

I b_cbj Ybh]cbY```i bhYfk Y[g.'5`hYfbUh]j Y FY]gYn]Y`Y'^YbgY]hg'XYf'A UggYb

9bhXYW_Yb'G]Y'j YfVcf[YbY'¾k Y`Yb'i bX'Ui h\Ybh]gW\Y ?i`hi fYb'UVgY]hg'hci f]gh]gW\Yf'DZUXY'a]h'UVYbhYi Yf`]W\Yb 5_h]j]hÀhYb']b'k Yb][Yf'VYgi W\hYb'GhÀXhYb"



GhY```X]f'j cfž'Xi 'V]gh'Ub'Y]bYa 'Cfhž'k c'X]Y'BUhi f'bcW\'i bVYfØ\fh
]ghž'X]Y'@ Zh'Zf]gW\'i bX'X]Y'A YbgW\Yb'\Yfn`]W\"'K c'X]Y
Hci f]ghYbgW\UfYb'ZY\`Yb'i bX'Xi 'XUg'; YZØ\``\Ughž'Y]b'[i h
[Y\ØhYhYg'; Y\Y]a b]g'YbhXYW_h'ni '\UVYb"'\D'X]YgYa '5fh]_Y`
bY\a Yb'k]f'X]W\'a]h'Ui Z'Y]bY'FY]gY'ni 'i b_cbj Ybh]cbY``Yb'N]Y`Ybž
X]Y'UVgY]hg'XYf'Ui g[YhfYhYbYb'DZUXY'`]Y[Yb'i bX'XUfUi Z'k UfhYbž
j cb'X]f'Yf_i bXYh'ni 'k YfXYb"'

K]f'nY][Yb'X]f'j YfghYW_hY'¾ k Y`Yb''']Xm``]gW\Y'@UbXgW\UZhYbž'X]Y
XY]b'<Yfn'\Ò\Yf'gW\`U[Yb'`UggYb'i bX'5VYbhYi Yfž'X]Y'XY]b
5XfYbU`]b'ni a 'FUgYb'Vf]b[Yb"'A UW\X]W\'VYfY]hž'i b[Yk Ò\b`]W\Y
5_h]j]hÀhYb']b'bcW\'i bVY_UbbhYb'FY[]cbYb'Ui gni dfcV]YfYb'i bX
X]Y'Ui h\Ybh]gW\Yb': UWYhhYb'`c_U`Yf'?i `hi fYb'\Ui hbU\'ni 'Yf`YVYb'''

<]Yf'[Y\h'Yg'b]W\h'bi f'i a 'XUg'JYffY]gYbž'gcbXYfb'i a 'XUg
9]bhUi W\Yb']b'bYi Y'K Y`hYb"'@Ugg'X]W\']bgd]f]YfYb'i bX'Z]bXY
\YfUi gž'k c'XY]b'bÀW\ghYg'5VYbhYi Yf'k UfhYh' 'ZYfbUV'j ca
A UggYbhci f]ga i g'i bX'X]fY_h']a '<YfnYb'i bYbhXYW_hYf'K i bXYf°</pre>

JYfVcf[YbY'ik Y`Yb.'8Ygh]bUh]cbYb'UVgY]hg XYf'hcif]gh]gWXYb'DZUXY'YbhXYW_Yb

GhY```X]f'j cfž'Xi 'ghY\gh'Ua 'I ZYf'Y]bYg'[`Ug_`UfYb'GYYgž'i a [YVYb j cb'a U'YghÀh]gWXYb'6Yf[Ybž'k À\fYbX'X]Y'GcbbY'gUbZh'\]bhYf'XYa <cf]ncbh'j YfgWXk]bXYh'''K]``_ca a Yb']a '[Y\Y]a Yb'K]b_Y``Dc`Ybg. XYa 'A Ugi f]gWXYb'@UbXž'k c'X]Y'BUhi f'bcWX'i bVYfØ\fh'i bX'X]Y 8 ÒfZYf'gc'WXUfa Ubh'g]bXž'XUgg'g]Y'k]Y'Ui g'Y]bYa 'A ÀfWXYb [YZU``Yb'gWXY]bYb'''<]Yf'[]Vh'Yg'_Y]bYb'Hfi VY``hci f]gh]gWXYf A UggYbž'gcbXYfb'Y]bY'C UgY'XYf'Fi \Y'i bX'XYf'bUhØf`]WXYb GWX Òb\Y]hž'X]Y'Ui Z'X]WX'k UfhYhž'YbhXYW_h'ni 'k YfXYb"

GdUn]YfY 'Xi fW\ 'X]Y'j Yfk]b_Y`hYb'; UggYb'j cb';] mW_cž'k c'Xi ']b XUg'U`hY'GW\`cgg'XYf'j cb'?f]Y[gZUa]`]Yb'[YdfÀ[hYb'; YgW\]W\hY Y]bhUi W\gh"'9]b'W\Ufa UbhYg'7UZ\d'Ua'<UZYb'`cW_h'a]h gY`Vgh[Ya UW\hYa'?i W\Yb'i bX'Ufca Uh]gW\Ya'?UZZYY"'8]Y 9]b\Y]a]gW\Yb'g]bX'\Yfn`]W\'i bX'`UXYb'X]W\'Y]bž']\fY'; YgW\]W\hYb ni '\OfYb'i bX']\fY'HfUX]h]cbYb'ni 'hY]`Yb"'BUW\XYa'Xi 'X]Y'GhUXh Yf_i bXYh'\Ughž'V]YhYh'g]W\'Y]b'6cchgUi gZi ['Ui Z'XYb'GYYb'Ubž'k c Xi ']b'XYf'Gh]``Y'XYf'BUhi f'X]Y'GYY`Y'VUi a Y`b'`UggYb'_Ubbgh"

9]b k Y]hYfYg'j YfghY W_hYg' \Rightarrow k Y``Z]b XYh'g]W\"]b'; Ycf[]Yb ž'k c'XUg W\"Ufa UbhY'8cfZ'G][\bU[\]ž'Ui W\"VY_Ubbh'U`g'X]Y'GhUXh'XYf'@]YVYž]b'XYb' < Ø[Y`b'XYf'? UW\Yh]YbfY[]cb'h\fcbh''A]h'gY]bYb'Vi bhYb < Åi gYfb'i bX'gW\a U`Yb'GhfU\"Yb'Yf]bbYfh'Yg'Ub'Y]b'`YVYbX][Yg; Ya Â`XY''' <]Yf'_Ubbgh'Xi 'a]h'XYb'9]b\Y]a]gW\Yb'Ui Z'XYa 'A Uf_h Zf]gW\Yg'C Vghž'Y]b\Y]a]gW\Y'K Y]bY'i bX'hfUX]h]cbY``Y'GdYn]U']h\AhYb[Yb]Y\"Yb'''9]b'`YV\UZhYg'; Ygdf\AW\"a]h'Y]bYa'`c_U`Yb'K]bnYf \OZZbYh'X]f'X]Y'HØfYb'ni '\U\f\i bXYfhYU'hYb'HfUX]h]cbYb'XYf K Y]b\YfghY``i b[zX]Y']b'X]YgYf'FY[]cb'j Yfk i fnY`h'g]bX''

8 Yb 'NUi VYf'X]YgYf'j YfVcf[YbYb '8 Ygh]bUh]cbYb '_Ubbgh'Xi gdØfYbž'k Ybb 'Xi 'UVgY]hg'XYf'Ui g[YhfYhYbYb 'DZUXY'k UbXYfgh"

6Ygi W.Y. XUg'_`Y]bY '8 cfZ'5 mgÅb']b'7\]`Yži a 'X]Y'UhYa VYfUi VYbXY B Uhi fdUhU[cb]Yb'ni 'Yf`YVYb"'<]Yfž'k Y]h'k Y['j ca A UggYbhci f]ga i gž'Yfk UfhYb'X]W. 'fUi gW.YbXY'K UggYfZÀ``Yž i bVYfØ\fhY'K À`XYf'i bX'X]Y'a U'YghÀh]gW.Yb'; 'YhgW.Yf'XYg B Uh]cbU`dUf_g'@U[i bU'GUb'F UZUY`"'I bhYfbY\a Y'Y]bY'[YZØ\fhY Hci fž'i a 'X]Y'ZUgn]b]YfYbXY': Ui bU'ni 'YbhXYW_Yb' 'j cb'Di a Ug'V]g \]b'ni 'XYb'Uba i h][Yb'5`VUhfcqqYbž'X]Y'ØVYf'XYb'<]a a Y``[`Y]hYb"

8]YgY'FY]gYn]Y`Y'YfnÀ\`Yb']\fY'Y][YbYb'; YgW\]W\hYbž'i bX'XUg
9]bhUi W\Yb']b'X]YgY'j YfVcf[YbYb'\dagger'k Y`Yb']gh'Y]b'5VYbhYi Yf'ZØf
g]W\"'G]Y'[YVYb'X]f'X]Y'A Ò[`]W_Y]hž'X]Y'YW\hYb'; Yg]W\hYf'XYf
@\AbXYf'_YbbYbni `YfbYb'i bX'9f]bbYfi b[Yb'ni 'gW\UZZYbž'X]Y'k Y]h
ØVYf'XUg'; Yk Ò\b`]W\Y'\]bUi g[Y\Yb"DUW_Y'XY]bYb'Fi W_gUW_ž
gW\bUdd'X]f'XY]bY'?Ua YfU'i bX'a UW\Y'X]W\'VYfY]h'ZØf'Y]b
i bj Yf[Ygg`]W\Yg'5VYbhYi Yf'UVgY]hg'XYf'j YfhfUi hYb'DZUXY"

$5VYbhYiYfZØf9bhXYW_Yf.Ib[YkÒ\b`]WXY$ $5_h]j]hÀhYb]bibYbhXYW_hYbFY[]cbYb$

GhY``X]f'j cfžXi 'ghY\gh'Ua 'I ZYf'Y]bYg'[`]hnYfbXYb'GYYg']b'XYb i bVYfØ\fhYb'K À`XYfb'j cb'9gh`UbX"'5VgY]hg'XYf'ØV`]WXYb Hci f]ghYbfci hYb'Yfk UfhYh'X]WX'Y]b'i bj Yf[Ygg`]WXYg'9f`YVb]g. ?U'U_ZU\fYb'a]h'Y]bYa '`c_U`Yb'; i]XYž'XYf'X]Y'; Y\Y]a b]ggY'XYg K UggYfg'i bX'X]Y'A mh\Yb'XYf'i a `]Y[YbXYb'K À`XYf'_Ybbh"'8Ug gUbZhY'D`ÀhgWXYfb'XY]bYg'DUXXY`g'\YVh'X]Y'Gh]``Yž'k À\fYbX'XYf A cf[YbbYVY```Ub[gUa 'ØVYf'XYa 'K UggYf'Ui ZghY][h"'8i 'gdØfgh'X]Y Zf]gWXY'@ Zh'i bX'X]Y'JYfV]bXi b['ni f'BUhi f' '\]Yf'[]Vh'Yg'_Y]bYb GhfYggž'gcbXYfb'bi f'XUg': `]Y»Yb'XYg'K UggYfg'i bX'XUg'FUi gWXYb XYf'6Ài a Y"

#ba]hhYb XYf a UYghAh]gWXYb @UbXgWX UZhYb j cb; Ycf[]Yb
Yfk UfhYh X]WX Y]bY _i `]bUf]gWXY '9bhXYW_i b[gfY]gY ž X]Y XY]b
; YgWXa UW_gYf`YVb]g bYi XYZ]b]YfYb k]fX" I bhYfb]a a Y]bY
K UbXYfi b['Xi fWX X]Y k i bXYfgWX ObY FY[]cb ? UWXYh]Yb" <]Yf
_Ubbgh Xi 'b]WXh bi f X]Y gdY_hU_i `AfYb K Y]bVYf[Y Yf_i bXYb ž
gcbXYfb 'Ui WX 'Ub Y]bYa 'hfUX]h]cbY``Yb : Ua]`]YbYggYb 'hY]`bY\a Yb"
@YfbY X]Y '?i bgh XYg _\ UWX Udi f] 'VUW_Yb ž k A\ fYbX 'Xi ']b 'X]Y
\Yfn`]WXY; UghZfYi bXgWX UZh XYf '9]b\Y]a]gWXYb 'Y]bhUi WX gh" 8]Y</pre>

?ca V]bUh]cb'Ui g'Zf]gWXYbž'fY[]cbU`Yb'Ni hUhYb'i bX'Y]bYa'; `Ug__UWXYh]gWXYf'K Y]b'k]fX'X]WX']b'Y]bY'UbXYfY'K Y`h'YbhZØ\fYb"

DYfi ž'YbgY]hg'XYf'VY_UbbhYb' D_U!DZUXYž'[]Vh'Yg'X]Y
UV[Y`Y[YbYb'K Y]hYb'XYf'7cfX]``YfU'6`UbWU'ni 'YbhXYW_Yb'''<]Yf
V]YhYh'g]W\X]Y'; Y`Y[Yb\Y]h'ZØf'Y]b'i bj Yf[Ygg`]W\Yg'HfY__]b[!
5VYbhYi Yf'Xi fW\XX]Y'UhYa VYfUi VYbXY'6Yf[`UbXgW\UZh''8]Y
[`]hnYfbXYb'; `YhgW\YfgYYbž'i a [YVYb'j cb'gW\bYYVYXYW_hYb
;]dZY`bž'g]bX'k]Y'Ui g'Y]bYa'; Ya À`XY'Ybhgdfi b[Yb''B]W\h'bi f'X]Y
BUhi f'k]fX'X]W\'j YfnUi VYfb/X]Y', VYfbUW\hi b[Yb']b
hfUX]h]cbY``Yb'6Yf[\ØhhYbž'k c'Xi'i bhYf'XYa 'GhYfbYb\]a a Y`
XY]bYb'GW\`UZd`Uhn'Ui ZgW\`À[ghĕ'a UW\Yb'X]YgY'9fZU\fi b[
VYgcbXYfg'a U[]gW\"

5VYf'Ui W.]b'5g]Yb'[]Vh'Yg'5VYbhYi Yf'UVgY]hg'XYf'Ui g[YhfYhYbYbDZUXY"'+b'XYf'UV[Y'Y[YbYb'Dfcj]bn'H\U_\Y_']b'@Ucg'_Ubbgh'Xi a]h'XYa'A chcffUX'Xi fW. ii bVYfØ\fhY'8gW.ii b[Y`ghfU» Yb'ZU\fYbžX]Y'ZYfbUV'XYf'hci f]gh]gW.Yb'<chgdchg'`]Y[Yb"'I bhYfk Y[gYbhXYW_gh'Xi'K UggYfZÀ'`Yž'_`Y]bY'8ÔfZYf'i bX'X]Y'\Yfn`]W.Y'; UghZfYi bXgW.UZh'XYf'@cWU`g"'8i'k]fgh'b]W.h'bi f']b'X]Y
VYY]bXfi W_YbXY'BUhi f'Y]bhUi W.Ybž'gcbXYfb'Ui W.X]Y'AÔ[`]W_Y]h\UVYbž'hfUX]h]cbY``Y'<UbXk Yf_g_i bgh'\Ui hbU\'ni 'Yf`YVYb' 'Yhk UVY]'XYf'<YfghY``i b['j cb'GY]XY'cXYf'XYa' HÒdZYfb']b'Y]bYa'Y]bYb'8cfZ'

8]YgY'j YfghYW_hYb'FY]gYn]Y`Y'V]YhYb'b]W\h'bi f'Ui » Yf[Yk Ò\b`]W\Y 5_h]j]hÀhYbž'gcbXYfb'Ui W\'X]Y'7\UbWYž'; YgW\]W\hYb'ni 'gUa a Y`b 'j cb'XYf'i bYbhXYW_hYb'BUhi f'V]g'\]b'ni 'XYb'\Yfn`]W\Yb 6Y[Y[bi b[Yb'a]h'9]b\Y]a]gW\Yb"'9g'g]bX'X]YgY'9f`YVb]ggYž'X]Y Y]bY'FY]gY'b]W\h'bi f'i bj Yf[Ygg`]W\ž'gcbXYfb'Ui W\'ni h]YZgh VYfY]W\YfbX'a UW\Yb"

@c_U`Y ?i `hi fYb \ Ui hb U\ . 5i h\ Yb h]gW\ Y 9fZU\ fi b[Yb]b k Yb][Yf VYgi W\ hYb GhÀ X hYb

GhY``Yb'G]Y'g]W\'jcfž'G]Y'gW\`YbXYfb'XifW\'X]Y'Yb[Yb'; UggYb'jcbGjUbYh]ž'Y]bYa'UV[Y`Y[YbYb'HU`']a'?Ui_Ugigž'kc'X]Y'NY]hgh]``nighY\Yb'gW\Y]bh"8]YgY'FY[]cb']b'; Ycf[]Yb'V]YhYh'b]W\h'bif

9]b 6Ygi W. i]b Y]bYa XYf _ Y]bYb ž ZUa]`]Åf [YZØ\fhYb F YghUi fUbhgž k c XYf 8i Zh j c b Zf]gW\ni VYfY]hYhYa ?\UW\Udi f] Y]bYa hmd]gW\Yb ? ÀgYVfch i]b XYf @ Zh \ Àb[hž]gh Y]b UVgc i hYg A i gg 8]Y; UghZfYi b XgW\UZh XYf 9]b\Y]a]gW\Yb i]gh ØVYfk À`h][Yb X " C Zh k]fX a Ub Y]b[Y`UXYb ž a]h Ua H]gW\D`Uhn ni bY\a Yb ž i b X k À\fYb X g]Y \ b Yb j cb i]\fYb 6f Ài W\Yb Yfn À\`Yb ž _ ObbYb G]Y XUg _ Ogh`]W\Y; Yf]W\h[Yb]Y\ Yb "GY]Yb G]Y j cf VYfY]hYhž \ fY 9ggYbgdcfh]cbYb [fc \ nØ[][bUW\ ni Zcf XYfb \ d b G] UbYh] a Yf_Yb G]Y gW\bY``ž XUgg X]Y 5V[YgW\]YXYb\Y]h Ui W\ Y]bYb FY]W\ hi a Ub HfUX]h]cbYb VYk U\fh`\Uhž X]Y i]b XYf gW\bY```YV][Yb a c XYfbYb K Y`h c Zh j Yf cfYb[Y\Yb"

9]b k Y]hYfYf; Y\Y]a h]dd]gh X]Y GhUXh A UhYfU]b *\underline \underline \un

±0.5g]Yb.[]Vh.Yg.YVYbgc.j YfVcf[YbY.GW.ÀhnYž.X]Y.XUfUi Z.k UfhYbž YbhXYW_h.ni k YfXYb".8Ug._Y]bY.8cfZ.≯J]gU.a Yfž.cZh.U.g.; c.XYbY GhUXh VYnY]W.bYhž.]Y[h.]ba]hhYb.XYf.K ØghY.H\Uf".8]Y.[c.XYbY

 $GUbXghY]bUfWX]hY_hi f'XYf'; YVÀi XY ghfU\`h'Y]bY a U[]gWXY 5 ha cgd\AfY 'Ui gž VYgcbXYfg'VY]'8 Åa a Yfi b[ž k Ybb'X]Y 'GcbbY XYb'GUbX']b'`Yi WXhYbXY': UfVYb'hUi WXh''J YfdUggYb'G]Y'b]WXhX]Y ; Y`Y[Yb\Y]hž'Ub'Y]bYa 'hfUX]h]cbY``Yb': Ygh'cXYf'Y]bYf'< cWXnY]h hY]`ni bY\a Ybž'k c'G]Y']b'X]Y'`YVYbX][Y'Aig]_'i bX'XYb'HUbn Y]bhUi WXYb'_ObbYbž'X]Y'XUg'< Yfn'XYf'`c_U`Yb'?i `hi f'j Yf_OfdYfb'' @UggYb'G]Y'g]WX'a]hfY]» Yb'j cb'XYb'?`Ab[Yb'XYf'FU'Ugh\Ub]!Aig]_ i bX'YfZU\fYb'G]Y'a Y\f'ØVYf'X]Y'6YXYi hi b[''YXYf'BchY'' cZh'k]fX XUg'Xi fWX'Y]bYb'Ybh\i g]Ugh]gWXYb'9]b\Y]a]gWXYb'Yf_`Afhž'XYf gY]bY'@Y]XYbgWXUZh'ZØf'X]Y'?i `hi f'a]h'\Left\bYb'hY]`h'' }$

GhY``X]f'j cfž'Xi 'ghY\gh'Ui Z'Y]bYa 'j YfghYW_hYb'5i gg]Wk hgdi b_hž
i a [YVYb'j cb'UhYa VYfUi VYbXYb'@UbXgWk UZhYbž'k Y]h'k Y['j ca
Hfi VY``XYf'A UggYb"'8]Y'gUbZhY'6f]gY'hfÀ[h'XYb'8i Zh'j cb
i bVYfØ\fhYf'BUhi f'i bX'Ui h\Ybh]gWkYb'?Ògh`]Wk_Y]hYb'ni 'X]f"'<]Yfž
Ub'C fhYbž'X]Y'bcWk'b]Wk h']b'FY]gYZØ\fYfb'j YfYk][h'g]bXž'k UfhYb
; YgWk]Wk hYb'Ui Z'X]Wk''; YgWk]Wk hYb'j cb'A YbgWkYb'i bX'?i `hi fYbž
X]Y'XY]bYb'<cf]ncbh'Yfk Y]hYfb'k YfXYb"'K Ufi a 'g]Wk'a]h'XYa
; Yk Ò\b`]WkYb'ni Zf]YXYb'[YVYbž'k Ybb'XUg'6YgcbXYfY'bi f'Y]bYb
GWkf]hh'k Y]hYf'YbhZYfbh']gh3

8]Y'j YfVcf[YbYb'¾k Y`Ybž'X]Y'k]f'X]f'dfÀgYbh]Yfh'\UVYbž'g]bX
a Y\f'U`g'bi f'FY]gYn]Y`Y"'G]Y'g]bX'9]b`UXi b[Ybž'bYi Y
DYfgdY_h]j Yb'ni 'YbhXYW_Yb'i bX'5VYbhYi Yf'ni 'Yf`YVYbž'X]Y'g]W\
Ua 'Di `g'XYf'i bYbhXYW_hYb'K Y`h'UVgd]Y`Yb"'K U[Y'Ygž'XUg
; Yk c\bhY'\]bhYf'X]f'ni '`UggYb'i bX']b'XUg'l bVY_UbbhY

Y]bni hUi W\Yb"'@Ugg'X]Y'9]b\Y]a]gW\Yb'ni 'XY]bYb': \emptyset \fYfb k YfXYbž'k À\fYbX'Xi 'Y]b'Gh \emptyset W_']\fYf'K Y`h']b'XY]bYa '<YfnYb'a]h bUW\'<Ui gY'b]a a gh"'

DUW_`XY]bY`?cZZYfž`gW\U`hY`XY]bYb`9bhXYW_Yf[Y]gh`Y]b`i bX`a UW\YX]W\`VYfY]h`ZØf`i bj Yf[Ygg`]W\Y`9f`YVb]ggY"`8Y]bY`bÀW\ghY`FY]gY_\ObbhY`X]Y`k Yfhj c``ghY`XY]bYf'; YgW\]W\hY`gY]b```i bX`g]Y`k UfhYh bi f`XUfUi Zž'j cb`X]f`YbhXYW_h`ni `k YfXYb"`G]bX`k]f`VYfY]h3

8 YhU]`q

6Ygi WXYb G]Y i bg Ui Z Y]bY!fY]gY "XY