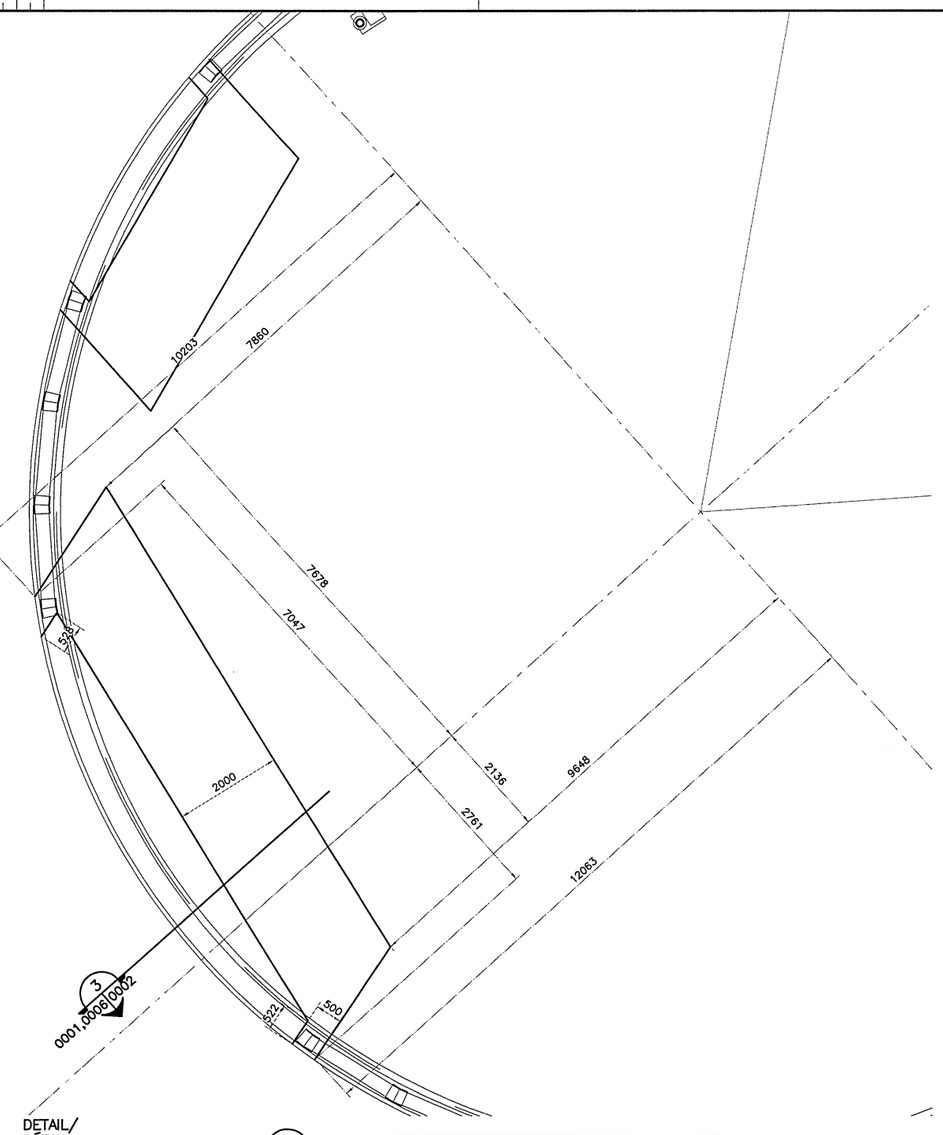

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FOR PERMIT
NOT FOR CONSTRUCTION

POUR PERMIS
PAS POUR CONSTRUCTION

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PROFESSIONAL ENGINEERS PEGL PROFESSIONNELS INGÉNIEURS NEWFOUNDLAND & LABRADOR CHRISTOPHER M. FUDGE 2013-04-05 DATE NEWFOUNDLAND & LABRADOR

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DESIGNED C.FUDGE	PROJECT DISCIPLINE ENGINEER N. GILLIS
DRAWN T.YOUNG	CLIENT
CHECKED C.FUDGE	DATE 2013/03/22
SCALE AS NOTED	

CLIENT
CANADIAN ROYALTIES INC.

PROJECT
NUNAVIK NICKEL
DECEPTION BAY PORT

TITLE
SSP CELLS
CONCRETE ABUTMENT DETAILS
SSP CELLULES
COORDONNÉES CULÉE EN BÉTON

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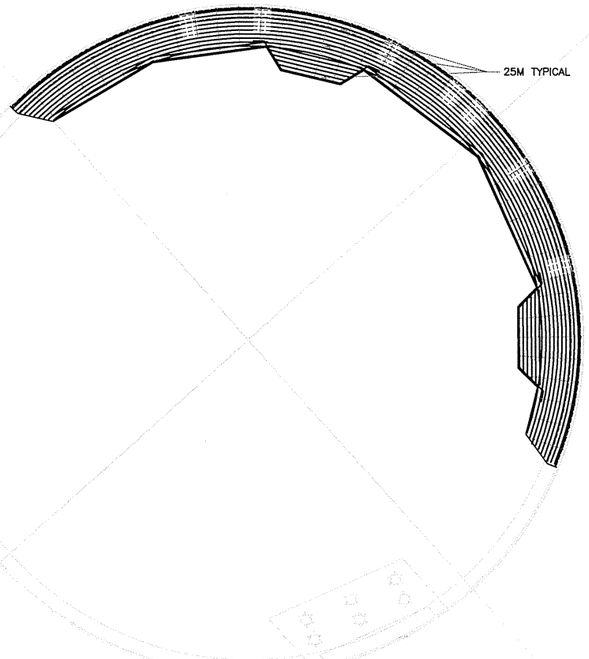

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PLAN – CELLULE DU NORD (1, 0001|0008)
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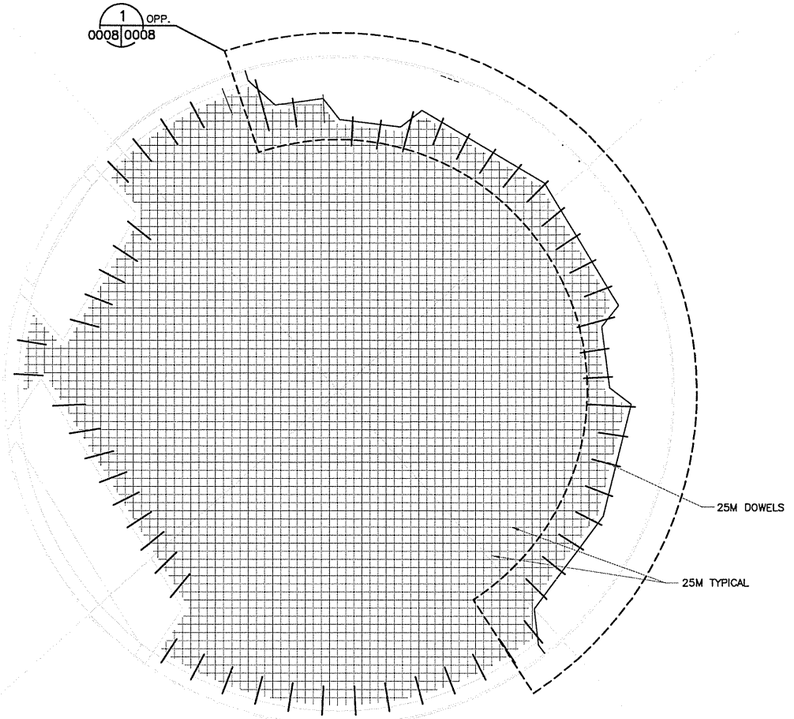

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PLAN – CELLULE DU SUD (2, 0001|0008)
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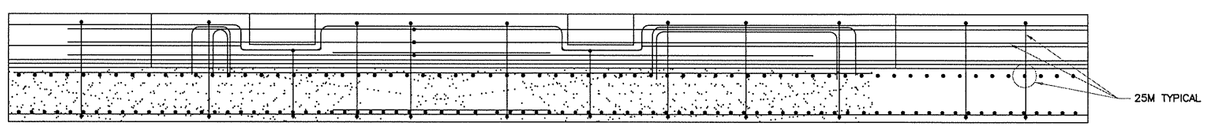

SECTION/
SECTION (3, 0001|0008)
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REVISION REGISTER

No	REFERENCE DRAWINGS NUMBER

PROFESSIONAL SEAL

REGISTERED PROFESSIONAL ENGINEER
PEGL
Newfoundland and Labrador
Provincial Licensing
CHRISTOPHER M. FUDGE
LICENCE
2013-04-05
DATE
NEWFOUNDLAND & LABRADOR

SNC·LAVALIN
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PREPARATION	APPROVAL
DESIGNED: C.FUDGE	PROJECT DISCIPLINE ENGINEER: N. GILLIS
DRAWN: T.YOUNG	CLIENT:
CHECKED: C.FUDGE	DATE: 2013/03/22
SCALE: AS NOTED	

CLIENT
CANADIAN ROYALTIES INC.

PROJECT
NUNAVIK NICKEL
DECEPTION BAY PORT

TITLE
SSP CELLS –
CONCRETE CAP REINFORCING
SSP CELLULES–
RENFORCEMENT COURONNEMENT EN BETON

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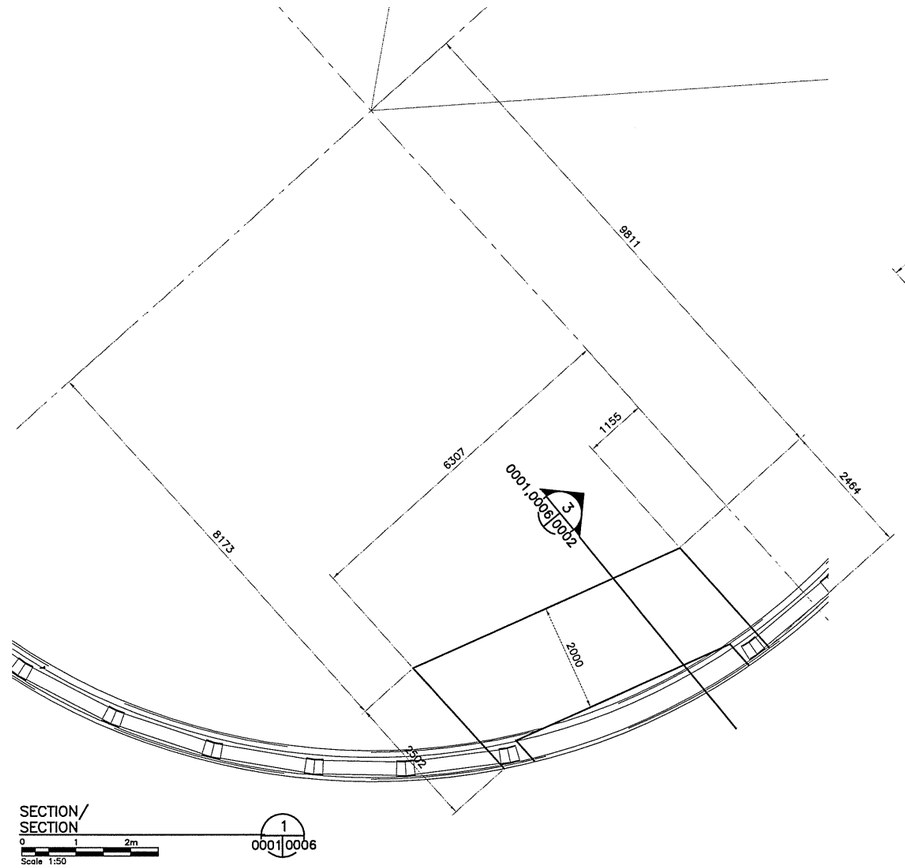

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SECTION 1 0001|0006

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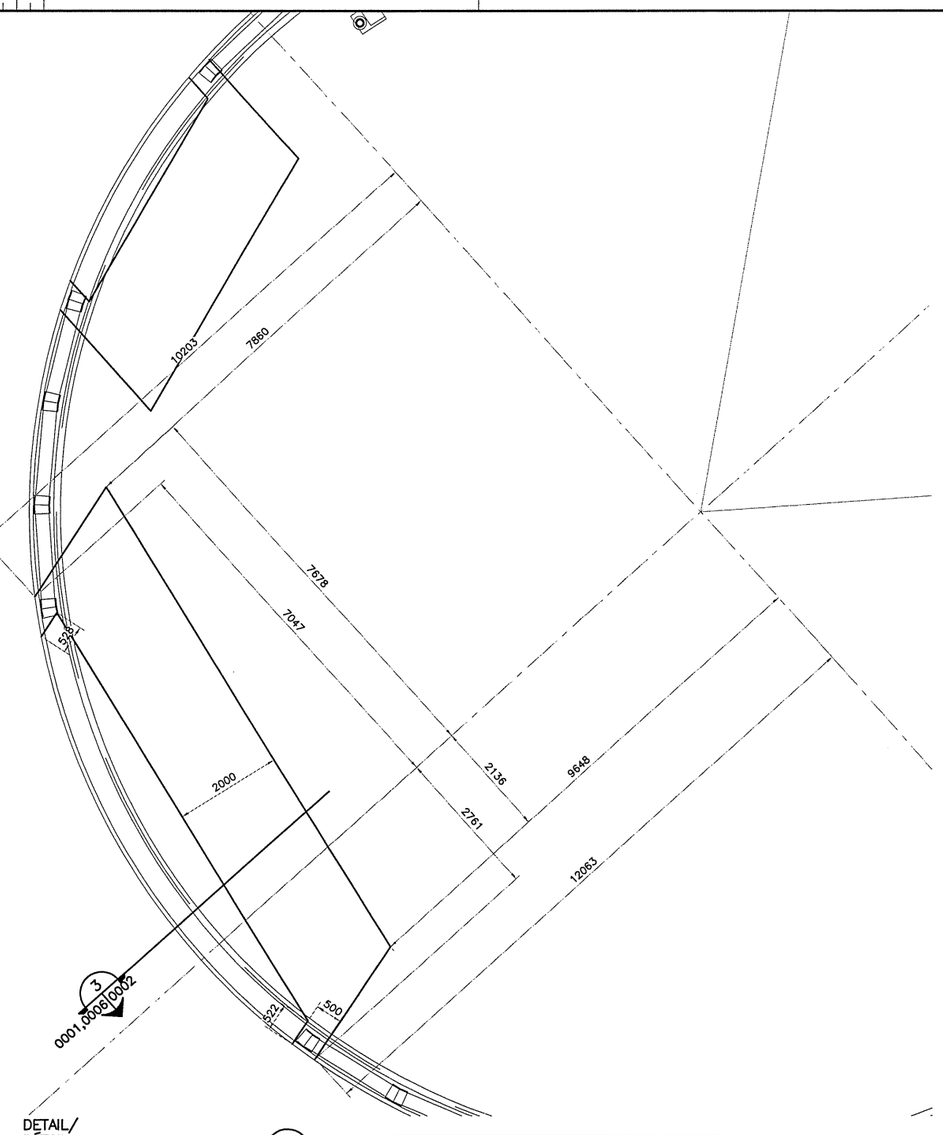

DETAIL/
DÉTAIL 2 0001|0006

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Scale 1:50

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SNC·LAVALIN
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PREPARATION	APPROVAL
DESIGNED C.FUDGE	PROJECT DISCIPLINE ENGINEER N. GILLIS
DRAWN T.YOUNG	CLIENT
CHECKED C.FUDGE	DATE 2013/03/22
SCALE AS NOTED	

CLIENT
CANADIAN ROYALTIES INC.

PROJECT
NUNAVIK NICKEL
DECEPTION BAY PORT

TITLE
SSP CELLS
CONCRETE ABUTMENT DETAILS
SSP CELLULES
COORDONNÉES CULÉE EN BÉTON

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
506117	8000	42	D1 0007	P1

020878A1HEN – FRAME A1 HORIZONTAL ENGLISH

Annexe 2

Stantec Consulting Ltd : Rapports géotechniques

Stantec Consulting Ltd.
102 – 40 Highfield Park Drive
Dartmouth NS B3A 0A3
Tel: (902) 468-7777
Fax: (902) 468-9009

FINAL GEOTECHNICAL REPORT
Proposed Wharf – Site 1
Deception Bay, Quebec

Report Prepared for:
Canadian Royalties Inc.

File: 121613564

Date: April 22, 2013

Table of Contents

LIST OF APPENDICES

1.0 Introduction

At the request of Canadian Royalties Inc., Stantec Consulting Ltd. has performed a subsurface investigation for the proposed wharf at port Site 1 for the Nunavik Nickel mine in Deception Bay, Quebec. The investigation consisted of drilling a series of boreholes and air track probes at three different proposed locations and was carried out during the summers of 2011 and 2012.

An interim report containing factual data from the investigation including 49 boreholes, 21 air track probes and selective laboratory testing was submitted September 27 2012. This final report follows an extensive design collaboration with CRI, SNC Lavalin, Ultragen and contractors; it includes all data from the interim report as well as geotechnical design parameters and analysis for the wharf.

This report is specifically and solely for the project described herein and presents all of our findings.

2.0 Site Description

The site is located along the southwest coast of Deception Bay in Nunavik region of northern Quebec. Deception Bay is located at approximately latitude 62°08’ N and longitude 74°40’ W. The Hudson Strait is located to the north east of Deception Bay. There is an existing operational wharf structure located to the northwest of the proposed location of this wharf structure.

The general topography of the area surrounding the bay is described as low mountains with numerous bedrock outcrops observed along the northern and southern coasts of the bay.

Based on previous experience in the area and geological mapping, the principal overburden consists of marine sediments comprised of clay and silt overlying a layer of silty sand with gravel. The bedrock at the site beneath the overburden consists of Felsic and Mafic Gneiss.

3.0 Investigation Procedures

3.1 GENERAL

The field program for the 2011 investigation consisted of 17 boreholes (BH01, BH04 to BH13, BH15, BH16, BH28 to BH30, and BH32) and 13 air track holes (AT21 to AT33), which were drilled during the period of September 3 to October 2, 2011. The field program for the 2012 investigation consisted of 32 boreholes (BH101 to BH117, BH408 to BH420, BH423, and BH424) and 8 air track holes (AT118 to AT121, AT421, AT422, AT425, and AT426), which were

drilled during the period of July 18 to July 31, 2012. All work for the investigation was supervised by Stantec Consulting Ltd. personnel.

The 2011 borehole program at this location varied from the program which was initially proposed due to the identification of poor soil conditions, primarily deep soft clay, at the west side of the proposed wharf location. For this reason, some of the proposed boreholes on the west side of the site were deleted and boreholes were added to the east side.

The borehole locations for the present investigation are shown on Drawing No. 101, in Appendix C.

3.2 MARINE BOREHOLES

A total of 49 marine boreholes were drilled at this site. The boreholes were drilled from a spud barge using a CME 55 drill rig mounted on skids. Soil samples were recovered at close intervals using a 50 mm diameter split spoon sampler in conjunction with Standard Penetration Tests and undisturbed samples were obtained in 75 mm thin walled Shelby tubes. Bedrock was cored in HQ and NQ size. In some boreholes it was necessary to core through the overburden in order to advance through cobbles and boulders. Boreholes BH29, BH32, BH106, and BH115 had to be terminated and restarted at locations adjacent to the original location because the barge needed to be moved. A second borehole was drilled adjacent to borehole BH101 to obtain a Shelby tube (undisturbed sample) profile of the clay and silt layer.

The coordinates of the boreholes are provided in the following table:

BH No.	Easting (m)	Northing (m)
BH01	516502.931	6889802.333
BH04	516522.453	6889763.246
BH05	516562.740	6889771.230
BH06	516552.170	6889748.340
BH07	516593.919	6889757.878
BH08	516583.083	6889734.967
BH09	516625.757	6889741.936
BH10	516615.078	6889719.981
BH11	516570.912	6889739.891
BH12	516569.092	6889729.676
BH13	516530.422	6889739.419
BH15	516577.062	6889709.750
BH16	516552.902	6889716.219
BH28	516574.998	6889744.611
BH29	516656.267	6889727.330
BH29A	516655.002	6889726.889
BH30	516645.131	6889705.969
BH32	516604.652	6889697.788
BH32A	516605.002	6889697.819

BH No.	Easting (m)	Northing (m)
BH101	516548.038	6889808.704
BH101A	516547.860	6889808.222
BH102	516566.333	6889824.013
BH103	516561.116	6889789.955
BH104	516581.530	6889803.838
BH105	516580.849	6889761.790
BH106	516600.405	6889776.857
BH106A	516601.129	6889776.967
BH107	516602.473	6889736.048
BH108	516619.994	6889750.820
BH109	516621.983	6889707.620
BH110	516640.322	6889723.788
BH111	516634.517	6889688.555
BH112	516653.630	6889703.534
BH113	516578.561	6889834.470
BH114	516594.005	6889813.105
BH115	516614.063	6889787.521
BH115A	516613.555	6889787.821
BH116	516634.954	6889759.121
BH117	516535.982	6889791.682
BH408	516636.639	6889698.715
BH409	516665.425	6889692.914
BH410	516657.671	6889683.015
BH411	516687.545	6889677.662
BH412	516679.500	6889665.100
BH413	516715.654	6889655.714
BH414	516706.068	6889644.016
BH415	516737.526	6889638.497
BH416	516727.217	6889627.448
BH417	516758.900	6889621.370
BH418	516749.580	6889611.530
BH419	516713.466	6889621.539
BH420	516721.718	6889615.140
BH423	516649.743	6889669.761
BH424	516643.474	6889675.419

3.3 LAND-BASED AIRTRACK PROBES

It wasn't possible to navigate the drill barge into the shallow water area and diamond drilling with sampling from the shore was not possible in the intertidal zone. Consequently, a series of air track probes were performed to estimate the elevation of the bedrock surface within the upper tidal zone on the beach. The coordinates of the air track probes are provided in the following table:

AT No.	Easting (m)	Northing (m)
AT21	516544.940	6889630.340
AT22	516575.960	6889650.720
AT23	516571.940	6889639.750
AT24	516562.700	6889622.100
AT25	516602.100	6889648.330
AT26	516589.960	6889631.820
AT27	516581.980	6889613.740
AT28	516635.790	6889633.820
AT29	516625.910	6889614.600
AT30	516619.190	6889597.890
AT31	516659.140	6889618.640
AT32	516650.110	6889607.020
AT33	516638.210	6889586.540
AT118	516677.241	6889603.174
AT119	516685.623	6889596.160
AT120	516665.587	6889593.611
AT121	516672.814	6889585.955
AT421	516686.048	6889584.598
AT422	516693.464	6889578.811
AT425	516614.848	6889638.956
AT426	516623.128	6889633.086

3.4 SURVEYING

The borehole locations and elevations were surveyed by EBC personnel using a Global Positioning System (GPS). We understand from EBC that elevations are referenced to LNT (Chart) Datum and locations are referenced to Universal Transverse Mercator (UTM) (Zone 18) projection.

3.5 LABORATORY TESTING

All soil samples were placed in moisture-proof containers and taken to our Dartmouth laboratory for final visual assessment and laboratory classification testing. Laboratory testing included moisture content determinations, Atterberg limits, hydrometers, mini-vanes, grain size analyses and unconfined compressive strength tests on samples of the bedrock. The results of the lab testing performed are provided on the attached Borehole Records and in Appendix B.

4.0 Subsurface Conditions

The subsurface conditions encountered in the boreholes are described on the appended Borehole Records. A summary of the various soil strata encountered in the investigation are provided in the following paragraphs, and are outlined in the following table:

BH No.	Ground Surface Elevation (m)	Thickness of Organic Silt to Silty SAND (m)	Thickness of Sand with Gravel (m)	Thickness of CLAY to Clayey SILT (m)	Thickness of Silty SAND with Gravel to Silty SAND (Elevation of Surface) (m)	Depth to Bedrock (Elevation) (m)
BH01	-6.9	2.0	-	~17.6	~1.4 (-26.5)	21.0 (-27.9)
BH04	-9.0	-	1.3	10.9	2.8 (-21.2)	15.0 (-24.1)
BH05	-12.0	-	2.4	4.5	5.3 (-18.9)	12.1 (-24.1)
BH06	-9.0	-	2.5	9.5	1.8 (-21.0)	13.8 (-22.8)
BH07	-11.9	1.2	-	3.7	5.4 (-16.7)	10.3 (-22.2)
BH08	-9.7	~1.3	-	3.4	3.6 (-14.5)	8.3 (-18.1)
BH09	-11.6	~0.9	-	~4.7	~0.8 (-17.2)	6.4 (-18.0)
BH10	-7.6	1.4	-	~2.9	~3.9 (-12.0)	8.2 (-15.9)
BH11	-10.7	3.0	-	~2.6	2.4 (-16.3)	8.0 (-18.7)
BH12	-6.2	3.4	-	5.0	3.6 (-14.6)	12.0 (-18.2)
BH13	-6.8	-	4.1	9.2	1.2 (-20.1)	14.0 (-20.8)
BH15	-4.5	1.9	-	2.8	5.1 (-11.1)	11.8 (-16.3)
BH16	-5.3	1.2	-	8.1	5.1 (-14.6)	14.4 (-19.7)
BH28	-10.4	~1.2	-	3.4	4.0 (-15.1)	8.7 (-19.1)
BH29	-15.4	1.1	-	4.8	>0.4 (-21.3)	-
BH29A	-14.7	-	-	-	>1.4	6.0 (-20.7)
BH30	-9.0	1.2	-	0.8	4.7 (-11.0)	6.7 (-15.7)
BH32	-4.5	1.5	-	>2.8	-	-
BH32A	-4.5	-	-	>1.3	2.5 (-10.1)	8.1 (-12.6)
BH101	-12.0	1.5	-	7.3	5.9 (-20.8)	14.7 (-26.7)
BH101A	-12.2	2.2	-	6.7	>0.36 (-21.1)	-
BH102	-17.0	0.2	-	6.1	4.0 (-23.3)	10.3 (-27.3)
BH103	-13.2	1.8	-	6.3	3.1 (-21.2)	11.2 (-24.4)
BH104	-15.1	3.3	-	4.0	4.3 (-22.4)	11.6 (--26.7)
BH105	-9.6	1.5	-	8.1	2.8 (-19.2)	12.4 (-22.0)
BH106	-13.5	2.4	-	>1.9	-	-
BH106A	-13.9	-	-	-	5.4 (-18.6)	10.1 (-24.0)
BH107	-11.9	0.1	-	1.4	4.2 (-13.5)	5.7 (-17.6)
BH108	-14.1	-	-	3.8	1.1 (-19.7)	6.8 (-20.8)
BH109	-6.2	1.7	-	2.6	4.7 (-10.4)	8.9 (-15.1)
BH110	-11.2	1.4	-	1.3	2.8 (-13.8)	5.5 (-16.7)
BH111	-4.6	2.5	-	0.6	3.6 (-7.8)	6.7 (-11.3)
BH112	-9.7	0.9	-	0.8	2.3 (-11.3)	4.0 (-13.7)

BH No.	Ground Surface Elevation (m)	Thickness of Organic Silt to Silty SAND (m)	Thickness of Sand with Gravel (m)	Thickness of CLAY to Clayey SILT (m)	Thickness of Silty SAND with Gravel to Silty SAND (Elevation of Surface) (m)	Depth to Bedrock (Elevation) (m)
BH113	-19.9	-	-	6.5	2.0 (-26.4)	8.5 (-28.4)
BH114	-19.3	0.9	-	5.3	4.6 (-25.6)	10.9 (-30.1)
BH115	-17.7	1.8	-	4.8	>2.7 (-24.3)	-
BH115A	-17.9	-	-	-	>2.0	11.0 (-28.9)
BH116	-16.8	2.3	-	2.2	4.1 (-21.4)	8.7 (-25.5)
BH117	-9.6	4.2	-	8.2	4.9 (-22.0)	17.3 (-27.0)
BH408	-6.2	1.6	-	1.2	4.0 (-8.9)	6.7 (-12.9)
BH409	-10.2	1.2	-	1.5	-	2.7 (-12.9)
BH410	-6.2	1.2	-	0.9	1.3 (-8.3)	3.4 (-9.6)
BH411	-14.3	1.2	-	4.0	-	5.2 (-19.5)
BH412	-8.2	0.9	-	-	0.8 (-9.1)	1.7 (-9.9)
BH413	-14.6	4.5	-	7.7	2.1 (-26.8)	14.3 (-28.9)
BH414	-11.0	2.7	-	8.9	-	11.6 (-22.6)
BH415	-14.4	0.9	-	11.3	2.1 (-26.6)	14.3 (-28.7)
BH416	-11.9	4.3	-	4.7	1.9 (-20.9)	10.9 (-22.8)
BH417	-13.9	3.0	-	8.4	1.7 (-25.3)	13.2 (-27.0)
BH418	-12.1	4.9	-	6.0	0.6*(-23.0)	11.5 (-23.6)
BH419	-6.7	7.5	-	4.7	1.0 (-18.9)	13.2 (-19.9)
BH420	-7.6	6.1	-	5.0	0.6 (-18.7)	11.7 (-19.3)
BH423	-3.6	4.1	-	0.2	0.6 (-7.9)	5.0 (-8.5)
BH424	-3.4	3.1	-	1.7	1.1 (-8.2)	5.9 (-9.3)

*Silty SAND with Gravel to Silty SAND layer inferred. Split spoon sheared off while driving.

The inferred bedrock elevations from the air track probes are summarized in the following table:

AT #	Ground Surface Elevation (m)	Depth to Inferred Bedrock (m)	Inferred Bedrock Elevation (m)
AT22	2.8	13.9	-11.1
AT23	3.1	12.8	-9.7
AT24	3.7	7.3	-3.6
AT25	2.4	12.2	-9.8
AT26	3.8	12.8	-9.0
AT27	4.4	8.7	-4.3
AT28	3.2	10.0	-6.8
AT29	3.4	6.7	-3.3
AT30	5.1	8.1	-3.0
AT31	3.2	10.5	-7.3
AT32	3.9	6.8	-3.0
AT33	5.8	5.8	0.0
AT118	3.0	10.5	-7.5
AT119	2.4	10.4	-8.0
AT120	3.6	11.2	-7.6

AT #	Ground Surface Elevation (m)	Depth to Inferred Bedrock (m)	Inferred Bedrock Elevation (m)
AT121	3.4	10.4	-7.0
AT421	2.8	>4.3	-
AT422	2.7	10.2	-7.5
AT425	3.3	11.9	-8.6
AT426	3.4	11.6	-8.2

4.1 ORGANIC SILT TO SILTY SAND

A surficial layer, consisting predominantly of organic silt to silty sand, was encountered in the majority of the boreholes drilled for this investigation. Trace amounts of sand, gravel and shells were encountered in this layer; occasional cobbles and boulders were also encountered in some of the boreholes. The thickness of the surficial organic silt to silty sand layer ranged between 0.1 and 7.9 metres.

In boreholes BH11 and BH12 the material encountered at the seabed consisted of silty sand to sand. It should be noted that dredging operations had occurred in this area prior to the commencement of the geotechnical investigation.

In borehole BH15 a layer of sandy clay with gravel to sand with silt was encountered beneath the organic silt layer. A grain size analysis performed on a sample of this material yielded 18% gravel, 29% sand, and 53% silt and clay sized particles. The moisture content of the sample of this material was determined to be 20%.

4.2 SAND WITH GRAVEL

A layer of cobbles and boulders with a sand and gravel matrix was encountered in boreholes BH04, BH05, BH06, and BH13 at ground surface. Trace amounts of silt were encountered at some of the locations where samples of this material could be obtained.

4.3 CLAY TO CLAYEY SILT

A predominantly very soft layer of grey clay to clayey silt was encountered in all of the boreholes drilled for this investigation with the exception of borehole BH412. In some of the boreholes a firmer crust of clay was encountered at the top of the layer. Occasional sand seams were encountered at the bottom of the layer in some of the boreholes. The thickness of the clay ranged between 0.2 and 17.6 metres over the site.

Grain size analyses performed on samples of the clay layer yielded 0% gravel, 2 to 3% sand, and 97 to 98% clay and silt sized particles. Atterberg limits performed on samples of this material yielded plastic limits of 19 and 20, liquid limits of 32 and 39, resulting in plasticity indexes of 13 and 19. The average moisture content of the samples tested was determined to be 35%. The undrained shear strength of the clay was determined using pocket penetrometers

in the field and miniature lab vanes on the Shelby tube samples. The results of these tests are provided on the borehole records in Appendix A.

4.4 SILTY SAND WITH GRAVEL TO SILTY SAND

A layer of silty sand with gravel to silty sand was encountered below the soft clay in all of the boreholes drilled for this investigation, with the exception of boreholes BH409, BH411, and BH414. Occasional cobbles and boulders were encountered. The relative density was described as loose to dense based on the N-values obtained as part of the standard penetration testing. The thickness of this layer ranged between 0.6 and 5.9 metres.

Grain size analyses performed on samples of the silty sand with gravel to silty sand layer yielded 11 to 32% gravel, 38 to 52% sand, and 30 to 48% silt and clay sized particles. The average moisture content of the samples tested was determined to be 9%.

4.5 GNEISS BEDROCK

Grey Felsic Gneiss bedrock was encountered in all of the boreholes with the exception of boreholes BH415 and BH417, where grey Mafic Gneiss was encountered. Seams of Mafic Gneiss were encountered within the Felsic Gneiss in boreholes BH114, BH419, and BH420. The rock mass quality generally ranged between fractured and very sound, however there were some locations where very severely fractured bedrock was encountered. An unconfined compressive strength test performed on a sample of this bedrock yielded a strength of 129 MPa.

5.0 Discussion

Design of the proposed wharf for the Nunavik Nickel Mine has many geotechnical challenges including restrictions on dredging in deep soft sediments, sloping bedrock surface contributing to poor sliding stability, and high ice forces.

The overburden for the site consists of relatively thick deposits of soft organic silt and clay deposits over compact to dense silty sand with gravel. Bedrock consists of Gneiss bedrock assumed to have a relatively smooth surface based on observation of outcrops on shore.

Several design concepts have been put forth by the civil engineering designers in consultation with CRI to address the challenges at a feasible cost. The final design is comprised of two free standing circular gravity structures, connected by a bridge. Initially the wharf structures were to be concrete caissons, however; following cost estimating (by others) CRI favoured steel sheet pile cellular structures to comprise the wharf. The shore access consists of two bridge spans supported in the centre by drilled socketed piles. The proposed SSP cell locations shown on Drawing 101 have been optimized considering soil/bedrock conditions as well as navigational

constraints. The following discussion details results of geotechnical analysis for both concrete cribs and Steel Sheet Pile cells.

Values of the geotechnical parameters, used for the purposes of the analyses presented in the following sections, are presented in the following table. The values were estimated based on field and laboratory testing and engineering judgment, guided in some cases by published literature.

Summary of Geotechnical Parameter Values Used in Analyses

Organic Silt to Silty Sand	
undrained shear strength, C_u (kPa)	lumped with clay to silty clay
unit weight (kN/m^3)	lumped with clay to silty clay
Clay to Silty Clay	
undrained shear strength, C_u (kPa)	10
unit weight (kN/m^3)	18
Silty Sand with Gravel to Silty Sand	
angle of internal friction (degrees)	30
unit weight (kN/m^3)	19
Gneiss Bedrock	
unconfined compressive strength (MPa)	100
unit weight (kN/m^3)	26
Rockfill	
angle of internal friction (degrees)	40
unit weight (kN/m^3)	20

5.1 CONCRETE CAISSONS

For analyses, the caissons were assumed to be circular, 25 m in diameter with a top deck elevation of 9 m LNT. Subsurface profiles, based on borehole data, are attached in Appendix D, Figures 1, 2 and 3. It was assumed that the soft silt/clay stratum would be dredged down to the silty sand and gravel, and that the caissons would be founded on a crushed rock mattress.

Bearing capacity analyses were performed for the caissons using a spreadsheet developed for the purpose. The results of the bearing capacity analyses are summarized in the following table.

Summary of Bearing Capacity Analyses Results – Concrete Caissons

Condition	FoS
North Caisson	
foundation at -14.5m fill and scour protection at -12.5m no ice loading	2.73
foundation at -14.5m fill and scour protection at -12.5m impact ice load = 15,000kN	1.78
foundation at -14.5m fill and scour protection at -12.5m thermal ice load = 7,000kN	2.30

Condition	FoS	
foundation at -15.0m fill and scour protection at -12.5m no ice loading	3.11	
foundation at -15.0m fill and scour protection at -12.5m impact ice load = 15,000kN	2.20	
foundation at -15.0m fill and scour protection at -12.5m thermal ice load = 7,000kN	2.39	
South Caisson		
	loader and surcharge not included	**loader and surcharge included**
foundation at -14.5m fill and scour protection at -12.5m no ice loading	3.67	3.68
foundation at -14.5m fill and scour protection at -12.5m impact ice load = 15,000kN	16.70	16.56
foundation at -14.5m fill and scour protection at -12.5m thermal ice load = 7,000kN	3.30	2.80
foundation at -14.5m scour protection at -12.5m fill at 0m no ice loading	3.06	
foundation at -14.5m fill and scour protection at -12.5m impact ice load = 15,000kN	>100	
foundation at -14.5m fill at 0m scour protection at -12.5m thermal ice load = 7,000kN	2.44	

As can be seen from the table, adequate factors of safety were obtained for all cases, using a target value of 3.0 under dead loading, and 1.5 under live (ice) loading. In all cases, it was assumed that there will be no fill placed behind (on the landward side of) the caissons above the -12.5m scour protection elevation. For the north caisson, it was necessary to use a founding elevation of el. -15.0 m to obtain the desired factors of safety, whereas for the south caisson a founding elevation of el. -14.5m proved to be adequate.

The global slope/sliding stability of the north caisson was also checked, using Slope/W. Examples of typical caisson geometry and loading configurations are shown in Figures 1, 2 and 3 of Appendix D. Under all loading cases (thermal ice load, impact ice load, dead loads only), a factor of safety of greater than 1.5 was obtained. This being the case, it was deemed unnecessary to explicitly check the global stability of the south caisson.

5.2 STEEL SHEET PILE CELLS

The SSP cells would be at the same locations selected for the caissons, and were taken to be 25m diameter. The top deck of the north cell is assumed to be elevation 9 m LNT. At the designers request the deck of the south cell is to be el. 10.4 metres. Slope/W was used to check

the global stability of the cells. Examples of typical geometry and loading used in the analyses are shown in Figures 4, 5, and 6 in Appendix D. The factors of safety obtained are summarized in the following table. In all cases, the factors of safety obtained from the analyses are greater than 2.0.

Summary of Global Slope/Sliding Stability Analyses Results – SSP Cells

Condition	FoS
North SSP Cell	
SSP sheets driven to -19.0m scour protection at -12.5m no ice loading	2.63
SSP sheets driven to -19.0m scour protection at -12.5m impact ice load = 15,000kN	2.96 (sliding offshore)
	6.50 (sliding toward shore)
SSP sheets driven to -19.0m scour protection at -12.5m thermal ice load = 7,000kN	2.26
South SSP Cell	
SSP sheets driven to -14.0m scour protection at -12.5m no ice loading	3.05
SSP sheets driven to -14.0m scour protection at -12.5m impact ice load = 15,000kN	4.87 (sliding offshore)
	9.34 (sliding toward shore)
SSP sheets driven to -14.0m scour protection at -12.5m thermal ice load = 7,000kN	2.27

It was deemed to be unnecessary to check bearing capacity of the north cell, in that the geometric conditions and loading are the same as for the caisson option, with the exception that the founding depth is greater in the case of SSP cells which increases the factor of safety against bearing capacity failure. However, since the proposed height of the south cell was increased to 10.4 metres bearing capacity was checked. The results showed that the minimum recommended factor of safety could be achieved if the sheet piles are driven at least to elevation -14.5 metres. Therefore it is recommended that the sheet piles for the south cell should be driven to this depth. Sheet piles for the north cell should be driven to elevation -19 or lower.

5.3 PILES AND ROCK ANCHORS

5.3.1 Concrete to Rock Compression Bond Stress

The unconfined compressive strength data from previous geotechnical investigations at this site (LEQ and Golder, total of 5 tests) average q_u = 116 MPa. We have assumed an unconfined compressive strength of concrete in the socket to be 35 MPa. Based on this the recommended ultimate bond stress on the walls of the socket would be 2.6 MPa. We recommend a geotechnical resistance factor of 0.4. We also recommend to add approximately 1 metre to the length of the socket to allow for possible weathered and or fractured surface material.

5.3.2 Tensile Capacity Socketed Piles or Rock Anchors

It is sometimes more practical to lengthen the pile rock socket to attain the tensile requirements than to drill a separate small diameter anchor. For tension within the rock socket we recommend an ultimate bond stress of 2.0 MPa; a resistance factor of 0.4 should be applied and as previously noted 1 metre of socket should be added to account for the possibility of poor quality rock. In addition to bond, piles in tension must be checked for uplift resistance from the weight of rock and soil. For this we recommend that the weight of rock within a 60 degree cone from the tip of the pile plus the vertical soil column above the rock cone should be included. The design submerged unit weight of rock and soil are recommended to be 16 kN/m^3 and 9 kN/m^3 respectively.

Allowable bond stress for anchors should be 1/30 times the unconfined compressive strength of the grout and should not to exceed 1.3 MPa.

5.3.3 Steel Piles Driven to Bedrock

We recommend using a design value for the unconfined compressive strength of rock not exceeding 100 MPa for the purposes of pile design. The ultimate contact stress for the rock may be taken as 500 MPa. We recommend a geotechnical resistance factor of no more than 0.4. Piles should be driven with a hammer delivering an energy of about 400 J/sq. cm. and should be provided with a cast driving shoe intended for use on rock.

For the purposes of structural design of the piles, we recommend that steel stresses be limited to 0.3 f_y. Structural design of the piles will likely govern.

6.0 Closure

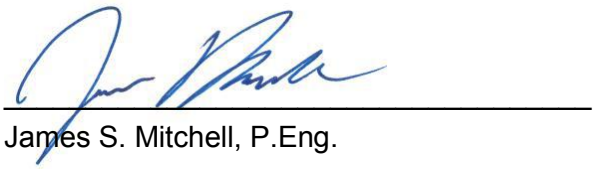
Use of this report is subject to the Statement of General Conditions provided in Appendix A. It is the responsibility of Canadian Royalties Inc., who is identified as “the Client” within the Statement of General Conditions, and its agents to review the conditions and to notify Stantec Consulting Ltd. should any of these not be satisfied. The Statement of General Conditions addresses the following:

- Use of the report
- Basis of the report
- Standard of care
- Interpretation of site conditions
- Varying or unexpected site conditions
- Planning, design or construction

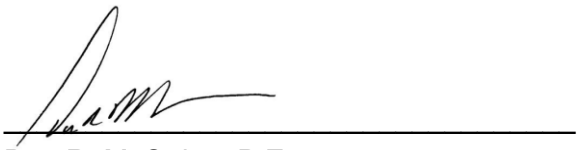
This report was prepared by James S. Mitchell, P.Eng. and Dan R. McQuinn, P.Eng. and reviewed by Brian B. Taylor, Ph.D., P.Eng. We trust that the information contained in it is adequate for your present purposes. If you have any questions about the contents of the report or if we can be of any other assistance please contact us at your convenience.

Yours very truly,

STANTEC CONSULTING LTD.



James S. Mitchell, P.Eng.



Dan R. McQuinn, P.Eng.

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APPENDIX A
Statement of General Conditions
Symbols and Terms Used on Borehole and Test Pit Records
Borehole Records

STATEMENT OF GENERAL CONDITIONS

USE OF THIS REPORT: This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Stantec Consulting Ltd. and the Client. Any use which a third party makes of this report is the responsibility of such third party.

BASIS OF THE REPORT: The information, opinions, and/or recommendations made in this report are in accordance with Stantec Consulting Ltd's present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Stantec Consulting Ltd. is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

STANDARD OF CARE: Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

INTERPRETATION OF SITE CONDITIONS: Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Stantec Consulting Ltd. at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited. extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Stantec Consulting Ltd. must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Stantec Consulting Ltd. will not be responsible to any party for damages incurred as a result of failing to notify Stantec Consulting Ltd. that differing site or sub-surface conditions are present upon becoming aware of such conditions.

PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Stantec Consulting Ltd., sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Stantec Consulting Ltd. cannot be responsible for site work carried out without being present.

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

Topsoil	- mixture of soil and humus capable of supporting vegetative growth
Peat	- mixture of visible and invisible fragments of decayed organic matter
Till	- unstratified glacial deposit which may range from clay to boulders
Fill	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Desiccated	- having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	- having cracks, and hence a blocky structure
Varved	- composed of regular alternating layers of silt and clay
Stratified	- composed of alternating successions of different soil types, e.g. silt and sand
Layer	- > 75 mm in thickness
Seam	- 2 mm to 75 mm in thickness
Parting	- < 2 mm in thickness

Terminology describing soil types:
The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488). The classification excludes particles larger than 76 mm (3 inches). The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):
Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present:

Trace, or occasional	Less than 10%
Some	10-20%
Frequent	> 20%

Terminology describing compactness of cohesionless soils:
The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test N-Value (also known as N-Index). A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
Very Loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

Terminology describing consistency of cohesive soils:
The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests.

Consistency	Undrained Shear Strength	
	kips/sq.ft.	kPa
Very Soft	<0.25	<12.5
Soft	0.25 - 0.5	12.5 - 25
Firm	0.5 - 1.0	25 - 50
Stiff	1.0 - 2.0	50 – 100
Very Stiff	2.0 - 4.0	100 - 200
Hard	>4.0	>200

ROCK DESCRIPTION

Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	*Very Poor, Crushed, Very Severely Fractured*
25-50	*Poor, Shattered and Very Seamy or Blocky, Severely Fractured*
50-75	*Fair, Blocky and Seamy, Fractured*
75-90	*Good, Massive, Moderately Jointed or Sound*
90-100	*Excellent, Intact, Very Sound*

Rock quality classification is based on a modified core recovery percentage (RQD) in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. RQD was originally intended to be done on NW core; however, it can be used on different core sizes if the bulk of the fractures caused by drilling stresses are easily distinguishable from *in situ* fractures. The terminology describing rock mass quality based on RQD is subjective and is underlain by the presumption that sound strong rock is of higher engineering value than fractured weak rock.

Terminology describing rock mass:

Spacing (mm)	Joint Classification	Bedding, Laminations, Bands
> 6000	*Extremely Wide*	-
2000-6000	*Very Wide*	*Very Thick*
600-2000	*Wide*	*Thick*
200-600	*Moderate*	*Medium*
60-200	*Close*	*Thin*
20-60	*Very Close*	*Very Thin*
<20	*Extremely Close*	*Laminated*
<6	-	*Thinly Laminated*

Terminology describing rock strength:

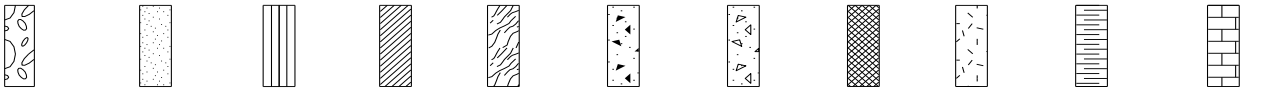
Strength Classification	Unconfined Compressive Strength (MPa)
Extremely Weak	< 1
Very Weak	1 – 5
Weak	5 – 25
Medium Strong	25 – 50
Strong	50 – 100
Very Strong	100 – 250
Extremely Strong	> 250

Terminology describing rock weathering:

Term	Description
Fresh	No visible signs of rock weathering. Slight discolouration along major discontinuities
Slightly Weathered	Discolouration indicates weathering of rock on discontinuity surfaces. All the rock material may be discoloured.
Moderately Weathered	Less than half the rock is decomposed and/or disintegrated into soil.
Highly Weathered	More than half the rock is decomposed and/or disintegrated into soil.
Completely Weathered	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders Cobbles Gravel | Sand | Silt | Clay | Organics | Asphalt | Concrete | Fill | Igneous Bedrock | Meta-morphic Bedrock | Sedi-mentary Bedrock

SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameter tube sampler hydraulically advanced)
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond coring bits.

WATER LEVEL MEASUREMENT

measured in standpipe, piezometer, or well

inferred

RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

N-VALUE

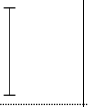
Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (64 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (305 mm) into the soil. For split spoon samples where insufficient penetration was achieved and N-values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N value corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to A size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (305 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

S	Sieve analysis
H	Hydrometer analysis
k	Laboratory permeability
γ	Unit weight
G_s	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
C	Consolidation
Q_u	Unconfined compression
I_p	Point Load Index (I_p on Borehole Record equals $I_p(50)$ in which the index is corrected to a reference diameter of 50 mm)

	Single packer permeability test; test interval from depth shown to bottom of borehole
	Double packer permeability test; test interval as indicated
	Falling head permeability test using casing
	Falling head permeability test using well point or piezometer

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BOREHOLE RECORD

BH01

CLIENT **CANADIAN ROYALTIES INC.** PROJECT No. **121613564**

LOCATION **PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC** BH SIZE **HW**

DATES: BORING **2011/09/03 to 2011/09/04** WATER LEVEL _____ DATUM **CHART**

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
0	-6.92	Loose to compact black ORGANIC SILT with gravel - cobbles throughout			SS	1	200	8	
1					SS	2	200	13	
2	-8.90	Very soft grey CLAY			SS	3	600	Wght. of Rods	
3					ST	4	600	Wght. of Rods	
4									
5					VANE				
6									
7					ST	5	600	Wght. of Rods	
8									
9					SS	6	600	Wght. of Rods	
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH01

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/03 to 2011/09/04

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
10		CLAY, cont'd.							
11					SS	7	600	Wght. of Rods	
12									
13					ST	8	650	PUSH	
14									
15									
16		-increasing silt content			SS	9	600	Wght. of Rods	
17									
18					ST	10	0	PUSH	
					SS	11	75	17	
19					SS	12	300	12	
	-26.50								
20		Compact grey silty SAND to silty SAND with gravel			SS	13	50	18	

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH01

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/03 to 2011/09/04

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
20		Silty SAND to silty SAND with gravel, cont'd.							
21	-27.92	Very sound grey FELSIC GNEISS:BEDROCK -150 mm Quartz seam at depth of 24.4 metres			NQ	14	83%	RQD 83%	
22									
23					NQ	15	76%	61%	
	-30.42	End of Borehole							
24									
25									
26									
27									
28									
29									
30									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH04

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/04 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
0	-9.04	COBBLES							
					SS	1	50	8	
1	-10.36								
		Very soft grey CLAY			SS	2	125	1/300mm	
2									
					SS	3	300	Wght. of Rods	
3									
					ST	4	525	Wght. of Rods	
4									
					SS	5	600	Wght. of Rods	
5									
					ST	6	600	PUSH	S
6									
7									
					SS	7	600	Wght. of Rods	
8									
9									
					ST	8	600	PUSH	
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH04

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/04

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10		CLAY, cont'd.							
11		- increasing silt content							
12	-21.23				SS	9	450	14	
		Compact grey silty SAND to silty SAND with gravel							
13									
14					SS	10	175	13	
	-24.05				SS	11	200	72/275mm	S
15		Very sound grey FELSIC GNEISS:BEDROCK							
					NQ	12	100%	RQD	
16					NQ	13	0%	85% 0%	
17					NQ	14	100%	65%	
18	-27.07				NQ	15	100%	54%	
		End of Borehole							
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH05

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/09

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-12.01						mm		
0		Very loose COBBLES and BOULDERS							
1									
2	-14.40								
		Very soft grey CLAY			SS	1	0	Wght. of Rods	
3									
4					ST	2	600	PUSH	
					SS	3	600	Wght. of Rods	
5									
					SS	4	600	Wght. of Rods	
6					SS	5	600	Wght. of Rods	
	-18.87								
7		Very loose to loose grey silty SAND to silty SAND with gravel - occasional cobbles and boulders			SS	6	275	37	
					SS	7	375	11	
8									
					SS	8	250	3	
9					SS	9	200	Wght. of Rods	
10					SS	10	200	Wght.	

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH05

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/09

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
10								of Rods	
		Silty SAND to silty SAND with gravel, cont'd.			SS	11	200	8	
11					NQ	12	600	-	
12	-24.13				NQ	13	100	-	
		Severely fractured to fractured grey FELSIC GNEISS:BEDROCK			NQ	14	94%	RQD 44%	
13									
14	-26.46				NQ	15	100%	59%	
		End of Borehole							
15									
16									
17									
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH06

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/12 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
0	-8.99	BOULDERS and COBBLES -intermixed with sand and gravel							
2	-11.50	Very soft grey CLAY			SS	1	600	Wght. of Hammer	
3					SS	2	600	Wght. of Rods	
4					ST	3	600	Wght. of Rods	
5					SS	4	600	Wght. of Rods	
6					ST	5	600	PUSH	
7					SS	6	600	Wght. of Hammer	
8		-sand seams and increasing gravel content starting at depth of 7.9 metres			SS	7	600	Wght. of Hammer	
9					SS	8	600	Wght. of Hammer	
10					SS	9	600	Wght. of Hammer	

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH06

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/12 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
10									
		CLAY, cont'd.			SS	10	600	16	
					SS	11	600	14	
11					SS	12	600	15	
	-21.00				ST	13	50	PUSH	
12		Compact grey silty SAND to silty SAND with gravel -occasional cobbles and boulders			SS	14	100	14	
					SS	15	25	19	
13	-22.81				SS	16	150	53/200mm	
		Severely fractured to sound grey FELSIC GNEISS:BEDROCK			HQ	17	80%	RQD 40%	
14					HQ	18	100%	29%	
					HQ	19	100%	91%	
15									
					HQ	20	100%	86%	
16	-25.83								
		End of Borehole							
17									
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH07

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

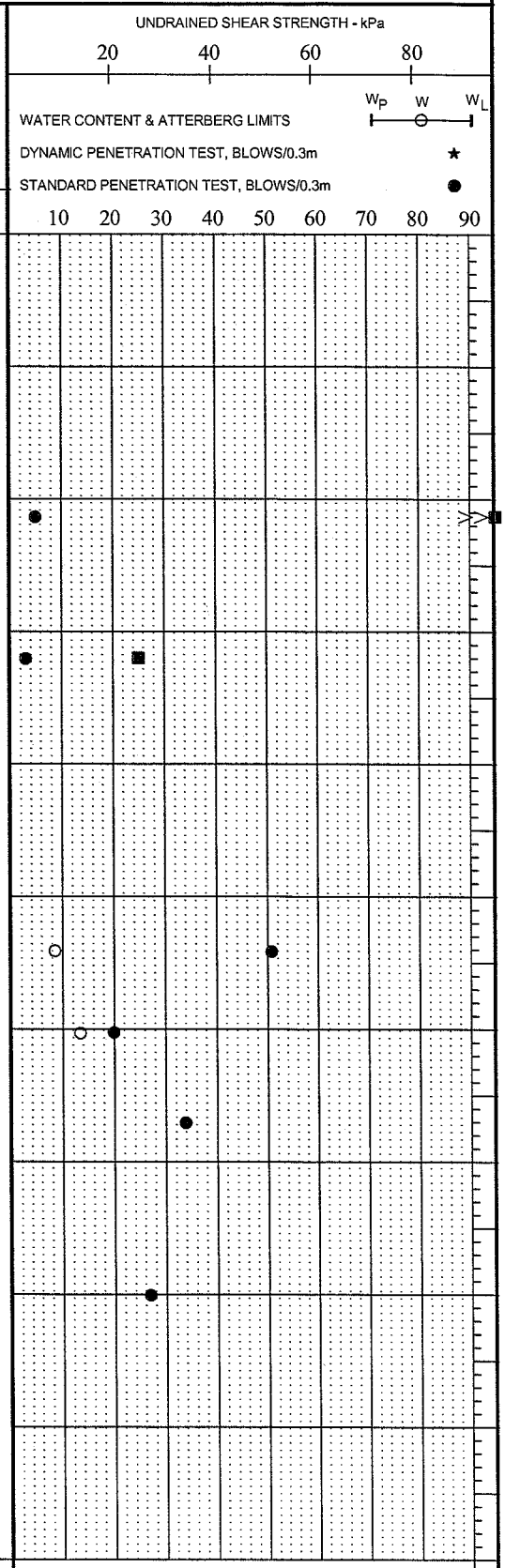
BH SIZE HW

DATES: BORING 2011/09/06

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-11.87						mm		
0		Very loose black ORGANIC SILT with sand - shells throughout			SS	1	250	Wght. of Hammer	
1	-13.09	Soft to stiff grey CLAY							
2					SS	2	250	5	
3					SS	3	450	3	
4					ST	4	150	PUSH	
	-16.75								
5		Compact to dense grey silty SAND to silty SAND with gravel - occasional cobbles and boulders			ST	5	150	PUSH	
					SS	6	300	51	S
6					SS	7	400	20	S
					SS	8	250	34	
7					HQ	9	325	-	
8					SS	10	325	27	
9									
					HQ	11	175		
10									



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BOREHOLE RECORD

BH07

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/06

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10	-22.16	Silty SAND to silty SAND with gravel, cont'd.			HQ	12	0	-	
		Fractured to sound grey FELSIC GNEISS:BEDROCK			NQ	13	90%	RQD 65%	
12					NQ	14	100%	68%	
13	-24.90				NQ	15	77%	77%	
		End of Borehole							
14									
15									
16									
17									
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH08

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/07 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
0	-9.73								
		Very loose ORGANIC SILT - shells encountered			SS	1	50	Wght. of Rods	
1	-11.05								
		Very soft to very stiff grey CLAY			ST	2	475	Wght. of Rods	
2					SS	3	575	Wght. of Rods	
3					ST	4	600	Wght. of Rods	S
4		- 50 mm sand seam encountered			SS	5	600	Wght. of Rods	
	-14.45								
5		Compact to dense grey silty SAND to silty SAND with gravel			ST	6	250	PUSH	
					SS	7	250	13	
6					SS	8	0	16	
7					SS	9	150	64/175mm	
8	-18.06								
		Very severely fractured to severely fractured grey FELSIC GNEISS:BEDROCK			NQ	10	97%	RQD 41%	
9					NQ	11	79%	0%	
10					NQ	12	90%	33%	

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH08

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/07 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10		FELSIC GNEISS:BEDROCK, cont'd.							
11					NQ	13	95%	0%	
	-21.01	End of Borehole							
12									
13									
14									
15									
16									
17									
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH09

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/05 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-11.58						mm		
0		Very loose grey ORGANIC SILT - trace shells			SS	1	475	Wght of Rods	
	-12.49								
1		Very soft grey CLAY							
2									
3									
4		- gravel encountered at top of Shelby Tube sample			ST	2	300	PUSH	
5									
	-17.19								
6		Loose grey silty SAND to silty SAND with gravel			SS	3	25	Wght of Rods	
	-18.01								
7		Fractured to sound grey FELSIC GNEISS:BEDROCK			HQ	4	100%	RQD 62%	
8					HQ	5	100%	89%	
9					HQ	6	81%	56%	
	-21.26								
10		End of Borehole							

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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Stantec

BOREHOLE RECORD

BH10

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/07 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-7.64						mm		
0		Loose grey ORGANIC SILT with sand - shells encountered throughout - occasional cobbles and boulders			SS	1	325	5	
1	-9.09				SS	2	375	7	
		Very soft grey CLAY			SS	3	50	3	
2									
3					ST	4	600	Wgt. of Rods	
4	-11.98				~~ST~~	~~5~~	~~0~~	~~PUSH~~	
		Loose to compact grey silty SAND to silty SAND with gravel			SS	6	100	8	
5					SS	7	250	9	
					SS	8	125	50/125mm	
6					HQ	9	925		
7					HQ	10	0		
					SS	11	150	18	
8	-15.87				SS	12	75	50/75mm	
		Sound to very sound grey FELSIC GNEISS:BEDROCK			HQ	13	100%	RQD 75%	
9									
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH10

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/07 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10		FELSIC GNEISS:BEDROCK,cont'd.			HQ	14	100%	91%	
11	-18.84	End of Borehole							
12									
13									
14									
15									
16									
17									
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH11

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/05

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
0	-10.74	Very loose grey silty SAND							
1					SS	1	425	Wght. of Rods	
2					ST	2	0	PUSH	
3	-13.74	Soft to firm grey CLAY			SS	3	325	2	
4									
5					ST	4	375	PUSH	
6	-16.30	Loose grey silty SAND to silty SAND with gravel - 75 mm cobble encountered			NQ	5	75		
7									
8	-18.69	Fractured to very sound grey FELSIC GNEISS:BEDROCK - 200 mm seam of soil at depth of 9.17 m			SS	6	0	9	
9					NQ	7	98%	RQD 96%	
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH11

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/05

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10		FELSIC GNEISS:BEDROCK, cont'd.			NQ	8	100%	65%	
	-21.59	End of Borehole							
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH12

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/05 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-6.19						mm		
0		Very loose to compact black SAND - trace organic silt - shells throughout			SS	1	150	Wght. of Rods	
1					SS	2	200	13	
2	-8.50				SS	3	250	5	
		Soft to stiff grey CLAY							
3					SS	4	225	2	
4									
					ST	5	525	Wght. of Rods	
5									
					SS	6	600	Wght. of Rods	
6									
7					ST	7	525	PUSH	
					SS	8	600	Wght. of Rods	
8	-14.57								
		Compact grey silty SAND to silty SAND with gravel - cobbles and boulders throughout			~~ST~~ SS	~~9~~ 10	~~0~~ 250	~~PUSH~~ 54	
9					SS	11	250	15	
					~~SS~~	~~12~~	~~50~~	~~50/50mm~~	
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH12

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/05

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10		Silty SAND to silty SAND with gravel, cont'd.			NQ	13	575	-	
11					NQ	14	0	-	
12	-18.15	Severely fractured to very sound grey FELSIC GNEISS:BEDROCK			HQ	15	100%	RQD 93%	
13									
14	-20.97				HQ	16	100%	34%	
15		End of Borehole							
16									
17									
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH13

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

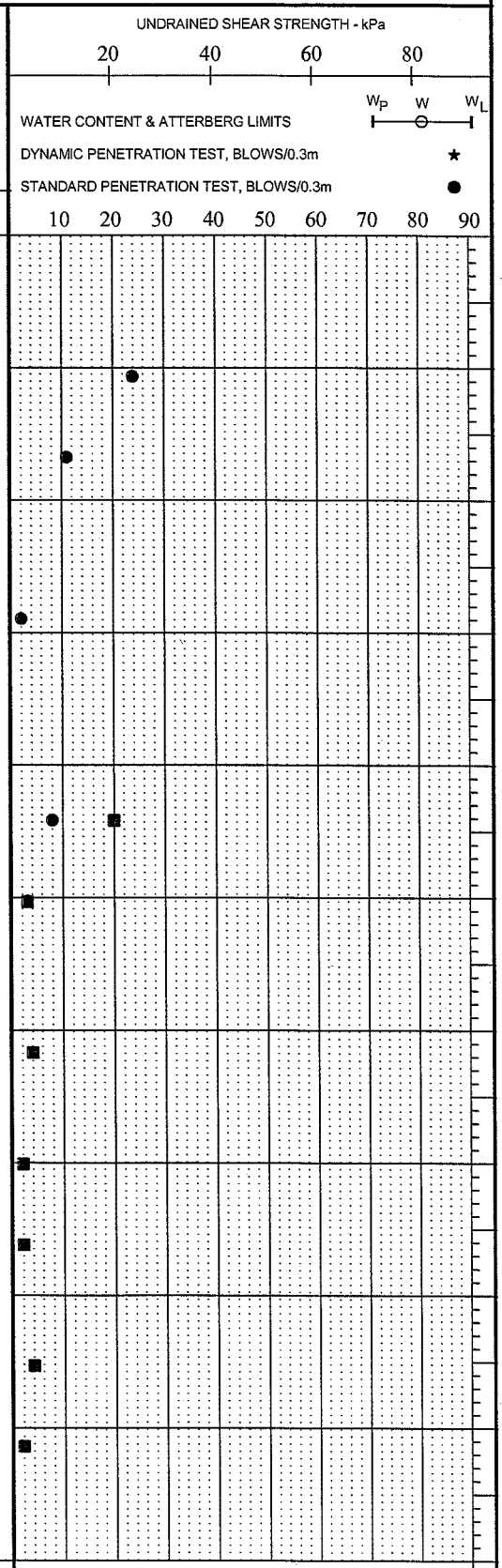
BH SIZE HW

DATES: BORING 2011/09/09 to 2011/09/10

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
0	-6.81	Loose to compact grey SAND and GRAVEL -boulders and cobbles throughout -trace silt			SS	1	50	Wght. of Rods	
1					SS	2	75	24	
2					SS	3	150	11	
					SS	4	0	Wght. of Hammer	
3					SS	5	50	2	
		- 900 mm boulder at depth of 3.2 metres							
4	-10.92	Very soft grey CLAY			SS	6	600	8	
5					SS	7	350	3	
6					SS	8	275	PUSH	
7					ST	9	600	PUSH	
					SS	10	600	Wght. of Rods	
8					SS	11	600	Wght. of Hammer	
9					SS	12	600	Wght. of Hammer	
10									



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BOREHOLE RECORD

BH13

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/09 to 2011/09/10 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10		CLAY, cont'd.			SS	13	600	Wght. of Hammer	
11					SS	14	600	Wght. of Hammer	
12					SS	15	600	Wght. of Hammer	
13					SS	16	600	Wght. of Hammer	
	-20.07	Compact grey silty SAND to silty SAND with gravel			SS	17	175	12	
14	-20.86				SS	18	125	50/25mm	
		Very severely fractured to sound grey FELSIC GNEISS:BEDROCK			HQ	19	43%	RQD 0%	
15					HQ	20	100%	72%	
16					HQ	21	57%	57%	
17	-24.06								
		End of Borehole							
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH15

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

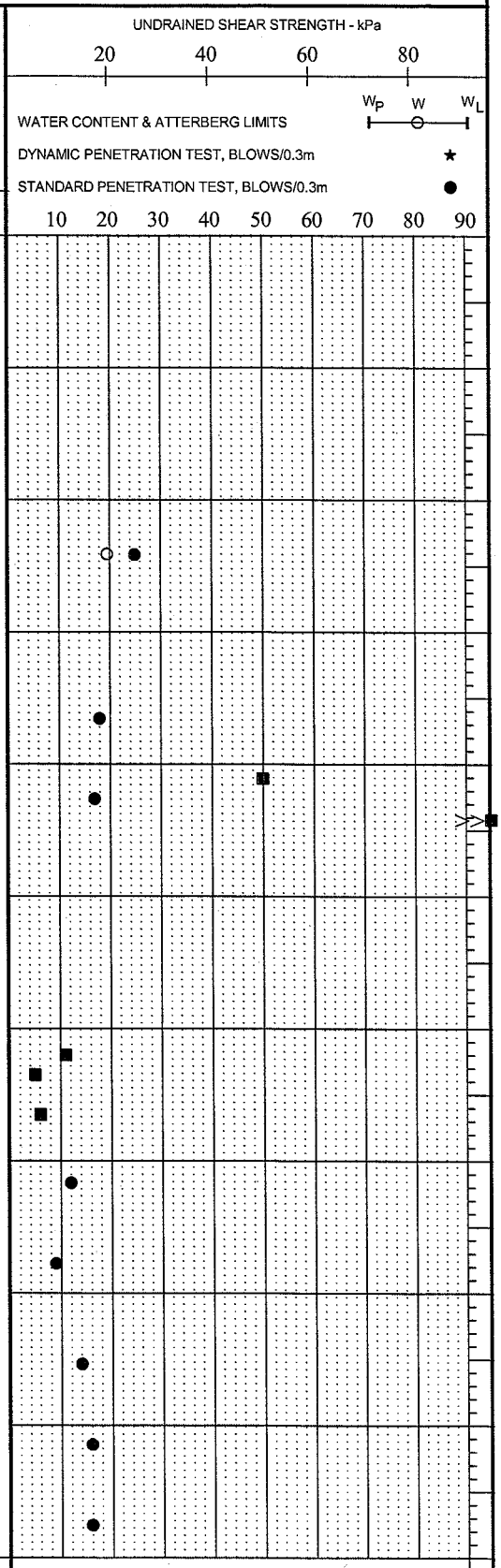
BH SIZE HW

DATES: BORING 2011/09/08

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
0	-4.50	Very loose black ORGANIC SILT			SS	1	25	1/300mm	
1					SS	2	25	Wght. of Hammer	
2	-6.41	Compact grey sandy CLAY with gravel - shells throughout			SS	3	225	Wght. of Rods	
3					SS	4	450	25	S
4	-8.31	Very soft grey CLAY			SS	5	350	50/125mm	
5					SS	6	400	18	
6	-11.15				SS	7	300	17	
7		Very loose to compact grey silty SAND to silty SAND with gravel - occasional cobbles and boulders			SS	8	150	Wght. of Rods	
8					ST	9	500	PUSH	
9					SS	10	600	Wght. of Rods	
10					SS	11	300	12	
					SS	12	300	9	
					SS	13	150	14	
					SS	14	175	16	
					SS	15	200	16	



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BOREHOLE RECORD

BH15

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/08

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10		Silty SAND to silty SAND with gravel, cont'd.			SS	16	100	Wght. of Rods	
					NQ	17	150	-	
11					SS	18	150	19	
	-16.29				SS	19	200	50/50mm	
12		Severely fractured to sound grey FELSIC GNEISS:BEDROCK			NQ	20	80%	RQD 29%	
13					NQ	21	90%	73%	
14					NQ	22	100%	69%	
15	-19.69								
		End of Borehole							
16									
17									
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH16

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/14 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
0	-5.31	Very loose ORGANIC SILT - trace sand and gravel - shells throughout			SS	1	50	Wght. of Rods	
1	-6.48				SS	2	300	Wght. of Rods	
		Firm grey CLAY			SS	3	500	6	
2	-7.62				SS	4	575	3	
		Very soft grey CLAY - sand and trace gravel seams throughout			SS	5	600	Wght. of Rods	
3					SS	6	600	Wght. of Hammer	
4					SS	7	600	Wght. of Rods	
					SS	8	325	Wght. of Hammer	
5									
6					SS	9	600	Wght. of Hammer	
					SS	10	600	Wght. of Hammer	
7									
8					SS	11	600	Wght. of Rods	
					SS	12	550	Wght. of Hammer	
9	-14.56				~~SS~~	~~13~~	~~50~~	~~50/50mm~~	
		Very dense silty SAND to silty SAND with gravel - numerous cobbles and							
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH16

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/14 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
10		boulders throughout Silty SAND to silty SAND with gravel, cont'd. - numerous cobbles and boulders spaced approximately 150 mm apart			HQ	14	1150		
11									
12									
13					HQ	15	925		
14	-19.69								
15		Fractured moderately weathered grey FELSIC GNEISS:BEDROCK - iron staining throughout			HQ	16	92%	RQD 53%	
16	-21.87								
17		End of Borehole							
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH28

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/08 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
0	-10.41	Very loose grey to brown ORGANIC SILT							
1	-11.63	Very soft to stiff grey CLAY			SS	1	300	14	
2					ST	2	325	PUSH	
3					SS	3	300	8	
4	-15.06				SS	4	425	6	
5		Very loose to compact grey silty SAND to silty SAND with gravel			SS	5	600	4	
6					ST	6	600	PUSH	
7					SS	7	200	22	
8	-18.79				SS	8	100	3	
9		Very severely fractured to sound, moderately weathered FELSIC GNEISS:BEDROCK - iron staining observed throughout			SS	9	400	3	
10					SS	10	100	50/125mm	
					HQ	11	95%	RQD 66%	

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH28

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/08 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10		FELSIC GNEISS:BEDROCK, cont'd.			HQ	12	100%	0%	
	-21.36								
11		End of Borehole							
12									
13									
14									
15									
16									
17									
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH29

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/13 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-15.44						mm		
0		Very loose grey to black ORGANIC SILT - trace sand - shells throughout							
1	-16.53				SS	1	450	Wght. of Hammer	
		Very soft grey CLAY			SS	2	150	Wght. of Hammer	
2									
					ST	3	575	Wght. of Rods	
3					SS	4	600	Wght. of Rods	
4									
					SS	5	600	Wght. of Rods	
5					SS	6	600	Wght. of Rods	
	-21.33				ST	7	200	PUSH	
6	-21.69	Compact grey GRAVEL with sand			SS	8	75	60/200mm	
		End of Borehole - hole terminated because barge needed to be moved							
7									
8									
9									
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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MBH 9/28/12

Stantec

BOREHOLE RECORD

BH29A

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/13 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-14.66						mm		
0		Advanced casing to start Borehole again							
1									
2									
3									
4	-19.33								
5		COBBLES and BOULDERS - silty sand matrix			HQ	1	550	-	
6	-20.68				HQ	2	100%	RQD 84%	
7		Severely fractured to sound moderately weathered grey FELSIC GNEISS:BEDROCK - iron staining throughout			HQ	3	100%	42%	
8	-23.19								
9		End of Borehole							
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

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BOREHOLE RECORD

BH30

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/13

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-8.97						mm		
0		Very loose black ORGANIC SILT - shells throughout			SS	1	300	1	
1	-10.21				SS	2	325	2	
		Very soft grey CLAY			ST	3	250	PUSH	
2	-10.98								
		Loose to compact grey silty SAND to silty SAND with gravel			SS	4	250	11	
3					SS	5	150	12	
					SS	6	300	21	
4					SS	7	75	15	
5					SS	8	375	11	
					SS	9	125	8	
6					SS	10	400	8	
	-15.68								
7		Very severely fractured to very sound grey FELSIC GNEISS:BEDROCK			HQ	11	97%	RQD 0%	
8					HQ	12	100%	80%	
9					HQ	13	100%	100%	
	-18.93	End of Borehole							
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH32

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/14 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-4.47						mm		
0		Loose black ORGANIC SILT - trace shells and wood			SS	1	325	7	
1					SS	2	550	6	
	-5.92								
		Firm grey CLAY - trace gravel - trace shells			~~ST~~	~~3~~	~~0~~	~~PUSH~~	
2					SS	4	0	Wght. of Rods	
		- 300 mm boulder encountered at depth of 2.6 metres							
3					SS	5	250	7	
	-8.51								
4					SS	6	600	3	
	-8.74	Very soft grey CLAY							
		End of Borehole - barge needed to be moved as low tide was approaching							
5									
6									
7									
8									
9									
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH32A

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/14 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
0	-4.47	Advanced casing to start borehole again							
4	-8.79								
5		Very soft grey CLAY - sand seams encountered			SS	1	25	Wght. of Hammer	
					SS	2	600	Wght. of Hammer	
6	-10.08	Compact grey silty SAND to silty SAND with gravel - trace clay - occasional cobbles and boulders - shells in top 100 mm of layer			SS	3	450	11	
					SS	4	325	20	
7					SS	5	50	19	
					SS	6	275	50/125mm	
8	-12.57				HQ	7	500		
9		Severely fractured to fractured grey FELSIC GNEISS:BEDROCK			HQ	8	100%	RQD 23%	
10					HQ	9	100%	72%	

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH32A

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2011/09/14 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
10	-14.83	FELSIC GNEISS:BEDROCK, cont'd.							
		End of Borehole							

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH101

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/21

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-12.01						mm		
0		Very loose grey to dark grey ORGANIC SILT with sand			SS	1	275	Wght. of Rods	
1					SS	2	150	Wght. of Rods	
	-13.53								
2		Very soft grey CLAY			SS	3	500	Wght. of Rods	
3					SS	4	600	Wght. of Rods	
4					ST	5	600	Wght. of Rods	
5					SS	6	350	Wght. of Rods	
6					SS	7	600	Wght. of Rods	
7					SS	8	600	Wght. of Rods	
8					SS	9	600	Wght. of Rods	
	-20.80								
9		Loose to compact grey SAND with silt to silty SAND with gravel -occasional cobbles and boulders			SS	10	100	10	
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH101

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/21

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10		SAND with silt to silty SAND with gravel, cont'd.			SS	11	250	8	
11					SS	12	475	14	
12					SS	13	0	14	
13					SS	14	0	14	
14					SS	15	125	12	
	-26.72				SS	16	300	60/100mm	
15		Very severely fractured to severely fractured slightly weathered grey FELSIC GNEISS:BEDROCK			NQ	17	100%	RQD 17%	
16					NQ	18	89%	30%	
17	-29.10								
		End of Borehole							
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH101A

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/31 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
0	-12.20	Very loose dark grey ORGANIC SILT with sand -shells throughout			SS	1	200	Wght. of Rods	
2	-14.41	Very soft grey CLAY			SS	2	600	Wght. of Rods	
3					ST	3	600	Wght. of Rods	
4					ST	4	600	Wght. of Rods	
5					ST	5	600	Wght. of Rods	
6					ST	6	600	Wght. of Rods	
7					ST	7	600	Wght. of Rods	
8					ST	8	600	Wght. of Rods	
9	-21.09				ST	9	150	PUSH	
	-21.45	Grey silty SAND with gravel							
10		End of Borehole							

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH102

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

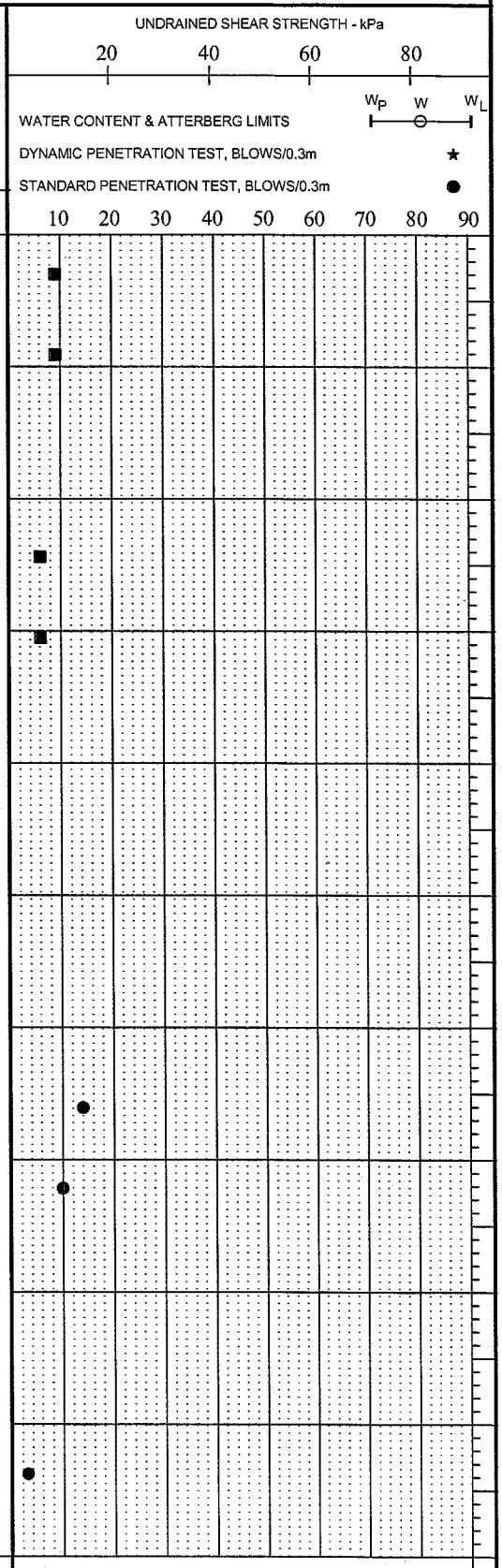
BH SIZE HW

DATES: BORING 2012/07/29

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
0	-17.04								
	-17.22	Very loose grey ORGANIC SILT			SS	1	500	Wght. of Rods	
		Very soft grey CLAY			SS	2	600	Wght. of Rods	
1									
2					SS	3	600	Wght. of Rods	
					SS	4	600	Wght. of Rods	
3									
					SS	5	0	Wght. of Rods	
4					SS	6	150	Wght. of Rods	
					SS	7	450	Wght. of Hammer	
5									
6	-23.34								
		Very loose to compact grey silty SAND with gravel to SAND with silt -occasional cobbles and boulders			SS	8	275	14	
7					SS	9	150	10	
8									
					SS	10	0	1/600mm	
9					SS	11	100	3	
10									



■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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Stantec

BOREHOLE RECORD

BH102

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/29

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10	-27.33	Silty SAND with gravel to SAND with silt, cont'd.			SS	12	75	50/75mm	
		Severely fractured to fractured slightly weathered grey FELSIC GNEISS:BEDROCK			NQ	13	100%	RQD 45%	
11									
12					NQ	14	95%	76%	
	-29.56	End of Borehole							
13									
14									
15									
16									
17									
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH103

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/20 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
0	-13.16								
		Very loose dark grey ORGANIC SILT with sand			SS	1	350	Wght. of Rods	
1					SS	2	550	Wght. of Rods	
	-14.99								
2		Very soft to soft grey CLAY			SS	3	350	Wght. of Rods	
					SS	4	500	Wght. of Rods	
3									
					ST	5	650	Wght. of Rods	
4					SS	6	425	Wght. of Rods	
5									
					SS	7	400	Wght. of Rods	
6					SS	8	600	1	
					ST	9	250	Wght. of Rods	
7					SS	10	600	Wght. of Hammer	
8	-21.24								
		Compact grey SAND with silt to silty SAND with gravel			SS	11	125	17	
9					SS	12	275	22	
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH103

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/20

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10		SAND with silt to silty SAND with gravel, cont'd.			SS	13	0	35	
					SS	14	350	35	
11	-24.39								
		Very severely fractured to sound slightly weathered grey FELSIC GNEISS:BEDROCK			NQ	15	44%	RQD 0%	
12					NQ	16	63%	53%	
13									
14	-27.56				NQ	17	100%	81%	
		End of Borehole							
15									
16									
17									
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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Stantec

BOREHOLE RECORD

BH104

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/29

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-15.07						mm		
0		Compact black ORGANIC SILT with sand to SAND with organic silt			SS	1	250	11	
	-15.81								
1		Loose to compact dark grey to grey silty SAND -trace gravel -occasional cobbles and boulders -300 mm boulder at depth of 1.2 metres			SS	2	350	80/225mm	
					NQ	3	350	-	
2					SS	4	0	9	
3					SS	5	0	14	
	-18.37								
4		Intermixed layers of very soft grey CLAY and grey SILT -sand seams encountered below depth of 6 metres			SS	6	200	Wght. of Hammer	
					SS	7	400	Wght. of Hammer	
5					ST	8	0	PUSH	
6					SS	9	600	Wght. of Rods	
					SS	10	475	Wght. of Rods	
7					SS	11	600	3	
	-22.39								
		Very loose to compact grey SAND with silt to silty SAND with gravel -occasional cobbles			SS	12	200	12	
8					SS	13	225	2	
9					SS	14	150	Wght. of Hammer	
					SS	15	525	12	
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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MBH 9/28/12

Stantec

BOREHOLE RECORD

BH104

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/29 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10		SAND with silt to silty SAND with gravel, cont'd.			SS	16	25	6	
11					SS	17	250	12	
	-26.68				SS	18	75	50/75mm	
12		Very sound slightly weathered grey FELSIC GNEISS:BEDROCK			NQ	19	96%	RQD 96%	
13					NQ	20	100%	98%	
14	-29.19								
		End of Borehole							
15									
16									
17									
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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Stantec

BOREHOLE RECORD

BH105

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/20 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
0	-9.60								
0		Black to dark grey ORGANIC SILT with sand -shells throughout			SS	1	400	Wght. of Rods	
1	-11.12								
2		Very soft grey CLAY -occasional sand seams			SS	2	250	2	
3					SS	3	550	1	
4					ST	4	650	Wght. of Rods	
5					SS	5	600	Wght. of Rods	
6					ST	6	650	Wght. of Rods	
7					SS	7	600	Wght. of Rods	
8									
9					SS	8	200	Wght. of Hammer	
	-19.18				SS	9	250	3	
10		Very loose grey SAND with silt -occasional cobbles and							

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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Stantec

BOREHOLE RECORD

BH105

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/20 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
10		boulders SAND with silt, cont'd.			SS	10	100	Wght. of Rods	
11					SS	11	175	2	
12	-21.97				SS	12	150	50/75mm	
13		Severely fractured to very sound grey FELSIC GNEISS:BEDROCK			NQ	13	74%	RQD 39%	
14	-24.13				NQ	14	100%	100%	
15		End of Borehole							
16									
17									
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH106

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/30 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
0	-13.50	Very loose grey ORGANIC SILT with sand -trace gravel -occasional cobbles and boulders -600mm boulder at depth of 0.3 metres			SS	1	150	50/25mm	
1									
2					SS	2	200	Wght. of Hammer	
	-15.94				SS	3	425	Wght. of Hammer	
3		Very soft grey clayey SILT							
4					SS	4	600	Wght. of Rods	
	-17.69				SS	5	600	Wght. of Rods	
	-17.84	Very soft grey CLAY End of Borehole -needed to restart borehole as casing wasn't straight							
5									
6									
7									
8									
9									
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH106A

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/30

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
0	-13.92	Advance casing to where BH106 was terminated							
4	-18.57	Very loose to compact grey silty SAND with gravel to SAND with silt -occasional cobbles and boulders -325 mm boulder encountered at depth of 5.2 metres			SS	6	150	70/225mm	
5					NQ	7	375	-	
7					SS	8	175	3	
8					SS	9	200	6	
9					SS	10	125	17	
10					SS	11	350	65/225mm	

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

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BOREHOLE RECORD

BH106A

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/30 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10	-23.98	Silty SAND with gravel to SAND with silt, cont'd.			NQ	12	100%	RQD 44%	
		Fractured to sound slightly weathered grey FELSIC GNEISS:BEDROCK			NQ	13	100%	79%	
11	-25.63	End of Borehole							
12									
13									
14									
15									
16									
17									
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

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BOREHOLE RECORD

BH107

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/21 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-11.95						mm		
0	-12.00	Very loose dark grey ORGANIC SILT			SS	1	150	Wght. of Rods	
		Very soft grey CLAY							
1					SS	2	275	Wght. of Rods	
	-13.45								
2		Very loose to compact grey SAND with silt to silty SAND with gravel -occasional cobbles			SS	3	225	24	
					SS	4	350	28	
3					SS	5	0	10	
					SS	6	150	5	
4					SS	7	75	5	
					SS	8	325	2	
5					~~SS~~	~~9~~	~~0~~	~~50/75mm~~	
	-17.64								
6		Sound to very sound slightly weathered grey FELSIC GNEISS:BEDROCK			NQ	10	100%	RQD 83%	
					NQ	20	100%	93%	
7	-19.47								
		End of Borehole							
8									
9									
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

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BOREHOLE RECORD

BH108

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/20

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-14.05						mm		
0		Very soft grey CLAY							
1									
2					SS	1	450	Wght. of Rods	
3					SS	2	550		
	-17.86								
4		Very loose grey clayey SAND -trace gravel -occasional cobbles			SS	3	300	13	
5					SS	4	325	3	
	-19.71								
6		Compact to dense SAND with gravel and silt to silty SAND			SS	5	175	31	
					SS	6	150	50/75mm	
	-20.83								
7		Severely fractured to fractured grey FELSIC GNEISS:BEDROCK			NQ	7	78%	RQD 38%	
8					NQ	8	77%	57%	
	-23.17								
9		End of Borehole							
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

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BOREHOLE RECORD

BH109

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/19 to 2012/07/20

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-6.15						mm		
0		Black to dark grey ORGANIC SILT with sand -trace shells			SS	1	150	2	
1					SS	2	375	2	
	-7.83								
2		Very soft grey CLAY			SS	3	0	3	
					SS	4	350	1	
3					ST	5	450	Wght. of Rods	
4	-10.42				ST	6	525	Wght. of Rods	
		Very loose to very dense grey silty SAND to silty SAND with gravel -trace clay -occasional cobbles and boulders			SS	7	250	17	
5					SS	8	125	9	
6					SS	9	275	7	
					SS	10	75	13	
7					SS	11	0	4	
8					SS	12	0	8	
					SS	13	400	64	
	-15.09								
9		Fractured to very sound grey FELSIC GNEISS:BEDROCK			NQ	14	80%	RQD 53%	
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH109

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/19 to 2012/07/20

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10		FELSIC GNEISS:BEDROCK, cont'd.							
11					NQ	15	100%	92%	
	-17.58	End of Borehole							
12									
13									
14									
15									
16									
17									
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH110

CLIENT **CANADIAN ROYALTIES INC.** PROJECT No. **121613564**

LOCATION **PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC** BH SIZE **HW**

DATES: BORING **2012/07/22** WATER LEVEL _____ DATUM **CHART**

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY	N-VALUE OR-RQD %	OTHER TESTS
	-11.16						mm		
0		Very loose dark grey to black ORGANIC SILT with sand -shells throughout			SS	1	175	Wght. of Rods	
1	-12.53				SS	2	75	Wght. of Hammer	
		Very soft grey CLAY							
2	-13.83				SS	3	475	Wght. of Rods	
		Compact grey SAND with silt to silty SAND -trace clay -occasional cobbles and boulders			SS	4	550	13	
3									
4					SS	5	0	12	
5					SS	6	275	14	
	-16.67								
		Very severely fractured to severely fractured slightly weathered grey FELSIC GNEISS:BEDROCK			NQ	7	100%	RQD 57%	
6					NQ	8	65%	41%	
7									
8					NQ	9	55%	5%	
	-19.95								
9		End of Borehole							
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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Stantec

BOREHOLE RECORD

BH111

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/22 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-4.62						mm		
0		Loose to compact dark grey ORGANIC SILT with sand -trace gravel -shells throughout			SS	1	225	6	
1					SS	2	450	24	
2					SS	3	250	31	
	-7.16								
		Stiff grey CLAY			SS	4	425	14	
3	-7.77								
		Loose to compact SAND with silt to silty SAND with gravel -occasional cobbles			SS	5	150	23	
4					SS	6	50	20	
5					SS	7	275	6	
					SS	8	200	32	
6					SS	9	100	50/100mm	
	-11.33								
7		Fractured to very sound grey FELSIC GNEISS:BEDROCK			NQ	10	100%	RQD 100%	
8					NQ	11	100%	67%	
9	-13.76								
		End of Borehole							
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH112

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/18 to 2012/07/19

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-9.66						mm		
0		Compact grey to dark grey ORGANIC SILT -trace shells			SS	1	600	11	
	-10.57								
1		Very soft grey CLAY			SS	2	500	2	
	-11.34								
2		Compact grey to dark grey silty SAND to silty SAND with gravel -occasional cobbles			SS	3	175	22	
					SS	4	350	13	
3					SS	5	200	15	
	-13.65				~~SS~~	~~6~~	~~25~~	~~50/25mm~~	
4		Severely fractured to very sound grey FELSIC GNEISS:BEDROCK - sands seams and quartz seams encountered			NQ	7	100%	RQD 100%	
5					NQ	8	91%	91%	
6					NQ	9	82%	34%	
	-16.19								
		End of Borehole							
7									
8									
9									
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

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BOREHOLE RECORD

BH113

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/28 to 2012/07/29 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-19.89						mm		
0		Very soft grey CLAY			SS	1	200	Wght. of Rods	
1					SS	2	600	Wght. of Rods	
2					SS	3	600	Wght. of Rods	
					SS	4	600	Wght. of Rods	
3					ST	5	600	Wght. of Rods	
4									
					SS	6	600	Wght. of Rods	
5					SS	7	600	Wght. of Rods	
6									
	-26.42				SS	8	600	Wght. of Rods	
7		Loose to compact grey silty SAND with gravel -occasional cobbles			SS	9	325	7	
8					SS	10	200	9	
	-28.42				SS	11	50	50/50mm	
		Sound grey FELSIC GNEISS:BEDROCK							
9					NQ	12	85%	RQD 79%	
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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Stantec

BOREHOLE RECORD

BH113

CLIENT **CANADIAN ROYALTIES INC.** PROJECT No. **121613564**

LOCATION **PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC** BH SIZE **HW**

DATES: BORING **2012/07/28 to 2012/07/29** WATER LEVEL _____ DATUM **CHART**

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10		FELSIC GNEISS:BEDROCK, cont'd.			NQ	13	96%	87%	
11	-30.91	End of Borehole							
12									
13									
14									
15									
16									
17									
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH114

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/29

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
0	-19.30								
		Very loose grey sandy SILT with gravel to silty SAND with gravel			SS	1	50	Wght. of Rods	
	-20.21				SS	2	100	Wght. of Hammer	
1		Very soft grey clayey SILT			SS	3	425	Wght. of Rods	
2					SS	4	450	Wght. of Rods	
	-21.74								
		Very soft grey CLAY			SS	5	600	Wght. of Rods	
3					SS	6	600	Wght. of Rods	
4									
					ST	7	600	Wght. of Rods	
5									
					SS	8	600	Wght. of Hammer	
6	-25.55								
		Loose to compact grey silty SAND with gravel to SAND with silt			SS	9	300	6	
7									
					SS	10	150	5	
8					SS	11	75	6	
9					SS	12	225	15	
					SS	13	325	6	
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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Stantec

BOREHOLE RECORD

BH114

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/29

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10		Silty SAND with gravel to SAND with silt, cont'd.			~~SS~~	~~14~~	~~0~~	~~50/25mm~~	
	-30.15								
11		Fractured to sound slightly weathered grey FELSIC GNEISS:BEDROCK			NQ	15	175 100%	- RQD 77%	
12		-275 mm zone of dark grey MAFIC GNEISS encountered at depth of 11.8 metres			NQ	16	97%	38%	
13	-32.33	End of Borehole							
14									
15									
16									
17									
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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Stantec

BOREHOLE RECORD

BH115

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/30

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-17.69						mm		
0		Very loose dark grey to black ORGANIC SILT with sand -shells throughout			ST	1	450	PUSH	
1					ST	2	425	PUSH	
	-19.52				ST	3	600	PUSH	
2		Very soft grey clayey SILT -shells throughout							
					SS	4	550	Wght. of Rods	
3	-20.87				SS	5	600	Wght. of Rods	
		Very soft grey CLAY							
4					SS	6	575	Wght. of Rods	
					SS	7	600	Wght. of Rods	
5									
					ST	8	550	Wght. of Rods	
6					SS	9	400	3	
	-24.29								
		Very loose to compact grey SAND with silt to silty SAND with gravel -occasional cobbles and boulders							
7					SS	10	225	12	
					SS	11	325	12	
8									
					SS	12	50	2	
9	-26.96				SS	13	300	50/75mm	
		End of Borehole -barge needed to be moved for an onshore blast							
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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Stantec

BOREHOLE RECORD

BH115A

CLIENT **CANADIAN ROYALTIES INC.** PROJECT No. **121613564**

LOCATION **PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC** BH SIZE **HW**

DATES: BORING **2012/07/30 to 2012/07/31** WATER LEVEL _____ DATUM **CHART**

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-17.91						mm		
0		Advanced casing to where BH115 was terminated							
1									
2									
3									
4									
5									
6									
7									
8									
9	-26.90	Grey SAND with silt to silty SAND with gravel -cobbles and boulders throughout							
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

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BOREHOLE RECORD

BH115A

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/30 to 2012/07/31

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10		SAND with silt to silty SAND with gravel, cont'd.			NQ	14	850	-	
	-28.88								
11		Very severely fractured slightly to moderately weathered grey FELSIC GNEISS:BEDROCK			NQ	15	71%	RQD 14%	
12									
13					NQ	16	97%	17%	
	-31.60								
14		End of Borehole							
15									
16									
17									
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

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BOREHOLE RECORD

BH116

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/31 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
0	-16.79	Very soft grey clayey SILT			SS	1	150	Wght. of Rods	
1	-17.93	Dark grey to grey ORGANIC SILT with sand to silty SAND -frequent shell fragments			SS	2	200	Wght. of Rods	
2	-19.13	Very soft grey clayey SILT			SS	3	600	Wght. of Hammer	
3	-20.40	Very soft grey CLAY			SS	4	600	Wght. of Rods	
4	-21.36	Very loose to compact grey SAND with silt to silty SAND with gravel -occasional cobbles			SS	5	600	Wght. of Rods	
5					SS	6	600	Wght. of Rods	
6					SS	7	75	4	
7					SS	8	50	8	
8	-25.45	Severely fractured to fractured slightly to moderately weathered grey FELSIC GNEISS:BEDROCK -occasional sand seams			SS	9	100	9	
9					SS	10	325	6	
10					SS	11	25	10	
					SS	12	400	4	
					NQ	13	100%	RQD 31%	

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH116

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/31

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10		FELSIC GNEISS:BEDROCK, cont'd.			NQ	14	74%	37%	
11					NQ	15	100%	39%	
12					NQ	16	100%	50%	
	-29.59								
13		End of Borehole							
14									
15									
16									
17									
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH117

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/21

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
0	-9.58	Very loose black to dark grey ORGANIC SILT with sand -shells throughout			SS	1	250	Wght. of Rods	
1									
2	-11.76				SS	2	150	Wght. of Hammer	
		Very loose to compact grey silty SAND -trace clay -shells throughout			SS	3	425	Wght. of Hammer	
3					SS	4	150	16	
4	-13.75				SS	5	275	2	
		Very soft grey CLAY -sand seams encountered below depth of 10.2 metres			SS	6	0	Wght. of Rods	
5					SS	7	475	Wght. of Rods	
6					ST	8	675	Wght. of Rods	
7					SS	9	600	Wght. of Rods	
8									
9					SS	10	600	Wght. of Rods	
					SS	11	600	Wght. of Rods	
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH117

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/21 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
10									
		CLAY, cont'd.			SS	12	400	Wght. of Rods	
11					SS	13	600	Wght. of Rods	
12	-21.98								
		Very loose to compact grey SAND with silt to silty SAND with gravel -occasional cobbles and boulders			ST	14	0	PUSH	
13					SS	15	225	1	
					SS	16	150	Wght. of Hammer	
14									
					SS	17	250	8	
15					SS	18	400	80/225mm	
	-25.56								
16		COBBLES and BOULDERS			NQ	19	250	-	
					NQ	20	100%	50%	
17	-26.90								
		Very severely fractured slightly weathered grey FELSIC GNEISS:BEDROCK							
18	-27.61								
		End of Borehole							
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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Stantec

BOREHOLE RECORD

BH408

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/22 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-6.17						mm		
0		Loose grey to dark grey silty SAND to sandy SILT -trace organics -trace gravel -trace shells			SS	1	100	6	
1					SS	2	450	13	
	-7.74				SS	3	600	3	
		Very soft grey CLAY							
2					SS	4	300	3	
	-8.91								
3		Compact grey SAND with silt to silty SAND with gravel -occasional cobbles and boulders			SS	5	50	15	
4					SS	6	275	14	
		- 325 mm boulder							
5					SS	7	50	50/75mm	
6		- 300 mm boulder			SS	8	100	56/175mm	
	-12.88								
7		Sound to very sound slightly weathered grey FELSIC GNEISS:BEDROCK			NQ	9	98%	RQD 87%	
8					NQ	10	85%	74%	
	-15.21								
9		End of Borehole							
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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Stantec

BOREHOLE RECORD

BH409

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/22 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-10.19						mm		
0		Very loose dark grey ORGANIC SILT with sand -shells throughout			SS	1	100	Wght. of Rods	
1	-11.41				SS	2	0		
		Soft grey CLAY -trace gravel							
2					SS	3	25	1/900mm	
	-12.93								
3		Severely fractured to sound slightly weathered grey FELSIC GNEISS:BEDROCK			SS	4	50	50/75mm	
					NQ	5	100%	RQD 50%	
4					NQ	6	93%	78%	
	-15.12								
5		End of Borehole							
6									
7									
8									
9									
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

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Stantec

BOREHOLE RECORD

BH410

CLIENT **CANADIAN ROYALTIES INC.** PROJECT No. **121613564**

LOCATION **PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC** BH SIZE **HW**

DATES: BORING **2012/07/22 to 2012/07/23** WATER LEVEL _____ DATUM **CHART**

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-6.22						mm		
0		Very loose grey sandy SILT			SS	1	0	Wght. of Rods	
1					SS	2	350	Wght. of Rods	
	-7.44	Very soft grey CLAY			SS	3	600	Wght. of Hammer	
2	-8.30	Compact grey SAND with silt to silty SAND -trace gravel			SS	4	400	8	
3					SS	5	225	14	
	-9.57				SS	6	125	50/125mm	
4		Very sound grey FELSIC GNEISS:BEDROCK			NQ	7	98%	RQD 92%	
5					NQ	8	100%	100%	
	-11.81								
6		End of Borehole							
7									
8									
9									
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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Stantec

BOREHOLE RECORD

BH411

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/23 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-14.30						mm		
0		Very loose grey to dark grey ORGANIC SILT			SS	1	325	Wght. of Rods	
	-15.21								
1	-15.52	Very loose grey sandy SILT to silty SAND -trace gravel -occasional shells			SS	2	600	Wght. of Rods	
2		Very soft grey CLAY			SS	3	600	Wght. of Hammer	
3									
					ST	4	600	Wght. of Rods	
4					SS	5	600	Wght. of Rods	
					SS	6	600	Wght. of Rods	
5	-19.48								
		Severely fractured moderately weathered grey FELSIC GNEISS:BEDROCK			NQ	7	90%	RQD 43%	
6									
7					NQ	8	81%	46%	
8	-22.45								
		End of Borehole							
9									
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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Stantec

BOREHOLE RECORD

BH412

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/23 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-8.22						mm		
0		Very loose black to dark grey ORGANIC SILT with sand -shells throughout			SS	1	350	Wght. of Rods	
	-9.06								
1		Loose to compact grey silty SAND -shells throughout			SS	2	100	8	
	-9.87				SS	3	200	37	
		Sound to very sound grey FELSIC GNEISS:BEDROCK			NQ	4	100%	RQD 100%	
2					NQ	5	100%	71%	
3					NQ	6	94%	86%	
4	-12.54								
		End of Borehole							
5									
6									
7									
8									
9									
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

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BOREHOLE RECORD

BH413

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/23 to 2012/07/24

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
0	-14.60	Very loose dark grey to black ORGANIC SILT with sand -strong organic odour			SS	1	200	Wght. of Hammer	
1	-15.97				SS	2	450	Wght. of Rods	
2		Very loose black SAND with organic silt -strong organic odour			SS	3	600	1	
3	-17.34	Compact dark grey silty SAND with gravel to SAND with silt -organic odour -shells throughout			SS	4	600	12	
4	-19.10	-375 mm boulder							
5		Very soft grey CLAY			SS	5	600	Wght. of Rods	
6					SS	6	300	Wght. of Rods	
7					ST	7	0	Wght. of Rods	
8					SS	8	600	Wght. of Rods	
9					ST	9	600	PUSH	
10					SS	10	600	Wght. of Rods	

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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Stantec

BOREHOLE RECORD

BH413

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/23 to 2012/07/24 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10		CLAY, cont'd.							
11									
12	-26.79				SS	11	450	Wght. of Rods	
		Compact grey silty SAND with gravel to SAND with silt -occasional cobbles and boulders			SS	12	150	11	
13					SS	13	0	50/25mm	
14	-28.93								
		Fractured to sound slightly weathered grey FELSIC GNEISS:BEDROCK			NQ	14	82%	RQD 59%	
15									
16	-31.06				NQ	15	88%	88%	
		End of Borehole							
17									
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH414

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2102/07/23

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
0	-11.02								
		Very loose dark grey ORGANIC SILT with sand			SS	1	200	Wght. of Rods	
	-11.48	Very loose dark grey to black SAND with organic silt -shells throughout -strong organic odour			SS	2	250	3	
1									
2					SS	3	25	Wght. of Hammer	
	-13.66				SS	4	425	1	
3		Intermixed layers of very soft grey CLAY and grey SILT -sand seams encountered below depth of 10 metres			SS	5	450	Wght. of Rods	
4					SS	6	450	7	
					SS	7	600	Wght. of Rods	
5					SS	8	600	Wght. of Rods	
6					SS	9	300	Wght. of Rods	
					SS	10	600	Wght. of Rods	
7					SS	11	600	Wght. of Rods	
8					SS	12	600	Wght. of Rods	
					ST	13	600	Wght. of Rods	
9					SS	14	600	Wght. of Rods	
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH414

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2102/07/23 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10		CLAY and SILT, cont'd.			SS	15	450	Wght. of Rods	
11					SS	16	425	Wght. of Rods	
	-22.58								
12		Severely fractured to fractured slightly to moderately weathered grey FELSIC GNEISS:BEDROCK -quartz mineralization throughout			NQ	17	100%	RQD 38%	
13					NQ	18	100%	70%	
	-25.04								
14		End of Borehole							
15									
16									
17									
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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Stantec

BOREHOLE RECORD

BH415

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

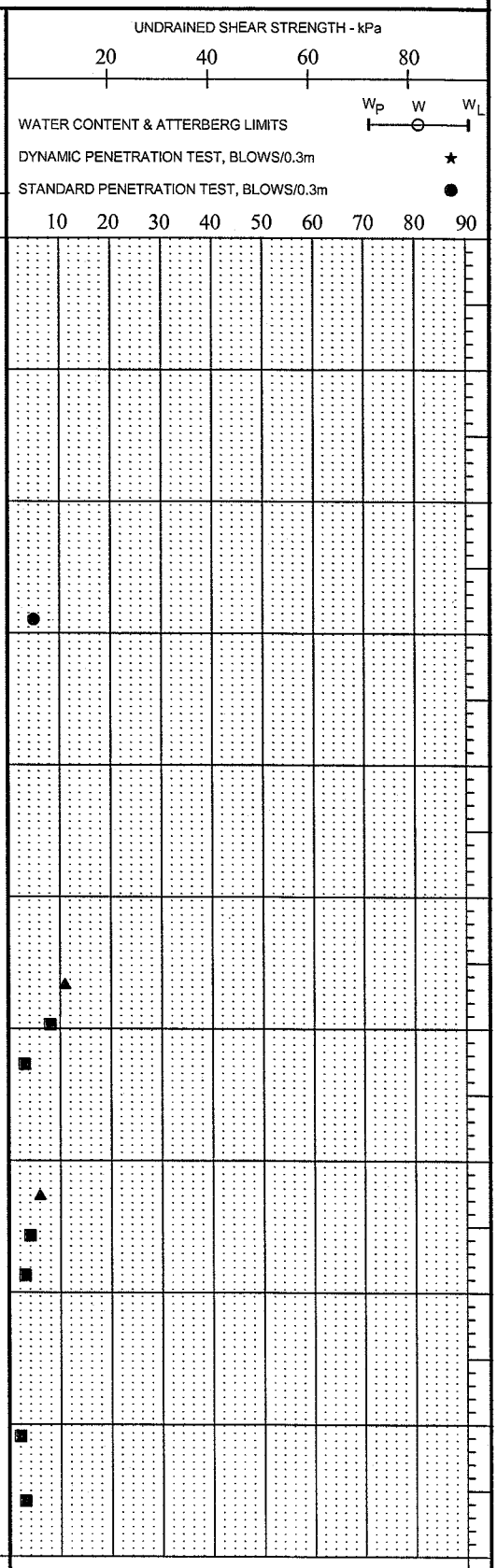
BH SIZE HW

DATES: BORING 2012/07/24

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
0	-14.41								
	-14.79	Very loose grey ORGANIC SILT with sand			SS	1	550	Wght. of Rods	
1	-15.32	Very loose grey silty SAND -trace gravel -trace shells			SS	2	600	Wght. of Hammer	
	-16.39	Soft grey CLAY							
2		Very loose grey SILT with sand to silty SAND -shells throughout -trace gravel			SS	3	600	Wght. of Rods	
3					SS	4	600	5	
	-18.19								
4		Very soft grey CLAY			SS	5	600	Wght. of Hammer	
5									
6					ST	6	600	Wght. of Rods	
					SS	7	600	Wght. of Rods	
7									
					ST	8	600	Wght. of Rods	
8					SS	9	600	Wght. of Rods	
9					SS	10	600	Wght. of Rods	
					SS	11	600	Wght. of Rods	
10									



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BOREHOLE RECORD

BH415

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/24 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10		CLAY, cont'd.							
11					ST	12	600	PUSH	
12	-26.58				SS	13	400	Wght. of Rods	
		Compact grey silty SAND with gravel to SAND with silt			SS	14	175	10	
13	-27.87				SS	15	100	85/250mm	
		COBBLES and BOULDERS -possible bedrock at 13.9 metres			NQ	16	425	-	
14	-28.74				NQ	17	500mm	-	
		Very severely fractured to sound slightly weathered dark grey MAFIC GNEISS:BEDROCK					100%	RQD 0%	
15					NQ	18	100%	66%	
16									
17		- 125 mm Quartz seam at depth of 16.9 metres			NQ	19	100%	89%	
	-32.04								
18		End of Borehole							
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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Stantec

BOREHOLE RECORD

BH416

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/24 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
0	-11.93								
		Very loose dark grey ORGANIC SILT with sand -trace gravel -shells throughout -strong organic odour			SS	1	75	Wght. of Rods	
1					SS	2	575	Wght. of Hammer	
					SS	3	150	2	
2	-14.29				SS	4	525	10	
		Very loose to loose grey silty SAND with gravel to SAND with silt -shells throughout			SS	5	600	Wght. of Hammer	
3					SS	6	75	4	
4	-16.20								
		Very soft grey CLAY			SS	7	400	Wght. of Hammer	
5					SS	8	600	Wght. of Rods	
					ST	9	300	PUSH	
6		-300 mm thick layer of sand at depth of 6.2 metres			SS	10	175	2	
7					SS	11	600	Wght. of Rods	
					SS	12	600	Wght. of Rods	
8									
9	-20.92								
		Loose to compact grey silty SAND with gravel to SAND with silt			SS	13	250	10	
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH416

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/24

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10		Silty SAND with gravel to SAND with silt, cont'd.			SS	14	350	5	
	-22.83				SS	15	75	56/200mm	
11		Fractured to very sound grey FELSIC GNEISS:BEDROCK							
12					NQ	16	77%	RQD 70%	
13					NQ	17	100%	100%	
	-25.85				NQ	18	100%	70%	
14		End of Borehole							
15									
16									
17									
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH417

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/25 to 2012/07/26 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-13.88						mm		
0		Very loose dark grey ORGANIC SILT			SS	1	350	Wght. of Rods	
1					SS	2	600	Wght. of Rods	
	-15.43								
2		Very loose grey silty SAND with gravel -trace shells			SS	3	200	Wght. of Hammer	
					SS	4	300	1	
3	-16.93								
		Very soft grey CLAY							
4					SS	5	600	Wght. of Rods	
					SS	6	600	Wght. of Rods	
5					SS	7	600	Wght. of Rods	
6									
					SS	8	350	Wght. of Rods	
7									
8					SS	9	600	Wght. of Rods	
9					SS	10	600	Wght. of Rods	
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH417

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/25 to 2012/07/26 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10		CLAY, cont'd.			SS	11	600	Wght. of Rods	
11	-25.31				ST	12	600	Wght. of Rods	
12		Loose grey silty SAND with gravel			SS	13	300	Wght. of Rods	
13	-27.04								
14		Fractured to sound dark grey MAFIC GNEISS:BEDROCK			NQ	14	89%	RQD 78%	
15					NQ	15	100%	73%	
16	-29.98	-quartz seam from depth of 15.72 metres to bottom of core			NQ	16	100%	67%	
		End of Borehole							
17									
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH418

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/25

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
0	-12.13								
		Very loose dark grey ORGANIC SILT with sand -occasional cobbles -shells throughout			SS	1	350	Wght. of Rods	
1					SS	2	600	Wght. of Rods	
2					SS	3	50	7	
	-14.64				SS	4	600	3	
		Very loose grey SILT with sand to sandy SILT -shells throughout							
3					SS	5	400	Wght of Hammer	
4					SS	6	600	Wght of Hammer	
	-17.01				ST	7	0	PUSH	
5		Very soft grey CLAY			SS	8	600	Wght. of Rods	
6									
					SS	9	600	Wght. of Rods	
7									
8					ST	10	600	Wght. of Rods	
9									
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH418

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/25 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10		CLAY. cont'd.			SS	11	600	Wght. of Rods	
	-23.00								
11		Inferred to be silty SAND with gravel			SS	12	-	27	
	-23.61	-spoon broke off in borehole							
		Fractured moderately weathered grey FELSIC GNEISS:BEDROCK			NQ	13	100%	RQD 53%	
12									
					NQ	14	93%	67%	
13									
	-26.02				NQ	15	100%	61%	
14		End of Borehole							
15									
16									
17									
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH419

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/24 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
0	-6.74								
		Very loose to loose dark grey to black ORGANIC SILT with sand			SS	1	0	Wght. of Rods	
1	-7.76				SS	2	200	Wght. of Rods	
		Very loose to loose black SAND with organic silt -strong organic odour -shells throughout							
2					SS	3	25	Wght. of Hammer	
					SS	4	225	6	
3									
					SS	5	0	Wght. of Hammer	
4					SS	6	300	1	
	-11.06								
		Very loose to loose dark grey SAND with organic silt to ORGANIC SILT with sand -strong organic odour -shells throughout			SS	7	375	Wght. of Hammer	
5					SS	8	400	5	
	-12.28								
		Very loose to loose grey silty SAND to SAND with silt -shells throughout -trace gravel			SS	9	0	8	
6					SS	10	200	7	
					SS	11	0	1	
7	-14.26								
		Very soft grey SILT			SS	12	600	Wght. of Hammer	
8									
	-15.53				SS	13	200	Wght. of Hammer	
		Very soft grey CLAY			SS	14	600	Wght. of Rods	
9									
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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BOREHOLE RECORD

BH419

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/24

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10		CLAY, cont'd.			SS	15	550	Wght. of Rods	
					SS	16	600	Wght. of Rods	
11		-sand seams at depth of 10.8 metres							
12	-18.93				SS	17	600	Wght. of Rods	
		Loose grey silty SAND with gravel to SAND with silt -occasional cobbles			SS	18	325	8	
13	-19.90				NQ	19	75mm 100%	- RQD 10%	
14		Very severely fractured to fractured slightly to moderately weathered grey FELSIC GNEISS:BEDROCK -two seams of MAFIC GNEISS encountered							
15					NQ	20	95%	19%	
16					NQ	21	91%	65%	
17	-23.71								
		End of Borehole							
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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Stantec

BOREHOLE RECORD

BH420

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/25 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
0	-7.61	Very loose to loose black ORGANIC SILT with sand -shells throughout			SS	1	50	Wght. of Rods	
1					SS	2	400	Wght. of Rods	
2	-9.13	Very loose to loose SAND with organic silt -shells throughout -occasional cobbles -strong organic odour			SS	3	25	6	
3					SS	4	400	3	
4	-11.50	Black ORGANIC SILT -trace gravel -occasional cobbles			SS	5	225	9	
5	-12.11	Very loose to loose dark grey silty SAND with gravel -shells throughout			SS	6	600	4	
6	-13.71	Very soft grey SILT			SS	7	350	6	
7	-14.26	Very soft grey CLAY -sand seam at depth of 9.24 metres			SS	8	600	Wght. of Rods	
8					SS	9	600	Wght. of Rods	
9					SS	10	600	Wght. of Rods	
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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Stantec

BOREHOLE RECORD

BH420

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/25 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
							mm		
10		CLAY, cont'd.			SS	11	600	Wght. of Rods	
11	-18.68				SS	12	600	Wght. of Rods	
	-19.29	Loose grey silty SAND with gravel			SS	13	50	50/50mm	
12		Very severely fractured to severely fractured grey FELSIC GNEISS:BEDROCK -seam of MAFIC GNEISS encountered			NQ	14	44%	RQD 0%	
13					NQ	15	97%	36%	
14	-21.86								
		End of Borehole							
15									
16									
17									
18									
19									
20									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

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Stantec

BOREHOLE RECORD

BH423

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/25

WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES N-VALUE OR-RQD %	OTHER TESTS
	-3.56						mm		
0		Very loose black ORGANIC SILT			SS	1	100	1	
	-4.17	-shells throughout							
1		Compact black SAND with organic silt			SS	2	350	14	
		-trace gravel							
		-occasional cobbles			SS	3	275	32	
2		-shells throughout							
		-strong organic odour			SS	4	225	25	
	-6.02								
		Loose grey SILT with sand to silty SAND with gravel							
3		-occasional cobbles			SS	5	25	9	
					SS	6	450	7	
4	-7.70								
	-7.90	Very soft grey CLAY							
		Dense grey silty SAND with gravel			SS	7	175	63/250mm	
	-8.54	-occasional cobbles							
5		Severely fractured to sound slightly weathered grey FELSIC GNEISS:BEDROCK			NQ	8	75mm 100%	- RQD 77%	
6		-iron staining							
					NQ	9	98%	47%	
7	-10.98								
		End of Borehole							
8									
9									
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

App'd Sep 28 2012 8:28:44

MBH 9/28/12

Stantec

BOREHOLE RECORD

BH424

CLIENT CANADIAN ROYALTIES INC.

PROJECT No. 121613564

LOCATION PROPOSED WHARF - SITE 1, DECEPTION BAY, QUEBEC

BH SIZE HW

DATES: BORING 2012/07/25 WATER LEVEL

DATUM CHART

DEPTH(m)	ELEVATION(m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY	N-VALUE OR-RQD %	OTHER TESTS
	-3.37						mm		
0		Very loose dark grey ORGANIC SILT with sand -shells throughout			SS	1	150	Wght. of Rods	
	-4.06	Very loose grey SILT to SILT with sand -gravel in top 550 mm -trace shells			SS	2	525	4	
1					SS	3	425	2	
2					SS	4	300	1	
3	-6.52				SS	5	475	Wght. of Hammer	
		Very soft grey CLAY			SS	6	600	Wght. of Hammer	
4					SS	7	225	Wght. of Hammer	
	-8.20	-sand seams below depth of 4.4 metres			SS	8	575	9	
5		Loose grey silty sand with gravel -occasional cobbles			SS	9	25	7	
	-9.29				SS	10	100	50/100mm	
6		Severely fractured to fractured slightly weathered grey FELSIC GNEISS:BEDROCK			NQ	11	100mm-100%	RQD 42%	
7					NQ	12	98%	73%	
	-11.07								
8		End of Borehole							
9									
10									

UNDRAINED SHEAR STRENGTH - kPa

20 40 60 80

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

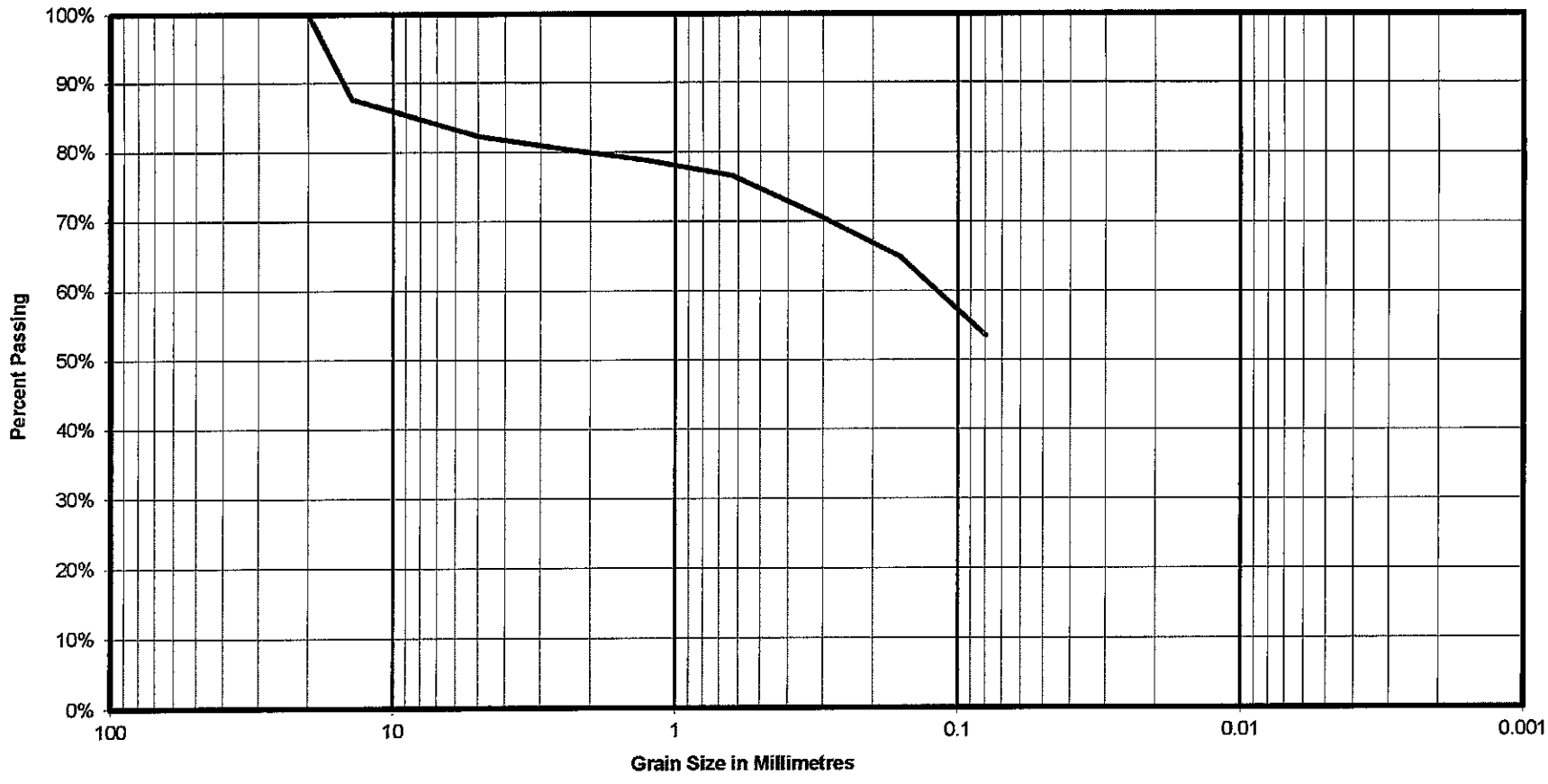
■ PENETROMETER
▲ FIELD VANE TEST
◆ MINIATURE VANE SHEAR TEST
✖ UU TRIAXIAL TEST

App'd Sep 28 2012 8:28:45

MBH 9/28/12

APPENDIX B
Grain Size Curves

Approved:



	Gravel		Sand			Silt and Clay
	Coarse	Fine	Coarse	Medium	Fine	

Unified Soil Classification System ASTM D 2487/2488

Curve	BOREHOLE/TESTPIT	SAMPLE	DEPTH (m)	Soil Fractions			Soil Description
				Gravel	Sand	Silt/Clay	
———	BH 15	Sa 4	2.11 - 2.72	18%	29%	54%	Sandy CLAY with Gravel

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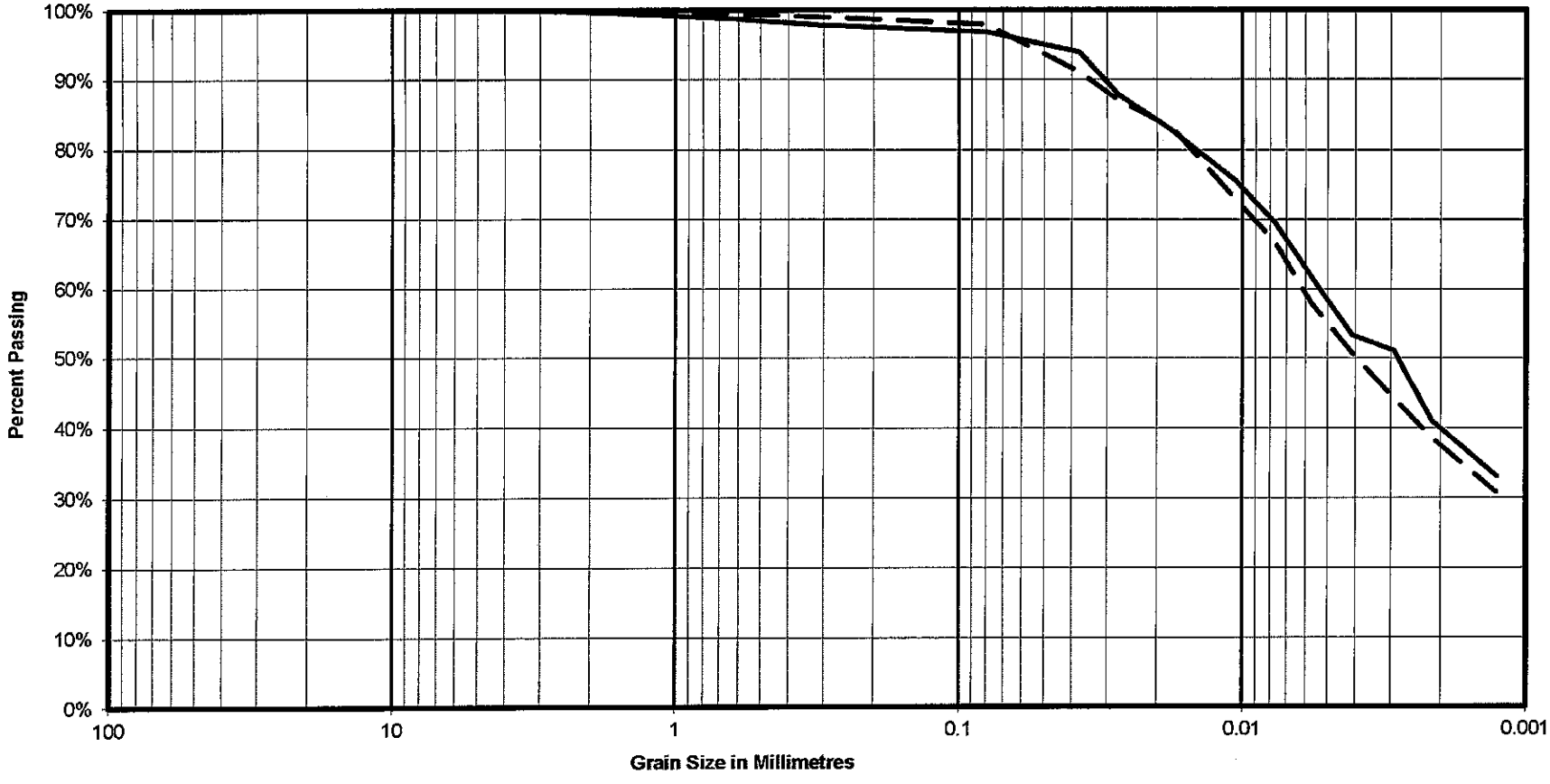
Job No.: 121613564

Approved:



	Gravel		Sand			Silt and Clay
	Coarse	Fine	Coarse	Medium	Fine	

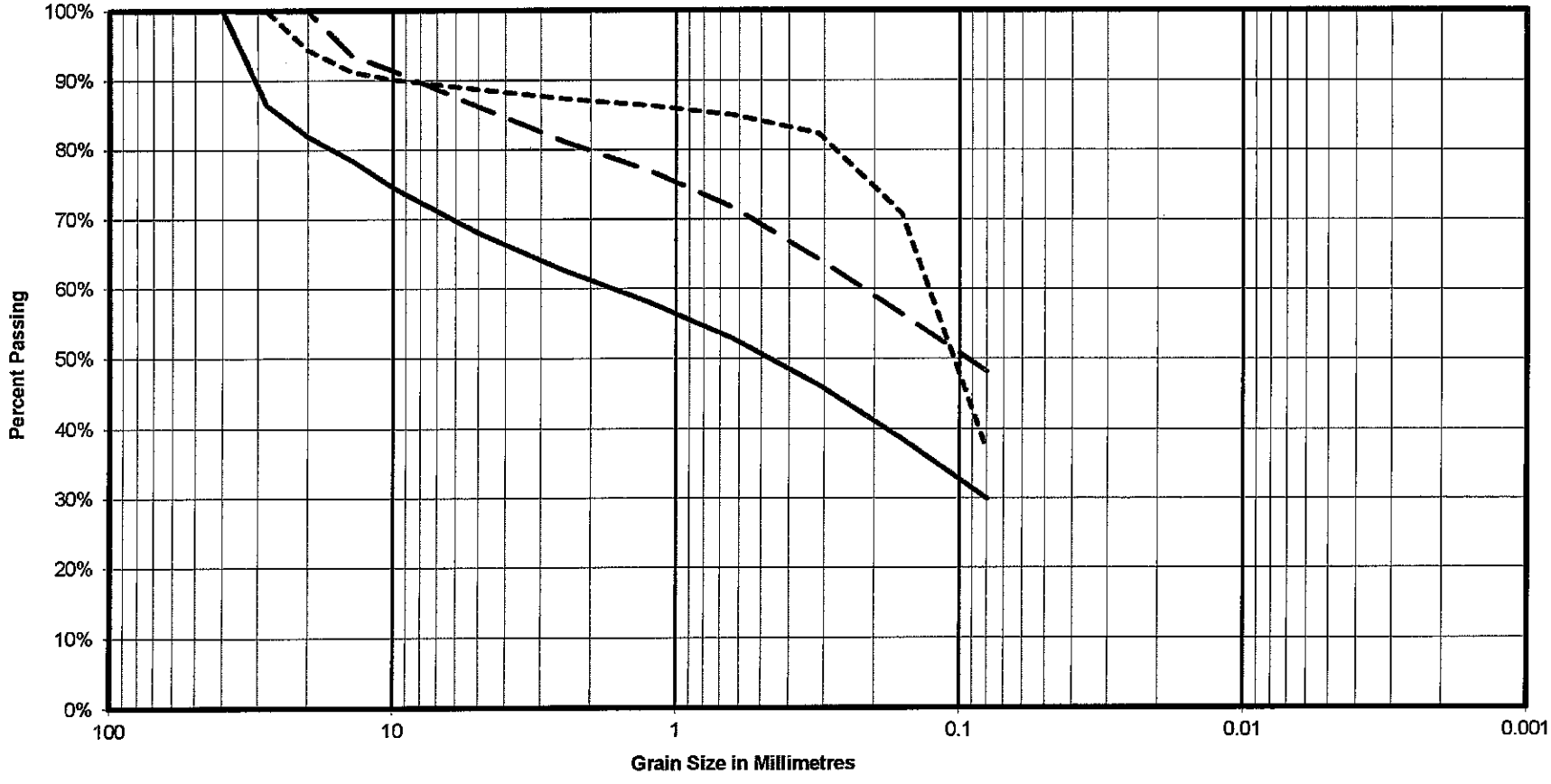
Unified Soil Classification System ASTM D 2487/2488

Curve	BOREHOLE/TESTPIT	SAMPLE	DEPTH (m)	Soil Fractions			Soil Description
				Gravel	Sand	Silt/Clay	
———	BH 4A	Sa 6	6.1		3%	97%	CLAY
— — —	BH 8	Sa 4	3.05 - 3.66		2%	98%	CLAY

Stantec

Job No.: 121613564

Approved:



	Gravel		Sand			Silt and Clay
	Coarse	Fine	Coarse	Medium	Fine	

Unified Soil Classification System ASTM D 2487/2488

Curve	BOREHOLE/TESTPIT	SAMPLE	DEPTH (m)	Soil Fractions			Soil Description
				Gravel	Sand	Silt/Clay	
———	BH 4	Sa 11	14.43 - 15.04	32%	38%	30%	Silty SAND with Gravel
— — -	BH 7	Sa 6	5.11 - 5.71	14%	38%	48%	Silty SAND
- - - -	BH 7	Sa 7	5.71 - 6.32	11%	52%	37%	Silty SAND

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Job No.: 121613564

APPENDIX C
Drawing No. 101, Borehole Location Plan

LEGEND

- BOREHOLE LOCATION
- [–XX.X] BOTTOM CLAY ELEVATION (FROM BOREHOLE LOGS)
- (–XX.X) BEDROCK ELEVATION (FROM BOREHOLE LOGS)

516500

516750

6889750

BH113 [–26.4] (–28.4)
BH114 [–25.6] (–30.1)
BH102 [–23.3] (–27.3)
BH104 [–22.4] (–26.7)
BH115 [–24.3] (N/A)
BH115A [N/A] (–28.9)
BH101A [–21.1] (N/A)
BH101 [–20.8] (–26.7)
BH106 [N/A] (N/A)
BH106A [–18.6] (–24.0)
BH116 [–21.4] (–25.5)
BH103 [–21.2] (–24.4)
BH108 [–19.7] (–20.8)
BH117 [–22.0] (–27.0)
BH01 [–26.5] (–27.9)
BH05 [–18.9] (–24.1)
BH105 [–19.2] (–22.0)
BH07 [–16.7] (–22.2)
BH09 [–17.2] (–18.0)
BH29A [N/A] (–20.7)
BH29 [–21.3] (N/A)
BH107 [–13.5] (–17.6)
BH110 [–13.8] (–16.7)
BH28 [–15.1] (–19.1)
BH112 [–11.3] (–13.7)
BH04 [–21.2] (–24.1)
BH06 [–21.0] (–22.8)
BH08 [–14.5] (–18.1)
BH30 [–11.0] (–15.7)
BH409 [N/A] (–12.9)
BH411 [N/A] (–19.5)
BH11 [–16.3] (–18.7)
BH10 [–12.0] (–15.9)
BH109 [–10.4] (–15.1)
BH12 [–14.6] (–18.2)
BH408 [–8.9] (–12.9)
BH410 [–8.3] (–9.6)
BH111 [–7.8] (–11.3)
BH412 [–9.1] (–9.9)
BH413 [–26.8] (–28.9)
BH13 [–20.1] (–20.8)
BH15 [–11.1] (–16.3)
BH32A [–10.1] (–12.6)
BH424 [–8.2] (–9.3)
BH423 [–7.9] (–8.5)
BH414 [N/A] (–22.6)
BH415 [–26.6] (–28.7)
BH417 [–25.3] (–27.0)
BH16 [–14.6] (–19.7)
BH416 [–20.9] (–22.8)
BH418 [–23.0] (–23.6)
BH419 [–18.9] (–19.9)
BH420 [–18.7] (–19.3)

PROPOSED CELL [CENTER COORDINATES E 516595 N 6889756]

PROPOSED CELL [CENTER COORDINATES E 516631 N 6889715]

PROPOSED PIER [CENTER COORDINATES E 516593 N 6889655]

LWL (APPROX)

HWL (APPROX)

AT25 (–9.8)
AT425 (–8.6)
AT426 (–8.2)
AT28 (–6.8)
AT31 (–7.3)
AT118 (–7.5)
AT119 (–8.0)
AT22 (–11.1)
AT32 (–3.0)
AT23 (–9.7)
AT26 (–9.0)
AT29 (–3.3)
AT120 (–7.6)
AT422 (–7.5)
AT121 (–7.0)
AT21 (–4.0)
AT24 (–7.6)
AT27 (–4.3)
AT30 (–3.0)

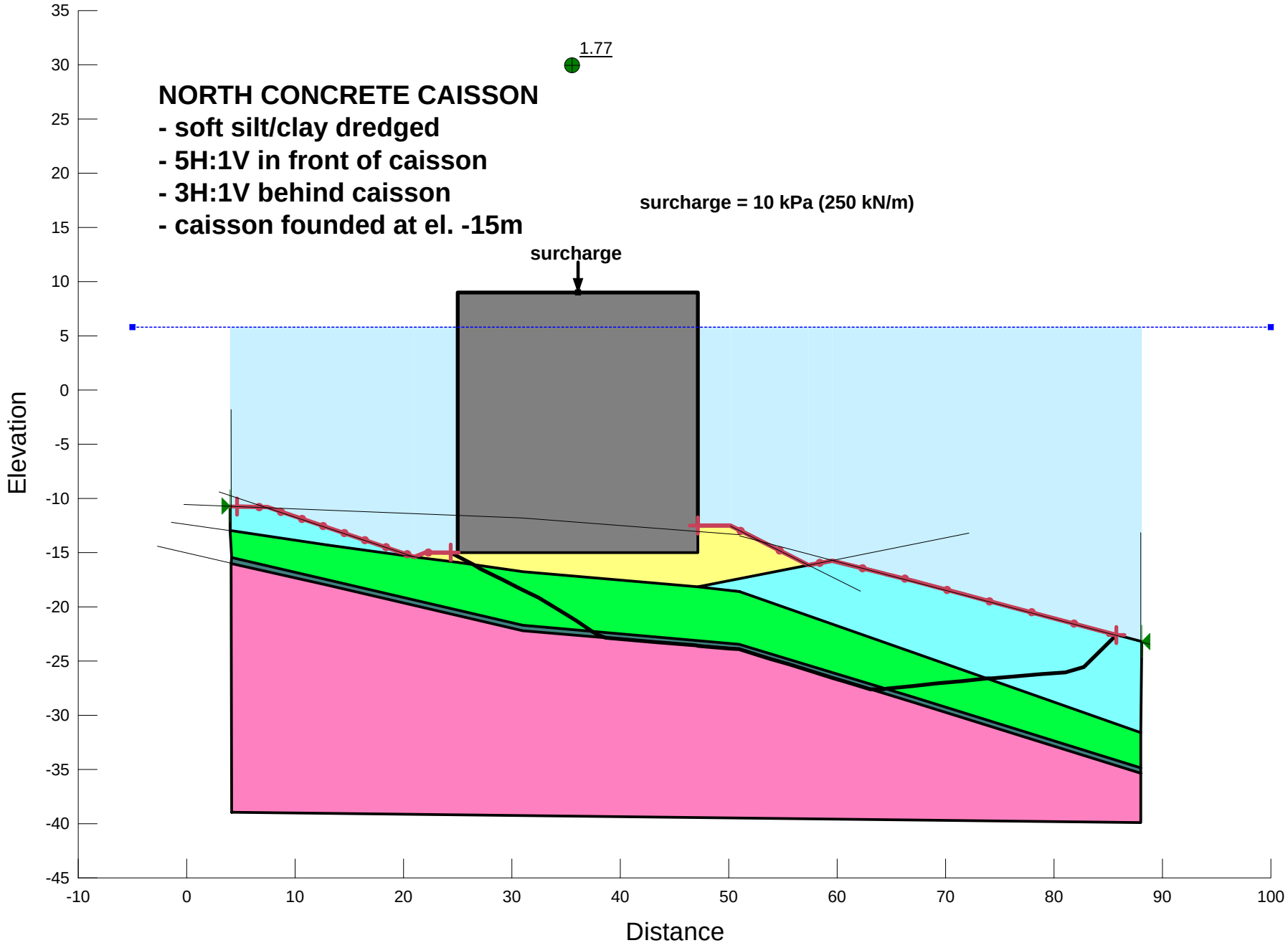
NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

T:\1216XX\121613564 deception bay\121613564-101.dwg PRINTED: Apr 22, 2013

Reference: -CAD FILE "10730_contours.dwg" PROVIDED BY IGLU, 5 JULY 2012 -CAD FILE "8063SG-001-BTY-DECPT12-01-0.dwg" PROVIDED BY FUGRO JACQUES GEOSURVEYS INC., 30 AUG, 2011	Job No.: 121613564 Scale: 1:1000 Date: 2013/04/16 Dwn. By: BSP App'd By:	Client: CANADIAN ROYALTIES INC. Site Address: DECEPTION BAY, QUEBEC	Project: DECEPTION BAY WHARF SITE 1	Drawing Title: BOREHOLE LOCATION PLAN	Dwg. No.: 101

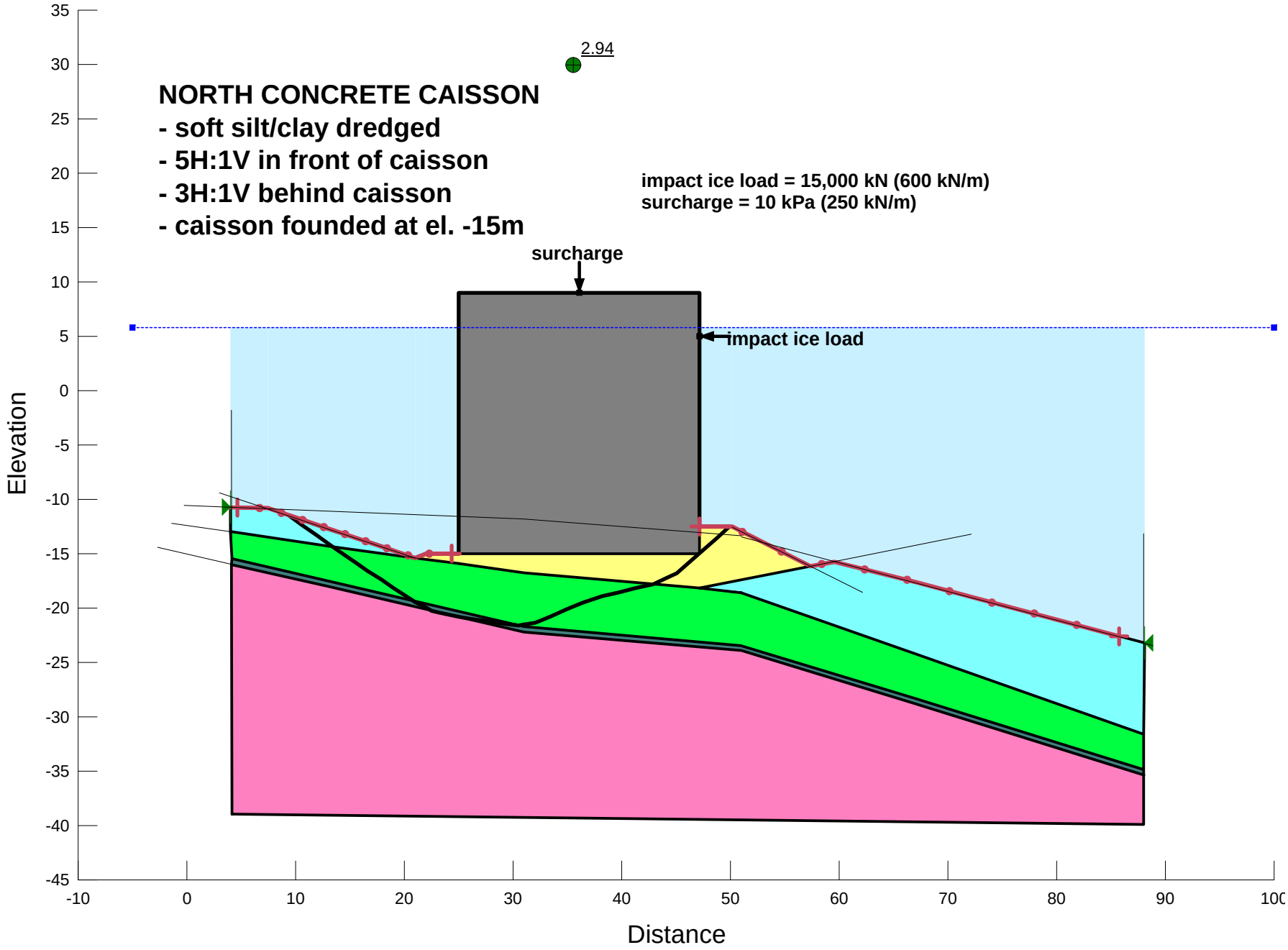
Stantec

APPENDIX D
Figures 1 to 6, Typical Wharf Sections



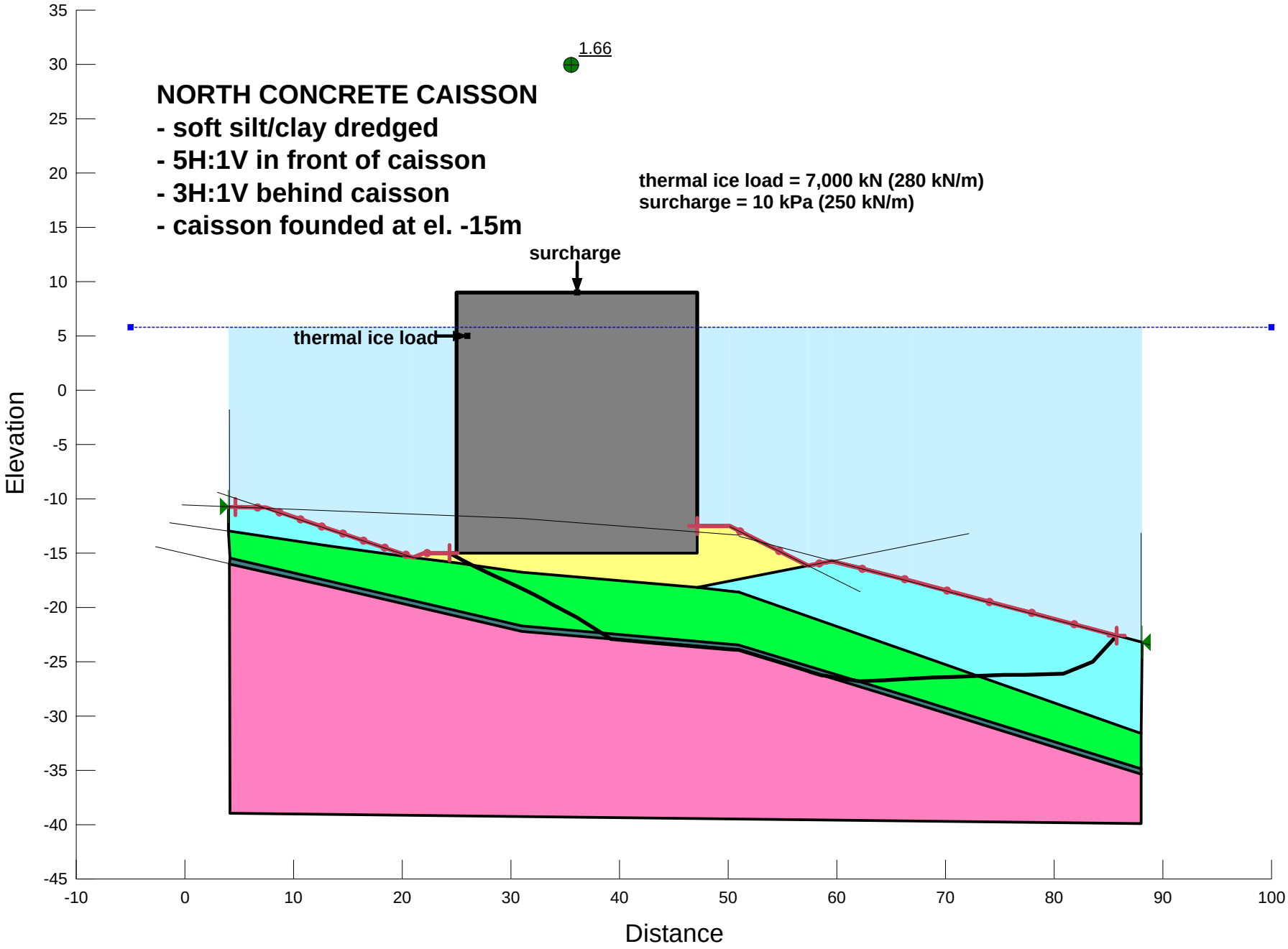
Project No. 121613564

Figure 1



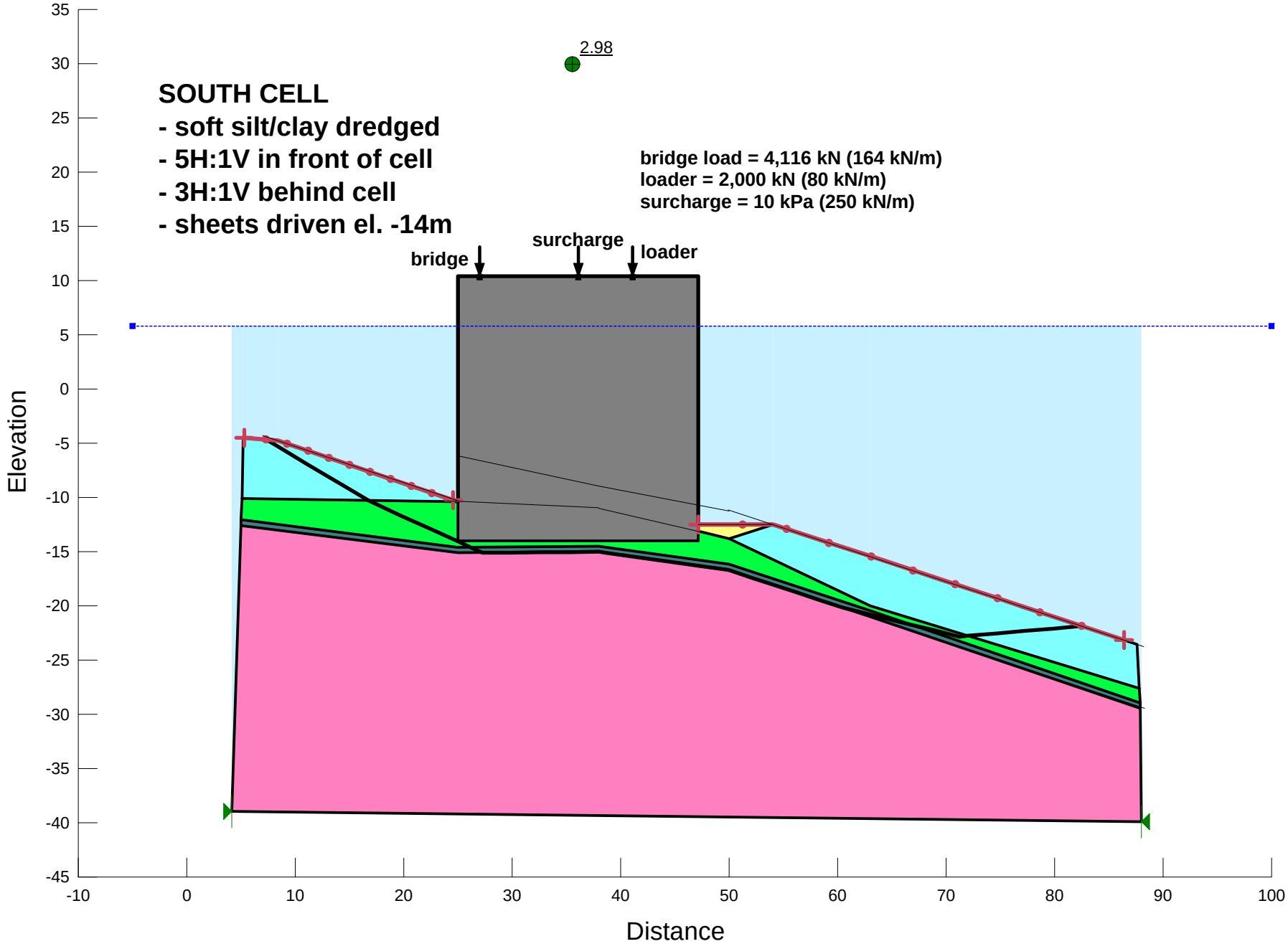
Project No. 121613564

Figure 2



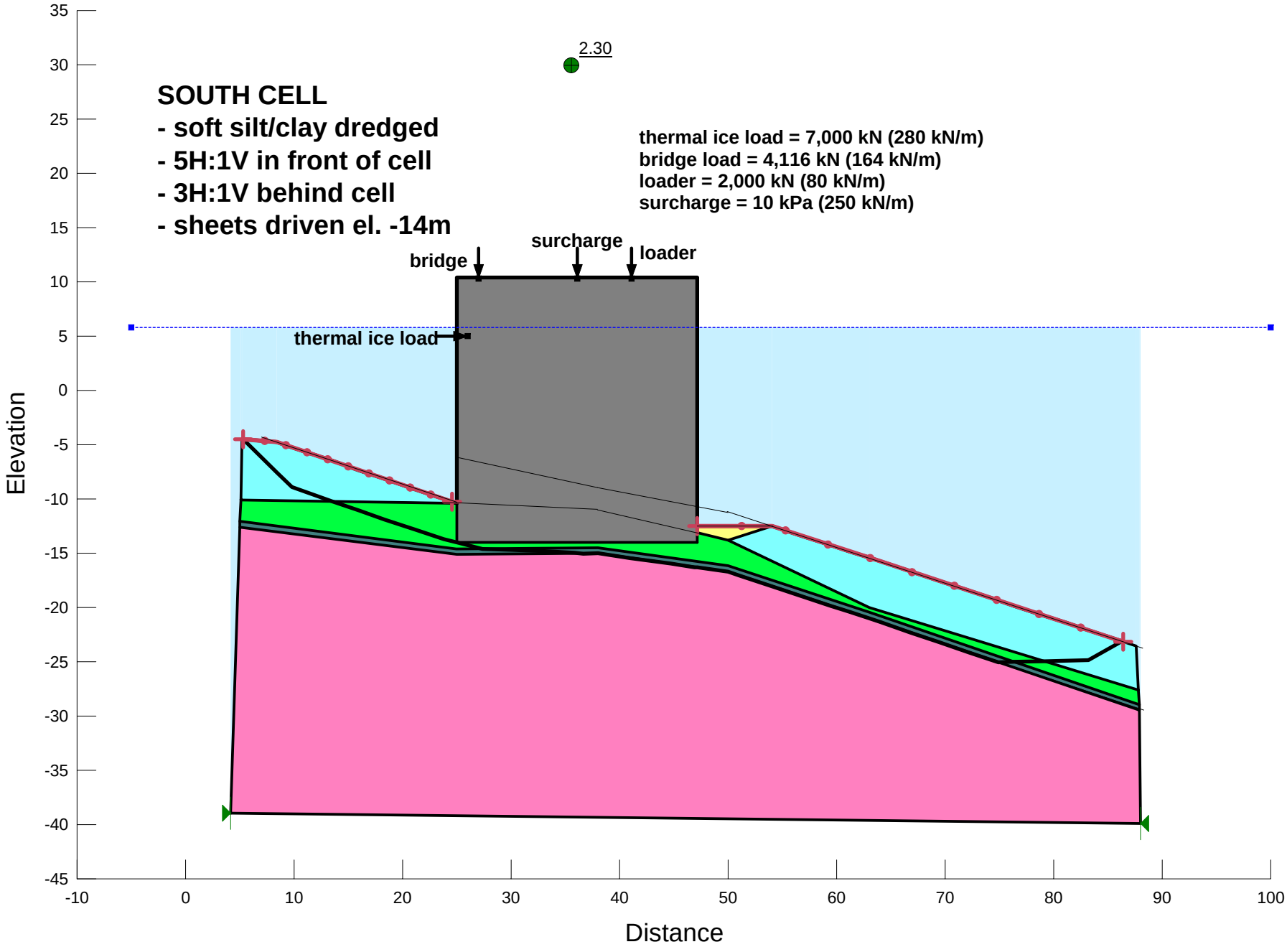
Project No. 121613564

Figure 3



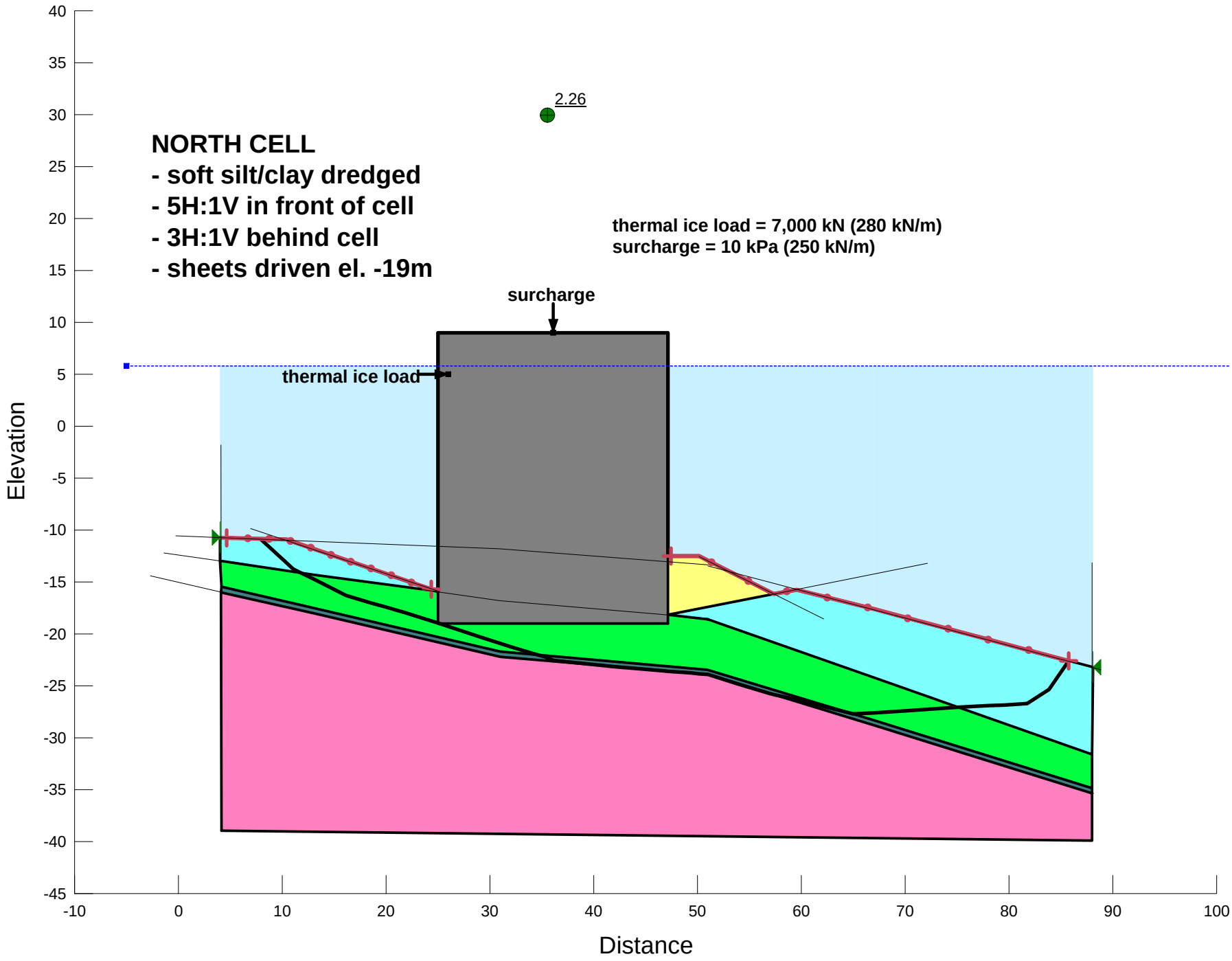
Project No. 121613564

Figure 4



Project No. 121613564

Figure 5



Project No. 121613564

Figure 6

De :	McQuinn, Dan
A :	Gail Amyot
Cc :	Natalie Gagne; Jean Corbeil; Joel Desmeules; briantaylor@accesswave.ca
Objet :	RE: questions from COFEX
Date :	7 mai 2013 14:33:09

Gail,

please find attached response to geotechnical questions by the Department of Fisheries and Oceans. Each question is preceded by a bullet and succeeded by our response. If any clarification is need please do not hesitate to contact us.

- How can we be sure of the slopes' stability? Can the clay to silty clay layer support/take up the weight of the riprap? Can you calculate the security factor of the slope (after the excavation and with the riprap)?

We have not specifically calculated the slope stability for each condition within the clay to silty clay surrounding the proposed SSP cells. However, in general the rock fill /riprap will only replace the volume of clay that will be removed. Although the weight of rock fill is assumed to be approximately 10 percent more than the clay that it replaces the rock would form a significant part of the shear plane and would therefore reinforce the slope relative to its original condition. Hence, we expect the final factor of safety against slope failure to be equivalent to or better than the pre-construction condition.

Stability calculations conducted for the riprap fill around the centre bridge pier indicate a need for revision of this detail and we have been in contact with the designers on this matter. Revisions may include reduction of the fill height or, benching of the fill to improve the slope stability or a combination of these. Other solutions could include strengthening the pile bent to reduce the need for armouring or surrounding the pier with a steel sheet pile barrier. The final solution would be submitted as an addendum to the design specifications.

- Can you calculate the global stability in pseudo static condition?

For earthquake loading, we have used a site peak ground acceleration (PGA) of 0.102g. This value was obtained from Natural Resources Canada for Deception Bay using 2%/50 years probability. For pseudostatic slope stability analysis, k_h = 0.051g and k_v = 0g were used. The recommended value of k_h is based on Hynes-Griffin and Franklin (1984) criteria which suggests that for pseudostatic analysis, 50% of the PGA is appropriate.
We have assumed that the earthquake loading does not act simultaneously with the thermal ice loading, in that they are both considered to be extraordinary loads. Our analyses for the north cell yield a factor of safety of 1.63 under earthquake loading, compared to 2.63 under dead loads alone. The Slope/W output for the global stability analysis is attached.

Since the south cell has a higher factor of safety under dead loads than the north cell, we infer that the south cell factor of safety under earthquake loading will be greater than 1.63.

Using similar assumptions, bearing capacity analysis of the South cell (the critical case under static conditions) under a pseudostatic earthquake loading gives a factor of safety against bearing capacity failure of 3.

- Is there settlement anticipated under the riprap?

We would expect consolidation settlement of the clay to silty clay where the future net pressure exceeds the existing in situ pressure. However, settlements would be within tolerable limits.

- What is the bearing capacity of the clay to silty clay layer?

We have assumed the undrained shear strength of the clay to silty clay to be 10 kPa. Based on this the unfactored bearing capacity would be 50 kPa. In some locations this is a conservative value considering that the sediment layer that failed in 2011 was estimated to be supporting in excess of 5 metres of fill, approximately equivalent to 100 kPa. However, the borehole and test pit data indicate that there is variation in the strength of the silty clay layer, although no trends or patterns could be determined. Accordingly, for analysis and design purposes we have adopted the aforementioned value of 10 kPa.

Reference

Hynes-Griffin, M.E., and Franklin, A.G. 1984. "Rationalizing the seismic coefficient method", Miscellaneous Paper GL-84-13, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS

From: Gail Amyot [mailto:gail.amyot@canadianroyalties.com]
Sent: Friday, May 03, 2013 1:45 PM
To: McQuinn, Dan
Cc: Natalie Gagné; Jean Corbeil; Joel Desmeules
Subject: questions from COFEX

Hi Dan

We recently got some other questions from DFO related to the port conception and geotecnical stability of the location.

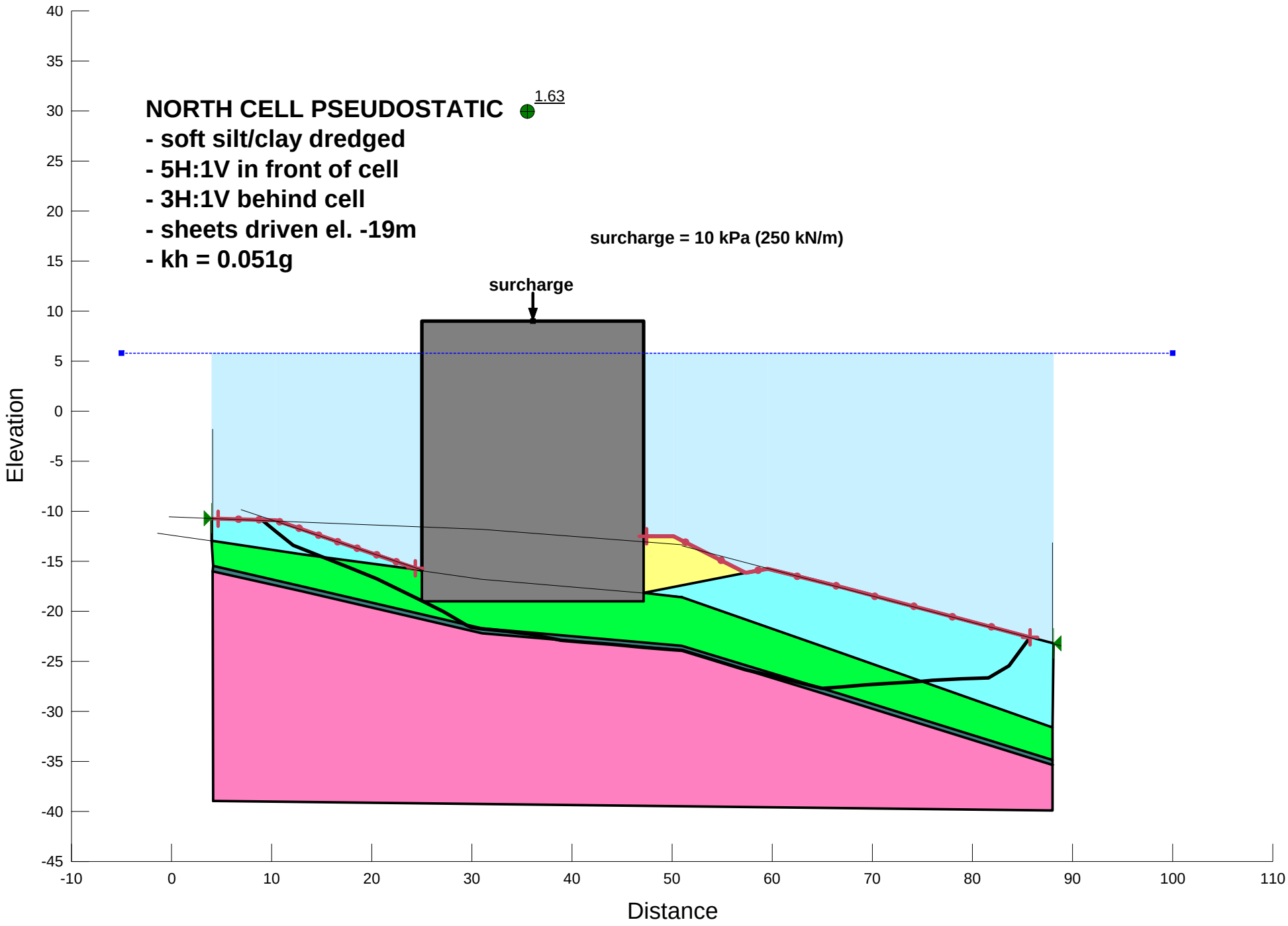
Could you please provide us answers to the followings:

- How can we be sure of the slopes' stability? Can the clay to silty clay layer support/take up the weight of the riprap? Can you calculate the security factor of the slope (after the excavation and with the riprap)
- Can you calculate the global stability in pseudo static condition?
- Is there settlement anticipated under the riprap?
- What is the bearing capacity of the clay to silty clay layer?

As you might know we are in the final stretch of permitting process; so rapid answer will be appreciated.

Best regards

Gail Amyot


NORTH CELL PSEUDOSTATIC
1.63
- soft silt/clay dredged
- 5H:1V in front of cell
- 3H:1V behind cell
- sheets driven el. -19m
- kh = 0.051g
surcharge = 10 kPa (250 kN/m)
surcharge
Elevation
Distance
40
35
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-10
0
10
20
30
40
50
60
70
80
90
100
110

Annexe 3

GENIVAR : Note technique : méthodes de dragage

NOTE TECHNIQUE

DESTINATAIRE : Madame Gail Amyot, ing. M.Sc.
EXPÉDITEUR : Mme Natalie Gagné, ing. M.Sc., GENIVAR
COPIE : M. François Hazel, biologiste
DATE : 2013-04-19
OBJET : **Projet Nunavik Nickel, Canadian Royalties Inc. (CRI)**
Étude d'impact sur l'environnement et le milieu social pour l'aménagement d'infrastructures portuaires et la gestion des sédiments à la baie Déception
Techniques de dragage
N/Réf. : 101-53046-03_100

1.0 MISE EN CONTEXTE

Dans le cadre de l'analyse de l'Étude d'impact sur l'environnement et le milieu social (EIES) pour l'aménagement d'infrastructures portuaires et la gestion de sédiments à la baie Déception, déposée en décembre 2012, les analystes du ministère des Pêches et Océans ont soulevé des commentaires relativement à la méthode de dragage préconisée ainsi qu'aux mesures proposées pour le confinement des sédiments.

La présente note technique vise à fournir les prémisses ayant guidé GENIVAR inc. (GENIVAR) dans le choix de la technique de dragage. Les sections suivantes passent en revue et comparent les différentes variantes de dragage afin de faire ressortir la solution qui semble la plus appropriée aux travaux requis à la baie Déception.

Outre les méthodes de dragage, les mesures de contrôle proposées pour le panache de dispersion des sédiments dans le cadre de l'EIES seront également présentées et commentées en termes d'efficacité dans le contexte de la baie Déception.

2.0 TECHNIQUES DE DRAGAGE

L'éventail des appareils de dragage les plus couramment utilisés se divise en trois catégories : les dragues mécaniques, les dragues hydrauliques et les dragues spécialisées (1992; Herbich, 1992; Bray, 2008).

2.1 Les dragues mécaniques

Les dragues mécaniques sont utilisées aussi bien dans les matériaux durs que meubles. Elles retirent les sédiments par l'application directe d'une force mécanique sur le fond. Il existe trois types de dragues mécaniques, soit la drague à benne preneuse, la drague à

cuillère et la drague rétrocaveuse. Le tableau 1 présente les principales caractéristiques de chaque type de drague, tandis que leurs principaux avantages et inconvénients apparaissent au tableau 2.

Drague à benne preneuse : Cette drague compte parmi les plus répandues dans le monde et est parfois considérée comme une drague environnementale (Bray, 2008). La drague à peine preneuse comporte une plateforme flottante qui peut être autopropulsée ou déplacée à l'aide de remorqueurs. Elle est montée sur une grue qui est elle-même installée sur un ponton stabilisé au moyen de béquilles ou d'un système d'ancrage. La grue peut être à câbles ou hydraulique. Le ponton peut être équipé de puits à clapets qui reçoivent les déblais de dragage, mais le plus souvent, pour leur transport, les déblais de dragage sont accumulés dans des chalands ou des barges. Les dragues à benne preneuse sont des appareils peu encombrants et relativement précis; de plus, elles offrent une grande flexibilité en eaux agitées, car elles peuvent bouger verticalement. Toutefois, ce type de drague peut causer une remise en suspension des sédiments à plusieurs étapes du dragage, soit au moment de l'impact de la benne sur le fond, de sa pénétration dans les sédiments, de la remontée du matériel et du débordement des déblais de dragage des barges ou chalands, ainsi qu'au moment de leur rejet en eau libre, le cas échéant. Selon Herbich (1992), l'utilisation de bennes preneuses étanches est souhaitable d'un point de vue environnemental, car ces outils réduisent la turbidité de 30 à 70 % comparativement aux autres bennes.

Drague à cuillère : Cette drague se compare à une pelle mécanique montée sur un ponton qui est muni de trois béquilles. Les deux béquilles avant servent à soulever le ponton au droit de sa position de dragage, tandis que la béquille arrière maintient la drague en position fixe. Elle est le plus souvent utilisée pour l'extraction de roches tendres et de dépôts sédimentaires indurés, de même que pour la récupération d'infrastructures submergées. La perte de matériaux fins est toutefois importante au moment de la remontée du godet.

Drague rétrocaveuse : Cette drague est semblable aux excavatrices utilisées sur terre sauf qu'en mer, elle est installée sur le pont renforcé d'un chaland. Le godet de la drague est fixé à un bras articulé et les sédiments sont excavés en ramenant le godet vers la drague. Les déblais de dragage peuvent être déversés dans des chalands, des camions ou directement sur la rive. Cette méthode de dragage est très précise, mais a l'inconvénient de remettre facilement en suspension la fraction fine des matériaux. Il importe de noter que le tirant d'eau des chalands à clapets utilisés durant le dragage est d'environ 2,4 m lorsqu'ils sont remplis de sédiments. En outre, il faut prévoir une profondeur d'eau additionnelle de 3,7 m pour permettre l'ouverture des clapets au moment du largage.

Tableau 1 Caractéristiques des principaux types de dragues utilisées dans le Saint-Laurent

	Dragues mécaniques			Dragues hydrauliques			Dragues écologiques	
	Drague à benne preneuse	Drague à cuillère	Drague rétrocaveuse	Drague suceuse simple	Drague suceuse à désagrégation	Drague suceuse autoporteuse	Drague à tarière horizontale (Mud Cat™)	Drague à godet-pompe (Amphibex™)
Types de matériaux à draguer	Sédiments fins, consolidés, gravier et sables	Roches brisées tendres et sédiments denses	Tous types	Boue, sable peu compact, gravier	Boue, sable, gravier, matériaux compacts	Matériaux sableux, meubles et non cohésifs	Sédiments fins	Tous types
Profondeur d'eau maximale	40 m	12 m	12 m	25 m	25 m	20 m	6,1 m	6,5 m
Précision du dragage	35 à 50 cm	35 à 50 cm	10 cm (avec les appareils récents)	10 à 20 cm	10 à 20 cm (selon la production désirée)	Verticale : 15 à 25 cm (avec appareil perfectionné, sinon 0,5 à 1 m) Horizontale : 3 à 10 m	10 à 20 cm	5 cm
Rendement	30 à 500 m³/h	30 à 200 m³/h	30 à 200 m³/h	50 à 1000 m³/h	50 à 1000 m³/h	50 à 500 m³/h	90 m³/h	100 m³/h
Remise en suspension	Moyenne	Importante	Moyenne	Faible au site de dragage	Faible au site de dragage	Importante	Importante	Moyenne
Teneur en eau des déblais de dragage	Faible	Faible	Faible	Importante	Importante	Importante	Importante	Moyenne
Transport des déblais	Chalands, camions	Chalands, camions	Chalands, camions	Conduite (pipeline)	Conduite (pipeline)	Intégré	Conduite (pipeline)	Chalands, camions, conduite

Source : Alliance Environnement (2004).

Tableau 2 Principaux avantages et inconvénients des dragues mécaniques utilisées dans le Saint-Laurent

	Avantages	Inconvénients
Général	• Faible remaniement des matériaux excavés pour une teneur élevée en solides et faible en eau. • Envergure minimale des installations nécessaires pour le transport, le traitement et le dépôt des matériaux. • Possibilité de travailler en toute sécurité près des quais et autres ouvrages fixes. • Efficace pour l'enlèvement des sédiments pollués près de la rive ou dans la plaine inondable. • Flexibilité de mise en œuvre dans des matériaux meubles ou indurés et en présence d'obstacles ou de débris. • Coûts unitaires généralement moins élevés que celui des dragues hydrauliques pour le dragage de petits volumes de sédiments. • Bonne précision de dragage en eaux peu profondes. • Rejet en eaux libres par barges générant moins de turbidité que par la conduite d'une drague hydraulique. • Transport des matériaux dragués sur de longues distances facilité.	• Taux de production relativement faible et décroissant avec la profondeur. • Taux de remise en suspension des sédiments relativement élevé dans la colonne d'eau, particulièrement durant le travail dans des matériaux fins et non cohésifs. • Efficacité faible dans les sédiments fluides ou en présence de débris. • Peut constituer un encombrement pour la navigation. • Manipulations additionnelles requises lorsque le rejet en eaux libres est impossible. • Sécurité de l'équipage (possibilité de contact direct avec les matériaux contaminés, le cas échéant).
Drague à benne preneuse	• Manœuvrabilité. • Teneur en eau des déblais semblable à celle des sédiments en place. • Dragage possible à de très grandes profondeurs d'eau.	• Mélange des couches sédimentaires. • Remise en suspension moyenne à importante, notamment dans les matériaux très fins et non cohésifs.
Drague à cuillère	• Stabilité du ponton. • Performante pour l'excavation dans le roc ou les matériaux très cohésifs.	• Opération difficile par mauvais temps. • Rendement faible. • Remise en suspension importante dans les matériaux fins et non cohésifs.
Drague rétrocaveuse	• Stabilité du ponton. • Évite de mélanger les couches sédimentaires. • Sédiments dragués maintenant leur propre densité. • Grande précision de dragage offerte.	• Opération difficile par mauvais temps. • Rendement faible. • Remise en suspension moyenne à importante notamment dans les matériaux fins et non cohésifs.

Source : Alliance Environnement (2004).

2.2 Les dragues hydrauliques

Le dragage hydraulique s'effectue au moyen d'un appareil qui désagrège les sédiments puis les aspire en suspension dans une conduite ayant un fort débit d'eau. Elles sont généralement montées sur des barges munies de pompes centrifuges qui sont actionnées par un moteur diesel ou électrique. Les pompes sont raccordées à des conduites (pipelines) de refoulement de 15 à 122 cm de diamètre, maintenues en surface par des flotteurs. Les dragues hydrauliques aspirent et refoulent les sédiments sous forme d'une boue liquide dont la teneur en eau oscille autour de 90 % (USACE, 2008). Il existe trois types principaux de dragues hydrauliques : la drague suceuse simple, la drague suceuse à désagrégation et la drague suceuse autoporteuse. Certaines caractéristiques propres à ces dragues sont présentées au tableau 1. Les principaux avantages et inconvénients des divers équipements hydrauliques sont colligés au tableau 3.

Drague suceuse simple : Cette drague fonctionne au moyen d'une pompe centrifuge et elle se déplace généralement grâce à un système de câbles d'ancrage.

Drague suceuse à désagrégation : Cette drague est munie d'un puissant appareil rotatif qui est installé à l'extrémité d'une élinde (conduite d'aspiration). L'étape de désagrégation sert à fragmenter les matériaux durs et cohésifs en débris qui sont ensuite pompés par la tête aspiratrice. Pour un rendement optimal, la capacité du bac de l'élinde et de l'appareil de désagrégation doit être entièrement utilisée, ce qui signifie que l'épaisseur minimale de la couche sédimentaire doit atteindre de 1 à 3 m (Alliance Environnement, 2004).

Drague suceuse autoporteuse : Cette machinerie diffère des deux autres types de dragues hydrauliques, car elle est plutôt installée sur des navires autopropulsés. En outre, elle transporte les déblais de dragage à son bord plutôt que de les acheminer vers le lieu de mise en dépôt via une conduite. Les déblais de dragage sont aspirés par l'élinde pour être déversés dans des puits où les solides décantent. Le surplus d'eau à faible teneur en matières en suspension (MES) est rejeté en eau libre par des déversoirs et les solides sont accumulés à bord pour être ensuite mis en dépôt dans un site aquatique autorisé. Comme ce type de drague est exploité sans aucun système d'ancrage, l'élévation de la surface draguée est souvent très irrégulière, ce qui nécessite un surcreusage pour obtenir partout la profondeur d'eau désirée.

Tableau 3 Principaux avantages et inconvénients des dragues hydrauliques utilisées dans le Saint-Laurent

	Avantages	Inconvénients
Général	• Taux de production élevé (jusqu'à plusieurs centaines de m^3 à l'heure). • Taux de remise en suspension des sédiments dans la colonne d'eau plus faible qu'avec les dragues mécaniques, à l'endroit du dragage. • Utilisation non limitée par les vitesses de courant. • Dans les sédiments pollués, minimalisation des risques pour les travailleurs et la population grâce au transport par pipeline. • Pour l'excavation de grands volumes, spécialement dans le cas de travaux de capitalisation importants, coûts unitaires généralement moins élevés que ceux des dragues mécaniques.	• Haute teneur en eau des matériaux excavés (80 % à 90 %). • Grandes surfaces nécessaires pour les dépôts des matériaux dragués et le traitement des eaux. • Impossibilité d'enlever la plupart des débris de façon hydrauliques. • Drague elle-même et présence du pipeline pouvant constituer un obstacle à la navigation. • Rejet en eaux libres par pipeline générant plus de turbidité que le rejet par barge des dragues mécaniques. • Présence de gaz dans les sédiments pouvant affecter le fonctionnement des pompes. • Transport sur de grandes distances (plus de quelques kilomètres) impossible. • Nuisance sonore parfois importante.
Drague suceuse simple	• Rendement important dans les sédiments fins et lâches.	• Possibilité de mélange des couches sédimentaires.
Drague suceuse à désagrégation	• Compatible avec une vaste gamme de matériaux. • Précision et uniformité de l'excavation.	• Possibilité de remise en suspension importante au site de dragage si la puissance de pompage n'est pas en adéquation avec le pouvoir de découpe de l'engin de désagrégation.
Drague à pompe autoporteuse	• Peu sensible à la houle et aux vagues. • Entrave à la navigation nulle. • Transport sur de longues distances facilité et aucune manipulation additionnelle lorsque le rejet en eaux libres est possible. • Utilisation maximale des compartiments grâce à la surverse.	• Type de drague limité au dragage des sables non contaminés qui peuvent être rejetés en eaux libres (généralement réservé à l'excavation de volumes importants dans le chenal de navigation du Saint-Laurent). • Profondeur de dragage limitée par le tirant d'eau du bateau et des élindes. • Nécessité de surcreusement (plusieurs passages pour obtenir une surface draguée régulière).

Source : Alliance Environnement (2004).

3.0 TECHNIQUE DE DRAGAGE PRECONISEE

Dans le contexte des travaux de dragage à baie Déception, trois (3) méthodes de dragage sont envisageables, à savoir :

- Drague mécanique à l'aide d'une drague à benne preneuse environnementale;
- Drague hydraulique de type suceuse-refouleuse à tête désintégratrice; ou
- Drague hydraulique suceuse.

À la lumière des avantages et inconvénients listés aux tableaux 2 et 3, le dragage mécanique apparait plus favorable que le dragage hydraulique. Le principal inconvénient de la méthode utilisant une benne preneuse consiste au taux de remise en suspension des sédiments relativement élevé dans la colonne d'eau, particulièrement en présence de matériaux fins et non cohésifs. Cependant, l'utilisation d'une benne preneuse environnementale limite cette problématique considérablement car cette dernière, une fois fermée, est étanche. De plus, elle empêche la remise en suspension des matériaux dragués dans la colonne d'eau lorsque la benne est remontée ou qu'elle traverse la surface de l'eau, ou encore dans le cas où la benne se balance dans les airs entre le point de dragage et son point de déversement. La mise en suspension de sédiments au point de contact de la benne avec le fond marin demeure, mais à cette profondeur, les courants sont quasi-nuls. Il est entendu que le chaland utilisé pour le transport des matériaux jusqu'à la rive doit être étanche.

La drague preneuse environnementale est adaptée pour les activités de dépôts de matériaux en milieu terrestre. Elle offre comme avantage que la teneur en eau des déblais est semblable à celle des sédiments en place. Cet avantage est significatif car il limite la quantité d'eau à gérer au site de déposition. La quantité d'eau excédentaire dépend du volume de la benne et du taux de remplissage de celle-ci. Sur la base de données compilées lors de travaux de dragage utilisant cette méthode, le volume de remplissage de la benne varie de 39 % à 70 %, donc le volume d'eau varie de 61 % à 30 %. Un autre avantage à ne pas négliger est que le dragage mécanique à l'aide d'une benne preneuse permet aux matériaux dragués de conserver leur intégrité, ce qui réduit le temps de déposition des sédiments dans le bassin conçu à cette fin et, en conséquence, facilite la gestion des eaux excédentaires : l'argile consolidée étant faiblement remaniée, le taux de MES dans les eaux surnageantes est moindre.

Le dragage hydraulique pourrait être utilisé; cependant, les grandes quantités d'eau générées par l'utilisation de cette méthode ont un impact majeur sur les installations du site de dépôt. Les valeurs rencontrées dans la littérature suggèrent de considérer un pourcentage de solides dans la boue pompée d'environ 8 % à 12 % (USACE, 2008), donc une teneur en eau de l'ordre de 90 %.

Les matériaux excavés dans le cadre des travaux à la baie Déception sont constitués principalement d'une argile consolidée, obligeant l'utilisation d'une drague suceuse à désagrégateur afin de rendre le matériau uniforme et facile à pomper. Il importe de souligner que des matériaux hétéroclites risquent d'être présents; des pierres de calibres variables peuvent également être rencontrées, ce qui nuirait grandement à l'efficacité de cette méthode. L'utilisation de cette dernière peut aussi entrainer une grande turbidité de l'eau au point de contact si le niveau de succion est inadéquat.

Il faut aussi considérer que la désintégration des matériaux dragués risque d'augmenter de façon significative le temps de décantation des matières solides une fois transférées au site de gestion des sédiments en milieu terrestre. L'augmentation de la turbidité de l'eau obligerait CRI à surdimensionner les ouvrages de sédimentation et, compte tenu de la grosseur des particules mises en suspension (de l'ordre du micron), elle risque de rendre difficile l'atteinte des critères de qualité de l'eau. CRI n'autorisera le dragage hydraulique que si l'entrepreneur démontre que la méthode hydraulique utilisée sera combinée à d'autres opérations permettant de respecter les critères de qualité de l'eau : les eaux retournées à la baie Déception devront présenter en tout temps un taux de MES inférieur à 30 mg/l.

4.0 METHODE DE CONFINEMENT

Le contrôle de la dispersion des sédiments dans le cadre de travaux de dragage peut s'effectuer selon deux (2) principes :

- Mise en place de méthode de confinement d'ingénierie :
  - Batardeau, palplanches
  - Rideaux de confinement : géomembranes, géotextiles, pneumatique (bulles)
  - Utilisation de géotubes
- Contrôle des opérations

Les méthodes de confinement d'ingénierie consistent à ériger des barrières physiques pour isoler la zone de travaux. À prime abord, la construction d'un batardeau à l'aide d'enrochement ou de palplanches est à exclure en raison des impacts majeurs sur le milieu.

Dans le contexte de la baie Déception, l'utilisation de rideaux de confinement s'avère peu efficace. En effet, un rideau de confinement est habituellement utilisé dans des lacs ou des zones marines ou portuaires protégées des vents et des conditions océanographiques (IADC/CEDA, 1999; Bray, 2008). Or, à la baie Déception, le site des travaux n'est pas abrité du vent et des vagues et, par ailleurs, des marées de plus de 5 m sont présentes. Selon Bray (2008), les conditions météorologiques et océanographiques du site peuvent limiter

l'utilisation d'une telle mesure d'atténuation. Effectivement, lorsque les conditions climatiques ne sont pas parfaites (vagues inférieures à 1 m et marée inférieure à 3 m), le taux de rétention d'un rideau de confinement est de l'ordre de 25 % à 40 % (Bray, 2008). Nonobstant la faible efficacité de la méthode, dans le contexte climatique de la baie Déception où des conditions océanographiques difficiles sont fréquentes, le déploiement d'un rideau de confinement s'avère une opération dangereuse face à la sécurité des travailleurs, car la complexité de son déploiement requiert l'équipement nécessaire et une bonne expérience de l'entrepreneur (Bray, 2008). En outre, lorsque les travaux sont effectués à des profondeurs de plus de 3 à 5 m (20 m dans le cas présent), l'utilisation de rideaux oblige la mise en place de systèmes de flottation excessifs. Ainsi, pour des raisons techniques et de sécurité, l'utilisation d'un rideau de confinement a été exclue pour contrôler la dispersion des sédiments.

L'utilisation d'un rideau de bulles est une alternative au rideau de confinement avec membrane. Cependant, cette technique est efficace uniquement lorsque les conditions sont parfaites, ce qui est rarement le cas à la baie Déception. De plus, elle nécessite l'injection d'une grande quantité d'air, et conséquemment, consomme une grande quantité d'énergie. Le bruit généré par les compresseurs peut également s'avérer une nuisance à ne pas négliger.

En raison de la faible efficacité des méthodes de confinement d'ingénierie dans le contexte de la baie Déception, il a été jugé préférable d'appliquer des mesures visant à contrôler les opérations de dragage dans le but de minimiser à la source la dispersion des sédiments. Ces mesures de contrôle sont les suivantes :

- contrôler et limiter la vitesse de remontée de la benne;
- utiliser une benne dont les mâchoires sont raisonnablement étanches;
- utiliser un chaland étanche pour le transport des matériaux dragués jusqu'à la rive;
- éviter la surverse du chaland où sont contenus les matériaux dragués;
- éviter le surdragage;
- aménager une aire de transbordement des matériaux sur la rive, assurer le respect des critères de qualité de l'eau retournée à la baie.

Ces méthodes de contrôle seront incluses au devis sur lequel les entrepreneurs seront invités à soumissionner.

5.0 CONCLUSION

CRI préconise le dragage mécanique considérant l'utilisation d'une benne preneuse environnementale (étanche). Le dragage hydraulique ne sera autorisé que s'il est démontré que la méthode suggérée par l'entrepreneur permette de respecter en tout temps les critères de qualité de l'eau.

En raison des conditions climatiques et marégraphiques, ainsi que de la nature des travaux de dragage à la baie Déception, il s'avère plus efficace de contrôler la dispersion des sédiments en imposant des méthodes de travail plutôt que d'avoir recours à des méthodes de confinement d'ingénierie.

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